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MEMORANDA
OF THE
ORIGIN, PLAN, AND RESULTS
OF THE
FIELD AND OTHER EXPERIMENTS,

CONDUCTED

On the Farm and in the Laboratory

OF

SIR JOHN BENNET LAWES, BART., D.C.L., LL.D., Sc.D., F.R.S.,

AT

ROTHAMSTED, HERTS.

Being a Report to the Lawes Agricultural Trust Committee,

By SIR J. HENRY GILBERT, F.R.S.

ISSUED BY THE COMMITTEE.

FIFTY-FIFTH YEAR OF THE EXPERIMENTS.

1898.

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ORIGIN, SCOPE, AND PLAN,
OF THE
ROTHAMSTED EXPERIMENTS.⁽¹⁾

MR. (NOW SIR) JOHN BENNET LAWES was the founder of the Rothamsted Experimental Station. He commenced experiments with different manuring substances, first with plants in pots, and afterwards in the field, soon after entering into possession of his hereditary property at Rothamsted² in 1834. The researches of De Saussure on vegetation were the chief subjects of his study to this end. Of all the experiments so made, those in which the neutral phosphate of lime, in bones, bone-ash, and apatite, was rendered soluble by means of sulphuric acid, and the mixture applied for root-crops, gave the most striking results. The results obtained on a small scale in 1837, 1838, and 1839, were such as to lead to more extensive trials in the field in 1840 and 1841, and subsequently.

In 1843, more systematic field experiments were commenced; and a barn, which had previously been partially applied to laboratory purposes, became almost exclusively devoted to agricultural investigations. The foundation of the Rothamsted Experimental Station may be said to date from that time (1843).

The Rothamsted station has from the commencement been entirely disconnected from any external organization, and has been maintained entirely at the cost of Sir John Lawes. It had in previous years been stated, that he had further set apart a sum of £100,000, the Laboratory, and certain areas of land, for the continuance of the investigations after his death. In February 1889, Trustees were appointed, and the necessary Trust Deed was executed; and, in accordance with the provisions of the Deed, a Committee of Management was soon afterwards appointed, and entered upon its duties.

⁽¹⁾ The statement of the origin, scope, and plan, of the Rothamsted Investigations, was originally drawn up in answer to a circular letter issued by a Committee appointed to arrange for the commemoration of the twenty-fifth anniversary of the establishment of the First Experimental Station in Germany (Möckern), which was held in Leipzig in September 1877. The precise form of the statement depended on the order and form of the questions to which it was an answer. It was published in German, almost in full, with the series of reports of other Experimental Stations, which was issued at the time of the Jubilee Meeting. (Die landwirthschaftlichen Versuchs-Stationen. Band xxii. 1877.) To the general statement, which is annually given in the form in which it was originally drawn up, but which is each year corrected up to date, are appended lists of the titles of all the papers already published, with full reference to the Journals in which they appeared.

⁽²⁾ Rothamsted is in Hertfordshire, twenty-five miles from London, on the Midland Railway; Station, Harpenden. Postal address—Rothamsted, St. Albans. Telegraphic address—Harpenden.

N.B.—It is requested that those wishing to inspect the experiments will give notice, either by letter or telegram, to Sir John B. Lawes, Bart., or to Sir J. Henry Gilbert, as to the time of their intended visit.

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The Earl of CAWDOR.	
And Sir J. B. LAWES himself.	

From June 1843, up to the present time, Dr. (now Sir) J. Henry Gilbert has been associated with Sir John Bennet Lawes in the conduct of the experiments, and has had the direction of the laboratory.

In 1854-5 a new laboratory was built, by public subscription of agriculturists, and was presented to Sir John Lawes in July 1855, from which date the old barn-laboratory was abandoned, and the new one has been occupied.

The number of assistants and other helps has increased from time to time. At first only one laboratory man was employed; but very soon a chemical assistant was necessary, and next a computer and record-keeper.

For many years the staff has consisted of—

One or two, and sometimes three, chemists.

Two or three general assistants. One of these is usually employed in routine chemical work, but sometimes in more general work. The chief occupation of the general assistants is to superintend the field experiments—that is, the making of the manures, the measurement of the plots, the application of the manures, and the harvesting of the crops; also, the taking of samples, the preparation of them for preservation or analysis, and the determinations of dry matter, ash, &c. These assistants also keep the meteorological records, and superintend any experiments made with animals.

A botanical assistant has also occasionally been employed, with from three to six boys under him; and with him has been associated one of the permanent general assistants, who at other times undertakes the botanical work.

Two or three (and sometimes four) computers and record-keepers have been occupied in calculating and tabulating field, feeding, and laboratory results, copying, &c.

A laboratory man, and other helps, are also employed.

Besides the permanent laboratory staff, chemical assistance has frequently been engaged in London, or elsewhere. In this way, Mr. R. Richter, now of Charlottenburg (Berlin), but who was for some years in the Rothamsted Laboratory, has executed much analytical work sent from Rothamsted. He has, in fact, here and at Charlottenburg, made more than 800 complete analyses of the ashes of various products, animal and vegetable, of known history.

The field experiments, and occasionally feeding experiments, also employ a considerable but a very variable number of agricultural labourers.

There is now a collection of more than 45,000 bottles of samples of experimentally-grown vegetable produce, of animal products, of ashes, or of soils, besides some thousands of samples not in bottles; and, the Laboratory having become very inconveniently full, a new detached building—a "Sample House"—was erected in the autumn of 1888, comprising two large rooms for the storing of specimens, and for some processes of preparation, and also a drying room. The Laboratory, where a very large number of specimens, and the records, will still be kept, is thus relieved of the heavier, the more bulky, and the more combustible, of its former contents, and also of the risk of fire from stove-drying.

Nothing has been done at Rothamsted in the way of manure-feeding-stuff- or seed-control.

The investigations may be classed under two heads :—

I.—FIELD EXPERIMENTS, EXPERIMENTS ON VEGETATION, ETC.

The general scope and plan of the field experiments has been :—

To grow some of the most important crops of rotation, each separately, year after year, for many years in succession on the same land, without manure, with farmyard-manure, and with a great variety of chemical manures; the same description of manure being, as a rule, applied year after year on the same plot. Experiments on an actual course of rotation, without manure, and with different manures, have also been made. In this way field experiments have been conducted for the periods, and over the areas, indicated in the following Table :—

Crops.	Duration.		Plots.
	Years.	Acres.	
Wheat (various manures)	55	11	34 (or 37)
Wheat, alternated with Fallow	47	1	2
Wheat (varieties)	15	4-8	about 20
Barley (various manures)	47	4½	29
Oats (various manures)	10 (1)	0¾	6
Beans (various manures)	32 (2)	1½	10
Beans (various manures)	27 (3)	1	5
Beans, alternated with Wheat	28 (4)	1	10
Clover (various manures)	29 (5)	3	18
Various Leguminous Plants	21	3	18
Turnips (various manures)	28 (6)	8	40
Sugar Beet (various manures)	5	8	41
Mangel-Wurzel (various manures)	23	8	41
Total Root Crops	56		
Potatoes (various manures)	23	2	10
Rotation (various manures)	51	3	12
Permanent Grass (various manures)	43	7	22

(1) Including 1 year Fallow.
 (2) Including 1 year Wheat, and 5 years Fallow.
 (3) Including 4 years Fallow. (4) Including 2 years Fallow.
 (5) Clover, 12 times sown (first in 1848), 8 yielding crops, but 4 of these very small, 1 year Wheat, 5 years Barley, 12 years Fallow.
 (6) Including Barley without Manure 3 years (11th, 12th, and 13th seasons).

Comparative experiments with different manures have also been made on other descriptions of soil, in other localities.

Samples of all the experimental crops are taken, and brought to the laboratory. Weighed portions of each are partially dried, and preserved for future reference or analysis. Duplicate weighed portions of each are dried at 100° C., the dry matter is determined, and it is then burnt to ash on platinum sheets, in cast-iron muffles. The quantities of ash are determined and recorded, and the ashes themselves are preserved for reference, or analysis.

In a large proportion of the samples the nitrogen is determined; and in some the amount existing as albuminoids, amides, and nitric acid.

In selected cases, illustrating the influence of season, manures, exhaustion, &c., complete ash-analyses have been made, numbering in all about 800.

Also in selected cases, illustrating the influence of season and manuring, quantities of the experimentally-grown Wheat grain have been sent to the mill, and the proportion and composition of the different mill-products determined.

In the Sugar Beet, Mangel-Wurzel, and Potatoes, the sugar has in many cases been determined by polariscope, and frequently by copper also.

In the case of the experiments on the Mixed Herbage of Permanent Grass-land, besides the samples taken for the determination of the chemical composition (dry matter, ash, nitrogen,

woody fibre, fatty matter, and composition of ash), carefully averaged samples have frequently been taken for the determination of the botanical composition. In this way, on four occasions, at intervals of five years—viz., in 1862, 1867, 1872, and 1877—a sample of the produce of each plot was taken, and submitted to careful botanical separation, and the percentage, by weight, of each species in the mixed herbage determined. Partial separations, in the case of samples from selected plots (frequently of both first and second crops), have also been made in many other years.

INVESTIGATION OF SOILS.

Samples of the soils of most of the experimental plots have been taken from time to time, generally to the depth of 9, 18, and 27 inches, sometimes to twice, and sometimes, for special purposes, to even four times this depth; samples being taken at two, or sometimes even at eight places, on the same plot. In this way more than 4200 individual samples have been taken; but sometimes those of corresponding depth from the different places on the same plot, have been at once mixed, so that the number for analysis has thus been reduced by about two-fifths. The individual or mixed samples are submitted to partial mechanical separation; generally some further mixtures are then made; and weighed portions (frequently several), of the individual or mixed sifted soils, are carefully preserved for analysis. In a large number of samples the loss on drying at different temperatures, and at ignition, has been determined. In most the nitrogen has been determined, in many by the soda-lime method, but in recent years the Kjeldahl method has also been used. In many the carbon, and in many the nitrogen as nitric acid, and the chlorine, have been determined. Some experiments have also been made on the comparative absorptive capacity (for water and ammonia) of the different soils and subsoils. The systematic investigation of the amount, and the condition, of the nitrogen, and of some of the more important mineral constituents, of the soils of the different plots, and from different depths, has been undertaken, and is from time to time recurred to.

RAINFALL AND DRAINAGE.

Almost from the commencement of the field experiments the rainfall has been measured, for more than forty-five years in a gauge of one-thousandth of an acre area, as well as in an ordinary small funnel-gauge of 5 inches diameter. An 8-inch "Board of Trade" copper gauge has also been in use since January 1, 1881. The nitrogen, as ammonia and as nitric acid, has periodically, and for some years past monthly, been determined in the rain waters. The chlorine has been determined in a considerable series of samples; and sometimes the sulphuric acid also.

Three "drain-gauges," also each of one-thousandth of an acre area, for the determination of the quantity and composition of the water percolating respectively through 20 inches, 40 inches, and 60 inches depth of soil (with its subsoil in natural state of consolidation) were constructed in 1870. A more numerous series of smaller "drain-gauges," arranged for the investigation of the influence of different crops, and of different manures, on the amount and composition of the drainage waters, were constructed in 1874; but they proved not to be water-tight, and have therefore not been used.

Each of the differently manured plots of the permanent experimental Wheat-field having a separate pipe-drain, samples of the drainage waters have been, and are still, collected and analysed. For the purpose of collection, an open pit was, in 1866, dug at the point of junction of each individual plot-drain with the main cross-drain, and the connection broken. The collection-pits were, however, 22 yards further from the manure- and crop-line of the plots at one side of the field than at the other. During the spring of 1896, a brick trench, 434 feet long, and nearly 3 feet wide and deep, was constructed, at a uniform distance from the manure- and crop-line of all the plots, into which the plot-drain of each was brought; a length of cement-jointed glazed piping being substituted for the "horse-shoe and sole" drains, up to within 6 feet of the manure- and crop-line, thus equalising and lessening the distance that the unjointed drains run under unmanured and uncropped land

subject to the passage downwards of surface-water. This arrangement for the better collection of the drainage water from the experimental plots has already been found to be a great improvement; and it will doubtless prove of much value in the future.

Nearly 25 years ago, Professor Frankland determined the nitrogen, as ammonia, as nitric acid, and as organic nitrogen, and also some other constituents, in many samples both of the rain and of the various drainage-waters collected at Rothamsted. The late Dr. Voeleker also determined the combined nitrogen, and likewise the incombustible constituents, in sixty-five samples of the drainage-waters. And Dr. W. J. Russell has determined the sulphuric acid in some of the monthly mixed samples of rain-water.

The nitrogen existing as nitric acid, sometimes that in other forms, and also some other constituents, are, and for some time past have been, determined periodically, in the Rothamsted Laboratory, in both the rain and the various drainage waters.

AMOUNT OF WATER TRANSPIRED BY PLANTS.

Commencing in 1849, experiments were made, for ten years in succession, to determine the amount of water given off by plants during their growth. In this way various plants, including representatives of the gramineous, the leguminous, and other Orders, were experimented upon. Similar experiments were also made with various evergreen and deciduous trees.

BOTANICAL CHARACTERISTICS, &c.

Having regard to the difference in the character and amount of the constituents assimilated by plants of different botanical relationships, under equal external conditions, or by the same description of plants, under varying conditions, observations have been made on the character and range of the roots of different plants, and on their relative development of stem, leaf, &c. In the case of various crops, but more especially with Wheat and Beans, samples have been taken at different stages of growth, and the composition determined, in more or less detail, sometimes of the entire plant, and sometimes of the separated parts. In a few cases, the amounts of dry matter, ash, nitrogen, &c., in the above-ground growth of a given area, at different stages of development, have been determined. The amounts of stubble of different crops have also occasionally been estimated. Experiments have also been made to ascertain approximately the acidity of the root-sap of a large number of plants representing various Natural Orders.

EXPERIMENTS ON THE ASSIMILATION OF FREE NITROGEN.

Experiments were commenced in 1857, and conducted for several years in succession, to determine whether plants assimilate free or uncombined nitrogen, and also various collateral points. Plants of the gramineous, the leguminous, and of other families, were operated upon. The late Dr. Pugh took a prominent part in this inquiry. The conclusion arrived at was that our agricultural plants do not themselves directly assimilate the free nitrogen of the air by their leaves.

In recent years, however, the question has assumed quite a new aspect. It now is—whether the free nitrogen of the atmosphere is brought into combination under the influence of micro-organisms, or other low forms, either within the soil, or in symbiosis with a higher plant, thus serving indirectly as a source of nitrogen to plants of a higher order. Considering that the results of Hellriegel and Wilfarth on this point were, if confirmed, of great significance and importance, it was decided to make experiments at Rothamsted on somewhat similar lines. Accordingly, a preliminary series was undertaken in 1888; more extended series were conducted in 1889, and in 1890; and the investigation was continued up to the commencement of the year 1895. The results obtained show that, when a soil growing leguminous plants is infected with appropriate organisms, there is a development of the so-called leguminous nodules on the roots of the plants, and, coincidentally, increased growth, and gain of nitrogen. The results are further referred to at pp. 37 and 44-5.

II.—EXPERIMENTS ON ANIMALS, ETC.

Experiments with the animals of the farm were commenced early in 1847, and have been continued, at intervals, nearly up to the present time.

The following points have been investigated:—

1. The amount of food, and of its several constituents, consumed in relation to a given live-weight of animal within a given time.
2. The amount of food, and of its several constituents, consumed to produce a given amount of increase in live-weight.
3. The proportion, and relative development, of the different organs or parts of different animals.
4. The proximate and ultimate composition of the animals in different conditions as to age and fatness, and the probable composition of their increase in live-weight during the fattening process.
5. The composition of the solid and liquid excreta (the manure) in relation to that of the food consumed.
6. The loss or expenditure of constituents by respiration and the cutaneous exhalations—that is, in the mere sustenance of the living meat-and-manure-making machine.
7. The yield of milk in relation to the food consumed to produce it; and the influence of different descriptions of food, on the quantity, and on the composition, of the milk.

The general plan of experimenting was as follows:—

To provide data as to the amount of food, or its several constituents, consumed in relation to a given live-weight of animal within a given time, and to produce a given amount of increase in live-weight, several hundred animals—oxen, sheep, and pigs—have been experimented upon. Selected lots of animals were supplied, for many weeks, or for months consecutively, with weighed quantities of foods, selected and allotted according to the special point under inquiry. The composition of the foods was determined by analysis. The weights of the animals were taken at the commencement, at intervals during the progress, and at the conclusion of the experiment.

The amount, and relative development, of the different organs and parts were determined in 2 calves, 2 heifers, 14 bullocks, 1 lamb, 249 sheep, and 59 pigs.

The percentages of water, mineral matter, fat, and nitrogenous substance, were determined in certain separated parts, and in the entire bodies, of ten animals—namely, one calf, two oxen, one lamb, four sheep, and two pigs. Complete analyses of the ashes, respectively, of the entire carcasses, of the mixed internal and other “offal” parts, and of the entire bodies, of each of these ten animals, have also been made.

From the data provided, as just described, as to the chemical composition of the different descriptions of animal, in different conditions as to age and fatness, the composition of the increase whilst fattening, and the relation of the constituents stored up in increase to those consumed in food, have been estimated.

To ascertain the composition of the manure in relation to that of the food consumed, oxen, sheep, and pigs, have been experimented upon.

In the case of oxen, the food and litter (sometimes with an acid absorbent), were weighed, sampled, and analysed; the animals were fed in boxes, for periods of from five to nine weeks, and the total dung produced was well mixed, weighed, sampled, and analysed. The constituents determined in the food and litter on the one hand, and in the dung on the other, were dry matter, ash, and nitrogen.

In the case of sheep no litter was used; the animals were kept in lots of five, on rafters, through which (but with some little loss) the solid and liquid excreta passed on to a sheet-zinc flooring at such an incline that the liquid drained off at once into carboys containing acid, and the solid matter was removed two or three times daily, and also mixed with acid. The

constituents determined in the food and manure were dry matter, mineral matter, sometimes woody-fibre, and nitrogen.

In the case of pigs, individual male animals were experimented upon, each for periods of three, five, or ten days only. Each animal was kept in a frame, preventing it from turning round, and having a zinc bottom, with an outlet for the liquid to run into a bottle, and it was watched night and day, and the voidings carefully collected as soon as passed, which could easily be done, as the animal never passed either faeces or urine without getting up, and in getting up he rang a bell, and so attracted the notice of the attendant. The constituents determined were, in the food and faeces, dry matter, ash, and nitrogen, and in the urine, dry matter, ash, nitrogen, and urea.

The loss or expenditure of constituents, by respiration and the cutaneous exhalations has not been determined directly, that is, by means of a respiration-apparatus, but only by difference, that is, by calculation, founded on the amounts of dry matter, ash, and nitrogen in the food, and in the (increase) faeces, and urine.

Independently of the points of inquiry above enumerated, the results obtained have supplied data for the consideration of the following questions:—

1. The sources in the food of the fat produced in the animal body.
2. The characteristic demands of the animal body (for nitrogenous or non-nitrogenous constituents of food) in the exercise of muscular power.
3. The comparative characters of animal and vegetable food in human dietaries.

SUPPLEMENTARY INVESTIGATIONS.

In conjunction with the late Professor Way, an extensive investigation was undertaken on the application of town sewage to different crops, but especially to grass. The amount, and the composition, of both the sewage and the produce grown were determined; and, in selected cases, the composition of the land drainage-water was also determined. Comparative experiments were also made on the feeding qualities of the differently grown produce; the amount of increase yielded by oxen, and the amount and composition of the milk yielded by cows, being determined. In this inquiry part of the analytical work was performed at Rothamsted, but most of it by Professor Way in London.

The chemistry of the malting process, the loss of food constituents during its progress, and the comparative feeding value of barley and malt, have been investigated.

Experiments were commenced in 1884, and continued for several years, to determine the changes and losses which food-crops undergo in the process of ensilaging. Experiments have also been made to determine the comparative value as food—of red-clover-silage as against red-clover-hay-chaff and swedes, when given (with other foods), to fattening oxen; of red-clover-silage, and meadow-grass-silage, as against mangels, when given (with other foods) to milking cows; of silaged green oats, against oats (grain and straw) allowed to ripen, given (with other foods) to fattening oxen; and of meadow-grass-silage, as against corresponding meadow-grass-hay, given (with other foods) to fattening oxen.

A mixed crop of beans, peas, tares, and oats, was silaged in 1886, 1887, and in 1888, and the changes and losses determined by weight and analysis, but the silage was not fed experimentally. A similar mixed crop was sown in June 1889; but it failed, and was ploughed up.

Although many of the results of the investigations above enumerated have already been published, a large proportion as yet remains unpublished.

The following lists give the titles of the papers already published, arranged in two Series, and within each Series arranged in chronological order; and they show in what Journal each paper appeared.

SERIES I.—REPORTS OF FIELD EXPERIMENTS, EXPERIMENTS ON VEGETATION, &c.

PUBLISHED 1847—1898, INCLUSIVE.

1. Agricultural Chemistry (Jour. Roy. Ag. Soc. Eng., vol. viii., p. 226) 1847
2. Agricultural Chemistry, Turnip Culture (Jour. Roy. Ag. Soc. Eng., vol. viii., p. 494) 1847
3. Experimental Investigation into the Amount of Water Given Off by Plants during their Growth, especially in relation to the Fixation and Source of their various Constituents (Jour. Hort. Soc. Lond., vol. v., p. 38) 1850
4. Report of some Experiments undertaken at the suggestion of Professor Lindley, to ascertain the Comparative Evaporating Properties of Evergreen and Deciduous Trees (Jour. Hort. Soc. Lond., vol. vi., p. 227) 1851
5. Agricultural Chemistry, especially in relation to the Mineral Theory of Baron Liebig (Jour. Roy. Ag. Soc. Eng., vol. xii., p. 1) 1851
6. On the Amounts of, and Methods of Estimating, Ammonia and Nitric Acid in Rain-water (Report of the British Association for the Advancement of Science for 1854—Liverpool Meeting) 1854
7. Report to the Right Hon. the Earl of Leicester, on the Experiments, conducted by Mr. Keary, on the Growth of Wheat upon the same land for four successive years, at Holkham Park Farm (Jour. Roy. Ag. Soc. Eng., vol. xvi., p. 207) 1855
8. On some points connected with Agricultural Chemistry; being a reply to Baron Liebig's "Principles of Agricultural Chemistry" (Jour. Roy. Ag. Soc. Eng., vol. xvi., p. 411) 185
9. On the Growth of Wheat by the Lois Weedon System, on the Rothamsted Soil; and on the Combined Nitrogen in Soils (Jour. Roy. Ag. Soc. Eng., vol. xvii., p. 582) 1856
10. On some points in the Composition of Wheat Grain, its Products in the Mill, and Bread (Journal of the Chemical Society of London, vol. x., p. 1) 1857
11. On the Growth of Barley by Different Manures continuously on the Same Land; and on the Position of the Crop in Rotation (Jour. Roy. Ag. Soc. Eng., vol. xviii., p. 454) 1857
12. Report of Experiments with different Manures on Permanent Meadow Land, with Tabular Appendix (Jour. Roy. Ag. Soc. Eng., vols. xix., p. 552, and xx., pp. 228 and 398) 1858-9
13. Report of Experiments on the Growth of Red Clover by different Manures (Jour. Roy. Ag. Soc. Eng., vol. xxi., p. 178) 1860
14. On the Sources of the Nitrogen of Vegetation; with special reference to the question whether Plants Assimilate Free or Uncombined Nitrogen.—Abstract (Proceedings of the Royal Society of London, vol. x., p. 544) 1860
15. On the Application of Different Manures to Different Crops, and on their Proper Distribution on the Farm 1861
16. On some Points in connection with the Exhaustion of Soils.—Abstract (Report of the British Association for the Advancement of Science for 1861—Manchester Meeting) 1861
17. On the Sources of the Nitrogen of Vegetation, with special reference to the question whether Plants Assimilate Free or Uncombined Nitrogen (Philosophical Transactions, part 2, 1861, p. 431) 1861
18. Report of Experiments made at Rodmersham, Kent, on the Growth of Wheat by different Descriptions of Manure for several years in succession on the same land (Jour. Roy. Ag. Soc. Eng., vol. xxiii., p. 31) 1862

19. The Effects of Different Manures on the Mixed Herbage of Grass Land (Jour. Roy. Ag. Soc. Eng., vol. xxiv., p. 131) 1863
20. On the Sources of the Nitrogen of Vegetation, with special reference to the question whether Plants assimilate Free or Uncombined Nitrogen (Jour. Chem. Soc., new series, vol. i.; entire series, vol. xvi.) 1863
21. Liebig and the "Mineral Theory" (note, extracted from a paper by Messrs. Lawes and Gilbert, Jour. Roy. Ag. Soc. Eng., vol. xxiv., part 2) 1863
22. Further Report of Experiments with Different Manures on Permanent Meadow Land (Jour. Roy. Ag. Soc. Eng., vol. xxiv., part 2) 1863
23. Report of Experiments on the Growth of Wheat for Twenty Years in Succession on the same land (Jour. Roy. Ag. Soc. Eng., vol. xxv., parts 1 and 2) 1864
24. On the Selection of Artificial Manures for the Sugar-cane 1864
25. On the Accumulation of the Nitrogen of Manure in the Soil (Report of the British Association for the Advancement of Science for 1866—Nottingham Meeting) .. 1866
26. Preliminary Notice of Results on the Composition of Wheat grown for twenty years in succession on the same land (Report of the British Association for the Advancement of Science for 1867—Dundee Meeting) 1867
27. On the Home Produce, Imports, and Consumption of Wheat (Jour. Roy. Ag. Soc. Eng., vol. iv., s.s., part 2) 1868
28. Exhaustion of the Soil in relation to Landlords' Covenants, and the Valuation of Unexhausted Improvements (read before the London Farmers' Club, April 4, 1870) 1870
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30. Reports of Experiments on the Influence of various Manures on different Species of Plants (Proceedings of the Royal Horticultural Society, p. 19) 1870
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32. Notes on Clover Sickness (Jour. Roy. Hort. Soc., vol. iii., p. 86) 1871
33. Report of Experiments on the Growth of Barley for Twenty Years in Succession on the same land (Jour. Roy. Ag. Soc. Eng., vol. ix., s.s., parts 1 and 2) 1873
34. Unexhausted Tillages and Manures, with reference to the Landlord and Tenant (Ireland) Act, 1870 1874
35. On the more frequent Growth of Barley on Heavy Land (read before the London Farmers' Club, February 1, 1875) 1875
36. On the Valuation of Unexhausted Manures (Jour. Roy. Ag. Soc. Eng., vol. xi., s.s., part 1) 1875
37. Note on the Occurrence of "Fairy Rings" (Jour. Linn. Soc., Botany, vol. xv., p. 17) 1875
38. On some points in connection with Vegetation (Address delivered at South Kensington in the Chemical Section of the Science Conferences) 1876
39. On Rainfall, Evaporation, and Percolation (Proceedings of the Inst. of Civil Engineers, vol. xiv., part 3) 1876
40. Freedom in the Growth and Sale of the Crops of the Farm, considered in relation to the interests of the Landowner and the Tenant Farmer (Jour. Soc. Arts, December 14, 1877) 1877
41. Composition of Potatoes (Note—Jour. Roy. Hort. Soc., vol. v., part 5; Proceedings, p. xxxvii.) 1878
42. On Nitrification; Reports of Experiments made in the Rothamsted Laboratory. (Part I., Jour. Chem. Soc., January, 1878; Part II., Jour. Chem. Soc., July, 1879; Part III., Jour. Chem. Soc., December, 1884; Part IV., Jour. Chem. Soc., July, 1891.) See also—Rep. Brit. Ass. 1881—York Meeting; Jour. Chem. Soc., October 1885, February 1887, and August 1888 1878-91
43. Is Higher Farming a remedy for Lower Prices? (Lecture delivered before the East Berwickshire Agricultural Association, May 3, 1879. Published by G. Macaskie, 'Warder' Office, Berwick) 1879

44. On the Determination of Nitric Acid as Nitric Oxide, by means of its action on Mercury; a Report of Experiments made in the Rothamsted Laboratory (Jour. Chem. Soc., July, 1879) 1879
45. On the Determination of Nitric Acid by means of Indigo, with special reference to Water Analysis; a Report of Experiments made in the Rothamsted Laboratory (Jour. Chem. Soc., September, 1879). See also—Chem. News, Feb. 2 and 9, 1877 1877-79
46. Agricultural, Botanical, and Chemical Results of Experiments on the Mixed Herbage of Permanent Meadow, conducted for more than twenty years in succession on the same Land. Part I., The Agricultural Results. Abstract (Proceedings of the Royal Society, No. 197, 1879) 1879
47. On some points in connection with Agricultural Chemistry.—Abstract (Report of the British Association for the Advancement of Science for 1879—Sheffield Meeting) 1879
48. Our Climate and our Wheat-Crops (Jour. Roy. Ag. Soc. Eng., vol. xvi., s.s., part 1) 1880
49. On the Home Produce, Imports, Consumption, and Price of Wheat, over twenty-eight (or twenty-seven) harvest-years, 1852-53 to 1879-80 inclusive (Jour. of the Statistical Society, June, 1880) 1880
50. Agricultural, Botanical, and Chemical Results of Experiments on the Mixed Herbage of Permanent Meadow, conducted for more than twenty years in succession on the same Land.—Part I. The Agricultural Results. Full Paper. (Philosophical Transactions, part I, 1880) 1880
51. Sketch of the Progress of Agricultural Chemistry: Address to the Chemical Section of the British Association (Report of the British Association for the Advancement of Science for 1880—Swansea Meeting) 1880
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53. On the Determination of Carbon in Soils; a Report of Experiments made in the Rothamsted Laboratory (Jour. Chem. Soc., September, 1880).. .. . 1880
54. On the Home Produce, Imports, Consumption, and Price of Wheat, over twenty-seven (or twenty-eight) harvest-years, 1852-3 to 1879-80 (Jour. Roy. Ag. Soc. Eng., vol. xvi., s.s., part 2, 1880) 1880
55. Agricultural, Botanical, and Chemical Results of Experiments on the Mixed Herbage of Permanent Meadow, conducted for more than twenty years in succession on the same land. Part II., The Botanical Results. Abstract (Proc. Roy. Soc., vol. xxx., p. 556) 1880
56. Letter on "Bread Reform" (Journal of the Society of Arts, January 21, 1881) .. 1881
57. On the Amount and Composition of the Rain and Drainage-Waters collected at Rothamsted; Parts I., II. and III. (Jour. Roy. Ag. Soc. Eng., vol. xvii., s.s. (1881), pp. 241-279, and 311-350; vol. xviii. (1882), pp. 1-71. In the separate copies of the entire paper, Section 3 of Part III. is given as Part IV., and Appendix Tables are also added) 1881-82
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59. Some Practical Aspects of recent investigations on Nitrification (Journal of the Society of Arts, April 7, 1882) 1882
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- 61a. On the Determination of Nitric Acid in Soils (Jour. Chem. Soc., August, 1882) .. 1882

- 61b. On some of the changes which Nitrogenous Matter undergoes within the Soil (Lecture delivered at South Kensington, April 16, 1883) 1883
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64. The Nitrogen as Nitric Acid, in the Soils and Subsoils of some of the Fields at Rothamsted (Jour. Roy. Ag. Soc. Eng., vol. xix., s.s., part 2, 1883) 1883
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69. Note on some conditions of the development, and of the activity, of Chlorophyll.—Abstract (Report of the British Association for the Advancement of Science for 1885—Aberdeen Meeting) 1885
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74. A Contribution to the Study of Well Waters (Jour. Chem. Soc., June, 1887) .. 1887
75. On the present position of the question of the Sources of the Nitrogen of Vegetation, with some new results, and preliminary notice of new lines of investigation.—Preliminary Notice (Proc. Roy. Soc., vol. xliii., p. 108) 1887
76. Results of Experiments at Rothamsted on the Growth of Root-crops for many years in succession on the same Land (Agricultural Students' Gazette, New Series, vol. iii., part V.) 1887
77. On the Present Position of the Question of the Sources of Nitrogen of Vegetation, with some new Results, and Preliminary Notice of New Lines of Investigation. Full Paper. (Phil. Trans., vol. clxxx. (1889), B., pp. 1-107) 1889
78. Results of Experiments at Rothamsted on the Growth of Potatoes for twelve years in succession on the same Land (Agricultural Students' Gazette, New Series, vol. iv., part II.) 1888
79. The History of a Field newly laid down to Permanent Grass (Jour. Roy. Ag. Soc. Eng., vol. xxv., s.s., part I., 1889) 1889
80. The Amount of Nitric Acid in the Rain-Water at Rothamsted, with Notes on the Analysis of Rain-Water (Jour. Chem. Soc., August, 1889) 1889
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82. New Experiments on the question of the Fixation of Free Nitrogen—Preliminary Notice (Proc. Roy. Soc., vol. xlvii., p. 85) 1890
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84. Results of Experiments at Rothamsted on the Question of the Fixation of Free Nitrogen (Agricultural Students' Gazette, New Series, vol. v., parts II. and III.) 1890-91
85. Observations on Rainfall, Percolation, and Evaporation, at Rothamsted; with tabular results for twenty harvest-years (Sept. 1 to Aug. 31), 1870-1 to 1889-90 inclusive (Proceedings of the Inst. of Civil Engineers, vol. cv., part III.) 1891
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93. The Rothamsted Experiments; being an account of some of the Results of the Agricultural Investigations conducted at Rothamsted, in the Field, the Feeding-shed, and the Laboratory, over a period of Fifty years (Transactions of the Highland and Agricultural Society of Scotland, Fifth Series, vol. vii., 1895) .. 1895
94. The Depression of Corn Prices; and the Production of Wheat in some of the chief Exporting Countries of the World (Jour. Roy. Ag. Soc. Eng., vol. vii., t.s., part IV., 1896) 1896
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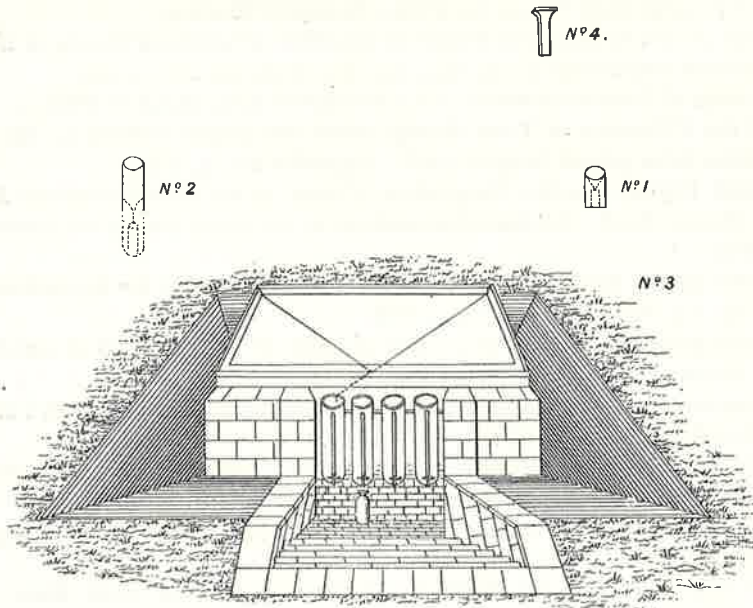
SERIES II.—REPORTS OF EXPERIMENTS ON THE FEEDING OF ANIMALS, SEWAGE UTILISATION, ENSILAGE, &c. PUBLISHED 1849-1895, INCLUSIVE.

1. Agricultural Chemistry: Sheep Feeding and Manure, Part I. (With Tabular Appendix in 1856.) (Jour. Roy. Ag. Soc. Eng., vol. x., p. 276) 1849
2. Report of Experiments on the Comparative Fattening Qualities of Different Breeds of Sheep; Hampshire and Sussex Downs (Jour. Roy. Ag. Soc. Eng., vol. xii., p. 414) .. 1851
3. Report of Experiments on the Comparative Fattening Qualities of Different Breeds of Sheep—Cotswolds (Jour. Roy. Ag. Soc. Eng., vol. xiii., p. 179) 1852
4. On the Composition of Foods in relation to Respiration and the Feeding of Animals (Report of the British Association for the Advancement of Science for 1852—Belfast Meeting) 1852
5. Agricultural Chemistry: Pig Feeding (Jour. Roy. Ag. Soc. Eng., vol. xiv., p. 459) .. 1853

6. On the Equivalency of Starch and Sugar in Food (Report of the British Association for the Advancement of Science for 1854—Liverpool Meeting) 1854
7. Experiments on the Comparative Fattening Qualities of Different Breeds of Sheep—Leicesters and Cross-breeds (Jour. Roy. Ag. Soc. Eng., vol. xvi., p. 45) 1855
8. On the Sewage of London (Journal of the Society of Arts, March 7, 1855) 1855
9. Letter on the Utilisation of Town Sewage (from the Report ordered by the House of Commons to be printed, Aug. 3, 1857. Appendix xii., p. 477) 1857
10. Experimental Inquiry into the Composition of some of the Animals Fed and Slaughtered as Human Food. Abstract (Proceedings of the Royal Society of London, vol. ix., p. 348) 1858
11. Observations on the recently-introduced Manufactured Foods for Agricultural Stock (Jour. Roy. Ag. Soc. Eng., vol. xix., p. 199) 1858
12. Experimental Inquiry into the Composition of some of the Animals Fed and Slaughtered as Human Food (Philosophical Transactions, Part 2, 1859) 1859
13. On the Composition of Oxen, Sheep, and Pigs, and of their Increase whilst Fattening (Jour. Roy. Ag. Soc. Eng., vol. xxi., p. 433) 1860
14. On the Composition of the Animal Portion of our Food, and on its relations to Bread—Abstract (Jour. Chem. Soc., vol. xii., p. 54) 1860
15. Fifth Report of Experiments on the Feeding of Sheep (Jour. Roy. Ag. Soc. Eng., vol. xxii., p. 189) 1861
16. Report of Experiments on the Fattening of Oxen at Woburn Park Farm (Jour. Roy. Ag. Soc. Eng., vol. xxii., p. 200) 1861
17. Experiments on the Question whether the Use of Condiments increases the Assimilation of Food by Fattening Animals, or adds to the Profits of the Feeder (Edinburgh Veterinary Review and Annals of Comparative Pathology, July, 1862) 1862
18. Supplementary Report of Experiments on the Feeding of Sheep (Jour. Roy. Ag. Soc. Eng., vol. xxiii., p. 191) 1862
19. The Utilisation of Town Sewage (Jour. Roy. Ag. Soc. Eng., vol. xxiv., p. 65) 1863
20. On the Chemistry of the Feeding of Animals for the Production of Meat and Manure (read before the Royal Dublin Society, March 31, 1864) 1864
21. On the Sewage of Towns (Third Report and Appendices 1, 2, and 3, of the Royal Commission. Presented to Parliament) 1865
22. Report (presented to Parliament) of Experiments undertaken by Order of the Board of Trade to Determine the Relative Values of Unmalted and Malted Barley as Food for Stock 1866
23. On the Composition, Value, and Utilisation of Town Sewage (Jour. Chem. Soc., New Series, vol. iv.; Entire Series, vol. xix.) 1866
24. Food, in its Relations to the various Exigencies of the Animal Body (Phil. Mag., July, 1866) 1866
25. On the Sources of the Fat of the Animal Body (Abstract—Rep. Brit. Ass. for 1866—Nottingham Meeting. Full paper—Phil. Mag., Dec. 1866) 1866
26. Note—On Sewage Utilisation (Proceedings of the Institution of Civil Engineers, vol. xiv., Part 3) 1876
27. On some Points in connection with Animal Nutrition (Address delivered at South Kensington in the Biological Section of the Science Conferences) 1876
28. On the Formation of Fat in the Animal Body (Journal of Anatomy and Physiology, vol. xi., Part 4) 1877
29. Supplement to former Paper entitled—"Experimental Inquiry into the Composition of some of the Animals Fed and Slaughtered as Human Food"—*Composition of the Ash of the Entire Animals, and of certain Separated Parts.* (Abstract—Proc. Roy. Soc., vol. xxxv. Full Paper—Philosophical Transactions, Part 3, 1883) 1883
30. Experiments on Ensilage conducted at Rothamsted, Season 1884-5 1885
31. The Feeding of Animals, for the Production of Meat, Milk, and Manure, and for the Exercise of Force (Jour. Roy. Ag. Soc. Eng., vol. vi., t.s., part I., 1895) 1895

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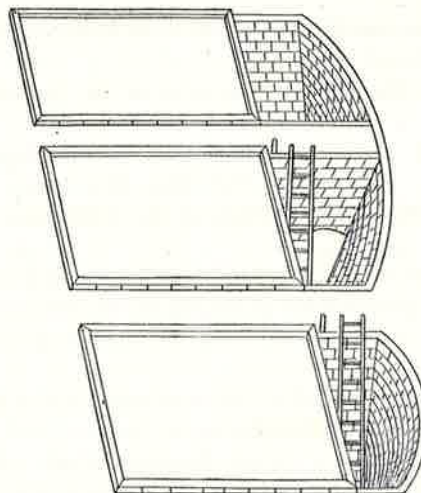
THE ROTHAMSTED RAIN GAUGES.



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.

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 28 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 more than 20 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 Table 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 27 Harvest-years to the end of August 1897—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 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. Finally, it is estimated that during the 27 Harvest-years ending with August 31, 1897, there has been a loss of nitrogen through the 20-inch gauge of $13\frac{1}{2}$, through the 40-inch of more than 7, and through the 60-inch of nearly $6\frac{1}{2}$ per cent., of the total combined nitrogen in the soil and subsoil.

C

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

In the Table (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 20 Harvest-years 1877-8 to 1896-7; the maximum and the minimum annual rainfall, with the corresponding drainage, evaporation, and loss of nitrogen, over the 20 Harvest-years; and the averages for each of the four successive five-yearly periods; also the averages for four-monthly periods, and for the total Harvest-year, over the 20 years. 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, 1895-6; thirdly, those for the last complete Harvest-year, 1896-7; and lastly, similar results for the current Harvest-year (1897-8) 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.					
	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.	Reckoned as Nitrogen.			Reckoned as Nitrate of Soda. (2)		
									Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.
Av. 19 yrs. 1851-2 to '69-70	inches. 23·80	inches. 27·04	inches. ..	inches. ..	inches. ..	inches. ..	inches. ..	inches. ..	lbs. ..	lbs. ..	lbs. ..	lbs. ..	lbs. ..	lbs. ..
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	246	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
RESULTS FOR MAXIMUM AND MINIMUM RAINFALL (LARGE GAUGE). 20 HARVEST-YEARS, 1877-8 TO 1896-7.														
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 (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
AVERAGES FOR 5, 5, 5, AND 5 HARVEST-YEARS (20 YEARS, 1877-8 TO 1896-7).														
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
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	2·41	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.

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.					
	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.	Reckoned as Nitrogen.			Reckoned as Nitrate of Soda. (2)		
									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, 1895-6.

September	0.97	1.06	0.10	0.12	0.08	0.96	0.94	0.98	0.42	0.27	0.21	2.7	1.7	1.3
October	2.52	2.69	0.82	0.84	0.72	1.87	1.85	1.97	3.30	2.38	2.00	21.1	15.2	12.8
November	4.69	4.96	4.04	4.13	4.16	0.92	0.83	0.80	13.07	10.84	10.55	83.5	69.2	67.4
December	2.14	2.34	1.84	2.04	2.01	0.50	0.30	0.33	2.70	3.98	4.04	17.3	25.4	25.8
January	1.06	1.12	0.70	0.86	0.81	0.42	0.26	0.31	0.81	1.46	1.60	5.2	9.3	10.2
February	0.57	0.59	0.04	0.13	0.11	0.55	0.46	0.48	0.05	0.20	0.20	0.3	1.2	1.3
March	3.62	3.75	2.06	2.20	2.13	1.69	1.55	1.62	2.24	2.94	3.52	14.3	18.8	22.5
April	0.88	0.95	0.02	0.13	0.08	0.93	0.82	0.87	0.03	0.13	0.14	0.2	0.9	0.9
May	0.45	0.48	(0.001)	0.01	0.03	0.48	0.47	0.45	..	0.02	0.04	..	0.1	0.3
June	2.09	2.25	0.07	0.11	0.11	2.18	2.14	2.14	0.15	0.19	0.21	0.9	1.2	1.3
July	1.21	1.27	..	0.01	0.01	1.27	1.26	1.26	..	0.01	0.01	..	0.1	0.1
August	2.78	2.91	0.15	0.17	0.10	2.76	2.74	2.81	0.41	0.35	0.26	2.6	2.2	1.7
Total	22.98	24.37	9.84	10.75	10.35	14.53	13.62	14.02	23.18	22.77	22.78	148.1	145.3	145.6

LAST HARVEST-YEAR, 1896-7.

September	7.66	8.08	6.14	6.45	6.36	1.94	1.63	1.72	20.43	15.33	16.27	130.5	98.0	103.9
October	3.87	4.13	2.82	3.06	2.99	1.31	1.07	1.14	5.75	5.68	6.23	36.7	36.3	39.8
November	1.30	1.39	0.78	0.92	0.83	0.61	0.47	0.56	0.93	1.47	1.73	6.0	9.4	11.1
December	4.05	4.42	3.83	4.00	3.81	0.59	0.42	0.61	3.72	5.16	6.29	23.8	33.0	40.2
January	1.84	2.03	1.42	1.66	1.59	0.61	0.37	0.44	1.03	1.69	2.04	6.6	10.8	13.1
February	2.74	2.92	3.20	3.58	3.26	-0.28	-0.66	-0.34	1.74	2.83	3.77	11.1	18.1	24.1
March	3.94	4.20	2.54	2.69	2.59	1.66	1.51	1.61	1.67	2.13	3.10	10.7	13.6	19.8
April	1.77	1.91	0.23	0.37	0.32	1.68	1.54	1.59	0.20	0.28	0.41	1.3	1.8	2.6
May	1.63	1.72	0.01	0.05	0.05	1.71	1.67	1.67	0.01	0.04	0.06	0.1	0.2	0.4
June	2.59	2.73	0.77	0.95	0.87	1.96	1.78	1.86	0.88	0.97	1.25	5.7	6.2	8.0
July	0.44	0.47	..	0.02	0.02	0.47	0.45	0.45	..	0.02	0.04	..	0.1	0.2
August	3.08	3.24	0.14	0.11	0.11	3.10	3.13	3.13	0.26	0.17	0.21	1.7	1.1	1.4
Total	34.91	37.24	21.88	23.86	22.80	15.36	13.38	14.44	36.62	35.77	41.40	234.2	228.6	264.6

CURRENT HARVEST-YEAR, 1897-8.

September	2.29	2.44	0.91	0.96	0.87	1.53	1.48	1.57	2.66	1.76	2.07	17.0	11.3	13.2
October	0.86	0.96	..	(0.001)	(0.001)	0.96	0.96	0.96	..	..	..	..	..	..
November	0.97	1.05	0.22	0.14	0.11	0.83	0.91	0.94	0.54	0.21	0.19	3.4	1.3	1.2
December	3.26	3.50	2.96	3.09	3.06	0.54	0.41	0.44	10.04	7.28	7.82	64.2	46.5	50.0
January	0.76	0.80	0.65	0.83	0.82	0.15	-0.03	-0.02	1.90	1.68	1.82	12.1	10.8	11.6
February	1.01	1.10	0.01	0.05	0.05	1.09	1.05	1.05	0.03	0.07	0.06	0.2	0.4	0.4
March	0.99	1.06	0.36	0.50	0.49	0.70	0.56	0.57	0.94	0.93	0.90	6.0	6.0	5.8
April	1.36	1.44	0.05	0.09	0.08	1.39	1.35	1.36	0.11	0.14	0.14	0.7	0.9	0.9
May	2.73	2.89	0.78	0.95	0.92	2.11	1.94	1.97	1.93	1.77	1.87	12.3	11.3	12.0
June .. .. .	..	..	..	..	..	..	..	..	..	..	..	..	..	..
July .. .. .	..	..	..	..	..	..	..	..	..	..	..	..	..	..
August .. .. .	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total .. .. .	..	..	..	..	..	..	..	..	..	..	..	..	..	..

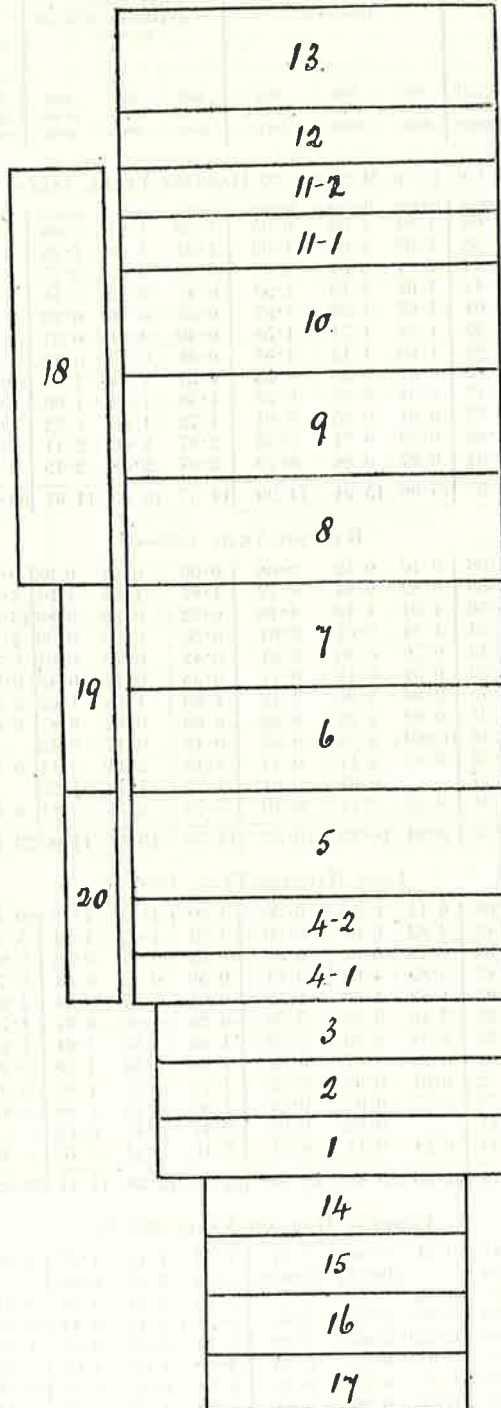
(1) Calculated on the Rainfall shown by the $\frac{1}{1000}$ th acre gauge.

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

PLAN OF THE PLOTS IN THE PARK, ON WHICH EXPERIMENTS HAVE BEEN MADE,
ON THE MIXED HERBAGE OF PERMANENT GRASS LAND.

43 years, 1856-1898 inclusive.

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



Total area under Experiment about 7 acres.

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

[For details of the manuring and produce, see pp. 22 and 23.]

RESULTS OF EXPERIMENTS MADE IN THE PARK,
ON THE MIXED HERBAGE OF PERMANENT GRASS-LAND.

These experiments were commenced in 1856, so that 1898 is the 43rd year of their continuance.

In the experiments with individual crops grown separately, on arable land, it was found, that those of the same natural Order—Wheat, Barley, and Oats, for example—had certain characters and manurial requirements in common; that those of the Leguminous Order had widely different characters and requirements; whilst crops of other Orders, such as Root-crops, Potatoes, &c., exhibited characteristics differing from the Gramineous, and more from the Leguminous crops. Compared with the conditions of growth of such individual crops grown separately, those of the *Mixed Herbage of Grass-land* are extremely complicated. It comprises, besides numerous Gramineous and Leguminous species, representatives of many other Natural Orders; and of some of great prominence and importance as regards their prevalence and distribution in vegetation generally. If, under the influence of characteristically different manures, there are notable differences in the degree of luxuriance, and in the character of development of closely allied plants when each is grown separately, and much greater differences between plants of different Orders when so separately grown it is only what might be expected, that there should be very remarkable variations of result when different manures are applied to an already established Mixed Herbage of perhaps some 50 species growing together, representing perhaps nearly 20 Natural Orders.

Accordingly, even in the early years of the experiments, it was observed that those manures which were the most effective with Wheat, Barley, or Oats—that is with Gramineous species grown separately—were also the most effective in bringing forward the *grasses proper*, in the Mixed Herbage. Again, those manures which were the most beneficial to beans or clover, the most developed the Leguminous species in the Mixed Herbage, and *vice versa*. There was also great variation in the predominance of individual species among both the grasses, and the representatives of other Orders. And again, there was very great difference in the tendency to produce merely increased leafy vegetation on the one hand, or to develop stem and seed formation on the other, according to the manure employed. Thus, the final product—the *hay*—was one thing when grown under certain manurial conditions, and quite another when grown under others. For example, the unmanured produce on the average included nearly 50 species—about 17 grasses, 4 leguminous plants, and 27 or more of other Orders; whilst the hay contained from 65 to 70 per cent. of gramineous produce, about $7\frac{1}{2}$ of leguminous herbage, and 20 to 25 per cent. of herbage of other Orders. Compared with this, the produce by farmyard manure contained fewer species, a higher proportion by weight of gramineous, and lower of both leguminous and miscellaneous herbage. Or, to take an extreme case, an excessive application of both mineral and nitrogenous manures for many years in succession, has reduced the number of species traceable, to only about 15, whilst gramineous herbage has contributed from 95 to 98 per cent., or even more of the total hay, leguminous herbage has been excluded, and miscellaneous herbage nearly so. It may be said that any manure that increases the luxuriance of some individual plants, more or less reduces the number of species, and of course alters the proportion of the different species in the final product—the hay; whilst there will, according to the conditions, be different proportions of leaf and stem, and different tendencies to maturation. It is obviously, therefore, very difficult to summarise in a few sentences the results of experiments with 20 different conditions of manuring, carried on over a period of more than 40 years.

It may be said, that the effect of purely nitrogenous manures, such as nitrate of soda, and more still, ammonium-salts, is to reduce the total number of species, characteristically to increase the growth of gramineous species, almost to exclude leguminous herbage, and to reduce the number and proportion of miscellaneous species, but to increase the luxuriance of a few of those that remain. Purely mineral manures, supplying abundance of potash and phosphoric acid, in a less degree reduce the total number of species, do not increase the luxuriance, though they favour the stemminess and maturation of the grasses, but reduce the percentage by weight of such herbage in the hay. Such manures, however, greatly increase the luxuriance, and proportion by weight in the hay, of leguminous species; whilst they reduce, both the number of species, and proportion by weight in the hay, of the miscellaneous herbage.

It is thus obvious that the weights of hay per acre yielded under the varying conditions of manuring, do not represent the comparative value of the produce grown under the different conditions. For example, there has been an average of only about 1 ton per acre of first-crop hay without manure, the produce being, however, the most complex of all. With purely mineral manures, containing potash, the average annual yield of first-crop hay has been rather more than $1\frac{1}{2}$ ton; with fewer species, but containing a considerable proportion of leguminous herbage; in fact, the hay grown by such manures, is of better quality than that produced by any other of the manures in the series. With an excess of mineral and nitrogenous manures together, the average yield per acre has been nearly 3 tons of first-crop hay; but the produce has contained no leguminous, and very little miscellaneous herbage, and from 95 to 98 per cent. of gramineous herbage, perhaps 90 per cent., consisting of only 4 to 6 of the most freely growing and coarser species, which have been characterised by great stemminess. Further, it may be stated, that the one ton of the very complex unmanured hay would contain about $7\frac{1}{2}$ lb. of phosphoric acid, about 25 lb. of potash, and about 30 lb. of nitrogen; that the $1\frac{1}{2}$ ton of hay grown by the purely mineral manures, with its ripened grasses, and large proportion of leguminous herbage, would contain about 18 lb. phosphoric acid, 75 lb. of potash, and 50 lb. of nitrogen; whilst the 3 tons of almost exclusively gramineous, and very stemmy hay, grown by excessive amounts of mineral and nitrogenous manures together, would remove about 30 lb. of phosphoric acid, about 145 lb. of potash, and about 108 lb. of nitrogen.

Between the extremes above indicated, the 20 plots afford examples of very great variety, not only in quantity of produce, but also in quality, depending on both the botanical and chemical composition, and on the character of development of the plants. The experiments were not arranged to provide exact examples for practice, but to ascertain the characteristic effects of different manurial agents on the quantity and quality of the Mixed Herbage, and thus to afford data for application in actual practice. The general result has been to show, that if artificial manures are largely or mainly relied upon, certain descriptions of herbage will be unduly forced at the expense of others, and also that the character of development of the plants will be materially affected. In order to maintain a due admixture of herbage on grass-land mown for hay, farmyard or stable dung should be liberally applied; and it is also conducive to the same end to consume the second crop on the land, with cake or corn. The more a good condition of the herbage is induced and maintained by such means, the more safely may some increased luxuriance, and so increased produce, be obtained, by the judicious use of artificial manures. Provided dung be liberally used it will not as a rule be necessary to apply potash artificially; but phosphates may advantageously be used as basic slag, and nitrogenous manure in the form of nitrate of soda, which, however, should seldom be used at the rate of more than 1 cwt., or at most $1\frac{1}{2}$ cwt. per acre.

For details of the manuring and produce of the different plots, see pages 22–23.

EXPERIMENTS WITH DIFFERENT MANURES ON

The Land has probably been laid down with Grass for some centuries. No fresh seed has been artificially sown within the last 50 years certainly; nor is there record of any having been sown since the Grass was first laid down. The experiments commenced in 1856, at which time the character of the herbage appeared fairly uniform over all the plots. The present season, 1898, is therefore the 43rd year of the experiments. Excepting as explained in the Table, and in the foot-notes, the same description of Manure has been applied year after year to the same plot.

During the first 19 years of the experiments, 1856-1874, the first crop only, each year, was mown, made into hay, removed from the land, and weighed. As a rule, the second crops were fed-off by sheep having no other food, the object being not to disturb the condition of the manuring. A given number was allotted to each plot, according to the amount of produce, penned upon a portion of it, and the area extended, day by day, until the whole was eaten down. Frequently, however, the animals suffered considerably; and in 1866, 1870, 1873, and 1874, the second crops (and third, if any) were cut, and spread on the respective plots. In the twentieth season, 1875, the second crops being unusually heavy, and the weather favourable, they were, for the first time, cut, weighed as hay, and removed. In 1876 they were cut and spread on the plots. In 1877 and 1878 the second crops were made into hay, weighed, and removed. In 1879, 1882, 1891, 1892, 1894, 1896 and 1897, the second crops were cut, sampled, carted, and weighed, green; the dry matter in the weighed samples was determined, and the produce reckoned into hay by adding one-fourth to the calculated dry matter per acre. In 1880, 1881, 1883, 1886, 1888, 1889, 1890, 1893, and 1895, the second crops were again made into hay, weighed and removed; and it is intended in future to adopt this plan whenever the weather will permit. In 1884, 1885, and 1887, owing to the dryness of the seasons after cutting the first crops, there was but little growth; the second crops were therefore again cut, but spread on the respective plots. Owing to the change in the treatment of the crops, the average produce per annum is given, separately, for the first 20 years, 1856-1875, first crops only; and for the succeeding 20 years, 1876-1895, first and second crops⁽¹³⁾. On January 7, 1881, coarsely broken chalk, in the

(Area under experiment,

PLOTS.	1 acre = (about) 0.404 Hectare or 1.585 Prussian Morgen.
	1 lb. (pound avoird.) . . = (about) 0.453 Kilogramme or 0.907 Zollverein Pfund.
	1 cwt. (hundredweight) = (about) 50.8 Kilogrammes or 1.016 Centner.
	1 ton = (about) 1015.6 Kilogrammes or 20.32 Centner.
	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.
	1 ton per acre = (about) 2512 Kilogrammes per Hectare or 12.82 Centner per Pr. Morgen.
Manures, per acre, per Annum. [In 1897, and since, 400 lbs. Basic Slag used throughout instead of Superphos.]	
1	{ 1856-63, 8 years, 14 tons Farmyard Manure, and 200 lbs. Ammonium-salts ⁽¹⁾ ; average produce 49½ cwts. } { 1864 and since, 200 lbs. Ammonium-salts alone; average produce (12 years, 1864-75) 38½ cwts. . . . }
2	{ 1856-63, 8 years, 14 tons Farmyard Manure; average produce 42½ cwts. } { 1864 and since, unmanured; average produce (12 years, 1864-75) 32½ cwts. }
3	Unmanured, continuously
4	3½ cwts. Superphosphate of Lime ⁽²⁾
5	3½ cwts. Superphosphate of Lime, and 400 lbs. Ammonium-salts
6	400 lbs. Amm.-salts, 42 yrs., 1856-97; 1898, half Unmanured, half 400 lb. Basic Slag, and 500 lb. Sulph. Pot. } { 1856-68, 13 years, 400 lbs. Ammonium-salts; average produce 30½ cwts. } { 1869-78, 300 lbs., 1879 and since 500 lbs., Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Magnesia, } { 3½ cwts. Superphosphate; average produce (7 yrs., 1869-75) 31½ cwts. }
7	{ 1856-78, 300 lbs., 1879 and since 500 lbs., Sulphate Potash, 100 lbs. Sulphate Soda, 100 lbs. Sulphate } { Magnesia, and 3½ cwts. Superphosphate }
8	{ 1856-61, 6 years, 300 lbs. Sulph. Potash, 200 lbs. Sulph. Soda, 100 lbs. Sulph. Magnesia, and 3½ cwts. } { Superphosphate; average produce 36 cwts. } { 1862 and since, 250 lbs. Sulphate Soda, 100 lbs. Sulphate Magnesia, and 3½ cwts. Superphosphate; } { average produce (14 years, 1862-75) 27½ cwts. }
9	{ 1856-78, 300 lbs., 1879 and since 500 lbs., Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Magnesia, } { 3½ cwts. Superphosphate, and 400 lbs. Ammonium-salts }
10	{ 1856-61, 6 yrs. 300 lbs. Sulph. Potash, 200 lbs. Sulph. Soda, 100 lbs. Sulph. Magnesia, 3½ cwts. Superphos- } { phate, 400 lbs. Ammonium-salts; average produce 55½ cwts. } { 1862 and since, 250 lbs. Sulph. Soda, 100 lbs. Sulph. Magnesia, 3½ cwts. Superphosphate, 400 lbs. } { Ammonium-salts; average produce (14 yrs., 1862-75) 42½ cwts. }
11	{ 1856-78, 300 lbs., 1879 and since 500 lbs., Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Magnesia, } { 3½ cwts. Superphosphate, 600 lbs. Ammonium-salts }
	{ 1856-78, 300 lbs., 1879 and since 500 lbs., Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Magnesia, } { 3½ cwts. Superphosphate, 600 lbs. Ammonium-salts, and 400 lbs. Silicate Soda ⁽⁷⁾ }
12	Unmanured continuously
13	{ 1856-78, 300 lbs., 1879 and since 500 lbs., Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Magnesia, } { 3½ cwts. Superphosphate, 400 lbs. Ammonium-salts, 2000 lbs. Cut Wheat-straw }
14	{ 550 lbs. Nitrate Soda ⁽⁸⁾ , 1858-78, 300 lbs., 1879 and since 500 lbs., Sulph. Potash, 100 lbs. Sulph. } { Soda, 100 lbs. Sulph. Magnesia, and 3½ cwts. Superphosphate }
15	{ 1858-75, 18 years, 550 lbs. Nitrate Soda } { 1876-78, 300 lbs., 1879 and since 500 lbs., Sulphate Potash, 100 lbs. Sulphate Soda, 100 lbs. Sulphate } { Magnesia, and 3½ cwts. Superphosphate }
16	{ 275 lbs. Nitrate of Soda, 500 lbs. (300 lbs., 1858-78), Sulph. Potash, 100 lbs. (200 lbs., 1856-63), Sulph. Soda, } { 100 lbs. Sulph. Magnesia, and 3½ cwts. Superphosphate }
17	275 lbs. Nitrate of Soda
18	{ Mixture supplying the quantity of Potash, Soda, Lime, Magnesia, Phosphoric acid, Silica, and Nitrogen, } { contained in 1 ton of Hay (commencing 1865) }
19	275 lbs. Nitrate of Soda, 290 lbs. Sulphate of Potash, and 3½ cwts. Superphosphate (commencing 1872) . .
20	327 lbs. Nitrate of Potash, and 3½ cwts. Superphosphate (commencing 1872)

(1) "Ammonium-salts"—In all cases equal parts Sulphate and Muriate of Ammonia of Commerce.
 (2) "Superphosphate of Lime," 1856 to 1888 inclusive, made from 200 lbs. Bone-ash, 150 lbs. Sulphuric Acid, Sp. gr. 1.7 (and water); 1889, and since, made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.
 (3) Plots 6, 8, and 10, had, besides the Manures specified, 2000 lbs. Sawdust per acre per annum for the first seven years, 1856-1862, but without effect. (4) 200 lbs., 1856-63 inclusive. (5) 500 lbs. in 1862 and 1863.
 (6) 800 lbs. 1856-58; 400 lbs. 1859-61; 300 lbs. 1862-81; 600 lbs. 1882 and since.
 (7) The application of Silicates did not commence until 1862; 9 years (1862-1870), 200 lbs. Silicate Lime, and 200 lbs. Silicate Soda; 1871, and since, 400 lbs. Silicate Soda. (8) 550 lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 400 lbs. of "Ammonium-salts."
 (9) The Manures specified were first applied in 1859 (previously, 1856-7 and 8, Sawdust only).

PARK.

PERMANENT GRASS LAND.

condition of moisture in which it was brought from the pit, was applied at the rate of 2000 lbs. per acre, for a length of 49 links down each of the Plots 1 to 13 inclusive; and on February 26, partially dried and finely ground and sifted chalk, was applied to the same portion of the same plots, at the rate of 1000 lbs. per acre. In November 1883, each plot (1 to 20 inclusive) was divided, and upon one-half of each 2000 lbs. per acre of fresh burnt lime (slacked), was applied, in addition to the ordinary manures as stated in the Table; and in November 1887, the other half of most of the plots also received 2000 lbs. per acre; the exceptions being, that Plot 5 did not receive any in 1887, and that the portions of Plots 11-1 and 11-2, which had received the Lime in 1883, in 1887 received 2000 lbs. per acre more, and the other half which did not receive any in 1883, then (1887) received 4000 lbs. per acre. Lastly, in December 1896, the half of Plot 5, which had not previously received any lime, received 4000 lbs. per acre of freshly burnt lime (slacked); and the other half, which had formerly received 2000 lbs., now received another 2000 lbs. per acre, making in all 4000 lbs., the same as on the other half.

It was not until some years after the application of chalk, early in 1881, to small portions of some of the plots as above referred to, that the effects were sufficiently marked to render it desirable to cut and weigh the produce separately; and it was not until 1884 that it was so treated. The produce of the whole of these chalked portions was, however, excluded from the reckoning of the average produce of the plots, as given in this annual report, in the case of all the first crops of 1881, 1882, 1883, and 1886 to 1897 inclusive. It was also excluded in 1884 and 1885, in the case of the plots where the produce was separately weighed (Plots 6, 7, and 8, 1884, and 3, 6, 7, 8, and 11-1, in 1885), but included in the other cases in those two years. Again, in the case of the second crops, it was only in those of 1881 (a few of those of 1882), 1886, 1891, 1892, 1894 and 1896 (excepting Plots 6, 7, and 8), and 1897, that the produce of the chalked portions was included. In the case of the remaining or main portion of the plots, to one-half of which a dressing of slacked lime was applied in November 1883, and to the other half in November 1887, there has, on some plots, been marked effect, but it is the average produce of the two portions that has each year been given, as the produce of the plots. Below is given, besides the usual averages, the produce for both 1896 and 1897.

For Plan of the Plots, and brief summary of results and conclusions, see pp. 20-21.

about 7 acres.)

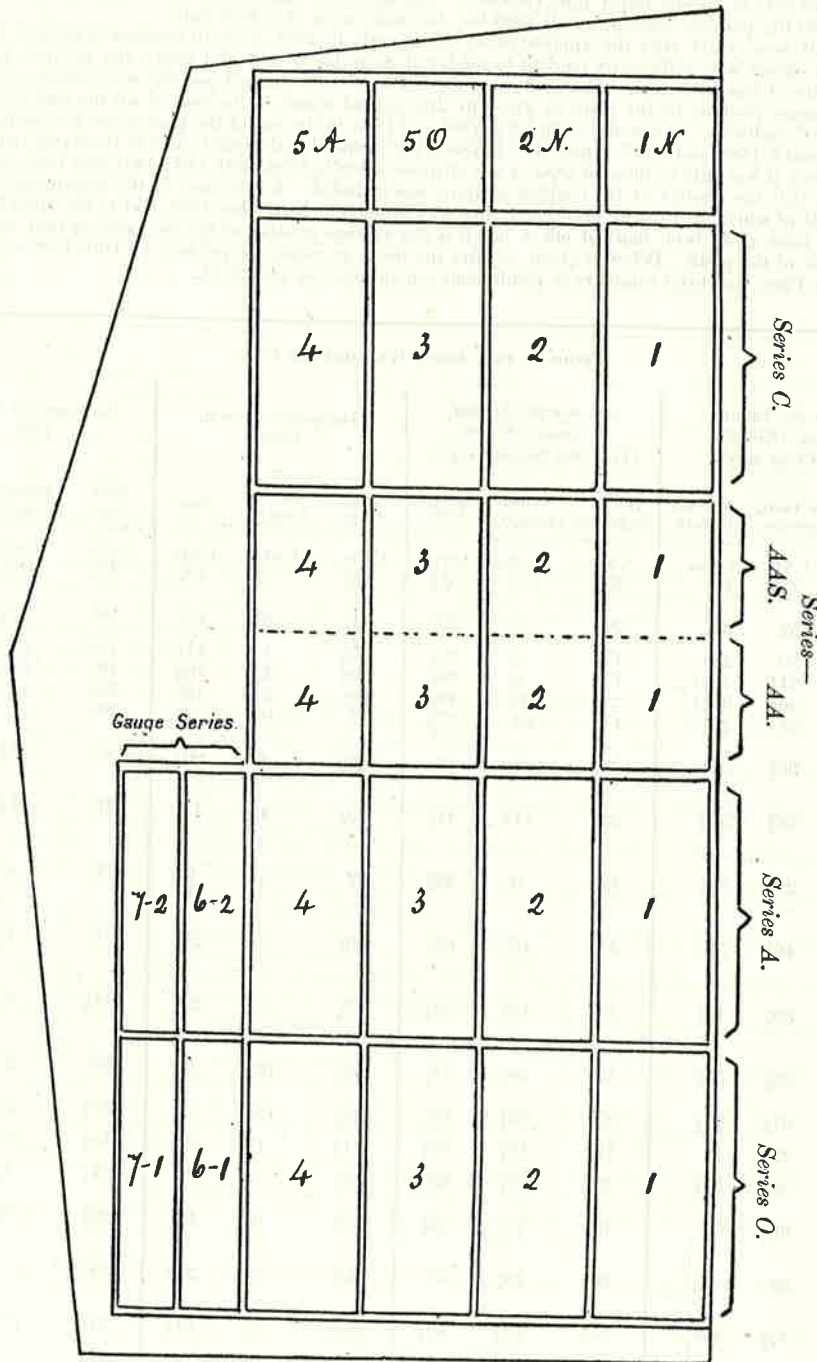
PLOTS.	PRODUCE PER ACRE, WEIGHED AS HAY.												PLOTS.
	Average per Annum, 20 Years, 1856-75. (First Crops only.)			Average per Annum, 20 Years, 1876-95. (First and Second Crops.)			Forty-first Season, 1896.			Forty-second Season, 1897.			
	10 Years, 1856-65.	10 Years, 1866-75.	20 Years, 1856-75.	First Crops ⁽¹³⁾ .	Second Crops ⁽¹⁴⁾ .	Total.	First Crop.	Second Crop ⁽¹⁵⁾ .	Total.	First Crop.	Second Crop ⁽¹⁵⁾ .	Total.	
1	Cwts. 48 $\frac{3}{8}$	Cwts. 37 $\frac{3}{4}$	Cwts. 43	Cwts. 26 $\frac{3}{8}$	Cwts. 11 $\frac{5}{8}$	Cwts. 38 $\frac{1}{2}$	Cwts. 16 $\frac{1}{4}$	Cwts. 3 $\frac{1}{4}$	Cwts. 19 $\frac{1}{2}$	Cwts. 25 $\frac{3}{8}$	Cwts. (16)	Cwts. 25 $\frac{3}{8}$	1
2	41 $\frac{5}{8}$	32	36 $\frac{7}{8}$	20 $\frac{7}{8}$	9	29 $\frac{7}{8}$	11 $\frac{3}{8}$	0 $\frac{7}{8}$	12 $\frac{1}{4}$	18 $\frac{3}{8}$	(16)	18 $\frac{3}{8}$	2
3	22 $\frac{1}{2}$	20	21 $\frac{1}{4}$	17 $\frac{1}{4}$	8 $\frac{3}{4}$	25 $\frac{7}{8}$	10 $\frac{1}{4}$	1	11 $\frac{1}{4}$	15 $\frac{1}{2}$	(16)	15 $\frac{1}{2}$	3
4	23 $\frac{1}{4}$	21 $\frac{1}{4}$	22 $\frac{1}{4}$	17 $\frac{3}{4}$	8 $\frac{7}{8}$	26 $\frac{3}{8}$	9 $\frac{3}{4}$	1	10 $\frac{3}{4}$	19	(16)	19	4
5	33 $\frac{7}{8}$	30 $\frac{1}{4}$	32 $\frac{1}{4}$	29 $\frac{3}{4}$	10 $\frac{7}{8}$	40 $\frac{3}{8}$	10 $\frac{3}{8}$	2	12 $\frac{3}{8}$	28 $\frac{3}{4}$	(16)	28 $\frac{3}{4}$	5
6	30 $\frac{3}{8}$	22	26 $\frac{1}{4}$	17 $\frac{1}{4}$	10	27 $\frac{1}{4}$	2	0 $\frac{3}{8}$	2 $\frac{3}{8}$	20 $\frac{3}{8}$	(16)	20 $\frac{3}{8}$	6
7	31 $\frac{3}{8}$	30 $\frac{1}{4}$	30 $\frac{3}{4}$	28 $\frac{3}{8}$	12 $\frac{3}{8}$	41	16 $\frac{1}{8}$	4 $\frac{1}{8}$	20 $\frac{1}{4}$	32 $\frac{1}{8}$	1 $\frac{1}{2}$	33 $\frac{3}{8}$	7
8	33 $\frac{7}{8}$	36 $\frac{3}{4}$	35 $\frac{1}{4}$	29 $\frac{3}{4}$	14 $\frac{1}{2}$	44 $\frac{1}{4}$	15 $\frac{1}{2}$	4 $\frac{3}{8}$	19 $\frac{7}{8}$	31 $\frac{1}{8}$	1 $\frac{1}{4}$	33 $\frac{1}{8}$	8
9	33 $\frac{5}{8}$	26 $\frac{1}{4}$	30 $\frac{3}{8}$	19 $\frac{1}{8}$	9 $\frac{5}{8}$	28 $\frac{3}{4}$	12	1 $\frac{3}{8}$	13 $\frac{3}{8}$	21 $\frac{1}{8}$	0 $\frac{5}{8}$	21 $\frac{3}{8}$	9
10	53 $\frac{5}{8}$	48 $\frac{1}{2}$	51	44 $\frac{7}{8}$	15 $\frac{7}{8}$	60 $\frac{3}{4}$	20 $\frac{1}{4}$	8	28 $\frac{1}{4}$	51 $\frac{1}{8}$	1 $\frac{7}{8}$	53	10
11	52 $\frac{3}{4}$	39 $\frac{5}{8}$	46 $\frac{1}{8}$	37 $\frac{1}{8}$	15 $\frac{5}{8}$	52 $\frac{3}{4}$	17 $\frac{1}{8}$	6 $\frac{1}{4}$	23 $\frac{3}{8}$	44 $\frac{1}{2}$	0 $\frac{7}{8}$	45 $\frac{3}{8}$	11
12	61 $\frac{3}{4}$	53 $\frac{5}{8}$	57 $\frac{5}{8}$	48	26 $\frac{5}{8}$	74 $\frac{1}{8}$	32 $\frac{7}{8}$	10 $\frac{5}{8}$	43	58 $\frac{7}{8}$	2	60 $\frac{7}{8}$	11
13	63 $\frac{1}{2}$	61 $\frac{3}{4}$	62 $\frac{1}{2}$	57 $\frac{7}{8}$	25 $\frac{1}{4}$	83 $\frac{1}{8}$	44 $\frac{3}{8}$	12 $\frac{3}{8}$	57	60 $\frac{1}{2}$	2 $\frac{5}{8}$	63 $\frac{1}{8}$	12
14	25	22 $\frac{7}{8}$	24	17 $\frac{5}{8}$	10 $\frac{3}{4}$	28 $\frac{3}{8}$	11 $\frac{1}{4}$	1 $\frac{1}{8}$	12 $\frac{3}{8}$	18 $\frac{1}{4}$	(16)	18 $\frac{1}{4}$	13
15	55 $\frac{1}{4}$	59 $\frac{5}{8}$	57 $\frac{1}{2}$	49 $\frac{1}{2}$	20 $\frac{3}{8}$	69 $\frac{7}{8}$	18 $\frac{1}{2}$	8 $\frac{3}{8}$	27	51 $\frac{3}{4}$	1 $\frac{7}{8}$	53 $\frac{3}{8}$	14
16	53 $\frac{1}{8}$	60 $\frac{1}{2}$	57	49 $\frac{5}{8}$	13 $\frac{7}{8}$	63 $\frac{3}{4}$	39 $\frac{1}{2}$	6 $\frac{1}{2}$	46	42 $\frac{3}{8}$	0 $\frac{7}{8}$	43 $\frac{1}{2}$	14
17	36 $\frac{1}{8}$	35	35 $\frac{3}{8}$	26 $\frac{3}{8}$	10 $\frac{3}{8}$	37	23 $\frac{1}{4}$	3 $\frac{1}{2}$	26 $\frac{3}{4}$	34 $\frac{7}{8}$	(16)	34 $\frac{7}{8}$	15
18	45 $\frac{1}{4}$	47 $\frac{5}{8}$	46 $\frac{3}{8}$	39 $\frac{1}{2}$	12 $\frac{3}{4}$	52 $\frac{1}{2}$	27 $\frac{3}{4}$	3 $\frac{1}{2}$	31 $\frac{1}{4}$	41	(16)	41	16
19	34 $\frac{1}{4}$	33 $\frac{1}{2}$	33 $\frac{3}{8}$	28 $\frac{1}{2}$	10 $\frac{3}{4}$	39 $\frac{1}{4}$	21 $\frac{3}{4}$	3	24 $\frac{3}{4}$	31 $\frac{1}{4}$	(16)	31 $\frac{1}{4}$	17
20	21	33 $\frac{1}{4}$	32 $\frac{3}{4}$	29 $\frac{3}{4}$	13 $\frac{1}{4}$	42 $\frac{7}{8}$	17 $\frac{3}{8}$	4 $\frac{1}{2}$	21 $\frac{7}{8}$	30	1 $\frac{3}{8}$	31 $\frac{1}{8}$	18
19	..	..	38 $\frac{3}{8}$	37	12 $\frac{1}{8}$	49 $\frac{1}{8}$	30	5 $\frac{1}{4}$	35 $\frac{1}{4}$	38 $\frac{1}{8}$	0 $\frac{3}{8}$	38 $\frac{3}{8}$	19
20	..	..	36 $\frac{1}{2}$	39	11 $\frac{3}{4}$	50 $\frac{3}{4}$	38	5 $\frac{1}{4}$	43 $\frac{3}{4}$	45 $\frac{1}{4}$	0 $\frac{3}{8}$	45 $\frac{3}{8}$	20

(10) Averages of 8 years, 10 years, and 18 years, as these experiments did not commence until 1858. (12) Averages of 4 years only, 1872-75.
 (11) Averages of (1 year), 10 years, and 11 years, as the experiment only commenced in 1865.
 (13) In 1888 and 1890, the first crops being got up in bad condition, the weights of hay per acre were corrected by adding one-fifth to the determined dry substance. This corresponds to an uniform amount of 16 $\frac{3}{4}$ per cent. of moisture in the first crops of hay.
 (14) As in 1876 the second crops were not removed, those of 1875, which were, are brought in instead; and as also in 1884, in 1885, and in 1887, the second crops were not removed, the aggregate second crops of the 17 years (1875, 1877-83, 1886, and 1888-95) are divided by 20 estimating the average amount of produce of second crops removed per annum over the 20 years. See also Note (12).
 (15) In 1897, as in '79, '82, '88, '90, '91, '92, '94, and '96, the second crops being got up in bad condition, the produce of hay per acre was corrected by adding one-fourth to the determined amount of dry substance. This corresponds to a uniform amount of 26 per cent. of moisture in the second crops of hay.
 (16) On these plots the crop was too small to weigh or remove.

PLAN OF THE PLOTS IN HOOS FIELD,
ON WHICH BARLEY HAS BEEN GROWN

for 47 years in succession, 1852 to 1898 inclusive.

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



Total area of ploughed land about $5\frac{1}{2}$ acres.

Area of Plots. { 1, 2, 3, and 4, of Series O, Series A, and Series C, each $\frac{2}{11}$ acre.
1, 2, 3, and 4, of Series AA, and Series AAS, each $\frac{1}{11}$ acre.
1 N, 2 N, 5 O, and 5 A, each $\frac{1}{11}$ acre.
6-1 and 6-2, each about $\frac{1}{2}$ acre (0.137 acre).
7-1 and 7-2, each about $\frac{1}{2}$ acre (0.118 acre).

The double lines indicate division paths between plot and plot.

[For details of the manuring and produce, see pp. 26 and 27.]

RESULTS OF EXPERIMENTS MADE IN HOOS FIELD ON THE GROWTH OF
BARLEY,

for 47 years in succession on the same land—without manure, with Farmyard manure, and with various artificial manures.

The results show, that on the growth of Barley year after year on ordinary arable land, the produce by mineral manures alone is higher than that without manure; that nitrogenous manures alone give more produce than mineral manures alone; and that mixtures of both mineral and nitrogenous manures give much more than either used alone—indeed, generally twice, or more than twice, as much as mineral manures alone. Of mineral constituents, whether used alone or in mixture with nitrogenous manures, phosphates were much more effective than mixtures of salts of potash, soda, and magnesia. The averages show that, under all conditions of manuring (excepting with farmyard manure), the produce was less over the later than over the earlier periods of the experiments—a result partly due to the seasons. But the average produce for 40 years of continuous growth of Barley was, in all cases where nitrogenous and mineral manures (containing phosphates) were used together, much higher than the average produce of the crop grown in ordinary rotation in the United Kingdom; and very much higher than the average in most other countries when so grown.

Barley is appropriately sown in a lighter soil than Wheat; and whilst Wheat is usually sown in the autumn, Barley is as a rule sown in the spring; and hence it relies in a much greater degree on the stores of the *surface* soil. Accordingly, it is more susceptible to exhaustion of the surface-soil in nitrogenous, and especially in mineral supplies; and hence, in the common practice of agriculture, it more generally requires the direct application of mineral manures, especially phosphatic manures, than does Wheat when grown under equal soil conditions. The exhaustion induced by both crops is, however, characteristically that of available nitrogen; and when, under the ordinary conditions of manuring and cropping, artificial manure is still required, nitrogenous manures are as a rule requisite for both crops; and for the spring sown Barley more generally than for Wheat, phosphatic manures also. It is not recommended that Barley should in practice be grown year after year on the same land by artificial manures as in these experiments; but, in addition to the lighter soils on which it is more appropriately grown in ordinary rotation, it may be grown, both in full quantity per acre and of good quality, after Wheat, or other grain crop, on the heavier soils, when the land is clean enough for a second cereal crop.

For details of the manuring and produce of the different plots, see pages 26 and 27.

EXPERIMENTS ON THE GROWTH OF BARLEY YEAR AFTER YEAR ON THE

Previous Cropping—1847, Swedish Turnips, with Dung and Superphosphate of Lime, the Roots carted off; 1848, Barley (with clover); 1849, Clover; 1850, Wheat; 1851, Barley manured with Amm.-salts.

First Experimental Barley Crop in 1852. Barley every year since. The crop of the present year, 1898, is, therefore, the 47th Barley crop in succession. Unless stated to the contrary in the Table, or in the foot-notes, the same Manure has been applied year after year to the same Plot. Description of

(Area under experiment,

PLOTS.	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 avoird.) .. = (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.	
	Manures, per acre, per annum. [In 1898, 400 lbs. Basic Slag was used throughout instead of Superphosphate.]	
1 O.	Unmanured continuously	
2 O.	3½ cwt. Superphosphate of Lime ⁽¹⁾	
3 O.	200 lbs. ⁽²⁾ Sulphate Potash, 100 lbs. ⁽³⁾ Sulphate Soda, 100 lbs. Sulphate Magnesia	
4 O.	200 lbs. ⁽²⁾ Sulphate Potash, 100 lbs. ⁽³⁾ Sulphate Soda, 100 lbs. Sulphate Magnesia, 3½ cwt. Superphosphate	
1 A.	200 lbs. Ammonium-salts ⁽⁴⁾	
2 A.	200 lbs. Ammonium-salts, and 3½ cwt. Superphosphate	
3 A.	200 lbs. Ammonium-salts, 200 lbs. ⁽²⁾ Sulph. Potash, 100 lbs. ⁽³⁾ Sulph. Soda, 100 lbs. Sulph. Magnesia	
4 A.	{ 200 lbs. Ammonium-salts, 200 lbs. ⁽²⁾ Sulph. Potash, 100 lbs. ⁽³⁾ Sulph. Soda, 100 lbs. Sulph. Magnesia, } 3½ cwt. Superphosphate	
1 AA.	275 lbs. Nitrate Soda	
2 AA.	275 lbs. Nitrate Soda, and 3½ cwt. Superphosphate	
3 AA.	275 lbs. Nitrate Soda, 200 lbs. ⁽²⁾ Sulph. Potash, 100 lbs. ⁽³⁾ Sulph. Soda, 100 lbs. Sulph. Magnesia	
4 AA.	{ 275 lbs. Nitrate Soda, 200 lbs. ⁽²⁾ Sulph. Potash, 100 lbs. ⁽³⁾ Sulph. Soda, 100 lbs. Sulph. Magnesia, } 3½ cwt. Superphosphate	
1 AAS.	275 lbs. Nitrate Soda, 400 lbs. Silicate Soda ⁽⁵⁾	
2 AAS.	275 lbs. Nitrate Soda, 400 lbs. Silicate Soda, and 3½ cwt. Superphosphate ⁽¹⁾	
3 AAS.	{ 275 lbs. Nitrate Soda, 400 lbs. Silicate Soda, 200 lbs. ⁽²⁾ Sulph. Potash, 100 lbs. ⁽³⁾ Sulph. Soda, 100 lbs. } Sulph. Magnesia	
4 AAS.	{ 275 lbs. Nitrate Soda, 400 lbs. Silicate Soda, 200 lbs. ⁽²⁾ Sulph. Potash, 100 lbs. ⁽³⁾ Sulph. Soda, 100 lbs. } Sulph. Magnesia, and 3½ cwt. Superphosphate	
1 C.	1000 lbs. Rape-cake	
2 C.	1000 lbs. Rape-cake, and 3½ cwt. Superphosphate	
3 C.	1000 lbs. Rape-cake, 200 lbs. ⁽²⁾ Sulph. Potash, 100 lbs. ⁽³⁾ Sulph. Soda, 100 lbs. Sulph. Magnesia	
4 C.	{ 1000 lbs. Rape-cake, 200 lbs. ⁽²⁾ Sulph. Potash, 100 lbs. ⁽³⁾ Sulph. Soda, 100 lbs. Sulph. Magnesia, } 3½ cwt. Superphosphate	
1 N.	275 lbs. Nitrate Soda	
2 N.	275 lbs. ⁽⁹⁾ Nitrate Soda	
5 O.	200 lbs. ⁽²⁾ Sulphate Potash, 3½ cwt. Superphosphate ⁽¹⁰⁾	
5 A.	200 lbs. ⁽²⁾ Sulphate Potash, 3½ cwt. Superphosphate, and 200 lbs. ⁽¹¹⁾ Ammonium-salts	
M.	100 lbs. Sulphate Soda, 100 lbs. Sulphate Magnesia, and 3½ cwt. Superphosphate	
6{1	Unmanured continuously	
2	Ashes (burnt soil and turf)	
7{1	Farmyard Manure 14 tons, 20 yrs., 1852-71; unmanured since	
2	Farmyard Manure 14 tons, every year	

(1) "Superphosphate of Lime," 1852 to 1887 inclusive, made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water); 1888, and since, made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.

(2) 300 lbs. per annum for the first six years, 1852-7.

(3) 200 lbs. per annum for the first six years, 1852-7.

(4) The "Ammonium-salts"—in all cases (excepting in 1887), equal parts Sulphate and Muriate of Ammonia of Commerce. In 1887 Sulphate Ammonia only, 225 lbs. per acre, equal in Nitrogen to the "Ammonium-salts" of previous years.

(5) First 6 years, 1852-7, instead of Nitrate of Soda, 400 lbs. Ammonium-salts per annum; next 10 years, 1858-67, 200 lbs. Ammonium-salts per annum; 1868, and since, 275 lbs. Nitrate of Soda per annum. 275 lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 200 lbs. "Ammonium-salts."

(6) The application of Silicates did not commence until 1864; in 1864-5-6 and 7, 200 lbs. Silicate of Soda and 200 lbs.

FIELD.

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

Barley—29 years, 1852–1880, Chevalier; 10 years, 1881–1890, Archer's Stiff Straw; 7 years, 1891–1897, Carter's Paris Prize; 1898, Archer's Stiff Straw. In the spring of 1894 permanent division paths were laid out between plot and plot. Below is given, besides the usual averages, the produce for both 1896 and 1897.

For Plan of the Plots, and brief summary of results and conclusions, see pp. 24–25. about 4½ acres.)

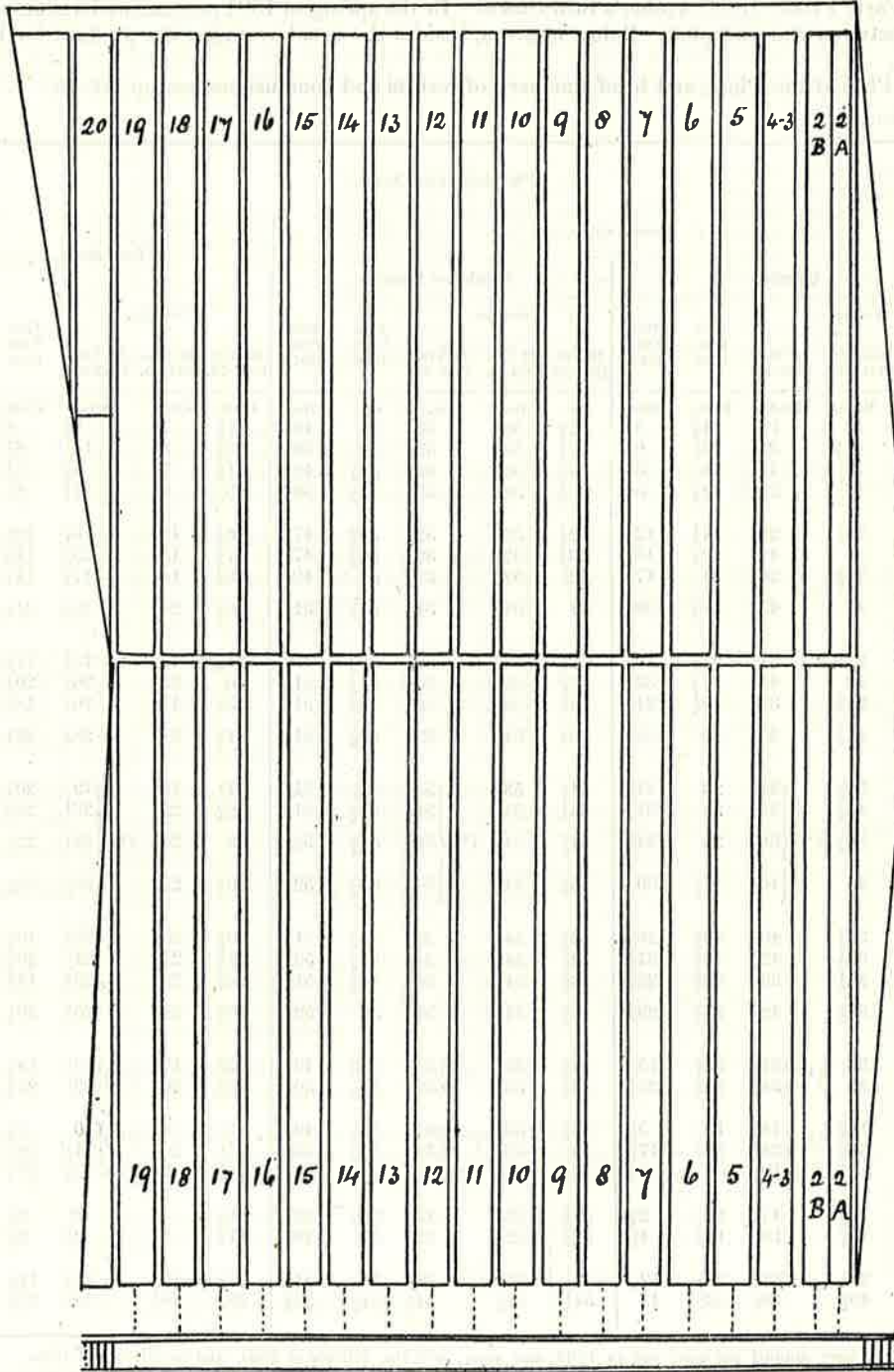
PLOTS.	PRODUCE PER ACRE.															PLOTS.
	Dressed Grain.										Total Straw.					
	Quantity.					Weight per Bushel.					Averages.					
	Averages.			46th Year, 1896.	46th Year, 1897.	Averages.			46th Year, 1896.	46th Year, 1897.	Averages.			46th Year, 1896.	46th Year, 1897.	
	22 Yrs. 1852-73.	22 Yrs. 1874-95.	44 Yrs. 1852-95.			22 Yrs. 1852-73.	22 Yrs. 1874-95.	44 Yrs. 1852-95.			22 Yrs. 1852-73.	22 Yrs. 1874-95.	44 Yrs. 1852-95.			
Bush.	Bush.	Bush.	Bush.	Bush.	lbs.	lbs.	lbs.	lbs.	lbs.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.		
1 O.	19½	13	16½	11½	5	52½	52	52½	54	48	11½	7	9½	8	5½	
2 O.	24½	17½	21½	13½	6½	53½	53½	53½	54	50½	12½	8½	10½	8½	5½	
3 O.	21½	13½	17½	11	3	53½	52½	52½	54½	49½	11½	7½	9½	7½	4	
4 O.	20½	17	21½	14½	5½	53½	52½	53½	54½	50½	13½	8½	11½	8½	5½	
1 A.	32½	28½	28	14½	12	52½	52½	52½	53½	47	18½	12½	15½	10½	11½	
2 A.	46½	37	42	20½	16	53½	52½	52½	50½	47½	27½	19½	23½	14½	15½	
3 A.	34½	26½	30½	21	17½	52½	52½	52½	54	49½	20½	14½	17½	14½	14½	
4 A.	45½	41	43½	41½	30½	54	54½	54½	54½	51½	28½	23½	25½	21½	21½	
1 AA.	36½	27½	31½	21½	17½	52½	52½	52½	52½	49½	21½	15½	18½	17½	14½	
2 AA.	48½	42	45½	37½	32½	53½	53½	53½	54½	51½	30	23½	26½	20½	24½	
3 AA.	36½	28½	32½	25½	21½	52½	52½	52½	53½	51½	23½	17½	20½	18½	18½	
4 AA.	48½	41½	45	35	30½	53½	54½	53½	54½	51½	31½	24½	28½	22½	23½	
1 AAS.	37½	33½	34½	33	24½	54½	53½	53½	53½	51½	21½	19½	19½	20½	21½	
2 AAS.	47½	44½	45½	39	31½	55½	54	54½	55½	51½	28½	25½	26½	22½	27½	
3 AAS.	42	36½	(12) 38	36	24½	54½	54	(12) 54½	54½	52½	25	20½	(12) 22½	22½	19½	
4 AAS.	48½	45	46½	41½	30	55½	54½	54½	55½	52½	30½	27½	28½	23½	22½	
1 C.	44½	36½	40½	36½	26½	53½	54½	53½	55½	51½	26½	20	23½	19½	18½	
2 C.	46½	39½	42½	40½	31½	53½	54½	54½	55½	52½	27½	21½	24½	20½	20½	
2 C.	43	35½	39	32½	25½	53½	54½	54	54½	51½	26½	20	23½	18½	16½	
4 C.	46½	38½	42½	37½	29½	53½	54½	54	56	52	28½	21½	25½	20½	19½	
1 N.	37½	30½	(13) 34	30½	15½	52½	52½	(13) 52½	55½	49½	22½	17½	(13) 19½	18½	17½	
2 N.	41½	35	(13) 38	36½	23½	52½	53½	(13) 53	56½	50½	25½	20½	(13) 22½	22½	20½	
5 O.	22	14½	(13) 18½	13½	5	53½	53½	(13) 53½	55½	49½	11½	8½	(13) 10	9½	6	
5 A.	43½	33½	(13) 38½	31½	17½	53½	53½	(13) 53½	56½	52½	27½	20½	(13) 24½	18½	15	
M.	20	18½	(14) 19½	(15)	(15)	53½	53½	(14) 53½	(15)	(15)	11½	9½	(14) 10½	(15)	(15)	
6(1	21½	14½	17½	12½	2½	52½	52½	52½	53½	49½	11½	7½	9½	8½	5½	
2	21½	15½	18½	13½	4½	52½	52½	52½	54½	49½	11½	8	9½	8½	5½	
7(1	47½	28½	38	22½	12½	54½	54	54½	55½	51½	27½	15½	21½	14½	11	
2	48½	49½	48½	53½	42	54½	54½	54½	54½	53½	28½	30½	29½	27½	29½	

Silicate of Lime were applied per acre, but in 1868, and since, 400 lbs. Silicate of Soda, and no Silicate of Lime. These plots ("AAS") comprise, respectively, one half of the original "AA" plots, and, excepting the addition of the Silicates, have been, and are, in other respects, manured in the same way as the "AA" plots.

- (7) 2000 lbs. Rape-cake per annum for the first six years, and 1000 lbs. only, each year since.
- (8) 300 lbs. Sulphate of Potash, and 3½ cwt. Superphosphate of Lime, without Nitrate of Soda, the first year (1852); Nitrate alone each year since.
- (9) 550 lbs. Nitrate of Soda for 1853-4-5-6, and 7; and 275 lbs. only, each year since.
- (10) Ammonium-salts also the first year, but not since.
- (11) By mistake 400 lbs. in 1880.
- (12) Averages of 10, 22, and 32 years, 1864-95.
- (13) Averages of 21, 22, and 43 years, 1853-95.
- (14) Averages of 16, 18, and 34 years, 1858-78, and 1880-92. The produce of 1879 was not weighed, owing to the foulness of the plot, from the wet season.
- (15) Not recorded.

PLAN OF THE PLOTS IN BROADBALK FIELD,
ON WHICH WHEAT HAS BEEN GROWN
for 55 years in succession, 1843-4 to 1897-8 inclusive.

[For 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 $\frac{1}{10}$ acre.

Area of Plot 20, about $\frac{1}{10}$ 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 and 31.]

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

for 55 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 44 years, 1852–1895, 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 gave very little increase; nitrogenous manures alone gave considerably more than mineral manures alone; but the mixture of the two gave 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 8 out of the 11 cases in which such mixtures were used, the average yield per acre was from 2 to 8 bushels more than the average yield of the United Kingdom (which is rather less than 28 bushels), 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.

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 47 years (1852 and since). The Crop of the present year, 1898, is, therefore, the 55th 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 are 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 1881-2, and since, "Club" or "Square Head" (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 of 1891 and since, however, the full number of rows have again been sown over the whole length of each plot.

(Area under experiment.

PLOTS.	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 avoird.) = (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.
Manures, per acre, per annum.	
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. Sulph. Mag., 3½ cwt. Superphos., 200 lbs. Amm.-salts ⁽³⁾ ..
6 (a and b)	200 lbs. ⁽¹⁾ Sulph. Potash, 100 lbs. ⁽²⁾ Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwt. Superphos., 400 lbs. Amm.-salts ⁽⁴⁾ ..
7 (a and b)	200 lbs. ⁽¹⁾ Sulphate Potash, 100 lbs. ⁽²⁾ Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwt. Superphos., 600 lbs. Amm.-salts ⁽⁵⁾ ..
8 (a and b)	200 lbs. ⁽¹⁾ Sulphate Potash, 100 lbs. ⁽²⁾ Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwt. Superphos., 275 lbs. Nitrate Soda ⁽⁶⁾ ..
9 { a	200 lbs. ⁽¹⁾ Sulph. Potash, 100 lbs. ⁽²⁾ Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwt. Superphos., 275 lbs. Nitrate Soda ⁽⁶⁾ ..
9 { b	275 lbs. Nitrate of Soda ⁽⁶⁾ . (For the Crops of 1894 and since, Plot 9b has received the same manures as Plot 9a.)
10 { a	400 lbs. Ammonium-salts alone, for 1845, and each year since (except '46 and '50); Mineral Manure '44, '48, '50 ..
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 cwt. Superphosphate
12 (a and b)	400 lbs. Ammonium salts, 3½ cwt. Superphosphate, and 366½ lbs. ⁽⁶⁾ Sulphate of Soda
13 (a and b)	400 lbs. Ammonium-salts, 3½ cwt. Superphosphate, and 200 lbs. ⁽⁶⁾ Sulphate of Potash
14 (a and b)	400 lbs. Ammonium-salts, 3½ cwt. Superphosphate, and 280 lbs. ⁽⁶⁾ Sulphate of Magnesia
15 { a	200 lbs. ⁽¹⁾ Sul. Pot., 100 lbs. ⁽²⁾ Sul. Sod., 100 lbs. Sul. Mag., 3½ cwt. Super. ⁽⁷⁾ ; 400 lbs. Amm.-salts, in Autm. ⁽⁸⁾ ..
15 { b	200 lbs. ⁽¹⁾ Sul. Pot., 100 lbs. ⁽²⁾ Sul. Sod., 100 lbs. Sul. Mag., 3½ cwt. 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 cwt. Superphos., and 800 lbs. Ammonium-salts; average produce 39½ bush. Grain, 46½ cwt. Straw 1865-1883, 19 years unmanured; average produce (19 years, 1865-83) 14½ bushels Grain, 12½ cwt. Straw .. 1884 and since, 200 lbs. Sul. Potash, 100 lbs. Sul. Soda, 100 lbs. Sul. Mag., 3½ cwt. Super., 550 lbs. Nitrate Soda ..
17 (a and b)	400 lbs. Ammonium-salts
18 (a and b)	200 lbs. ⁽¹⁾ Sulphate Potash, 100 lbs. ⁽²⁾ Sulphate Soda, 100 lbs. Sulphate Mag., and 3½ cwt. Superphosphate ..
19	{ 1878-9 to '81-2, 1700 lbs., '83 and since 1889 lbs. Rape-cake, in Autumn. Previously, '52-78, 3½ cwt. Superph. Lime ⁽²⁾ , 300 lbs. Sul. Am., and 500 lbs. Rape-cake; av. prod. (27 yrs., '52-78) 29½ bush. Grain, 27½ cwt. 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. Sulph. 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, and since, made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.
 (4) The "Ammonium-salts," in all cases (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.
 (5) 9a, 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. 9b, 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) 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.
 (9) For 1872 and previously, 300 lbs. Sulphate Ammonia and 500 lbs. Rape-cake, 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.
 (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.

FIELD.

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

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 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 the second 20, and for the 40 years, to 1891 inclusive, as given in the *Memoranda* for 1893, those given for the second 21, and for the 42 years, to 1893 inclusive, as given in the *Memoranda* for 1895 and 1896, and those now given for the second 22, and for the 44 years, in the Table below, 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 1894, 1895, 1896, and 1897, 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 1896 and 1897.

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.															PLOTS.	
		Dressed Grain.										Total Straw.						
		Quantity.					Weight per Bushel.					Averages.						
		Averages.			53rd Year, 1896.	54th Year, 1897.	Averages.			53rd Year, 1896.	54th Year, 1897.	Averages.			53rd Year, 1896.	54th Year, 1897.		
22 Yrs., 1852-73.	22 Yrs., 1874-95.	44 Yrs., 1852-95.			22 Yrs., 1852-73.	22 Yrs., 1874-95.	44 Yrs., 1852-95.			22 Yrs., 1852-73.	22 Yrs., 1874-95.	44 Yrs., 1852-95.						
Bush.	Bush.	Bush.	Bush.	Bush.	lbs.	lbs.	lbs.	lbs.	lbs.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.				
2	1	..	..	..	40	32	..	63 3/4	61 1/2	..	..	..	40 5/8	29 1/2		
3	2	35 1/2	34 7/8	35	44	37 1/2	60	60 7/8	60 1/2	64	61 1/2	33 3/8	32	32 3/4	44 1/2	34 1/2		
4	3	14 1/2	11 3/4	12 1/2	16 3/4	8 1/2	57 3/4	59 1/2	58 1/2	61 1/2	60 1/2	12 3/8	8 1/2	10 1/2	11 3/4	7 3/4		
5	4	15 1/2	11 1/2	13 1/2	16 1/4	9 3/4	58 1/4	59 1/2	58 1/2	61 5/8	59 1/4	13 3/8	8 1/2	10 1/2	11 7/8	8 3/8		
6	5	16 3/4	13 3/8	15	20 1/2	12 7/8	58 3/8	59 3/8	59	61 1/2	59 1/2	14 3/8	9 3/4	12 1/2	15	10 3/8		
7	6	25 3/4	22 3/4	24 1/2	29 7/8	19 3/8	59 3/8	60 1/2	60	62 1/2	60 7/8	24	19 3/8	21 1/2	24	17		
8	7	34 1/2	31 3/4	33 1/2	37 1/4	28 3/8	59 1/4	60 3/4	60	63 7/8	61 1/4	34 3/8	31 3/8	33	33 3/8	28 1/4		
9	8	37 3/4	35 1/2	36 1/2	44 1/2	37	59	60 1/2	59 3/4	64 1/2	61 3/4	40 3/8	39 3/8	40 1/2	45 1/2	39		
10	9	37	32 1/2	34 1/2	32 1/2	25 3/8	58 3/8	60 1/2	59 1/2	62	60 3/8	42	34 3/8	38 3/8	28 3/8	26		
11	10	25 3/4	19 3/4	22 3/4	33 1/4	23 3/8	56 1/2	57 3/8	57	62 1/4	60 1/2	28	17 7/8	22 7/8	28 3/8	23 3/8		
12	11	22 1/2	17	19 1/2	21 3/4	17 1/2	57	57 3/4	57 3/4	62 1/2	58 3/8	21 3/8	14	17 1/2	18 3/8	15 7/8		
13	12	25 1/2	18 3/4	21 1/2	22 1/2	16 1/2	57 3/4	57 3/4	57 3/4	62 1/2	58 1/2	24 1/2	15 3/8	19 7/8	19 1/2	16 3/8		
14	13	27 3/8	21 3/4	24 3/4	24	16	57 3/8	58 1/8	57 1/2	62 1/2	57 3/8	26	20 1/2	23 1/2	22 7/8	18 1/2		
15	14	33 1/2	27 3/4	30 1/2	34	21 7/8	59 3/8	59 3/8	59 1/2	62 3/8	59	31 3/8	25 3/8	28 1/2	29 3/8	21 3/8		
16	15	33 1/2	30	31 1/2	34	27 3/8	59 3/8	60 1/2	60 1/2	63 3/8	60 3/8	33 3/8	29 3/8	31 3/8	30 3/8	27 1/2		
17	16	33 1/2	28 1/2	30	29 3/8	19 1/2	59 1/2	59 1/2	59 3/8	63	59 1/4	32 1/2	26 3/8	29 3/8	25 3/8	20 1/2		
18	15	32 3/8	28 3/8	31	30 3/8	20 1/2	59 3/8	60 1/2	60	62 1/2	60 3/8	32 3/8	26 3/8	30	26 3/8	19 1/2		
19	16	33 3/8	28 3/8	31	30 3/8	20 1/2	59 3/8	60 1/2	60	62 1/2	60 3/8	32 3/8	26 3/8	30	26 3/8	19 1/2		
20	17	30 5/8	24 3/8	27 3/8	37 3/8	27 1/2	58 7/8	59 1/2	59 1/2	63 3/8	60 1/2	33 7/8	24 3/8	29 3/8	35 1/2	32 7/8		
21	18	30 7/8	29 3/8	(14) 30 1/2	35 3/8	11 (16)	59 3/8	60 1/2	(14) 60	63 3/8	59 3/8 (16)	30 3/8	27 1/2	(14) 28 7/8	31 3/8	10 1/2 (16)		
22	19	17 1/2	13 3/4	(15) 15 1/2	17	30 1/2 (17)	58 7/8	59 3/8	(15) 59 1/2	61 1/2	61 3/8 (17)	15 3/8	11	(15) 13 3/8	1 3/4	29 1/2 (17)		
23	20	30 1/2	26 1/2	28 1/2	36	22	58 3/8	59 3/8	59	61 1/2	60 1/2	28 3/8	23	25 3/8	32 1/2	21		
24	21	14 1/2	13 1/2	(18) 13 1/2	14	8	57 3/8	58 3/8	(18) 58 1/2	61 1/2	61 1/2	13 3/8	10	(18) 11 3/8	9 3/4	8		
25	22	21 1/2	16 3/4	(19) 19	..	..	58 3/8	58 3/8	(19) 58 3/8	..	..	19 3/8	13 7/8	(19) 16 7/8	..	..
26	23	21	17 3/4	(19) 19 3/8	..	..	58 1/2	58 3/8	(19) 58 3/8	..	..	19 1/2	14 3/8	(19) 17 1/2	..	..

(11) The Manures of Plots 17 and 18 are, year by year, transposed. (12) Made with Muratic 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 Ammonium-salts, alternated with Mineral Manures. (15) Averages of Mineral Manures, alternated with Ammonium-salts.
 (16) Plot 17 had the Mineral Manure for the Crop of 1897. (17) Plot 18 had the Ammonium-salts for the Crop of 1897.
 (18) Averages of 21, 22, and 43 years only; as, in 1868, owing to a mistake in carting, the produce could not be ascertained.
 (19) The Plots marked "a and b" were, up to 1893 inclusive, divided into 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 16. For the crop of 1880 and since the return of the straw has been discontinued. (19) Averages of 16, 16, and 32 years, 1852-83.

EXPERIMENTS ON WHEAT ALTERNATED WITH FALLOW, AND WHEAT GROWN CONTINUOUSLY.

The results given in the following Table show the produce of Wheat obtained on the Rothamsted soil for many years in succession, after bare fallow, compared with that of wheat grown continuously year after year on the same land, without the intervention of fallow; in both cases without manure.

Hoos-field, in which the experiments on alternate wheat and fallow are conducted, adjoins *Broadbalk-field*, in which wheat has now been grown continuously without manure (also with different descriptions of manure), for 55 years in succession; and the produce of the unmanured plot of that field, is compared with that grown in alternation with fallow, also without manure, in *Hoos-field*.

The description of seed sown has been the same in the two fields in the corresponding years; namely—for the crop of 1852 "Red Cluster"; for 28 years, 1854 to 1881 inclusive, "Red Rostock"; and for 1882 and since, "Club" or "Square Head" (Red). During the first or preliminary period of 5 years, 1851-1855, the cropping of the acre set apart for the experiment on wheat alternated with fallow was as follows:—1851, Fallow (after wheat in 1850); 1852, Wheat; 1853, Fallow; 1854, Wheat; 1855, half Fallow, and half Wheat. From that time to the present the respective halves have been alternately fallow and wheat, giving therefore a crop of wheat succeeding fallow, on half the acre each year.

In the upper division of the Table are given the results for each of the five years of the preliminary period; and in the main division are recorded the results for each individual year of the exact experiment, from 1856 up to the present time.

In the first column of each main vertical division of the Table is given the produce per acre under experiment, 1 acre.)

acre, on the half acre of wheat after fallow; and in the second column the produce per acre obtained in the adjoining field (Broadbalk), where wheat is grown year after year on the same land. Lastly, in the third column of each of the vertical divisions is given the amount of produce after fallow, + or - that grown year after year on the same land.

The results for the individual years show that during the earlier years of the experiments on alternate wheat and fallow, when the accumulations due to previous treatment were less exhausted, the produce after fallow was more in excess of that grown in the adjoining field year after year on the same land than afterwards. Referring to the two sets of averages at the foot of the Table, it is seen that if (as in the upper of the two divisions), the produce after fallow is reckoned at the yield per acre of the half in crop each year, it gives on the average several bushels more grain, and also more straw, per acre per annum, than where the crop is grown continuously. On the other hand, if the produce after fallow is reckoned (as in the bottom division) at the yield per acre of the whole area, half in crop and half fallow, it gives several bushels less grain, and also less straw, per acre per annum, than where the crop is grown year after year on the same land.

The conclusion to be drawn is, that although there is an increase of produce after fallow compared with that of wheat grown continuously, it is obtained at the sacrifice of a crop every other year; and that a given area of land yields more when the crop is grown year after year than when alternated with fallow. The explanation doubtless is, that much of the nitrogen brought into an available condition under the influence of the fallow, is lost by drainage during the long period that the land is without a crop.

Year	Dressed Grain.		Weight per Bushel.		Total Grain.		Total Straw.		Total Produce (Grain and Straw).	
	Wheat after Fallow each year.	Wheat after Fallow + or - after Wheat.	Wheat after Fallow each year.	Wheat after Fallow each year.	Wheat after Fallow each year.	Wheat after Fallow + or - after Wheat.	Wheat after Fallow each year.	Wheat after Fallow + or - after Wheat.	Wheat after Fallow each year.	Wheat after Fallow + or - after Wheat.
1851	Bushels. Fallow 37	Bushels. - 157	lbs. Fallow 61.1	lbs. Fallow 1083	lbs. Fallow 2088	lbs. Fallow 4934	lbs. Fallow 1627	lbs. Fallow 7022	lbs. Fallow 2710	lbs. Fallow - 2710
1852	Fallow 42	+ 23 1/2	Fallow 53.0	860	Fallow 2709	1228	1597	+ 3337	2457	+ 4565
1853	17 1/2	+ 21	54.0	1072	1080	1734	1413	Fallow 7254	1772	- 1772
1854	24 1/2	+ 0 1/2	59.2	828	1440	2150	2137	2814	3496	+ 3758
1855	21 1/2	+ 11	60.6	828	1440	2150	1787	2814	2859	- 45
1856	21 1/2	+ 7 1/2	60.0	892	1388	2113	1558	3501	2450	+ 1051
1857	38	+ 18	58.3	1236	2299	3075	1577	5374	2813	+ 2361
1858	25 1/2	+ 7 1/2	60.4	1141	1630	2468	1670	4098	2811	+ 1287
1859	34	+ 15 1/2	55.0	1051	1376	3686	2175	5662	3226	+ 2436
1860	121	+ 0 1/2	52.5	738	1226	2626	1459	1923	2197	- 274
1861	17 1/2	+ 6 1/2	57.4	736	1145	2072	1254	3217	1990	+ 1227
1862	22 1/2	+ 6 1/2	57.8	996	1361	2294	1713	3655	2709	+ 946
1863	32 1/2	+ 15 1/2	61.4	1127	2090	2900	1600	4990	2727	+ 2263
1864	31 1/2	+ 14 1/2	61.7	1078	2005	2746	1350	4751	2428	+ 2323
1865	24 1/2	+ 11	57.6	828	1440	2150	1033	3590	1861	+ 1729

PERIOD OF EXACT COMPARISON.

Year	Dressed Grain.		Weight per Bushel.		Total Grain.		Total Straw.		Total Produce (Grain and Straw).	
	Wheat after Fallow each year.	Wheat after Fallow + or - after Wheat.	Wheat after Fallow each year.	Wheat after Fallow each year.	Wheat after Fallow each year.	Wheat after Fallow + or - after Wheat.	Wheat after Fallow each year.	Wheat after Fallow + or - after Wheat.	Wheat after Fallow each year.	Wheat after Fallow + or - after Wheat.
1856	Bushels. Fallow 21 1/2	Bushels. - 157	lbs. Fallow 61.1	lbs. Fallow 1083	lbs. Fallow 2088	lbs. Fallow 4934	lbs. Fallow 1627	lbs. Fallow 7022	lbs. Fallow 2710	lbs. Fallow - 2710
1857	38	+ 23 1/2	Fallow 53.0	860	Fallow 2709	1228	1597	+ 3337	2457	+ 4565
1858	25 1/2	+ 21	54.0	1072	1080	1734	1413	Fallow 7254	1772	- 1772
1859	121	+ 0 1/2	59.2	828	1440	2150	2137	2814	3496	+ 3758
1860	17 1/2	+ 0 1/2	60.6	828	1440	2150	1787	2814	2859	- 45
1861	21 1/2	+ 7 1/2	60.0	892	1388	2113	1558	3501	2450	+ 1051
1862	32 1/2	+ 15 1/2	58.3	1236	2299	3075	1577	5374	2813	+ 2361
1863	31 1/2	+ 14 1/2	60.4	1141	1630	2468	1670	4098	2811	+ 1287
1864	24 1/2	+ 7 1/2	55.0	1051	1376	3686	2175	5662	3226	+ 2436
1865	21 1/2	+ 6 1/2	52.5	738	1226	2626	1459	1923	2197	- 274
1866	17 1/2	+ 6 1/2	57.4	736	1145	2072	1254	3217	1990	+ 1227
1867	22 1/2	+ 6 1/2	57.8	996	1361	2294	1713	3655	2709	+ 946
1868	32 1/2	+ 15 1/2	61.4	1127	2090	2900	1600	4990	2727	+ 2263
1869	31 1/2	+ 14 1/2	61.7	1078	2005	2746	1350	4751	2428	+ 2323
1870	24 1/2	+ 11	57.6	828	1440	2150	1033	3590	1861	+ 1729

1866	10 1/2	12 1/2	1 1/2	58.5	61.3	653	777	124	1146	1269	123	1799	2046	247	1866
1867	9 1/2	8 1/2	0 1/2	58.2	56.1	616	582	84	1126	973	133	1742	1505	237	1867
1868	25	10 1/2	4	63.4	61.0	1686	1054	193	2398	973	1425	4054	2027	2027	1868
1869	10 1/2	14 1/2	4 1/2	60.1	56.1	655	848	130	1019	1350	331	1674	2198	524	1869
1870	17 1/2	15	2 1/2	62.5	61.8	1101	956	145	1282	1046	286	2383	2002	881	1870
1871	9 1/2	10 1/2	0	58.5	54.8	605	615	10	1287	1100	187	1892	1715	177	1871
1872	12 1/2	11 1/2	2	58.3	59.0	780	705	75	1307	1152	155	2087	1857	230	1872
1873	2 1/2	11 1/2	9	42.0	57.0	181	701	520	875	902	27	1036	1603	547	1873
1874	21 1/2	11 1/2	10	60.0	58.3	1370	694	676	2000	990	1010	3370	1684	1684	1874
1875	16 1/2	8 1/2	7 1/2	57.2	60.0	993	567	426	1725	1008	717	2718	1575	1143	1875
1876	10 1/2	8 1/2	2 1/2	58.7	59.0	635	500	135	790	642	148	1425	1142	283	1876
1877	10 1/2	8 1/2	1 1/2	60.5	58.9	649	543	106	829	748	81	1478	1291	187	1877
1878	19 1/2	12 1/2	7 1/2	57.9	59.0	1171	776	395	1684	1081	573	2325	1857	968	1878
1879	6	4 1/2	1 1/2	55.6	52.5	379	379	49	808	763	45	1187	1093	94	1879
1880	15 1/2	11 1/2	3 1/2	58.7	56.9	937	689	248	1665	1149	516	2602	1838	764	1880
1881	12 1/2	13 1/2	1 1/2	54.6	58.0	748	863	115	897	1146	249	1645	2009	364	1881
1882	11 1/2	11 1/2	0	58.6	58.7	719	679	40	1085	1095	10	1804	1774	30	1882
1883	18 1/2	13 1/2	4 1/2	61.2	61.2	1160	872	288	1301	1006	295	2461	1878	583	1883
1884	20 1/2	13 1/2	7 1/2	60.2	62.1	1240	824	416	1344	905	639	2784	1729	1055	1884
1885	23 1/2	15 1/2	7 1/2	57.9	59.0	1351	925	426	1812	1137	675	3163	2062	11101	1885
1886	9 1/2	9	0 1/2	62.2	61.5	588	564	24	657	570	87	1245	1134	111	1886
1887	19 1/2	14 1/2	4 1/2	59.9	59.8	1153	906	247	1212	895	317	2365	1801	564	1887
1888	12 1/2	10 1/2	2 1/2	56.1	58.8	735	614	121	1239	901	338	1974	1515	459	1888
1889	13 1/2	12 1/2	0 1/2	59.5	59.8	796	743	53	916	902	14	1712	1645	67	1889
1890	17 1/2	14 1/2	3 1/2	59.8	59.4	1088	849	239	1657	1004	653	2745	1853	892	1890
1891	23 1/2	13 1/2	9 1/2	58.9	57.4	1404	828	576	2241	1314	927	3645	2142	1503	1891
1892	11 1/2	9 1/2	2 1/2	60.2	59.6	731	589	142	1108	836	272	1839	1425	414	1892
1893	13 1/2	9 1/2	3 1/2	62.4	62.7	870	609	228	854	609	245	1724	1251	473	1893
1894	18 1/2	18 1/2	2 1/2	59.7	60.2	953	1121	168	1483	1487	4	2436	2608	172	1894
1895	15 1/2	10 1/2	5 1/2	62.2	62.5	978	664	314	1151	720	431	2129	1884	745	1895
1896	16 1/2	16 1/2	0 1/2	60.7	61.4	1020	1087	67	1312	1309	3	2332	2396	64	1896
1897	7 1/2	8 1/2	1 1/2	59.5	60.3	460	592	132	710	867	157	1170	1459	289	1897

AVERAGES—PRODUCE AFTER FALLOW RECKONED AT THE YIELD PER ACRE OF THE HALF IN CROP EACH YEAR.

5 yrs. 1851-'55	19 1/2	14 1/2	4 1/2	55.8	56.7	1175	947	228	2243	1712	531	3418	2659	759	5 yrs. 1851-'55
10 yrs. 1856-'65	26 1/2	15 1/2	10 1/2	58.5	57.9	1603	982	621	2473	1539	934	4076	2521	1555	10 yrs. 1856-'65
10 yrs. 1866-'75	13 1/2	11 1/2	1 1/2	57.9	58.5	861	745	116	1417	1076	341	2378	1821	457	10 yrs. 1866-'75
10 yrs. 1876-'85	14 1/2	11 1/2	3 1/2	58.4	58.5	899	700	199	1238	967	271	2137	1667	470	10 yrs. 1876-'85
10 yrs. 1886-'95	15 1/2	12 1/2	3	60.1	60.2	930	752	178	1252	924	328	2182	1676	506	10 yrs. 1886-'95
40 yrs. 1856-'95	17 1/2	12 1/2	4 1/2	58.7	58.8	1073	795	278	1595	1127	468	2668	1921	747	40 yrs. 1856-'95

AVERAGES—PRODUCE AFTER FALLOW RECKONED AT THE YIELD PER ACRE OF THE WHOLE AREA, HALF IN CROP AND HALF FALLOW.

5 yrs. 1851-'55	9 1/2	14 1/2	5 1/2	58.7	58.8	587	947	360	1122	1712	590	1709	2659	950	5 yrs. 1851-'55
10 yrs. 1856-'65	13	15 1/2	2 1/2	80.2	80.2	802	982	180	1236	1539	303	2038	2521	488	10 yrs. 1856-'65
10 yrs. 1866-'75	6 1/2	11 1/2	5 1/2	430	430	430	745	315	709	1076	367	1139	1821	682	10 yrs. 1866-'75
10 yrs. 1876-'85	7 1/2	11 1/2	3 1/2	449	449	449	700	251	619	967	348	1068	1667	599	10 yrs. 1876-'85
10 yrs. 1886-'95	7 1/2	12 1/2	4 1/2	465	465	465	752	287	626	924	298	1091	1676	585	10 yrs. 1886-'95
40 yrs. 1856-'95	8 1/2	12 1/2	4 1/2	536	536	536	795	259	798	1127	329	1334	1921	587	40 yrs. 1856-'95

GEESCROFT

EXPERIMENTS ON THE GROWTH OF OATS YEAR AFTER YEAR ON THE SAME

Previous Cropping—1847 and 1848, Clover, Experimental Manures; 1849—1859, Beans, Experimental Manures; 1860, Fallow; 1861 and 1862, Wheat, Unmanured; 1863, Fallow; 1864, Beans, Dunged; 1865, Wheat, Unmanured; 1866, Beans, Unmanured; 1867 and 1868, Wheat, Unmanured.

(Area under experiment,

PLOTS.	MANURES, PER ACRE, PER ANNUM.	PRODUCE PER ACRE.					
		1ST SEASON, 1869.			2ND SEASON, 1870.		
		Dressed Grain.		Total Straw.	Dressed Grain.		Total Straw.
		Quantity.	Weight per Bushel.		Quantity.	Weight per Bushel.	
		Bushels.	lbs.	cwts.	Bushels.	lbs.	cwts.
1	Unmanured	36 $\frac{3}{8}$	36 $\frac{3}{8}$	19 $\frac{1}{4}$	16 $\frac{3}{8}$	35	9 $\frac{1}{2}$
2	{ 200 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, 100 lbs. Sulphate Magnesia, and 3 $\frac{1}{2}$ cwts. Superphosphate of Lime ⁽¹⁾ }	45	38 $\frac{1}{2}$	24 $\frac{1}{2}$	19 $\frac{1}{8}$	35 $\frac{1}{8}$	9 $\frac{5}{8}$
3	400 lbs. Ammonium-salts ⁽²⁾	56 $\frac{1}{2}$	37 $\frac{1}{2}$	36 $\frac{1}{8}$	30	34 $\frac{1}{8}$	17 $\frac{1}{2}$
4	{ 400 lbs. Ammonium-salts, 200 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, 100 lbs. Sulphate Magnesia, and 3 $\frac{1}{2}$ cwts. Superphosphate .. }	75 $\frac{1}{4}$	39 $\frac{1}{4}$	54	50 $\frac{3}{8}$	36	28 $\frac{3}{8}$
5	550 lbs. Nitrate of Soda ⁽³⁾	62 $\frac{1}{4}$	38 $\frac{1}{2}$	42 $\frac{3}{4}$	36 $\frac{1}{2}$	35 $\frac{1}{4}$	23
6	{ 550 lbs. Nitrate of Soda, 200 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, 100 lbs. Sulphate Magnesia, and 3 $\frac{1}{2}$ cwts. Superphosphate .. }	69 $\frac{3}{8}$	38 $\frac{1}{2}$	49 $\frac{1}{8}$	50	35 $\frac{3}{8}$	28 $\frac{3}{8}$

SECOND 5 YEARS ; MINERAL MANURES AS BEFORE,

		6TH SEASON, 1874.			7TH SEASON, 1875.		
		Bushels.	lbs.	cwts.	Bushels.	lbs.	cwts.
1	Unmanured	12	31 $\frac{1}{2}$	7	12 $\frac{1}{2}$	29 $\frac{3}{8}$	5 $\frac{1}{8}$
2	{ 200 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, 100 lbs. Sulphate Magnesia, and 3 $\frac{1}{2}$ cwts. Superphosphate of Lime ⁽¹⁾ }	13 $\frac{3}{8}$	31 $\frac{1}{2}$	6 $\frac{1}{2}$	13 $\frac{1}{8}$	29 $\frac{3}{8}$	6 $\frac{1}{8}$
3	200 lbs. Ammonium-salts ⁽²⁾	37 $\frac{1}{4}$	33 $\frac{1}{4}$	22 $\frac{7}{8}$	30 $\frac{3}{8}$	32 $\frac{7}{8}$	15 $\frac{3}{8}$
4	{ 200 lbs. Ammonium-salts, 200 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, 100 lbs. Sulphate Magnesia, and 3 $\frac{1}{2}$ cwts. Superphosphate .. }	46 $\frac{3}{8}$	34 $\frac{3}{8}$	24 $\frac{3}{8}$	30 $\frac{3}{8}$	34 $\frac{7}{8}$	20 $\frac{1}{4}$
5	275 lbs. Nitrate of Soda ⁽³⁾	35 $\frac{1}{8}$ ⁽⁴⁾	30 ⁽⁴⁾	16 $\frac{1}{2}$ ⁽⁴⁾	23 $\frac{1}{2}$ ⁽⁴⁾	31 $\frac{1}{4}$ ⁽⁴⁾	11 $\frac{3}{8}$ ⁽⁴⁾
6	{ 275 lbs. Nitrate of Soda, 200 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, 100 lbs. Sulphate Magnesia, and 3 $\frac{1}{2}$ cwts. Superphosphate .. }	28 $\frac{1}{4}$ ⁽⁴⁾	33 $\frac{1}{2}$ ⁽⁴⁾	16 $\frac{3}{8}$ ⁽⁴⁾	28 $\frac{3}{8}$ ⁽⁴⁾	33 $\frac{3}{8}$ ⁽⁴⁾	14 $\frac{1}{2}$ ⁽⁴⁾

(1) "Superphosphate of Lime"—in all cases, made from 200 lbs. Bone-ash, 150 lbs. Sulphuric Acid sp. gr. 1.7 (and water).
 (2) "Ammonium-salts"—in each case, equal parts Sulphate and Muriate of Ammonia of Commerce.
 (3) 550 lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 400 lbs. "Ammonium-salts."
 (4) On these plots, where large quantities of Nitrate of Soda had been applied year after year, the land, though more worked, was so wet that it could not be got into favourable condition for sowing, and the plant was very irregular.

FIELD.

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

The first Experimental Oat Crop was in 1869; the last in 1878, since which, owing to the wetness and the foulness of the land for several years, it was left fallow; and the experiment is now discontinued. Description of Oats—Black Tartarian every year excepting 1874, when White Tartarian were sown.

$\frac{3}{4}$ acre.)

PRODUCE PER ACRE.

3RD SEASON, 1871.			4TH SEASON, 1872.			5TH SEASON, 1873.			AVERAGE PER ANNUM 5 YEARS, 1869-1873.		
Dressed Grain.		Total Straw.	Dressed Grain.		Total Straw.	Dressed Grain.		Total Straw.	Dressed Grain.		Total Straw.
Quantity.	Weight per Bushel.		Quantity.	Weight per Bushel.		Quantity.	Weight per Bushel.		Quantity.	Weight per Bushel.	
Bushels.	lbs.	cwts.	Bushels.	lbs.	cwts.	Bushels.	lbs.	cwts.	Bushels.	lbs.	cwts.
20 $\frac{1}{2}$	33 $\frac{1}{2}$	11 $\frac{1}{4}$	15	36 $\frac{1}{2}$	7 $\frac{1}{2}$	10 $\frac{1}{2}$	27 $\frac{1}{2}$	5 $\frac{3}{8}$	19 $\frac{1}{2}$	33 $\frac{3}{4}$	10 $\frac{3}{8}$
22	35 $\frac{1}{2}$	13 $\frac{1}{2}$	19 $\frac{1}{2}$	37 $\frac{3}{4}$	10 $\frac{3}{8}$	17	28 $\frac{1}{2}$	8 $\frac{1}{2}$	24 $\frac{1}{2}$	35	13 $\frac{3}{8}$
57 $\frac{1}{2}$	36 $\frac{3}{8}$	40 $\frac{3}{8}$	55 $\frac{3}{8}$	37 $\frac{1}{2}$	30 $\frac{3}{8}$	36 $\frac{1}{2}$	32 $\frac{3}{8}$	16 $\frac{3}{8}$	47	35 $\frac{1}{2}$	28 $\frac{1}{2}$
58 $\frac{3}{8}$	35 $\frac{3}{8}$	50	62 $\frac{3}{8}$	39 $\frac{1}{2}$	45 $\frac{1}{2}$	48 $\frac{1}{2}$	34 $\frac{3}{8}$	27 $\frac{3}{8}$	59	37	41 $\frac{1}{2}$
55	36 $\frac{3}{8}$	34 $\frac{3}{8}$	42 $\frac{3}{8}$	36 $\frac{3}{8}$	20 $\frac{3}{8}$	39 $\frac{3}{8}$	30 $\frac{1}{2}$	16 $\frac{1}{2}$	47 $\frac{1}{2}$	35 $\frac{1}{2}$	27 $\frac{1}{2}$
60 $\frac{1}{4}$	33 $\frac{3}{8}$	48 $\frac{3}{8}$	44 $\frac{3}{8}$	37 $\frac{1}{2}$	24	63 $\frac{1}{2}$	33 $\frac{3}{8}$	24	57 $\frac{1}{2}$	35 $\frac{3}{8}$	35

AMMONIUM-SALTS AND NITRATE OF SODA ONLY HALF AS MUCH AS PREVIOUSLY.

8TH SEASON, 1876 (*).			9TH SEASON, 1877 (*). FALLOW.			10TH SEASON, 1878.			AVERAGE PER ANNUM 4 YEARS, 1874, '5, '6, and '8.		
Bushels.	lbs.	cwts.	Bushels.	lbs.	cwts.	Bushels.	lbs.	cwts.	Bushels.	lbs.	cwts.
8 $\frac{1}{2}$	32	2 $\frac{3}{8}$	..	..	..	22 $\frac{1}{2}$	32	8 $\frac{3}{8}$	13 $\frac{3}{8}$	31 $\frac{1}{2}$	6
7 $\frac{3}{8}$	30	2 $\frac{3}{8}$	..	..	..	17 $\frac{3}{8}$	35 $\frac{1}{2}$	8 $\frac{1}{2}$	13 $\frac{1}{2}$	31 $\frac{1}{2}$	6 $\frac{1}{2}$
17 $\frac{3}{8}$	34 $\frac{1}{2}$	6	..	..	..	30	32 $\frac{3}{8}$	12 $\frac{3}{8}$	28 $\frac{1}{2}$	33 $\frac{1}{2}$	14 $\frac{1}{2}$
29 $\frac{1}{2}$	35 $\frac{1}{2}$	12 $\frac{1}{2}$	..	..	..	45 $\frac{3}{8}$	37	22 $\frac{1}{2}$	38	35 $\frac{1}{2}$	20
12 $\frac{3}{8}$	30 $\frac{1}{2}$	3 $\frac{1}{2}$	..	..	..	34 $\frac{1}{2}$	34 $\frac{1}{2}$	12 $\frac{1}{2}$	26 $\frac{3}{8}$	31 $\frac{1}{2}$	11 $\frac{1}{2}$
19 $\frac{3}{8}$	33 $\frac{1}{2}$	8	..	..	..	37	36 $\frac{1}{2}$	17 $\frac{1}{2}$	28 $\frac{1}{2}$	34 $\frac{1}{2}$	14

(* Owing to the extremely wet condition of the land, especially on the Nitrate plots, it was not sown until April 6, and then with a very unfavourable seed bed; and, there being a heavy fall of snow a week later, the plant came up very irregularly, and much of it perished from standing surface-water.

(*) Owing to the very wet winter, 1876-7, the land could not be worked in time for sowing, and was therefore left fallow in 1877; no manures being applied.

The experiments were discontinued after 1878.

PLAN OF THE PLOTS IN HOOS FIELD,
ON WHICH EXPERIMENTS HAVE BEEN MADE
ON LEGUMINOUS PLANTS.

50 years, commencing 1849.

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

Series III	Series II	Series I
6	6	6
5	5	5
4	4	4
3	3	3
2	2	Vetch
		Red Clover
		White Clover
		Sainfoin
		Bokhara Clover
		Beans (or Peas)
1	1	Lucerne
		Small Beds see pp. 41, 42.
Series III	Series II	Series I

Total area under experiment about 3 acres, divided into 3 Series.

Each Series about 1 acre, divided into 6 differently manured plots.

Series I. Mineral Manures only;

Series II. The Mineral Manures, and Nitrate of Soda;

Series III. The Mineral Manures, and Ammonium-salts or Rape-cake, etc.

There are now 7 different Leguminous plants growing on *each* plot, namely—Lucerne, Beans (or Peas), Bokhara Clover, Sainfoin, White Clover, Red Clover, and Vetch; as indicated on Plot 2, Series I.

In the spring of 1898, owing to the growing foulness of the plots in recent years, Plot 1 of Series I. (Small Beds), and all the Plots (1-6), of Series II, and Series III, were ploughed up for thorough cleaning; after which the future treatment of them will be considered. At present the experiments are confined to Plots 2, 3, 4, 5, and 6, of Series I.

RESULTS OF EXPERIMENTS MADE IN HOOS FIELD ON THE GROWTH OF
VARIOUS LEGUMINOUS CROPS,

year after year on the same land, with mineral, and with mineral and nitrogenous manures, commencing in 1848-9. Clover seed was sown 12 times in 29 years, and the plant failed 8 times out of the last 10 trials. The results showed that when Red Clover was thus sown frequently on the same land, there was almost uniform failure. In fact, after the first few years practically no crop was obtained. In 1878, after the cessation of the trials with Red Clover, various other Leguminous plants, of different habits of growth, and especially of different character and range of roots, were sown on the, so to speak, Clover-exhausted land. The result was that whilst Red Clover, which was included in the list of the new experiments, still failed, giving an average of only 22 lbs. of nitrogen per acre per annum in 5 years of crop over 7 years, the more weakly-rooted and more weakly-growing White Clover, which had not been grown on the land for many years, gave an average of 47 lbs. in 6 years of crop over 9 years; the more freely-growing, and deeper-rooting Vetch an average of 75 lbs. over 14 years; Bokhara Clover, 64 lbs. per annum in 11 years of crop over 12 years; and the very deeply, and very powerfully-rooting Lucerne an average of 160 lbs. of nitrogen over 12 years. Here, then, when various other Leguminous plants followed on the Red Clover-exhausted land, they grow luxuriantly, and yielded much larger, and in some cases very large, amounts of nitrogen. Further, the surface-soils gained rather than lost nitrogen.

Experiments have also been made with Leguminous crops in Geescroft Field. Thus, Beans were grown year after year on the same land, without manure, with mineral manures, and with mineral and nitrogenous manures—commencing 1847. The results showed considerable increase in the produce, and coincidentally in the yield of nitrogen, by the use of mineral manures containing potash, and but little further increase by the addition of nitrogenous manures; notwithstanding that Beans, like other Leguminous crops, contain a much higher percentage of nitrogen, and yield much more nitrogen per acre, than grain crops. Further, on the growth of Beans thus year after year on the same land, the amount of produce and the yield of nitrogen, declined considerably, both being much less under all conditions of manuring in the later than in the earlier years. The results further showed, however, that, as in the case of the growth of various other Leguminous crops on the Clover-exhausted land (in Hoos Field), so now after the failure of the Beans and decline in the yield of nitrogen in them, on sowing Red Clover with its very different character and range of roots, on the Bean-exhausted land, very large crops of Clover, containing very large amounts of nitrogen, were obtained. Not only was so much nitrogen removed in the Clover crops, but the surface-soil became determinably richer in nitrogen, due to accumulation of nitrogenous crop-residue.

In view of the failure to grow Red Clover continuously on ordinary arable land, it is a fact of much interest that it has been grown for forty years in succession on rich garden-soil. There was, however, a much reduced persistence of the plant, a considerably reduced amount of produce, and of nitrogen in it, and with this a considerable reduction of the stock of nitrogen in the soil, in the later than in the earlier years. Nevertheless, the amount of produce over the 40 years, 1854-1893, corresponded to an average yield of nearly 3 tons of Clover hay, containing about 160 lbs. of nitrogen, per acre per annum; quantities which exceed the average produce of the crop grown once in 8 or more years, in rotation on ordinary arable land.

The results, as a whole, indicate a soil source of failure on the arable land, and a soil source of success on the rich garden-soil.

Lastly, recent experiments at Rothamsted confirm those of others in showing that, by adding to a sterilised sandy soil growing Leguminous plants, a small quantity of the watery extract of a soil containing the appropriate organisms, a marked development of the so-called leguminous nodules on the roots is induced; and that there is, coincidentally, increased growth, and gain of nitrogen.

It is concluded that in the growth of Leguminous crops, such as Clover, Vetches, Peas, Beans, Sainfoin, Lucerne, &c., at any rate some, and sometimes much, of the large amount of nitrogen which they contain, and of the large amount which they frequently leave as nitrogenous residue in the soil for future crops, is due to atmospheric nitrogen brought into combination by the agency of lower organisms. But it is still a question—how far the failure of Clover, or of other Leguminous crops, may be due to the exhaustion of available combined nitrogen, or of mineral constituents, within the range of the roots, and how far to the exhaustion of the organisms necessary for the bringing about of the fixation of free nitrogen.

For further particulars, see pages 7 and 38-47; also Section III. in Nos. 92 and 93, in Series I. of the list of papers at page 14.

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS.

I.—BEANS, PEAS, AND TARES—GEESCROFT FIELD.

EXPERIMENTS on the growth of Leguminous corn-crops (beans, peas, and tares), with different descriptions of manure, were commenced in 1847, about nine acres being devoted to the purpose.

Experiments with BEANS were continued without a break, for thirteen consecutive seasons, to 1859 inclusive; but, during the later years, the crop fell off very much, and the land became very foul.

In 1860 the land was fallowed.

In 1861 a crop of wheat, without manure, was taken.

In 1862 beans were again sown, but with some variation in the manuring.

In 1863 the land was fallowed.

In 1864, 5, 6, 7, 8, and 9, beans were grown, with much the same manures on the same plots, each year, as in 1862.

In the winter of 1869-70, 5000 lbs. of fresh burnt lime were applied per acre, over all the plots.

In 1870 beans were grown with the same manures on the respective plots as in 1864-69.

In October 1870 winter beans were sown (without manure), but the plants were to so great an extent destroyed by the severe weather which followed, that, in April 1871, the crop was ploughed up, and the land left fallow.

During the winter and early spring of 1871-2, the land was so wet that it could not be prepared in time for sowing. It was therefore left fallow for 1872; at the end of May it was subsoiled to a depth of about 12 inches, and re-ploughed in July.

The winter and early spring of 1872-3 were also so extremely wet, that it was again impossible to prepare the land in time for sowing; it was, however, ploughed up towards the end of March, again left fallow, and re-ploughed in July and October (1873).

On February 2, 1874, the land was again set with Beans, but without manure.

In 1875 Beans were re-sown, with the same manures on the respective plots as in 1864-1870; but owing to the wetness of the land in the first instance, and the subsequent hindrance by other spring sowing, they were not put in until April 1 and 2.

The wetness of the winter 1875-6, again prevented the preparation of the land in due time; and, though the manures were sown, and the land ploughed, it was left fallow during the summer of 1876.

Early in October 1876, winter Beans were put in (drilled), without further manuring.

In 1878 the usual manures were sown, and beans were drilled on February 26.

Owing to the wetness of the winter, and the foul condition of the land, it was left fallow in 1879.

Owing to the continued wetness in the autumn, the severe winter, and foulness of the land, it could not be got into order for sowing, and remained fallow in 1880.

During 1880 the land was ploughed, scarified, and partially cleaned, but owing to the wetness of the autumn, and the wetness and severity of the winter, it was again impossible to work it in time for sowing.

In the months of May and June 1881, the land was ploughed, scuffled, and harrowed, and again on July 9-12; since this time, however, the experiments with beans have been finally abandoned.

On February 1-4, 1882, the land was ploughed and cleaned, and on September 6-7 was harrowed, rolled, and sown with grass-seeds. These germinated satisfactorily, but owing probably to the extreme wetness of the succeeding winter months, the plant almost entirely died off.

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS—*continued*.

In April 1883, samples of soil were taken from many of the plots, generally to a depth of 27 inches, but in selected cases to a depth of 72 inches from the surface, and at that time very few grass plants could be seen. After the soil sampling, the whole field was scuffle-harrowed, and sown with Barley and Clover. In order to test the condition of the soil of the different plots of the continuous Bean and the alternate Wheat and Bean land, they were left unmanured; the remaining portion of the field, not recently under exact experiment, receiving 2 cwts. Nitrate Soda, and 2 cwts. Superphosphate per acre.

Notwithstanding the repeated failure of the Beans, though on the other hand the land had practically been fallow since 1878, the Clover came up very well, grew very rapidly, and on many of the plots to a great extent smothered the Barley; so that at harvest (1883) there was a very unusual proportion of Clover in the crop. The Clover plant remained strong through the mild winter, and gave heavy crops in June, and in August 1884; the two crops in many cases approaching, and in some exceeding, 4 tons of hay per acre. In 1885, a good plant remained on most of the plots, yielding a cutting on June 23, which in several cases approached, and in one exceeded, 2 tons of hay per acre. In fact, from several of the plots of this bean-exhausted land, the nitrogen in the surface soil of which had been much reduced, and was very low, more than 6 tons of clover-hay per acre, containing more than 300 lbs. of nitrogen, have been taken. It may be added, that the total yield has been greater on some of the previously continuous bean-plots than on those which had grown beans and wheat alternately. (See below.) After the cutting in 1885, the greater part of the land was thrown into the park for permanent grass; only the previously continuous bean-plots being still reserved for future experiment.

The general result of the experiments with BEANS has been that mineral constituents used as manure (more particularly potash), increased the produce very much during the early years; and, to a certain extent, afterwards, whenever the season was favourable for the crop. Ammonium-salts, on the other hand, produced very little effect; notwithstanding that a Leguminous crop contains two, three, or more times as much nitrogen as a Cereal one grown under similar conditions as to soil, &c. Nitrate of soda has, however, produced more marked effects. But when the same description of Leguminous crop is grown too frequently on the same land it seems to be peculiarly subject to disease, which no conditions of manuring that we have hitherto tried seem to obviate.

Experiments with PEAS were soon abandoned, owing to the difficulty of keeping the land free from weeds, and an alternation of BEANS and WHEAT was substituted; the Beans being manured much as in the experiments with the same crop grown continuously as above described. But the wetness of the winter of 1871-72 prevented the sowing of the Beans for the season of 1872; and again the wetness of the autumn and winter of 1872-3 prevented the sowing of the wheat until April 4, 1873, when Nursery wheat was put in, which, however, did not come to maturity, but was cut in the middle of September, yielding about 27 cwts. of gross produce per acre, containing too little corn to be worth thrashing. The land was ploughed in October 1873, and sown with beans February 3, 1874. On October 23, 1874, wheat was sown without manure. Beans should have been sown in 1876; indeed, the manures were sown, but, for the reason stated above, the land was left fallow; and wheat was put in October 24 (1876). In 1878 Beans were drilled, on February 26, with the usual manures. Owing to the wetness of the winter, and the condition of the land, it was left fallow in 1879; and it continued so up to September, 1882 when it was sown with grass-seeds; since which time it has been treated exactly as the continuous Bean Land. (See the bottom of the preceding page, and the top of this.)

In alternating WHEAT with BEANS, the remarkable result was obtained, that nearly as much wheat, and nearly as much nitrogen, were yielded in eight crops of wheat in alternation with the highly nitrogenous beans, as in sixteen crops of wheat grown consecutively without manure in another field, and also nearly as much as were obtained in a third field in eight crops alternated with bare fallow.

Experiments with TARES, like those with Peas, were soon abandoned, and for the same reasons. Beans were at first substituted, with some variation in the description of the manures employed; but this experiment also had to be abandoned.

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS—*continued*.

II.—RED CLOVER (*Trifolium pratense*).

1. *Experiments on ordinary arable land*.—HOOS FIELD.

EXPERIMENTS on the growth of Clover, on ordinary arable land, with many different descriptions of manure, were commenced in 1848-9, and, with the occasional interposition of a corn-crop, or fallow, were continued up to 1877, inclusive.

As with other *Leguminous* crops, the result was, that mineral constituents applied as manure (particularly potash) considerably increased the crops in the early years. Ammonium-salts had little or no beneficial effect, and were sometimes injurious. It may be added, that the beneficial effects of long previous applications of potash have been apparent whenever there was any growth at all. To go a little more into detail:—

In the first year, 1849, the crops were throughout very heavy; especially with mineral, and without nitrogenous manure.

In autumn 1849, wheat was sown, and in spring 1850, Red Clover. In 1851 small cuttings were taken; and in 1852, though the crops were not heavy, there was by no means a failure.

Since that time, however, all attempts to grow clover year after year on this ordinary arable land have failed to give anything like a full crop, or even a plant which would stand the usual time on the ground.

Small cuttings were obtained in the autumns of 1855 and 1859, from seed sown in the spring of those years; and small but rather heavier cuttings in June and August 1865, from seed sown in 1864.

In April 1868, a portion only of the land was sown with Clover, and the plant for the most part died off in the winter.

In April 1869, the same portion was re-sown, and gave a small cutting in September of that year; but the plant again died off in the winter.

In April 1870, Clover was sown over the whole of the experimental land, this time in conjunction with Barley; but on those portions which had also been sown in 1868 and 1869 the plant again died off during the winter and early spring; whilst from those which had not been sown in 1868 and 1869 two small cuttings were taken in 1871.

In the spring of 1872, the plant being then almost entirely gone, the land was ploughed up. It was again ploughed in July 1872, and in March 1873; the intention being to sow some other *Leguminous* crop; but owing to the wetness and lateness of the season this was not done, the land was again left fallow, and re-ploughed in the beginning of June and the end of July (1873).

On May 4, 1874, the land was again ploughed, and sown with Red Clover seed, May 5, without manure. The plant came up well, and was very forward in September, when the flowering stems were cut down, but left on the land. During the winter and early spring the plant on those portions from which cuttings had been taken in 1871 almost entirely failed, and the land was ploughed up in May, and again in August (1875); whilst on those from which none had been taken since 1869 a fair plant remained, and two small cuttings were obtained, namely on June 23, and on August 9 and 12 (1875). On September 22, this portion of the land was ploughed up.

In May (1876), the whole was re-ploughed, and again in July and September, and left fallow.

In May 1877, Barley and Clover were sown over the whole of the experimental land, without further manuring, but the clover plant completely died off during the winter.

On two occasions (1851 and 1854), heavy dressings of Farmyard dung were applied to some of the plots; and in 1854 some received a dressing of 20 tons of dung, and 5000 lbs. of lime, per acre.

On some portions of the land Clover was sown 12 times during the 30 years, 1848-1877, and more frequently alone than with a corn-crop. In 8 out of the last 10 trials the plant died off in the winter and spring succeeding the sowing of the seed; in 4 of these without giving any crop at all, and in the other 4, only very small cuttings.

In 1878, the land was devoted to experiments with *various Leguminous plants*, differently manured, and these experiments are still in progress (1898); for further particulars see pp. 46-7.

In reference to these field experiments on clover, it may be added that, in 1864, a portion of the land was trenched 2 feet deep, and one-third of the manure was mixed with the layer of soil from 24 to 16 inches, one-third from 16 to 8 inches, and the remainder from 8 inches

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS—*continued*.

upwards. Owing to the characters of the season, the mechanical condition of the land was at first very unfavourable after this treatment; but, although many years have now elapsed, and the excess of constituents supplied was in some cases considerable, the plant has died off as completely on these plots as elsewhere.

In the winter of 1867-8, a number of small beds, each 3 yards \times 2, were arranged on the previously unmanured plot of the experimental land. These were dug, some to the depth of 9 inches, some to the depth of 18, some to the depth of 27, and some to the depth of 36 inches, and sown to the respective depths with different mixtures; supplying in some cases very large amounts of potash, soda, lime, magnesia, phosphoric acid, sulphuric acid, nitrate of soda, &c.

From three similar sized beds, the soil was removed to the depths of 9, 18, and 27 inches respectively, and replaced by soil taken at the same depths from a garden border, on an adjoining portion of which Clover had been grown successfully since 1854 (see pp. 42-4).

In April 1868, clover was sown on the whole of these small beds (as well as on some other portions of the experimental land); but the plant for the most part died off during the following winter.

In April 1869, the small beds (and the other portions as in 1868) were re-sown, small quantities of clover were cut in September of that year, but the plant again died off in the winter.

In April 1870, Clover was again sown on the small beds in conjunction with barley (as on all the rest of the experimental land), but the plant again died in the winter.

In the spring of 1871, the small beds were again re-sown, and the three with garden-soil were entirely enclosed, both around and above, by galvanised wire netting. Small cuttings were taken from these small beds in July 1872; and (excepting from the beds of garden-soil, which had yielded considerably more than the others in 1872), larger cuttings were taken in July 1873. The produce was the largest where potash and nitrate of soda were employed, and where they were applied in the largest quantity, and to the greatest depths.

In April 1874, there was still some healthy plant on all the beds, but it was considered to be too irregular to preserve. It was, therefore, dug in. The artificially-manured beds were re-manured as before, but only to the depth of 9 inches, and seed was sown on May 4th, July 6th, and October 22nd; each time the plant coming up well, but subsequently dying off. On the three beds of garden-soil, the plant from the first sowing (May 4), for the most part stood; requiring only to be made good here and there on July 6; and in September small cuttings were taken.

More small beds were arranged in the spring of 1874; on these the manures were dug in, at the various depths, on May 11th to 14th, and the seed sown on May 16th. At this time, the wire netting was removed from above the three beds of garden-soil, but the whole series of small beds was now surrounded with netting, to keep out ground game. One series of the new plots received sulphate of potash only, another nitrate of soda only, and a third the two together. The plants came up fairly well, but there were some blanks in the rows, which were re-sown on October 22 (1874). A cutting was taken on June 22 and 23 (1875) from these new beds; the blanks in the rows were re-sown on July 24; a second cutting was taken on August 17; and the blanks were again re-sown on September 22 (1875). The plant was the most even on the beds with sulphate of potash, less so on those with nitrate of soda, and less still on those with both together. The amount of produce was also greater with each of the manures used separately, than with the mixture of the two.

In May 1875, the plant was entirely gone on the old artificially-manured beds, which were then dug up, and prepared for re-sowing. On the three beds of garden-soil, though the rows were imperfect, some healthy plants still remained, and gave a small cutting on June 22. On July 24 these beds were dug up; and they, as well as the artificially manured ones just referred to, were re-sown with seed. All came up well, but in May (1876), the plants on the beds of garden-soil were entirely gone, and those on the artificially manured ones nearly so, but they yielded small cuttings on July 17 (1876).

The plants on the new artificially manured beds, like those on the older ones, showed failure in the spring of 1876; but also, like them, gave small cuttings in July. All the small beds were dug up in August (1876); the artificially manured ones re-manured as in 1874, the manures dug in to a depth of 9 inches, and seed was sown on September 1, which came up, but the plants died off on all the plots in the winter of 1876-7.

In May 1877, all the small beds were dug up, and sown with Barley and Clover. To try the effects of shelter, the Barley stubble was left unusually high, but the young clover plants completely died off during the winter (1877-8).

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS—*continued*.

In the spring of 1878, the beds were dug up, and cleaned; and they were re-sown with Clover, without further manuring, on June 12 and 13. All came up well, but the plant was almost entirely destroyed by "Fly."

In May 1879, there remained about a quarter of a plant on the plot with the largest amount of mineral manure, including potash, and sown to the greatest depth, and perhaps a third of a plant where the same mineral manures, with nitrate of soda in addition, had been applied; but there was scarcely a single plant on any of the other plots. On June 9 and 10, 1879, all the beds were cleaned, and re-sown with seed, which came up well; but a very wet and cold season following, most of the plants died off during the summer and autumn.

Early in June 1880, all the small beds were cleaned, and forked up; and on June 10, they were re-sown with seed without further manure. All came up well, but the plants were for the most part destroyed by the severe winter which followed. In May 1881, there was perhaps half a plant on two or three only out of the forty small beds; namely, where the mixed mineral manure, including potash, was used without nitrogenous manure; and the greatest vigour was where the manure was applied in the largest quantity, and to the greatest depths. On no other beds, not even on the three made up of garden-soil, was there nearly as much plant; and on May 12 (1881), all the small beds were cleaned, the clover plants forked in, manures also forked in, as in 1876, to a depth of 8 or 9 inches, and clover seed sown, which came up well, but in most cases became very thin during the winter and spring of 1881-82. A small cutting was, however, taken on June 20, and another on August 18, 1882.

In May 1883, the beds were dug up, and sown with *Lucerne* without further manuring, but it gave no crop in that year. On April 3, 1884, the usual Nitrate Plots received Nitrate of Soda at the rate of 1000 lbs. per acre as a top-dressing. From all the plots, three cuttings were taken, viz. on June 27, August 16, and October 7. On March 9, 1885, the Nitrate plots received Nitrate of Soda at the rate of 500 lbs. per acre as a top-dressing; and three cuttings were taken, viz. on June 3, July 22, and October 10. In 1886 three cuttings were taken from all the plots, viz. on June 28, August 11, and December 3; and after the first cutting the usual Nitrate Plots received, on July 13, Nitrate Soda at the rate of 1000 lbs. per acre as a top-dressing. In 1887, three cuttings were taken, viz. on July 2, Aug. 15, and Oct. 12; and in 1888 two cuttings, viz. on July 6 and Sept. 26. In 1889 the usual Nitrate Plots received a solution of Nitrate of Lime, at the rate of 1490 lbs. per acre (= 86 lbs. of Nitrogen per acre); and two cuttings were taken from all the plots, one on July 5, and the other on August 31. In 1890, the plants on the garden-soil plots had almost entirely died off, and these beds were therefore dug up and re-sown with *Lucerne* on May 2; two cuttings were taken from each of the other plots, on July 5 and Sept. 2; and one cutting from the garden-soil plots on Sept. 2. In 1891, two cuttings were taken, viz. on July 8 and Sept. 15; in 1892, two cuttings, on June 27 and Aug. 30. In 1893, three cuttings, viz. on June 23, Aug. 3, and Oct. 5; in 1894, two cuttings, on July 9 and Oct. 28; in 1895, two cuttings, on May 30 and Aug. 2; in 1896, three cuttings, viz. on May 26, July 11, and Sept. 29; and in 1897, one cutting on June 8. After the cutting in June, there was a thin plant on most of the beds. In recent years they have required a great deal of hand-hoeing to keep down the weeds. The growth has usually been the more luxuriant where either Potash or Nitrate of Soda has been applied, but especially where the two were used together.

It will be observed that, although in the earlier years, the three small beds in the field which had been artificially made up of surface-soil and subsoil brought from a highly manured kitchen garden, maintained a plant of clover, and yielded better crops than the artificially manured beds, yet they finally failed quite as much as the rest.

In 1898, owing to the thinness of the plant, and the great prevalence of weeds, the whole of the small beds were ploughed up, and the experiment was abandoned. (See plan and footnote, p. 36.)

2.—*Experiments on rich garden-soil.*

In view of the failures in the attempt to grow Clover continuously on ordinary arable land it is a fact of much interest, that in 1854 Red Clover was sown in a garden, scarcely half-a-mile distant from the experimental field, on soil which had been under ordinary kitchen garden cultivation for probably two or three centuries, and it has shown very luxuriant growth almost every year since.

From the produce of the seed sown in 1854 (March 29), two cuttings were taken in 1854, three in 1855, two in 1856, three in 1857, two in 1858, and two in 1859.

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS—*continued*.

In 1856, the plot was divided into three equal portions, one being left without manure, another receiving gypsum, and the third a mixed mineral manure containing potash. In 1857 the surface-soil was sampled to a depth of 9 inches.

Seed was re-sown in 1860 (end of May); and yielded one cutting in October of that year, two in 1861, two in 1862, two in 1863, and two in 1864.

Seed was again sown in 1865 (April 22); and this sowing yielded one cutting in September of that year, two in 1866, two in 1867, and one very small cutting in April 1868.

Gypsum and the mixed mineral manure were again applied; and seed was re-sown, April 29, 1868; and from this sowing there were obtained two cuttings in 1869, and one in 1870.

The same manures were again applied March 30, and fresh seed was sown April 10, 1871; yielding one cutting in August of that year, two cuttings in 1872, and two in 1873.

Notwithstanding some injury from Dodder in 1873, there still remained too much plant to break up in the spring of 1874; and accordingly fresh seed was sown *between the rows* on May 4, and this failing, again on July 7, 1874. The manures had been applied between the rows on April 16. Three very small cuttings were taken in 1874 (in June, July, and September); and a small cutting again in June, 1875.

In 1875 (July 13), the old plants were dug in, and seed again sown, and this failing, seed was re-sown September 22. In spring 1876 there was luxuriant growth, but deficient plant, which yielded two small cuttings, on June 26, and August 7.

In 1876 (September 1), the beds were dug up, and re-sown with seed, which came up fairly, but the plant suffered during the winter, and in May 1877 it was dug up and re-sown. From this sowing a small cutting was taken on September 5, 1877; and three cuttings in 1878 (on June 10, July 26, and November 1).

In May 1879, there remained some fairly vigorous plants, but not nearly enough for a crop, so the ground was dug up (the soil sampled to a depth of 18 inches), the plants then dug in, and fresh seed was sown, on May 21. From this sowing a cutting was taken on September 13.

Owing to injury from Dodder in the autumn (1879), and the subsequent severity of the winter, the plant again died off, and seed was sown afresh on April 17, 1880. From this sowing two cuttings were taken in that year (August 5 and September 24).

In April 1881, there being too much plant to break up, but not enough to cover the ground, the blanks in the rows were re-sown with seed (April 29), and two small cuttings were afterwards taken, on June 23 and August 16.

On April 6, 1882, there being again many blanks in the rows, these were re-sown with seed. Three cuttings were afterwards taken—on June 14, August 8, and October 20, of the same year.

On April 18, 1883, the same manures were sown on the same portions as in 1874, and the ground was dug, the old plants being dug in. Fresh seed was sown on May 17, which gave one cutting on August 13, 1883; three cuttings in 1884, viz. on June 17, August 11, and October 6; and three cuttings in 1885, viz. on June 2, July 16, and August 31.

Owing probably in great part to the severe winter of 1885-6, the plants nearly all died, and on April 14, 1886, the few that remained were dug in, and fresh seed sown, without further manure, from which one cutting was taken on August 11. In 1887, owing to some destruction of the plant by a mole, a portion of the Unmanured Plot was re-sown with seed on April 21. Two cuttings were taken, viz. on July 8 and August 29.

The plant died during the winter, fresh seed was sown on April 13, 1888, the rows were mended on June 12, and a small cutting was taken on September 6. In April 1889, the rows were again mended, after which two cuttings were taken, viz. on June 21 and October 25.

In April 1890, the plants had almost entirely died off; and the beds were therefore dug up and re-sown with seed, which gave one crop, on August 12. Later in the autumn, however, many plants were destroyed by a dog after mice, so that the rows had to be mended with fresh seed, in May 1891, and cuttings were taken on July 15 and September 25.

During the winter of 1891-2 most of the plants died, the ground was therefore dug up and re-sown with seed on May 7, 1892. The seed germinated well, but some of the young plants were destroyed by "Fly," and the rows were mended on May 27, and one cutting was taken on August 26.

During the winter of 1892-3 some of the plants died, and the rows were accordingly mended on April 20, 1893, and cuttings were obtained on June 24, and on August 22.

In 1894 the rows were again mended on April 19 and gave two cuttings on July 9 and September 4. The plants had now become exceedingly thin and the soil covered with seed-weeds; the beds were therefore dug up later in the autumn, left fallow during the winter, and

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS—*continued*.

re-sown with seed on April 19, 1895. The seed germinated well, but was afterwards destroyed by "Fly," and was again sown on May 20; but owing to drought and heat the seed did not germinate, and a third sowing was made on July 2; no crop was, however, obtained in 1895.

During the winter of 1895, and early spring of 1896, most of the plants died, the plots were therefore cleaned from weeds, and prepared for re-sowing. On April 23, 1896, the soil was sampled at two places on each of the three portions. Each sample taken was 4×4×9 inches deep; and a similar sample was taken of the second 9 inches of depth. The top 9 inches of soil of each of the three portions was then taken out, a mixed mineral manure was then dug into the second 9 inches, and a similar quantity of the same mineral manure was mixed with the surface soil, which was then returned to its position. Seed was sown on July 1, which, however, gave no crop.

Most of the plants died during the winter of 1896-7. The beds were accordingly dug up in April 1897, and seed was resown on April 29, and gave two cuttings, viz., Aug. 7, and Oct. 27.

At the beginning of the winter of 1897, there was a strong and even plant; but it gradually declined, and in January, 1898, failure was very marked. On January 27 the plots were microbe-seeded, with the watery extract of the rich kitchen garden soil at Rothamsted. This did not, however, arrest the failure. Many of the plants were covered with a white fungus; the foliage was destroyed, and the crowns blackened and rotted away, very few plants remaining healthy. Early in March specimens of the plants were forwarded to Mr. Carruthers, who decided that they had suffered from the attack of the fungus "*Sclerotinia Trifoliorum*." Eventually, all the diseased plants were taken up and removed. The surface soil was also, little by little, removed, very carefully examined, the Sclerotia carefully picked out, and then the soil was returned. About 6 ozs. of the Sclerotia were thus picked out from the surface-soil of an area of not quite 10 square yards. It was thought desirable, however, to apply a fungicide to the soil before resowing with clover-seed, and bisulphide of carbon was selected for the purpose, as leaving less permanent residue than others. Accordingly, a small dressing of this was applied on May 7, and it was immediately raked in. It was hoped that by the application any remaining Sclerotia would be killed, and that the Leguminous nodule-microbes might not be injuriously affected. On June 2, that is nearly 4 weeks after the application of the bisulphide, clover-seed was again sown.

This (1898) is the 45th season of the growth of Clover, year after year, on this plot of rich garden ground. From the foregoing statements, it will be seen that seed was sown in 1854, 1860, 1865, 1868, 1871, 1874 (twice—between the rows), 1875 (twice), 1876, 1877, 1879, 1880, 1883, 1886, 1888, 1890, 1892, 1895 (3 times), 1896, 1897, and 1898; and in addition, the blanks in the rows were filled up in 1881, 1882, 1887, 1888, 1889, 1891, 1892, 1893, and 1894. Including the partial sowings to mend the rows, seed has been sown thirty-three times in the 45 years; only five times in the first 20 years, but 28 times in the last 25. It is obvious, therefore, that the plants stood very much longer in the earlier, than in the later years. It may be added that the produce of the first five sowings (1854, 1860, 1865, 1868, and 1871) was rather more than one and a-half times as much as has been obtained since. Lastly, the reduced persistence of the plant, and the reduced produce, have been coincident with a considerable reduction in the stock of nitrogen in the soil. Still, there has frequently been very luxuriant growth, even in the later years; and the produce over 40 years, to 1893 inclusive, was equivalent to an average of nearly 3 tons of clover hay per acre per annum.

Conclusions; Fixation of Free Nitrogen, &c.

The general result of the experiments on ordinary arable land in the field has been—that neither organic matter rich in carbon as well as other constituents, nor ammonium-salts, nor nitrate of soda, nor mineral constituents, nor a complex mixture, supplied as manure, availed to restore the clover-yielding capabilities of the land; though, where some of these were applied in large quantity, and at considerable depths, the result was better than when they were used in only moderate quantities, and applied only on the surface.

On the other hand, it is clear that the soil in the garden, which at the commencement contained in its upper layers about four times as much nitrogen as the arable land, and would doubtless be correspondingly rich in other constituents, has supplied the conditions under which clover can be grown year after year on the same land for many years in succession.

The results obtained on the soil in the garden seem to show that what is called "clover-sickness," cannot be due to the injurious influence of excreted matters upon the immediately succeeding crop.

That Clover frequently fails coincidentally with injury from parasitic plants, or insects,

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS—*continued*.

cannot be disputed; but it may be doubted whether such injury should be reckoned as the cause, or merely the concomitant, and an aggravation, of the failing condition.

The results of the experiments seem, therefore, to exclude the supposition that the *primary* cause of failure is either destruction by parasitic plants or insects, injury from excreted matters, or the shade of a corn-crop, and to indicate that it must be looked for in exhaustion of some kind within the range of the roots.

Still there remain several open questions. Is it exhaustion of certain organic matters rich in carbon, of nitrogenous food, or of mineral constituents? Again: is there an absolute deficiency in the soil of some of the substances in question, or only an unfavourable condition of combination, or, so to speak, of *soil-digestion* of them, for the requirements of Leguminous plants? Or, is there only an unfavourable distribution of them within the soil, considered in relation to the extent and character of the root-range of the crop? Or, lastly, is the failure connected with the condition, the distribution, or the exhaustion, of the organisms, the development of which in symbiosis with leguminous plants, has been shown by recent experiments to be associated with the fixation of free nitrogen? For further reference to this point, see next page, also page 7.

In reference to these various questions, it is a fact of much significance that from October 1857 to May 1879, the diminution in the amount of nitrogen in the garden-soil to the depth of 9 inches only, represented approximately two-thirds as much as was estimated to have been taken out in the crops of the 21 intermediate seasons; and it was concluded that there had been reduction in the lower depths also.

The subject cannot be further considered within the limits of this brief notice, which may be concluded by the following quotation from Rothamsted papers ('Journal of the Royal Agricultural Society of England,' vol. xxi. Part I. p. 178; and 'Journal of the Royal Horticultural Society of London,' vol. iii. p. 86, 1872):—

"When land is not what is called 'clover-sick,' the crop of clover may frequently be increased by top-dressings of manure containing potash and superphosphate of lime; but the high price of salts of potash, and the uncertainty of the action of manures upon the crop, render the application of artificial manures for clover a practice of doubtful economy.

"When the land is what is called 'clover-sick,' none of the ordinary manures, whether 'artificial' or natural, can be relied upon to secure a crop.

"So far as our present knowledge goes, the only means of insuring a good crop of Red Clover is to allow some years to elapse before repeating the crop upon the same land."

Recent experiments at Rothamsted have confirmed those of others, in showing that by adding to a sterilised sandy-soil growing leguminous plants, a small quantity of the watery extract of a soil containing the appropriate organisms, a marked development of the so-called leguminous nodules on the roots is induced, and that there is, coincidentally, increased growth, and gain of nitrogen. There is no evidence that the leguminous plant itself assimilates free nitrogen; the supposition is rather, that the gain is due to the fixation of nitrogen in the growth of the lower organisms in the root-nodules, the nitrogenous compounds so produced, being taken up and utilized by the leguminous plant.

It would seem, therefore, that in the growth of leguminous crops, such as clover, vetches, peas, beans, sainfoin, lucerne, &c., at any rate some of the large amount of nitrogen which they contain, and of the large amount which they frequently leave as nitrogenous residue in the soil for future crops, may be due to atmospheric nitrogen brought into combination by the agency of lower organisms. It has yet to be ascertained, however, under what conditions a greater or less proportion of the total nitrogen of the crop will be derived—on the one hand from nitrogen-compounds within the soil, and on the other from such fixation. It might be supposed, that the amount due to fixation would be the less in the richer soils, and the greater in soils that are poor in combined nitrogen, and which are open and porous. On the other hand, recent results obtained at Rothamsted, indicate that, at any rate with some leguminous plants, there may be more nodules produced, and presumably more fixation, with a soil rich in combined nitrogen, than in one poor in that respect.

In conclusion, as referred to above, the question remains—how far the failure of clover, and other leguminous crops, may be due to the exhaustion of available combined nitrogen, or mineral constituents, within the range of the roots, and how far to the exhaustion of the organisms necessary for the bringing about of the fixation of free nitrogen?

For further particulars on the Question of the Fixation of Free Nitrogen, see No. 92, Series I. (in the list of papers at page 14), pages 119–145; or, No. 93, Series I., pages 137–166.

EXPERIMENTS WITH VARIOUS LEGUMINOUS PLANTS.—HOOS FIELD.

The arable land (in Hoos Field) upon which attempts had been made to grow Red Clover in frequent succession since 1849, was devoted to experiments with various Leguminous Plants in 1878; so that the present season, 1898, is the twenty-first year of these experiments.

The object was to ascertain whether, among a selection of plants all belonging to the Leguminous family, but of different habits of growth, and especially of different character and range of roots, some could be grown successfully for a longer time, and would yield more produce, containing more nitrogen as well as other constituents, than others; all being supplied with the same descriptions and quantities of manuring substances, applied to the surface soil. Further, whether the success in some cases, and the failure in others, would afford additional evidence as to the source of the nitrogen of the Leguminosae generally, and as to the causes of the failure of Red Clover in particular, when it is grown too frequently on the same land.

Below are given, in a Tabular form, lists of the Plants grown in previous years, and now growing (June 1898); and below the Table, the dates of sowing seed are given.

As the details show, there were at first 14 descriptions of Leguminous Plant grown, but that some of these, which more or less failed, have been given up; whilst others have been transferred from one plot to another. Indeed, the object during the last few years has been to reduce the number from 14 to 7, taking two plots instead of one for each description. The land had, however, notwithstanding much hand-hoeing, become very foul, and after cutting the crops of 1892, all but the Medicago sativa plots were ploughed up, thoroughly cleaned, and re-arranged; with one exception (9 and 10), two of the original plots being ploughed into one, and permanent paths of separation left, between the now larger plots; and in 1896, the Medicago sativa on No. 10 having failed, the two lands (9 and 10) were then thrown together, and devoted to Trifolium repens.

As the tabular statement shows, the arrangement at the present time (1898), is as follows:— Nos. 1 and 2, Medicago sativa (Lucerne).

Nos. 3 and 4, Pisum arvense (Field Peas), or Faba vulgaris arvensis (Field Beans), alternately.

Nos. 5 and 6, Melilotus leucantha (Bokhara Clover).

Nos. 7 and 8, Onobrychis sativa (Sainfoin).

Nos. 9 and 10, Trifolium repens (White or Dutch Clover).

PLANTS GROWN ON EACH PLOT. There were originally 14 Plants on each Plot; but the number is now reduced to 7. (Area under Experiment, about 3 acres; each Plot about ½th acre.)

Years.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	Years.	
1878	Trifolium pratense (Common Red or Broad Clover).	Trif. prat. perenne (Perennial Clover or Coo-grass).	Trif. prat. hybridum (Suttons' Hybrid— Coo Clover).	Trifolium repens (Common White or Dutch Clover).	Trif. rep. perenne (Giant perennial White Clover).	Trifolium hybridum (Alsike Clover).	Trifolium incarnatum (Early Red or Crimson Clover).	Trifolium pratense (Common Red or Broad Clover).	Trifolium pratense (Perennial Clover or Coo- grass).	1878
1879										1879
1880	Lupinus hirsutus (Blue Lupin).	Lupinus luteus (Yellow Lupin).	Pisum arvense (Field Grey Peas).	Fallow.	Faba vulg. arvensis (Field Beans).	Melilotus leucantha. (Bokhara Clover).	Lupinus hirsutus (Blue Lupin).	Trifolium pratense (Common Red or Broad Clover).	Trifolium pratense perenne (Perennial Clover or Coo- grass).	1880
1881										1881
1882	Medicago sativa (Lucerne or Purple Medick).	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1882
1883										1883
1884	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1884
1885										1885
1886	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1886
1887										1887
1888	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1888
1889										1889
1890	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1890
1891										1891
1892	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1892
1893										1893
1894	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1894
1895										1895
1896	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1896
1897										1897
1898	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	" " "	1898

Nos. 11 and 12, Trifolium pratense (Red Clover).
Nos. 13 and 14, Vicia sativa (Common Tare or Vetch).
Below, is also given a Table showing the description and quantities of the manures applied to the different plots. Up to 1897 inclusive there were 3 "Series": Series 1, comprising 5 plots, and Series 2 and 3 each 6 plots. The same mineral manure (if any) has been applied to the same plot of each of the 3 Series.—Series 1, mineral manures only; Series 2, the same mineral manures, and nitrate of soda or lime; Series 3, the same mineral manures, with ammonium-salts, or rape-cake, or cows' urine, in addition. The manures have been applied in the quantities per acre stated in the Table, and the foot-notes thereto.

The general result is,—that very much more nitrogen has been removed in some of the other plants than in the Red Clover; the average annual yield in which over the 5 years of the 8 (1878–85), when there was any crop, was only about 22 lbs. per acre, giving over the 8 years an average of only 14 lbs. of nitrogen. Against this, Melilotus leucantha yielded in 1879 about 130 lbs., in 1882 about 145 lbs., and over the 8 years (1878–85) an average of about 70 lbs. per acre; Vicia sativa gave over 3 years (1882–84) an average of 130 lbs., and over the 8 years (1878–85) an average of about 84 lbs.; and, lastly, Medicago sativa yielded, in 1884 nearly 340 lbs., in 1885 about 270 lbs., and over the 6 years (1880–85), an average of about 153 lbs., of nitrogen; and over the 12 years ending 1891, it gave an average of 160 lbs. of Nitrogen per acre per annum. Further, as late as 1895 even red clover yielded very fair produce under some conditions of manuring, and sainfoin and Bokhara clover much more; whilst in 1897, Bokhara clover yielded very large crops.

Notwithstanding these remarkable results, there has, in recent years, been a tendency to failure, especially of the weaker plants; due largely to the difficulty of keeping the land clean. It was, therefore, decided early in 1898 to reduce the area from 3 acres to less than one acre; and it is hoped that with so much less land it may be possible to keep it properly cultivated and cleaned, and so obviate one serious source of failure—foulness. The plots of Series 1, with the mineral manures which have yielded the most important results, being retained, the manure, crop, and soil history is substantially continued. (See Plan and footnotes thereto at p. 36.)

EXPERIMENTS WITH VARIOUS LEGUMINOUS PLANTS.—HOOS FIELD—continued.

Years.	No. 9.	No. 10.	No. 11.	No. 12.	No. 13.	No. 14.	Years.
1878		(Not sown).					
1879	Medicago lupulina (Black Medick or Non-such).			Lotus corniculatus (Bird's-foot Trefoil).		Lathyrus pratensis (Meadow Vetchling).	1878
1880							1879
1881							1880
1882							1881
1883							1882
1884							1883
1885							1884
1886		Medicago sativa (Lucerne or Purple Medick).					1885
1887							1886
1888							1887
1889							1888
1890							1889
1891							1890
1892							1891
1893							1892
1894							1893
1895							1894
1896							1895
1897							1896
1898							1897
1899							1898
1900							1899

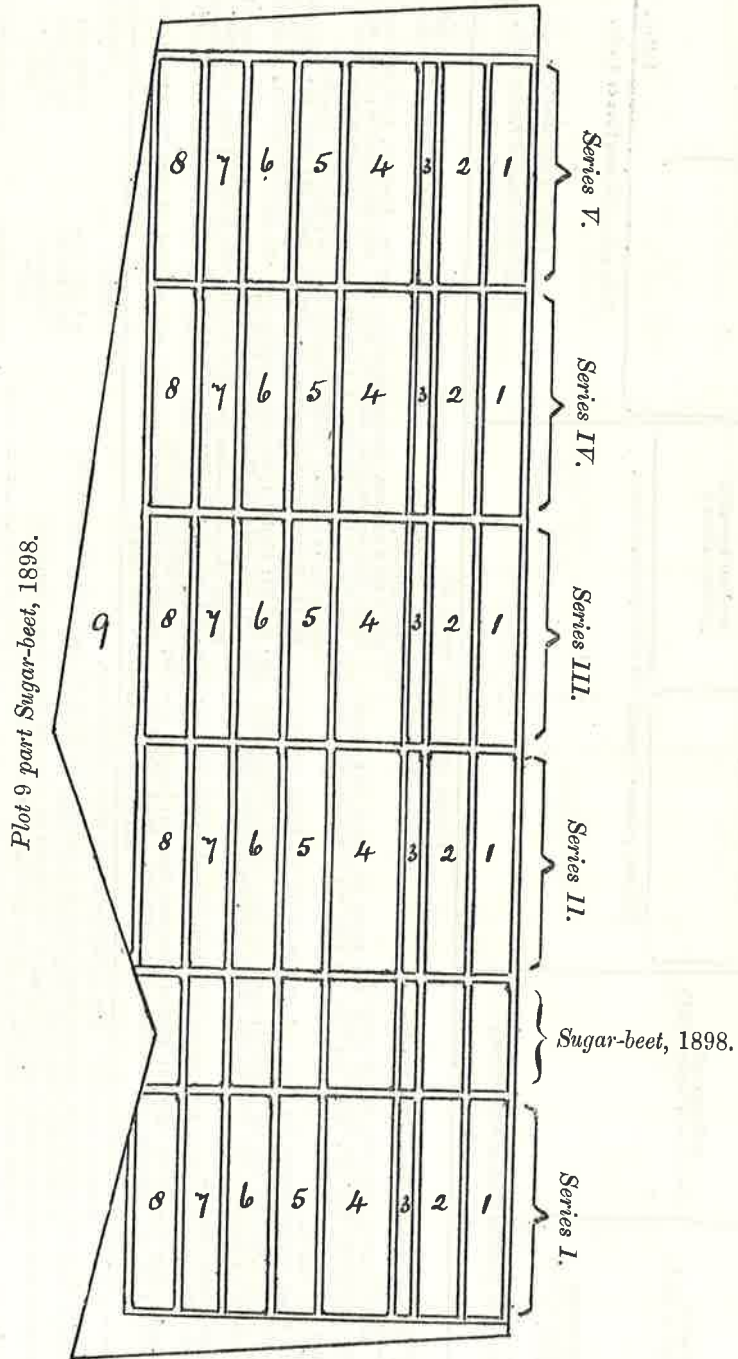
DATES OF SOWING SEED, &c.
 No. 1, Trifolium pratense—May '73; May '80; April '81; March '82; April '83; April '84; Lupinus hirsutus—May '86; No. 2, Trifolium pratense perenne—May '73; May '80; April '81; March '82; April '83; April '84; Lupinus luteus—May '86.
 No. 3, Trifolium pratense hybridum—May '73; May '80; April '81; March '82; April '83; Pisum arvense—Feb. '84; March '85; March '86; Feb. '87; April '88; Feb. '89; April '90; No. 4, Trifolium repens—May '73; May '80; April '81; March '82; April '83; Faba vulgaris arvensis—March '91; Feb. '92.
 Nos. 3 and 4 together. Pisum arvense—March '93; Faba vulgaris arvensis—March '97; Faba vulgaris arvensis—April '98.
 No. 5, Trifolium pratense perenne—May '73; May '80; April '81; March '82; April '83; Feb. '84; March '85; March '86; March '87; April '88; Feb. '89; April '90; No. 6, Trifolium hybridum—May '73; May '80; April '81; March '82; April '83; April '84; May '85; April '87 (mended); April and June '88; April '89; Mellilotus leucantha—May '90.
 Nos. 5 and 6 together. Mellilotus leucantha—No. 5, April '90, and No. 6, April '91;—April '93; April '94; June '96; June '98.
 No. 7, Trifolium incarnatum—May '73; May '80; April '81; Jan. and Sept. '82; Lupinus hirsutus—April '83; April '84; April '85; Trifolium pratense—May '86; April '89.
MANURES; QUANTITIES PER ACRE.
 SERIES 1; 5 Lands. (1) Without Manure, or with Mineral Manure only.
 The Mineral Manures were applied in the quantities stated below, or in half the quantities in parentheses, in 1878, 1880, (1882), (1883), (1884), (1885), 1887, (1889), 1893, and 1898.
 In October 1883, 2000 lbs. of fresh-burnt Lime (slacked) were applied per Acre over all the Plots of Series 1. (5)
 [In 1898, 400 lb. Basic Slag throughout used instead of Superphosphate.]
 Without Mineral Manure. (Series 1, portion devoted to the experiments on "Small Beds," 1867-'8, and since. See pp. 31-2)
 5 cwts. Superphosphate of Lime (1)
 1000 lbs. Sulphate Potash
 1000 lbs. Sulphate Potash, 5 cwts. Superphosphate.
 1000 lbs. Sulph. Potash, 250 lbs. Chloride Sodium (in 1884-5, and '87 Sulph. Soda instead) 250 lbs. Sulph. Lime, 250 lbs. Sulph. Magnesia
 1000 lbs. Sulph. Potash, 250 lbs. Chlor. Sod. (in 1884-5 and '87 Sulph. Soda instead) 250 lbs. Sulph. Lime, 250 lbs. Sulph. Mag., 5 cwts. Superph.
 (1) In November 1879, Lime was applied to the fifth land of Series 1, and to the adjoining land of Series 2, in addition to the other manures.
 (2) One of the two lands had received Cows' Urine, 6120 lbs. per acre in 1879; and in 1885 both lands received Cows' Urine, at the rate of 21,500 lbs. per acre.
 (3) In 1880, the Rape-cake was applied on only two lands (2nd and 3rd of the 5), Cows' Urine, at the rate of 6120 lbs. per acre, having been applied to the 1st of the 3 lands in 1879.
 (4) "Superphosphate of Lime," 1878 to 1887 inclusive, made from 300 lbs. Bone-ash, 225 lbs. Sulphuric acid ammonium-salts, or 2000 lbs. Rape-cake, per acre, was applied to the respective portions of No. 10 (Medicago sativa), No. 11 (Mellilotus leucantha), and No. 14 (Onobrychis sativa), on September 20, 1882. In 1893, all sown in rows; Beans 20 inches apart; Vetches 12 inches; Lucerne, Mellilotus, Sainfoin, White Clover, and Red Clover, each 11 inches apart.

Plots.	SERIES 1; 5 Lands.			SERIES 2.			SERIES 3; 5 Lands.		
	Without Mineral Manure.	With Mineral Manure.	With Mineral Manure and Superphosphate.	5 Lands (1); Each Plot as Series 1, and—	Nitrate of Soda, 550 lbs. in 1878, '82, and '84; in 1879, '80, '81, '85, '86, and 1887. 1889. (5)	Ammonium-salts, 400 lbs. in 1878, '82, and '84; 200 lbs. in 1879, '80, and '81; 225 lbs. Sulph. Amm., 1887. 1000 lbs. in 1887.	2 Lands (2); Each Plot as Series 1, and—	3 Lands (3); Each Plot as Series 1, and—	Rape Cake, 2000 lbs. in 1878, 1880, 1882, and 1884; 500 lbs. in 1885; 1000 lbs. in 1887.
1									
2									
3									
4									
5									
6									

PLAN OF THE PLOTS IN BARN FIELD,
ON WHICH EXPERIMENTS HAVE BEEN MADE
WITH ROOT-CROPS.

56 years, commencing 1843.

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



Total area of ploughed land about 8 acres.

- Area of Plots. {
- 1, 2, 5, 6, 7, and 8, of each Series, rather over $\frac{1}{2}$ acre (0.14598 acre)
 - 3, of each Series about $\frac{1}{2}$ acre (0.03649 acre).
 - 4, of each Series about $\frac{1}{2}$ acre (0.20074 acre).
 - 9, rather over $\frac{1}{10}$ acre (0.42 acre).

The double lines indicate division paths between plot and plot.
[For particulars of manuring and produce, etc., see pp. 50-75.]

RESULTS OF EXPERIMENTS MADE IN BARN FIELD ON THE GROWTH OF ROOT-CROPS,

for many years in succession on the same land, without manure, with Farmyard-manure, and with various artificial manures—commencing in 1843 ;

Norfolk White Turnips, 6 years, 1843-48 ;

Swedish Turnips, 4 years, 1849-52 ;

(Barley 3 years, 1853-55, without manure, to exhaust as far as possible the residue from previous manuring, and so to equalize the condition of the plots, before re-arrangement of them) ;

Swedish Turnips, 15 years, 1856-70 ;

Sugar-Beet, 5 years, 1871-75 ;

Mangel Wurzel, 23 years, 1876-98. (In 1898, small areas were devoted to Sugar-beet—See Plan p. 48 ; also p. 73.)

Root-crops are grown in most Rotations in Europe. Their growth affords an excellent opportunity for cleaning the land ; and they are generally considered to be in a sense restorative crops. But they depend for luxuriant growth on an abundance of nitrogenous as well as mineral constituents within the soil ; and they are generally highly manured. Indeed, when grown in ordinary soil without manure, either for a few years in succession, or even in rotation, they soon revert to the uncultivated condition. The restorative effects of their growth in rotation are in fact due—to the large amount of manure applied for their growth ; to the large residue of the manure left in the soil for future crops ; to the large amount of matter at once returned as manure again in the leaves ; to the large amount of food produced, and the small amount of the most important manurial constituents of the roots which is retained by the animals consuming them—the rest returning as manure again.

Feeding-roots are essentially *Sugar crops*. The *percentage* of sugar is the greater the more mature the roots, and is consequently as a rule the greater in the roots of the smaller crops. But the amount of sugar *produced per acre* is much the greater in the larger crops. The amount of crop, and of Sugar produced, depends greatly on the amount of Nitrogen taken up. The percentage of nitrogen in Feeding-roots is comparatively low, but it is the higher the greater the available supply within the soil, and the more luxuriant and less ripe the crop. A large, but variable, proportion of the nitrogen is non-albuminoid ; the more, the less ripe the crop. The proportion of albuminoid matter to non-nitrogenous food material is very much lower than in ripened products, such as cereal grains for example. The amount of crop, and the percentage and actual amount of nitrogen in the roots, depend very directly on the amount of nitrogen available within the soil ; and it is quite fallacious to suppose that root-crops gain a large amount of their nitrogen from atmospheric sources by means of their extended leaf-surface.

For particulars of the manuring and produce, and to some extent of the composition of the different descriptions of roots grown on the different plots, see pages 50-75.

EXPERIMENTS ON ROOT-CROPS.—BARN FIELD.

Experiments with Turnips were commenced in 1843. Eight acres, divided into numerous Plots, were set apart for the purpose, and the crop was grown for ten consecutive years on the same land; "Norfolk Whites" 1843-1846, and "Swedes" 1849-1852; on some Plots without manure, and on others with different descriptions of manure.

Barley was then grown for three consecutive seasons, 1853-1855, without manure, in order to test the comparative corn-growing condition of the different Plots, and also to equalise their condition, as far as possible, by the exhaustion of some of the most active and immediately available constituents supplied by the previous manuring.

A new series of experiments with Swedes was arranged in 1856, having regard to the character of the manures previously applied on the different Plots, and to the

results previously obtained. This second series was continued for fifteen years, namely from 1856 to 1870 inclusive.

The results obtained in the first three years, 1843, 1844, and 1845, were published in the "Journal of the Royal Agricultural Society of England," vol. viii. Part II., 1847. In the upper division of the Table below, there is shown the produce obtained Without Manure, and with Farmyard Manure, in the first 3 years, 1843, '44, and '45; and in the subsequent divisions there are given abstracts of the results obtained Without Manure, and with Different Manures, from 1845 to 1870 inclusive.

During the five years, 1871-1875, the land was devoted to experiments with Sugar-Beet, for particulars of which see pp. 52-55.

In 1876 experiments with Mangel-wurzel were substituted, and are still in progress; see pp. 56-75. (In 1898, small areas were devoted to Sugar-beet—See Plan p. 48; also p. 73.)

(Area under experiment about 8 acres; quantities, average per acre, per annum.)

NORFOLK WHITE TURNIPS, WITHOUT MANURE, AND WITH FARMYARD MANURE.

YEAR.	Roots per Acre.				Leaves per Acre.			
	Without Manure.		With Farm-yard Manure.		Without Manure.		With Farm-yard Manure.	
	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.
1843	4	4	9	10	} not weighed } not weighed			
1844	2	4	10	15				
1845	0	14	17	1					7	8

NORFOLK WHITE TURNIPS; FOUR SEASONS, 1845-1848; Roots and Leaves carted off the Land.

PLOTS.	STANDARD MANURES.		SERIES 1. Standard Manures only.		SERIES 2.		SERIES 3. Standard Manures, and Cross-dressed with 160 lbs. Sulphate Ammonia. 75 lbs. Muriate Ammonia.		SERIES 4. Standard Manures, and Cross-dressed with 160 lbs. Sulphate Ammonia. 75 lbs. Muriate Ammonia. 1840 lbs. Rape-cake.		SERIES 5. Standard Manures, and Cross-dressed with 1840 lbs. Rape-cake.	
	Roots.		Leaves.		Roots.		Leaves.		Roots.		Leaves.	
	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.
3	1	4	0	17	1	7	1	0	5	10	3	19
4	8	1	2	15	9	15	4	3	10	5	6	1
5	8	16	2	19	9	18	4	8	10	1	6	3
6	8	0	2	10	9	16	4	8	10	7	6	6
7	8	0	2	10	9	16	4	8	10	7	6	6
Average Produce, per Acre, per Annum.												
Gypsum 1845; without Manure 1846 and since (average 1846, 7, 8) Superphosphate, each year; Potash, Soda, and Magnesia, 1847 and '48 Superphosphate, each year Superphosphate, each year; and Potash 1847 and 1848												
Roots. Tons. cwts. 6 11 3 3 Leaves. Tons. cwts. 11 2 4 12 Roots. Tons. cwts. 10 18 4 15 Leaves. Tons. cwts. 10 17 4 13												

SWEDISH TURNIPS; FIVE SEASONS, 1849-1852; Roots and Leaves carted off the Land (excepting 1849, when the Leaves were too small to weigh or remove). Average Produce per acre per annum.

PLOTS.	STANDARD MANURES.	SERIES 1. Standard Manures only.		SERIES 2.		SERIES 3. Standard Manures and Cross-dressed with 200 lbs. Ammonium-salts, and 2000 lbs. Rape-cake.		SERIES 4. Standard Manures and Cross-dressed with 200 lbs. Ammonium-salts, and 2000 lbs. Rape-cake.		SERIES 5. Standard Manures and Cross-dressed with 2000 lbs. Rape-cake.	
		Roots.		Leaves.		Roots.		Leaves.		Roots.	
		Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.
3	Without Manure, 1846 and since	2	6	0	6	3	17	0	6	7	14
4	Superphosphate, Sulphates Potash and Magnesia, and Soda-ash	7	17	0	10	9	9	0	18	12	7
5	Superphosphate	7	9	0	11	8	14	0	13	10	10
6	Superphosphate, and Sulphate Potash	6	16	0	9	8	14	0	10	11	14
7	Superphosphate, and Sulphate Potash	6	16	0	9	8	14	0	10	11	14

BARLEY, without Manure (after Roots manured as above); THREE SEASONS, 1853-1855. Average Produce per acre per annum.

PLOTS.	SERIES 1.	SERIES 2.		SERIES 3.		SERIES 4.		SERIES 5.	
		Dressed Grain.		Straw.		Dressed Grain.		Straw.	
		Bushels.	Cwts.	Bushels.	Cwts.	Bushels.	Cwts.	Bushels.	Cwts.
3	Without Manure, 1846 and since	18½	12½	20½	15½	24½	15½	25½	16
4	Without Manure, 1846, and since	20½	12½	22½	13	25	14½	25½	14½
5	Without Manure, 1846, and since	21	11½	23	12½	26½	15	27	15½
6	Without Manure, 1846, and since	18½	10½	20½	11½	25	14½	25	14½
7	Without Manure, 1846, and since	18½	10½	20½	11½	25	14½	25	14½

SWEDISH TURNIPS; FIFTEEN SEASONS, 1856-1870. (1) Roots and Leaves carted off the Land. Average Produce per acre per annum.

PLOTS.	STANDARD MANURES.	SERIES 1. Standard Manures only.		SERIES 2. Standard Manures and Cross-dressed with 5 years, 1856-1860, 3000 lbs. Saw-dust, and 328 lbs. Nitric Acid.		SERIES 3. Standard Manures and Cross-dressed with 5 years, 1856-1860, 200 lbs. Ammonium-salts, and 3000 lbs. Sawdust.		SERIES 4. Standard Manures and Cross-dressed with 5 years, 1856-1860, 200 lbs. Ammonium-salts, and 3000 lbs. Sawdust.		SERIES 5. Standard Manures and Cross-dressed with 5 years, 1856-1860, 3000 lbs. Sawdust.	
		Roots.		Leaves.		Roots.		Leaves.		Roots.	
		Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.
1	Farmyard Manure, 14 tons	6	4	7	9	8	8	1	4	8	0
2	Farmyard Manure, 14 tons, and Superphosphate	6	7	0	16	8	5	1	5	7	16
3	Without Manure, 1846, and since	0	11	0	3	0	13	0	3	3	8
4	Superphosph., each year; Sulph. Potash, Soda, and Magnesia, 1856-60	2	16	0	8	4	12	0	14	5	8
5	Superphosphate, each year	2	12	0	9	4	13	0	16	5	8
6	Superphosphate, each year; Sulphate Potash, 1856-1860	2	7	0	7	4	5	0	13	5	0
7	Superphosph., each year; Sulph. Potash, and 36½ Amm.-salts, 1856-60	2	12	0	7	4	12	0	14	5	3
8	Uman. 1853, and since; previously part Uman.; part Superphosph.	1	3	0	4	1	2	0	5	3	14

NOTE.—"Sulphate of Ammonia" is estimated to contain 23 per cent. Ammonia, and "Muriate of Ammonia" 27 per cent. "Ammonium-salts," in each case, equal parts Sulphate and Muriate of Ammonia of commerce; and the mixture is estimated to contain 25 per cent. Ammonia. The 328 lbs. Nitric Acid (Sp. gr. 1.35), mixed with sawdust, and used as a cross-dressing on the Plots of Series 2, from 1856-1860, were estimated to contain Nitrogen = 50 lbs. Ammonia.

(1) The crops of 1859 and 1860 failed, and were ploughed in; but, as the manures were applied, and there would be accumulation within the soil for the succeeding crops, the average produce is calculated as for 15 years, that is the produce of the 13 years is, in each case, divided by 15.

EXPERIMENTS ON SUGAR BEET (VILMORIN'S GREEN-TOP WHITE SILESIA).—BARN FIELD.

GROWN YEAR AFTER YEAR ON THE SAME LAND, WITHOUT MANURE, AND WITH DIFFERENT DESCRIPTIONS OF MANURE, 5 YEARS, 1871-'75.

Previous Cropping:—1843-'48 (6 Seasons), experiments on Norfolk White Turnips, with different descriptions of Manure. 1849-'52 (4 Seasons), experiments on Swedish Turnips, with different descriptions of Manure. 1853-'55 (3 Seasons), Barley without Manure (with a view as far as possible to equalise the condition of the Plots). 1856-'70 (15 Seasons), experiments on Swedish Turnips, with different descriptions of Manure, in which the arrangement of the Plots was the same, and that of the Manures very similar—in fact, exactly the same during the last 10 years—as in the first year of Sugar Beet, excepting that, during those 10

years, the Alkalies were omitted for the Swedes. For the second and subsequent years of Sugar Beet slight alterations in the Mineral Manures were made, and in the fourth and fifth years the Farmyard Manure, Nitrate of Soda, Ammonium-salts, and Rape-cake were omitted, as will be seen below. In 1871, the seed was dibbled on ridges, in rows 26 inches apart, and 10 inches apart in the rows; in 1872-'75, seed dibbled on the flat; in rows 22 inches apart, and 11 inches apart in the rows; plants moulded up afterwards. Roots all carted off, Leaves weighed, spread on the respective Plots, and ploughed in.

Below are given the Manures and Produce for the 5 Seasons, 1871-'75. Area under experiment, about 8 acres. The experiments are arranged as under, in 5 Series, each of which comprises 8 Plots.

PLOTS.	Manures, per Acre, per Annum.				
	SERIES 1. Standard Manures only.	SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.	SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. "Ammonium-salts."	SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake, and 400 lbs. "Ammonium-salts."	SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.

FIRST SEASON, 1871. Seed dibbled April 13 and 14; Crop taken up November 30—December 19.

	PRODUCE PER ACRE (Roots trimmed as for feeding, not as for Sugar-making).															
	Leaves.		Roots.		Leaves.		Roots.		Leaves.		Roots.		Leaves.		Roots.	
	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.
1	18	3	27	13	6	19	22	1	5	6	26	4	28	18	5	14
2	14	13	2	14	5	15	21	15	4	6	25	2	25	4	5	5
3	7	11	2	0	22	3	15	6	4	16	19	18	20	16	4	12
4	7	11	1	5	22	15	17	10	3	5	22	15	21	7	3	19
5	5	12	1	8	20	19	15	4	3	19	19	18	18	19	4	5
6	5	1	1	4	21	5	17	4	3	4	23	11	21	0	3	11
7	5	18	1	5	20	19	18	8	4	3	21	0	21	7	3	17
8	7	10	1	14	21	13	16	2	4	15	17	19	20	7	4	9

SECOND SEASON, 1872. Seed dibbled May 1-3; Crop taken up November 12-28.

1	15	13	4	2	23	9	22	14	9	0	26	8	22	5	6	1
2	16	0	3	18	24	6	8	16	7	16	25	9	9	14	5	11
3	7	17	1	13	21	7	6	6	4	13	20	8	10	1	3	11
4	6	14	1	10	20	2	5	19	3	7	23	8	7	13	3	15
5	6	17	1	8	19	6	6	4	4	13	18	11	10	4	3	16
6	6	6	1	5	16	16	5	14	3	19	22	16	9	9	15	17
7	6	15	1	8	17	0	6	1	3	19	23	9	9	10	15	10
8	5	4	1	5	15	6	5	19	4	1	19	12	15	0	4	6

THIRD SEASON, 1873. Seed dibbled May 9-11; Crop taken up November 19-December 2.

1	Farmyard Manure (14 tons)	15 2	5 12	20 5	10 9	22 2	9 18	22 15	12 10	23 10	7 8
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	14 6	5 2	21 10	11 0	19 4	8 9	23 7	13 6	21 18	6 18
3	Without Manure (1846, and since)	5 1	1 11	14 5	6 11	9 3	3 16	15 12	9 11	14 13	4 1
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia }	5 2	1 13	16 9	6 11	12 10	3 10	20 3	8 0	16 1	3 8
5	3½ cwts. Superphosphate	5 5	1 11	18 8	5 13	10 19	5 0	14 15	9 8	13 19	4 9
6	3½ cwts. Superphos., 500 lbs. Sulph. Potash	4 12	1 5	15 17	4 4	12 18	3 12	20 2	9 5	14 14	3 11
7	3½ cwts. Superphos., 500 lbs. Sulph. Potash, 36½ lbs. Amm.-salts (2)	5 19	1 12	16 14	5 3	13 0	4 15	19 16	9 0	15 17	4 4
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	4 11	1 7	12 9	5 18	8 8	2 19	15 2	9 8	12 2	3 16

FOURTH SEASON, 1874 (3). Mineral Manures as in 1872 and 1873; but no Farmyard Manure, or cross-dressings of Nitrate Soda, Ammonium-salts, or Rape-cake. Seed dibbled April 30 and May 1; Crop taken up November 13-19.

1	Without Manure, 1874 and 1875 (Farmyard Manure in '71, '72, '73)	10 16	5 6	11 14	8 9	11 7	8 3	13 7	9 17	14 10	7 8
2	3½ cwts. Superphosphate (with Farmyard Manure, '71, '72, '73) ..	13 3	5 9	7 9	4 16	9 5	5 17	12 5	7 7	13 1	6 4
3	Without Manure (1846, and since)	5 2	1 5	3 2	2 6	3 7	2 2	2 11	2 10	3 19	2 9
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia }	6 10	1 8	8 16	3 6	7 10	2 0	10 12	4 16	8 2	3 11
5	3½ cwts. Superphosphate	5 19	1 7	7 10	3 6	7 6	2 8	7 15	5 4	5 17	3 6
6	3½ cwts. Superphos., 500 lbs. Sulph. Potash	5 11	1 5	8 1	2 14	8 1	1 18	9 10	4 13	7 13	3 2
7	3½ cwts. Superphos., 500 lbs. Sulph. Pot., and Amm.-salts, '71, '72, '73	6 14	1 3	9 5	2 11	8 15	1 14	11 14	4 11	8 4	3 9
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	5 0	1 2	7 13	2 16	6 10	2 0	7 6	4 7	3 12	2 1

FIFTH SEASON, 1875. Mineral Manures as in 1872, 1873, and 1874; but no Farmyard Manure, or cross-dressings of Nitrate Soda, Ammonium-salts, or Rape-cake. Seed dibbled April 29 and 30; Crop taken up November 23-30.

1	Without Manure, 1874 and 1875 (Farmyard Manure in '71, '72, '73)	17 5	2 11	19 18	2 14	21 0	3 6	22 7	3 12	19 13	2 11
2	3½ cwts. Superphosphate (with Farmyard Manure, '71, '72, '73) ..	15 11	2 2	19 18	2 18	18 17	2 18	20 9	3 5	18 10	2 1
3	Without Manure (1846, and since)	5 9	1 1	9 5	1 12	8 0	1 3	14 1	2 13	11 17	1 10
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia }	5 9	1 0	9 8	1 7	7 16	1 1	12 14	1 14	10 3	1 7
5	3½ cwts. Superphosphate	5 11	1 2	9 19	1 10	7 16	1 4	13 17	2 8	11 2	1 14
6	3½ cwts. Superphos., 500 lbs. Sulph. Potash	5 4	1 0	8 4	1 4	7 1	1 2	12 8	2 3	10 2	1 9
7	3½ cwts. Superphos., 500 lbs. Sulph. Pot., and Amm.-salts, '71, '72, '73	5 11	1 1	8 2	1 6	7 6	1 1	11 17	1 17	10 6	1 11
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	4 15	1 0	7 4	1 2	6 1	1 4	12 2	2 11	11 12	2 13

(1) "Superphosphate of Lime"—in all cases made from 200 lbs. Bone-ash, 150 lbs. Sulphuric Acid, sp. gr. 1.7 (and water).

(2) "Ammonium-salts"—in each case equal parts Sulphate and Muriate of Ammonia of Commerce.

(3) Owing to the deficiency of Rain for some time after sowing, a large proportion of the plants failed. Some were transplanted on Plots 1, but not on the other plots; and eventually the plant was (excepting on Plots 1) upon the whole very deficient and irregular, the remaining plants being larger than usual.

EXPERIMENTS ON SUGAR BEET.—BARN FIELD—continued.

SUMMARY OF THE COMPOSITION OF THE SUGAR-BEET ROOTS.

An abstract of the analytical results obtained illustrating the influence of different manures, and different seasons, on the composition of Sugar-beet, is given below. In interpreting the figures it must be borne in mind that with forty different experiments each year, and in each year four, or five, or more times as much produce on some Plots as on others, it would be impossible to sample each at its best, and all in the same condition of ripeness. Each year the seed was sown on all the Plots at the same time; and the samples (each consisting of the vertical fourths of 10 or 15 roots) were taken from all within a period of about a week, beginning with the ripest. It is obvious, however, that the smaller crops would be much riper than the larger ones. The dry matter, ash, and nitrogen, as given in the Table, are determined in the roots themselves; but they have generally been determined in the expressed juice also.

The sugar was determined in the expressed juice, and calculated into its percentage in the roots in accordance with the methods adopted at the time the experiments were made (1871-75), which were founded on the estimate of the percentage of juice in the roots, reckoned from the determined percentage of dry matter in the juice and in the roots. The results showed an average of about 95 per cent. of juice, and this figure was adopted in calculating the amount of sugar in the roots from that determined in the juice. In 1879, however, Scheibler published results obtained by determining the sugar in Sugar-beet, both directly in the roots by extraction with dilute alcohol, and also in the juice in the ordinary way. Whilst the old method indicated an average of about 95 per cent. of juice, the new one showed only about 90 per cent. Scheibler concluded that water equal to the difference (about 5 per cent.) existed in combination with the marc, and this he

termed "colloid water," as distinguished from the water of the juice. In the Rothamsted "Memoranda" for 1881, attention was called to Scheibler's new results and conclusions, and it was pointed out that if they were confirmed the percentages of sugar annually recorded in the Tables of the Rothamsted results should be reduced by about $\frac{1}{10}$ or $\frac{1}{20}$. Subsequently, further evidence, and especially results obtained by Maercker, by the extraction of the sugar in the roots by alcohol, left no doubt that the amount of juice in Sugar-beet averages more nearly 90 than 95 per cent.; and having in 1895 to re-consider the subject for a paper on "Root-crops," the previously annually recorded percentages of sugar in the experimentally grown Sugar-beet, were then corrected on the assumption that the amount of juice will on the average be only 90 per cent., and the results as so corrected are given in the Table below. It is obvious, however, that with roots varying so much in character of growth, size, and ripeness, the percentage of juice would not be the same in all. Nevertheless, it was considered that the results calculated on the assumption of 95 per cent. of juice, approximately and usefully represented the actual and relative amounts of sugar in the various roots; and now that only 90 per cent. of juice is assumed, it may be supposed that the results will be actually nearer the truth than before.

It need only further be observed that although, in comparable cases, the larger crops generally give a juice containing a lower percentage of sugar, and higher percentages of mineral matter and of nitrogen, yet the larger crops yielded very much more sugar per acre.

MANURES, PER ACRE, PER ANNUM, UNLESS OTHERWISE STATED (SEE BELOW).

PLOTS.	SERIES 1. Standard Manures only.			SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.			SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. "Ammonium-salts."			SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake, and 400 lbs. "Ammonium-salts."			SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.		
	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.
1	17.04	11.16	0.821	17.07	10.46	0.934	16.07	10.46	0.199	14.73	8.87	1.021	15.44	9.71	0.892
2	17.24	11.29	0.826	15.03	9.28	0.970	15.12	9.43	0.199	14.80	8.75	0.988	16.11	10.24	0.909
3	17.47	11.86	0.711	15.36	9.82	0.861	17.75	10.40	0.901	16.71	9.15	0.915	16.95	11.10	0.758
4	18.07	12.31	0.738	15.72	10.24	0.828	18.68	11.74	0.907	17.57	9.38	1.002	16.61	11.08	0.767
5	17.89	12.53	0.746	15.93	10.49	0.787	16.36	10.83	0.754	16.63	8.79	0.843	16.84	11.22	0.722
6	18.09	12.32	0.778	15.29	9.92	0.856	16.33	10.91	0.843	15.28	9.20	0.956	17.05	11.44	0.812
7	17.97	12.47	0.762	15.86	9.98	0.901	16.71	10.89	0.826	15.99	9.69	0.904	17.57	11.65	0.782
8	18.32	12.33	0.791	15.98	10.48	0.856	16.08	10.30	0.764	14.90	8.84	0.806	16.73	11.29	0.747

FIRST SEASON, 1871. (Results in all cases the means of determinations made on two samples, collected at the end of October, and the end of November, respectively.)

Mean Per Cent. Total Dry Matter, Sugar, Mineral Matter (Crude Ash), and Nitrogen in the Roots.

	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.
Farmyard Manure	17.04	11.16	0.821	17.07	10.46	0.934	16.07	10.46	0.199	14.73	8.87	1.021	15.44	9.71	0.892
Farmyard Manure, & Super.	17.24	11.29	0.826	15.03	9.28	0.970	15.12	9.43	0.199	14.80	8.75	0.988	16.11	10.24	0.909
Unmanured (1846, & since)	17.47	11.86	0.711	15.36	9.82	0.861	17.75	10.40	0.901	16.71	9.15	0.915	16.95	11.10	0.758
Super., & Pot., Sod., & Mag.	18.07	12.31	0.738	15.72	10.24	0.828	18.68	11.74	0.907	17.57	9.38	1.002	16.61	11.08	0.767
Superphosphate	17.89	12.53	0.746	15.93	10.49	0.787	16.36	10.83	0.754	16.63	8.79	0.843	16.84	11.22	0.722
Super., & Potash	18.09	12.32	0.778	15.29	9.92	0.856	16.33	10.91	0.843	15.28	9.20	0.956	17.05	11.44	0.812
Super., Pot., & 36½ lb. Am.-sfts.	17.97	12.47	0.762	15.86	9.98	0.901	16.71	10.89	0.826	15.99	9.69	0.904	17.57	11.65	0.782
Unmanured (1853, & since)	18.32	12.33	0.791	15.98	10.48	0.856	16.08	10.30	0.764	14.90	8.84	0.806	16.73	11.29	0.747

SECOND SEASON, 1872. (Samples collected early in November.)

1	Farmyard Manure ..	18-23	12-29	0-874	17-07	11-32	0-962	17-17	11-43	0-930	17-75	11-70	0-925
2	Farmyard Manure, & Super.	18-07	12-36	0-822	16-04	9-88	0-982	17-07	11-29	0-965	17-95	12-14	0-875
3	Unmanured (1846, & since)	19-22	13-26	0-767	17-83	12-11	0-823	17-87	11-93	0-720	19-12	13-21	0-683
4	Super., & Pot., Sod., & Mag.	19-08	13-41	0-778	0-110	16-97	11-55	0-860	0-148	0-128	0-184	18-67	12-67
5	Superphosphate ..	18-67	13-19	0-712	0-101	16-37	10-58	0-866	0-167	0-167	0-250	18-07	12-53
6	Super., & Potash ..	18-83	13-09	0-772	0-098	17-08	11-26	0-891	0-167	0-166	0-173	18-41	12-47
7	Super., Pot., & 36½ lb. Am.-sfts.	19-03	13-20	0-742	16-66	10-63	0-937	17-38	11-51	0-879	19-01	13-32	0-809
8	Unmanured (1853, & since)	18-69	..	0-701	16-84	..	0-911	17-98	12-15	0-797	18-95	..	0-685

THIRD SEASON, 1873. (Samples collected from November 10 to November 14.)

1	Farmyard Manure ..	17-62	12-06	0-924	16-64	10-61	0-947	16-76	10-74	0-965	16-88	11-03	0-887
2	Farmyard Manure, & Super.	18-49	12-34	0-847	16-35	10-19	0-973	16-54	10-98	0-951	16-33	10-92	0-960
3	Unmanured (1846, & since)	18-96	13-11	0-710	16-97	11-27	0-843	18-76	12-38	0-762	17-94	13-46	0-735
4	Super., & Pot., Sod., & Mag.	18-80	13-09	0-796	0-132	17-97	11-42	0-934	0-181	0-161	0-187	18-30	12-48
5	Superphosphate ..	19-25	13-52	0-679	0-121	16-89	10-90	0-847	0-184	0-186	0-227	18-93	12-77
6	Super., & Potash ..	19-64	13-60	0-757	0-119	17-94	11-84	0-810	0-169	0-140	0-212	18-22	12-29
7	Super., Pot., & 36½ lb. Am.-sfts.	19-63	13-67	0-747	17-42	11-10	0-907	18-81	13-00	0-858	19-00	12-40	0-852
8	Unmanured (1853, & since)	20-22	13-89	0-742	16-50	10-32	0-917	18-47	12-50	0-756	18-06	12-38	0-695

FOURTH SEASON, 1874 (1). Mineral Manures as in 1872 and 1873; but no Farmyard Manure, or cross-dressings of Nitrate Soda, Ammonium-salts, or Rape-cake. (Samples collected in the middle of November.)

1	Farmyard Manure, '71, '72 & '73	14-66	10-57	1-100	14-27	9-62	1-059	14-35	9-27	1-112	13-53	9-70	1-029
2	Farmyard Manure, & Super. '71-'73	15-00	12-08	1-022	13-84	9-41	1-082	14-24	9-58	1-081	14-59	9-58	0-970
3	Unmanured (1846, & since)	17-45	12-51	0-792	15-60	9-63	0-990	16-05	11-07	0-868	15-54	10-84	0-861
4	Super., & Pot., Sod., & Mag.	18-54	12-41	0-721	14-00	9-22	0-840	16-70	11-75	0-921	17-17	11-01	1-026
5	Superphosphate ..	18-06	12-32	0-668	14-91	9-26	0-898	16-87	11-76	0-833	14-89	10-94	0-746
6	Super., & Potash ..	17-83	12-30	0-752	15-95	9-95	0-839	16-70	12-97	0-865	15-30	11-41	0-938
7	Super., Pot., & 36½ lb. Am.-sfts.	16-88	..	0-730	15-56	..	0-903	17-74	..	0-784	16-08	..	0-907
8	Unmanured (1853, & since)	18-76	..	0-726	15-30	..	0-890	17-35	..	0-771	15-48	..	0-772

FIFTH SEASON, 1875. Mineral Manures as in 1872, 1873, and 1874; but no Farmyard Manure, or cross-dressings of Nitrate Soda, Ammonium-salts, or Rape-cake. (Samples collected in the middle of November.)

1	Farmyard Manure, '71, '72 & '73	16-02	11-10	0-749	16-16	11-22	0-751	16-33	10-91	0-814	16-29	11-39	0-840
2	Farmyard Manure, & Super. '71-'73	16-08	11-11	0-784	15-67	10-63	0-687	15-43	10-21	0-863	15-70	10-32	0-770
3	Unmanured (1846, & since)	17-29	12-11	0-671	15-66	10-92	0-720	17-52	12-12	0-675	15-90	10-85	0-652
4	Super., & Pot., Sod., & Mag.	16-67	11-48	0-773	0-103	16-10	11-42	0-751	0-112	0-755	16-56	11-27	0-758
5	Superphosphate ..	16-94	12-30	0-686	0-107	16-53	11-46	0-722	0-125	0-683	0-122	15-34	10-61
6	Super., & Potash ..	18-04	12-00	0-782	0-127	16-78	11-82	0-762	0-123	0-752	0-136	16-21	10-97
7	Super., Pot., & 36½ lb. Am.-sfts.	17-51	..	0-730	16-50	..	0-874	16-50	..	0-802	15-88	..	0-856
8	Unmanured (1853, & since)	16-81	..	0-770	16-01	..	0-812	16-56	..	0-767	15-96	..	0-768

(1) Owing to the deficiency of Rain for some time after sowing, a large proportion of the plants failed. Some were transplanted on Plots 1, but not on the other plots, and eventually the plant was (excepting on Plots 1) upon the whole very deficient and irregular, the remaining plants being larger than usual.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD (after SUGAR-BEET); commencing 1876.

Below are given the particulars of the Manures and Produce in each of the first 5 Seasons, 1876-1880; also the average Produce of those first 5 Seasons. For continuation, see pp. 60-1, 64-5, 68-9, and 72-73.

The arrangement of the Plots is precisely the same as previously for Sugar-beet, excepting that Plot 9, which was unmanured for Sugar-beet, and also previously for weighed, spread on the respective Plots, and ploughed in.

(Area under experiment about 8 acres.)

PLOTS.	MANURES PER ACRE PER ANNUM.				
	SERIES 1. Standard Manures only.	SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.	SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. "Ammonium-salts."	SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. "Ammonium-salts."	SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.

FIRST SEASON, 1876. Seed dibbled, May 22-26. Crop taken up, Nov. 3-17.

1 2 3 4 5 6 7 8 9	Farmyard Manure (14 tons) Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1) .. Without Manure (1846, and since) { 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia } 3½ cwts. Superphosphate 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash 3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am-salts (?) .. Unmanured, 1853, and since; previously part Unman., part Superphos. Farmyard Manure (14 tons), 3½ cwts. Superphosphate (?)	PRODUCE PER ACRE.																	
		Leaves.		Roots.		Leaves.		Roots.		Leaves.		Roots.							
		Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.						
19	12	4	9	25	2	7	5	29	19	7	12	31	9	10	5	24	9	5	19
19	13	4	6	27	13	7	3	29	8	7	10	30	18	9	16	29	19	6	12
6	10	1	14	20	13	5	12	14	3	4	10	19	19	7	7	17	4	4	15
8	8	1	15	25	1	6	0	19	19	4	9	30	8	8	13	25	8	5	10
7	10	1	14	21	0	5	14	13	10	5	1	17	2	7	14	17	17	5	17
6	16	1	12	21	2	5	8	17	15	4	13	26	8	9	0	20	10	5	4
8	13	2	3	22	11	5	14	19	2	5	11	27	2	9	9	20	12	5	15
5	9	1	10	15	16	5	3	11	17	4	16	18	2	7	11	15	12	4	18
..	..	..	..	..	..	..	..	25	14	7	6	..	..	..	..	..	..	..	..

SECOND SEASON, 1877. Seed dibbled, June 4-6 (Plots 8 and 9, June 11th). Crop taken up, Nov. 14-23.

1 2 3 4 5 6 7 8 9	Farmyard Manure (14 tons) Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1) .. Without Manure (1846, and since) { 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia } 3½ cwts. Superphosphate 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash 3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am-salts (?) .. Unmanured, 1853, and since; previously part Unman., part Superphos. Farmyard Manure (14 tons), 3½ cwts. Superphosphate (?)	PRODUCE PER ACRE.																	
		Leaves.		Roots.		Leaves.		Roots.		Leaves.		Roots.							
		Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.						
15	7	2	1	24	13	3	14	27	1	4	4	30	5	5	5	25	18	3	4
16	14	1	19	26	8	3	12	26	18	4	6	28	15	5	9	24	12	2	19
5	9	1	0	16	17	3	14	8	16	3	0	13	9	3	19	13	17	2	10
6	16	1	3	21	10	3	10	16	10	2	2	27	9	3	8	21	14	1	17
6	1	0	19	20	5	3	1	12	2	2	10	15	3	3	8	15	3	2	2
5	8	0	18	20	19	2	18	15	6	1	16	24	18	3	16	19	3	1	12
7	0	1	3	22	2	3	16	16	13	2	7	25	15	5	0	20	13	2	8
3	19	1	3	9	17	5	4	7	4	3	10	11	9	4	11	10	3	3	3
..	..	..	..	..	..	..	..	13	17	4	0	..	..	..	..	..	..	..	..

THIRD SEASON, 1878. Seed dibbled, June 8-9 (Plot 9, June 11th). Crop taken up, Nov. 7-20.

1	Farmyard Manure (14 tons)	13	5	2	16	18	15	4	4	20	11	5	6	22	4	6	3	17	1	8	13
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	14	16	2	19	21	4	4	15	19	15	5	3	20	18	5	17	18	17	3	15
3	Without Manure (1846, and since)	3	10	1	4	10	2	2	16	4	7	2	11	6	11	3	7	6	3	2	17
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia	5	9	1	7	18	10	4	6	14	3	2	12	21	2	4	14	15	19	3	2
5	3½ cwts. Superphosphate	4	14	1	8	14	11	3	18	8	2	3	6	8	4	3	3	8	1	3	6
6	3½ cwts. Superphosphate, 500 lbs. Sulphate Potash	3	18	1	3	15	1	3	7	12	0	2	14	15	3	4	11	12	5	3	3
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (?)	5	8	1	9	13	18	3	1	11	18	2	18	14	0	4	5	11	19	3	8
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	2	13	1	4	11	19	4	7	6	13	3	5	6	12	4	10	6	4	3	5
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (?) .. .. .	..	..	..	..	..	..	..	..	15	17	5	9	..	..	..	..	..	..	..	..

FOURTH SEASON, 1879. Seed dibbled, May 13-15. Crop taken up, Nov. 11-20.

1	Farmyard Manure (14 tons)	6	3	1	15	9	8	2	9	12	6	3	11	13	16	8	15	10	14	2	12
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	6	13	1	16	11	11	2	18	11	12	3	9	14	1	3	17	9	18	2	11
3	Without Manure (1846, and since)	1	12	0	12	4	17	1	19	3	12	2	4	7	17	3	3	6	8	1	17
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia	2	2	0	14	8	13	2	8	7	10	1	15	12	10	2	19	7	7	1	14
5	3½ cwts. Superphosphate	1	18	0	14	8	5	2	9	5	0	1	16	9	13	3	5	6	11	1	12
6	3½ cwts. Superphosphate, 500 lbs. Sulphate Potash	1	15	0	13	7	16	2	7	6	9	1	12	11	11	3	5	7	17	1	13
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (?)	1	18	0	14	8	2	2	6	6	7	1	14	11	2	3	6	8	4	2	0
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	1	5	0	11	5	16	2	7	3	10	1	16	9	2	3	14	6	9	2	5
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (?) .. .. .	..	..	..	..	..	..	..	..	9	7	2	19	..	..	..	..	..	..	..	..

FIFTH SEASON, 1880. Seed dibbled, April 22-23 (Plot 9, April 24th). Crop taken up, Nov. 2-11.

1	Farmyard Manure (14 tons)	18	11	2	14	26	8	3	5	25	4	5	10	27	3	6	1	27	5	4	1
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	17	8	2	0	27	16	3	14	25	15	5	10	26	0	5	12	27	9	4	3
3	Without Manure (1846, and since)	4	10	0	18	14	0	2	13	9	17	2	11	11	4	3	0	12	6	2	9
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia	5	17	0	19	23	6	3	3	19	14	2	18	30	11	5	12	24	4	3	6
5	3½ cwts. Superphosphate	5	3	0	16	18	6	2	4	9	18	2	13	12	9	2	18	14	8	2	13
6	3½ cwts. Superphosphate, 500 lbs. Sulphate Potash	4	15	0	14	21	10	2	11	18	12	3	4	27	4	5	11	21	8	2	7
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (?)	7	0	0	19	21	10	2	6	19	6	2	19	26	0	5	6	23	2	2	11
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	4	0	0	17	11	14	3	5	5	19	2	17	12	4	3	1	12	1	2	15
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (?) .. .. .	..	..	..	..	..	..	..	..	20	19	4	0	..	..	..	..	..	..	..	..

AVERAGE OF 5 SEASONS, 1876, '77, '78, '79, and 1880.

1	Farmyard Manure (14 tons)	14	12	2	15	20	17	4	3	23	0	5	5	24	19	6	6	21	1	3	18
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	15	1	2	12	22	18	4	8	22	14	5	4	24	2	6	2	22	3	4	0
3	Without Manure (1846, and since)	4	6	1	2	13	6	3	7	8	3	2	19	11	16	4	3	11	4	2	18
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } { Sodium (common salt), 200 lbs. Sulphate Magnesia	5	14	1	4	19	8	3	17	15	11	2	15	24	8	5	1	18	18	3	2
5	3½ cwts. Superphosphate	5	1	1	2	16	9	3	9	9	14	3	1	12	10	4	2	12	8	3	2
6	3½ cwts. Superphosphate, 500 lbs. Sulphate Potash	4	10	1	0	17	6	3	6	14	0	2	16	21	1	5	5	16	5	2	16
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (?)	6	0	1	6	17	13	3	9	14	13	3	2	20	16	5	9	16	18	3	4
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	3	9	1	1	11	0	4	1	7	1	3	5	12	0	4	13	10	2	3	5
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (?) .. .. .	..	..	..	..	..	..	..	..	17	3	4	15	..	..	..	..	..	..	..	..

(1) "Superphosphate of Lime"—in all cases made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water). (2) "Ammonium-salts"—in each case equal parts Sulphate and Muriate of Ammonia of Commerce. (3) Plot 9 sown on the flat instead of on ridges; plants ridged up afterwards; rows 22 inches apart, plants 10 inches apart in the rows.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE MANGEL ROOTS, in each of the first 5 Seasons, 1876-1880; also the average composition over the first 5 Seasons. For the composition in 1881 and succeeding years, see pp. 62-3, 66-7, 70-1, and 74-5.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Mangel, is given below. The dry matter, ash, and nitrogen, are of course determined in the roots themselves. The amounts of dry matter, ash, and nitrogen, have also, in many cases, been determined in the expressed juice. In many cases also, the amount of the nitrogen existing as albuminoids has been determined (by Church's method); and in some cases the amount of amides and as nitric acid. It may be observed that by far the larger proportion of both the mineral matter and the nitrogen of the roots is found in the juice; and of the nitrogen in the juice a variable proportion, ranging from less than one-fifth to not more than one-third of the total, is found to exist as albuminoids.

The sugar was determined in the expressed juice, and calculated into its percentage in the roots in accordance with the methods adopted at the time the experiments were made (1876-80), which were founded on the estimate of the percentage of juice in the roots, reckoned from the determined percentage of dry matter in the juice and in the roots. The results showed an average of about 96 per cent. of juice, and this figure was adopted in calculating the amount of sugar in the roots from that determined in the juice. In 1879, however, Scheibler published results obtained by determining the sugar in *Sugar-beet*, both directly in the roots by extraction with dilute alcohol, and also in the juice in the ordinary way. Whilst the old method indicated an average of about 95 per cent. of juice, the new one showed only about 90 per cent. Scheibler concluded that water equal to the difference (about 5 per cent.) existed in combination with the marc, and this he termed "colloid water," as distinguished from the water of the juice. In the Rothmanstedt "Memoranda" for 1884, attention was called to Scheibler's new results and conclusions, in regard to *Sugar-beet*, and it was pointed out that if they were confirmed the percentages of sugar annually recorded in the Tables of the Rothmanstedt results should be reduced by about $\frac{5}{100}$. It was further pointed out, that supposing the same applied to Mangels, and that the amount of true juice in them averaged only

90 instead of 96 per cent., the percentage of sugar in their roots would also be from $\frac{1}{10}$ or $\frac{1}{20}$ less than given in the Table. Subsequently, further evidence, and especially results obtained by Maercker, by the extraction of the sugar in the roots by alcohol, left no doubt that the amount of juice in *Sugar-beet* averages more nearly 90 than 96 per cent. We are not aware of any published results of the determinations of sugar in Mangel-roots by extraction with alcohol; but until direct evidence on the point is available, it is assumed that the amount of juice in Mangels, like that in *Sugar-beet*, will probably average about 90 per cent.; and having in 1885 to reconsider the subject for a paper on "Root-crops," the previously annually recorded percentages of sugar in the experimentally grown Mangel-roots, were then corrected on the assumption that the amount of juice will on the average be only 90 per cent., and the results as so corrected are given in the Table below. It is obvious, however, that with roots varying so much in character of growth, size, and ripeness, the percentage of juice would not be the same in all. Nevertheless, it was considered that the results calculated on the assumption of 96 per cent. of juice, approximately and usefully represented the actual and relative amounts of sugar in the various roots; and now that only 90 per cent. of juice is assumed it may be supposed that the results will be actually nearer the truth than before, and relatively as near.

In interpreting the figures, it must be borne in mind, that, with forty different experiments each year, and, in each year, four, five, or more times, as much produce on some Plots as on others, it would be impossible to sample each at its best, and all in the same condition of ripeness. Each year the seeds, was sown on all the Plots at the same time. The sample analysed was in each case a mixture of vertical sections of ten or fifteen roots, and all the samples were as a rule taken within a period of from one to two weeks; as far as practicable beginning with the ripest. It is obvious, however, that the smaller crops would be much riper than the larger ones; but, although the larger crops generally contain a lower percentage of sugar, they yield very much more sugar per acre.

MANURES, PER ACRE, PER ANNUM.

PLOTS.	ABBREVIATED DESCRIPTION OF STANDARD MANURES.	SERIES 1.			SERIES 2.			SERIES 3.			SERIES 4.			SERIES 5.			
		Standard Manures only.			Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.			Standard Manures, and Cross-dressed with 400 lbs. Ammonium-salts.			Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. Am.-salts.			Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.			
		Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.
		Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.
1	Farmyard Manure	12.14	6.70	0.969	1.031	10.54	5.35	1.031	1.031	8.98	11.30	1.065	1.065	11.30	11.30	0.989	0.989
2	Farmyard Manure & Super.	12.41	6.74	0.943	1.020	9.35	4.55	1.020	1.018	8.92	10.51	1.034	1.034	10.51	10.51	1.005	1.005
3	Unmanured (1846, & since)	15.14	..	0.828	0.903	11.94	..	0.903	0.904	11.60	..	0.811	0.811	12.42	..	0.751	0.751
4	Super., & Pot., Sod., & Mag.	13.99	8.42	0.905	0.917	11.36	5.92	0.917	0.989	12.23	9.91	5.27	1.067	11.28	6.51	1.003	1.003
5	Superphosphate	13.51	8.88	0.818	0.917	10.99	5.96	0.917	0.735	11.73	6.82	0.816	0.816	10.65	6.41	0.744	0.744
6	Super., & Potash	13.67	8.19	0.928	0.929	11.23	7.19	0.929	0.938	11.02	6.95	0.938	0.938	10.56	6.84	0.911	0.911
7	Super., Pot., & 36½ lb. Am.-slts.	13.63	..	0.882	0.922	11.61	..	0.922	0.969	10.62	..	1.015	1.015	11.58	..	0.936	0.936
8	Unmanured (1853, & since)	13.06	..	0.900	0.945	11.23	..	0.945	0.876	11.43	..	0.856	0.856	11.61	..	0.757	0.757
9	Farmyard Manure, & Super. ..	..	..	..	..	..	..	..	..	11.59	..	..	..	..	..	..	..

FIRST SEASON, 1876.

Mean Per Cent. Total Dry Matter; Sugar, Mineral Matter (Crude Ash), and Nitrogen, in the Roots.																	
		Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.
		Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.
		12.95	8.39	1.097	1.114	12.44	7.47	1.114	1.114	12.44	7.47	1.114	1.114	12.44	7.47	1.114	1.114
		13.24	7.35	1.089	1.126	11.78	7.20	1.126	1.126	11.78	7.20	1.126	1.126	11.78	7.20	1.126	1.126
		17.11	9.52	0.888	0.834	14.44	9.19	0.834	0.834	14.44	9.19	0.834	0.834	14.44	9.19	0.834	0.834
		13.11	8.77	1.085	1.221	12.69	7.04	1.221	1.221	12.69	7.04	1.221	1.221	12.69	7.04	1.221	1.221
		15.63	9.38	0.838	0.786	14.36	7.72	0.786	0.786	14.36	7.72	0.786	0.786	14.36	7.72	0.786	0.786
		15.05	8.86	1.095	1.061	14.27	8.34	1.061	1.061	14.27	8.34	1.061	1.061	14.27	8.34	1.061	1.061
		13.96	..	1.098	1.136	12.58	..	1.136	1.136	12.58	..	1.136	1.136	12.58	..	1.136	1.136
		14.95	..	0.932	0.811	14.51	..	0.811	0.811	14.51	..	0.811	0.811	14.51	..	0.811	0.811
		14.84	..	1.011	..	..	..	..	..	..	..	..	..	..	..	..	..

SECOND SEASON, 1877.

1	Farmyard Manure	14.48	8.48	0.988	1.122	12.01	7.70	1.122	1.122	12.95	8.39	1.097	1.114	13.34	7.30	1.010	1.010
2	Farmyard Manure, & Super. ..	13.85	9.39	0.961	1.072	12.91	7.70	1.072	1.072	13.24	7.35	1.089	1.126	14.08	7.97	1.000	1.000
3	Unmanured (1846, & since)	16.58	10.49	0.827	0.772	14.06	8.21	0.772	0.772	17.11	9.52	0.888	0.834	16.41	9.58	0.819	0.819
4	Super., & Pot., Sod., & Mag. ..	15.42	10.24	0.948	0.948	12.25	6.80	1.121	1.085	13.11	8.77	1.085	1.221	13.45	9.20	1.046	1.046
5	Superphosphate	15.84	10.93	0.797	0.889	12.90	8.01	0.889	0.838	15.63	9.38	0.838	0.786	15.35	10.04	0.784	0.784
6	Super., & Potash	16.15	10.60	0.891	1.135	12.53	8.53	1.135	1.098	15.05	8.86	1.098	1.061	14.10	9.32	0.978	0.978
7	Super., Pot., & 36½ lb. Am.-slts.	15.88	..	0.943	1.034	12.74	..	1.034	1.098	13.96	..	1.098	1.136	13.83	..	1.036	1.036
8	Unmanured (1853, & since)	16.23	..	0.933	1.023	14.01	..	1.023	0.932	14.95	..	0.932	0.811	14.87	..	0.807	0.807
9	Farmyard Manure, & Super. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

THIRD SEASON, 1878.

1	Farmyard Manure	12.26	6.87	0.995	0.170	11.47	5.97	1.086	0.218	11.17	5.88	1.018	0.206	10.83	5.80	1.046	0.241	11.98	6.47	0.985	0.186
2	Farmyard Manure, & Super.	11.51	6.53	0.981	0.182	10.05	4.89	1.072	0.216	11.00	5.70	1.034	0.206	10.50	5.57	0.987	0.217	10.66	5.76	0.948	0.175
3	Unmanured (1846, & since)	15.25	9.56	0.824	0.186	12.02	6.64	0.908	0.211	13.47	7.59	0.811	0.261	12.86	7.14	0.802	0.247	14.10	8.27	0.846	0.240
4	Super., & Pot., Sod., & Mag.	13.56	8.45	0.928	0.129	11.03	5.85	1.084	0.188	11.90	6.81	0.975	0.144	10.33	5.51	1.027	0.181	11.22	6.12	1.044	0.171
5	Superphosphate	13.91	8.60	0.810	0.144	11.61	6.47	0.873	0.188	13.00	7.63	0.845	0.187	13.87	7.20	0.739	0.244	13.87	8.12	0.786	0.211
6	Super., & Potash	14.23	8.55	0.989	0.173	11.04	5.84	0.986	0.193	13.55	8.13	0.988	0.184	12.09	6.53	1.016	0.235	12.18	6.90	0.940	0.197
7	Super., Pot., & 36½ lb. Am.-sfts.	13.42	..	0.976	..	11.26	..	0.982	..	11.82	..	0.982	..	12.03	..	0.986	..	12.05	..	0.977	..
8	Unmanured (1853, & since)	14.50	..	0.903	..	11.10	..	0.937	..	12.81	..	0.869	..	11.93	..	0.879	..	12.52	..	0.863	..
9	Farmyard Manure, & Super.	..	..	..	..	..	..	..	..	10.77	..	0.939	..	..	..	..	..	..	..	..	..

FOURTH SEASON, 1879.

1	Farmyard Manure	14.91	9.02	1.007	0.175	13.18	7.47	1.010	0.196	13.86	8.13	1.025	0.193	13.34	7.51	1.025	0.186	14.62	8.61	1.022	0.177
2	Farmyard Manure, & Super.	14.78	8.90	1.012	0.185	13.43	7.58	1.016	0.184	13.14	7.57	1.051	0.181	13.54	7.80	1.064	0.186	14.40	8.67	0.995	0.219
3	Unmanured (1846, & since)	18.81	11.72	0.861	0.205	16.01	9.38	0.955	0.226	17.18	10.39	0.834	0.252	16.27	9.79	0.831	0.260	16.16	9.81	0.843	0.203
4	Super., & Pot., Sod., & Mag.	15.56	9.78	0.980	0.131	12.83	7.60	1.010	0.156	14.03	8.70	0.862	0.134	13.67	7.84	1.086	0.171	13.51	8.08	0.938	0.136
5	Superphosphate	16.53	10.58	0.848	0.159	12.60	7.34	0.951	0.180	15.61	9.77	0.814	0.202	14.84	8.68	0.810	0.220	15.57	9.75	0.840	0.182
6	Super., & Potash	16.34	10.29	1.008	0.156	13.75	8.21	0.972	0.180	14.50	9.00	0.998	0.162	13.49	7.94	1.038	0.214	14.42	8.77	0.949	0.157
7	Super., Pot., & 36½ lb. Am.-sfts.	16.33	..	0.895	..	12.97	..	0.997	..	14.48	..	0.946	..	14.18	..	0.947	..	15.35	..	0.947	..
8	Unmanured (1853, & since)	18.46	..	0.903	..	13.78	..	0.963	..	15.44	..	0.812	..	14.13	..	0.853	..	15.58	..	0.852	..
9	Farmyard Manure, & Super.	..	..	..	..	..	..	..	..	14.52	..	0.930	..	..	..	..	..	..	..	..	..

FIFTH SEASON, 1880.

1	Farmyard Manure	12.65	7.79	0.841	0.126	10.72	5.63	0.942	0.186	11.23	6.39	0.871	0.172	11.26	6.35	0.877	0.212	12.08	6.72	0.877	0.176
2	Farmyard Manure, & Super.	12.87	7.56	0.850	0.136	10.44	5.52	0.986	0.188	11.68	6.59	0.891	0.189	10.47	5.94	0.948	0.220	11.66	6.69	0.855	0.171
3	Unmanured (1846, & since)	17.02	11.04	0.739	0.142	12.18	6.90	0.874	0.217	14.48	8.63	0.746	0.272	11.75	6.65	0.716	0.225	12.95	7.80	0.690	0.203
4	Super., & Pot., Sod., & Mag.	14.05	9.25	0.756	0.082	12.36	7.61	0.847	0.186	12.23	7.71	0.849	0.119	10.77	6.12	0.883	0.151	11.18	6.74	0.869	0.123
5	Superphosphate	13.72	8.85	0.709	0.100	11.50	6.47	0.819	0.173	12.84	7.94	0.709	0.158	10.72	6.20	0.679	0.192	12.27	7.35	0.676	0.165
6	Super., & Potash	14.04	8.99	0.761	0.097	11.64	7.00	0.807	0.153	12.40	7.46	0.878	0.123	12.16	7.00	0.837	0.188	13.17	8.14	0.742	0.151
7	Super., Pot., & 36½ lb. Am.-sfts.	13.63	..	0.798	..	11.64	..	0.862	0.154	12.14	..	0.863	..	11.68	..	0.906	..	12.79	..	0.742	..
8	Unmanured (1853, & since)	14.26	..	0.776	..	12.61	..	0.863	..	14.08	..	0.772	..	11.29	..	0.693	..	12.91	..	0.672	..
9	Farmyard Manure, & Super.	..	..	..	..	..	..	..	..	11.92	..	0.801	..	..	..	..	..	..	..	..	..

AVERAGE OF 5 (1) SEASONS, 1876, '77, '78, '79, and 1880.

1	Farmyard Manure	13.29	8.04	0.960	0.157	11.58	6.69	1.028	0.200	11.97	7.20	1.017	0.190	11.37	6.66	1.025	0.213	12.66	7.28	0.977	0.180
2	Farmyard Manure, & Super.	13.08	8.10	0.949	0.168	11.24	6.42	1.040	0.196	11.74	6.80	1.017	0.192	11.04	6.63	1.032	0.208	12.26	7.27	0.961	0.188
3	Unmanured (1846, & since)	16.56	10.70	0.816	0.178	13.24	7.78	0.942	0.218	14.88	9.03	0.837	0.262	13.38	8.20	0.799	0.244	14.41	8.87	0.790	0.215
4	Super., & Pot., Sod., & Mag.	14.52	9.23	0.903	0.121	11.97	6.76	1.015	0.160	12.70	7.74	0.972	0.132	11.47	6.36	1.057	0.168	12.13	7.33	0.980	0.143
5	Superphosphate	14.70	9.57	0.796	0.134	11.92	6.83	0.890	0.180	13.76	8.31	0.788	0.182	12.71	7.09	0.766	0.219	15.54	8.33	0.766	0.186
6	Super., & Potash	14.89	9.32	0.915	0.142	12.08	7.35	0.966	0.175	13.30	8.08	0.990	0.156	12.51	6.98	0.998	0.212	13.08	7.99	0.905	0.168
7	Super., Pot., & 36½ lb. Am.-sfts.	14.53	..	0.899	..	12.04	..	0.959	..	12.62	..	0.962	..	12.23	..	..	..	13.12	..	0.928	..
8	Unmanured (1853, & since)	15.30	..	0.883	..	12.55	..	0.946	..	13.74	..	0.858	..	12.41	..	0.818	..	13.50	..	0.790	..
9	Farmyard Manure, & Super.	..	..	..	..	..	..	..	..	12.61	..	0.911	..	..	..	..	..	..	..	..	..

(1) For Plots 1, 2, and 3, the average percentages of Sugar are taken over the last four years only; and in all cases the average percentages of Nitrogen are taken over the last three years only.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD (after SUGAR-BEET); commencing 1876—continued.

Below are given the particulars of the Manures and Produce of the Sixth, Seventh, Eighth, Ninth, and Tenth Seasons, 1881, 1882, 1883, 1884, and 1885. For the Manures and Produce of the 5 preceding Seasons, see pp. 56-7, and for those of succeeding seasons, see pp. 64-5, 68-9 and 72-3. The arrangement of the Plots, and of the Manures, is precisely the same as for the five preceding years of Mangels, and also the same as previously for Sugar-beet (see pp. 52-3), excepting that Plot 9, which was unmanured for Sugar-beet, and also respective Plots, and ploughed in. (Area under experiment, about 8 acres.)

PLOTS.	MANURES PER ACRE PER ANNUM.											
	SERIES 1. Standard Manures only.		SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.		SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. "Ammonium-salts."		SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. "Ammonium-salts."		SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.			
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.
	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.
1	13	15	2	8	17	19	3	16	15	14	3	13
2	15	2	2	3	19	12	4	4	16	10	4	8
3	4	8	0	13	11	6	2	12	3	15	1	14
4	6	3	0	16	16	18	3	5	12	17	2	10
5	5	11	0	13	15	13	2	10	7	3	2	18
6	4	19	0	12	16	8	2	9	11	9	2	10
7	6	12	0	16	16	17	2	17	12	12	2	13
8	4	10	0	13	10	16	3	13	4	3	2	1
9	..	..	..	..	..	..	..	..	20	18	5	10
	SIXTH SEASON, 1881. Seed dibbled, April 19. Crop taken up, October 31 to November 10.											
	STANDARD MANURES.											
1	Farmyard Manure (14 tons) Superphosphate (1)											
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)											
3	Without Manure (1846, and since) Superphosphate (1)											
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride											
5	Sodium (common salt), 200 lbs. Sulphate Magnesia											
6	3½ cwts. Superphosphate Sulphate Potash											
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (2)											
8	Unmanured, 1853, and since; previously part Unman., part Superphos.											
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (1)											
	SEVENTH SEASON, 1882. Drilling the seed commenced on April 23, but, owing to wet weather, it was not completed until May 9. Plot 9 was dibbled May 23. Crop taken up Nov. 8-21.											
1	14	14	2	12	21	19	3	19	23	5	5	13
2	15	18	2	17	25	17	5	4	23	5	6	4
3	4	12	0	19	14	5	2	15	6	3	3	8
4	4	19	1	0	18	3	3	8	17	13	2	13
5	4	14	1	1	15	10	3	15	9	8	3	18
6	4	5	0	18	15	16	3	14	17	2	2	18
7	6	1	1	3	16	8	3	14	17	6	3	5
8	3	10	0	17	11	9	3	12	7	0	3	18
9	..	..	..	..	..	..	..	..	18	3	5	10
	EIGHTH SEASON, 1883. Seed dibbled, April 19. Crop taken up, October 31 to November 10.											
	STANDARD MANURES.											
1	Farmyard Manure (14 tons) Superphosphate (1)											
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)											
3	Without Manure (1846, and since) Superphosphate (1)											
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride											
5	Sodium (common salt), 200 lbs. Sulphate Magnesia											
6	3½ cwts. Superphosphate Sulphate Potash											
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (2)											
8	Unmanured, 1853, and since; previously part Unman., part Superphos.											
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (1)											

EIGHTH SEASON, 1883. Seed dibbled April 5. Crop taken up Nov. 2-10. (4)

1	Farmyard Manure (14 tons)	22	12	3	16	27	5	4	7	24	6	6	3	33	5	7	33	5	4	7
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	18	19	2	16	28	15	5	2	23	5	6	10	32	14	7	31	2	3	19
3	Without Manure (1846, and since)	4	18	1	1	18	14	4	2	8	6	4	0	13	3	4	13	13	2	19
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } Sodium (common salt), 200 lbs. Sulphate Magnesia	5	15	1	1	23	15	3	16	19	18	3	2	33	12	5	23	10	3	2
5	3½ cwts. Superphosphate	5	3	0	18	21	12	3	10	10	15	3	9	14	12	5	3	16	4	3
6	3½ cwts. Superphosphate, 500 lbs. Sulphate Potash	4	6	0	16	21	1	2	14	19	4	2	17	33	5	6	23	9	2	13
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (2)	6	4	1	1	22	14	2	19	20	12	2	17	33	4	6	24	17	3	4
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	4	6	0	18	17	0	3	19	7	11	3	0	13	1	4	13	10	4	1
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (3) .. .. .	..	..	..	..	..	..	..	..	20	11	5	9	..	..	..	..	..	..	..

NINTH SEASON, 1884. Seed drilled April 10-11. Plot 9 dibbled April 12. Crop taken up Oct. 29-31.

1	Farmyard Manure (14 tons)	15	19	2	0	26	14	3	12	22	3	4	13	25	2	4	3	26	17	3	0
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	16	8	2	0	26	13	4	3	22	14	4	14	23	3	4	8	25	14	3	6
3	Without Manure (1846, and since)	5	11	0	19	7	5	2	8	5	15	2	9	7	16	2	15	10	0	2	18
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } Sodium (common salt), 200 lbs. Sulphate Magnesia	6	7	1	1	12	1	2	19	13	18	3	3	23	19	4	14	19	7	2	6
5	3½ cwts. Superphosphate	5	19	0	18	5	17	1	15	4	14	2	12	8	7	3	5	9	4	3	0
6	3½ cwts. Superphosphate, 500 lbs. Sulphate Potash	5	9	0	15	4	19	1	7	9	15	3	1	21	13	4	19	17	15	2	7
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (2)	7	9	1	1	3	3	0	15	8	0	2	2	19	18	4	6	19	6	2	12
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	4	15	0	16	1	8	0	13	3	2	1	7	7	8	2	12	7	4	2	9
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (3) .. .. .	..	..	..	..	..	..	..	..	14	8	3	8	..	..	..	..	..	..	..	..

TENTH SEASON, 1885. Mineral Manures and Rape-cake sown April 13; seed drilled April 14 and 15; Nitrate Soda and Ammonium-salts not sown (see note 5 below).
Crop taken up Oct. 26-Nov. 2.

1	Farmyard Manure (14 tons)	3	6	0	16	2	15	0	15	3	1	0	18	11	15	2	9	15	8	2	9
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	2	1	0	10	2	1	0	12	2	14	0	14	10	7	2	7	13	10	2	5
3	Without Manure (1846, and since)	0	1	0	1	0	1	0	1	0	1	0	1	2	5	1	8	3	3	1	10
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } Sodium (common salt), 200 lbs. Sulphate Magnesia	0	6	0	2	0	6	0	3	0	19	0	6	14	15	1	18	13	1	1	7
5	3½ cwts. Superphosphate	0	3	0	2	0	4	0	2	0	12	0	8	2	19	1	19	3	12	1	11
6	3½ cwts. Superphosphate, 500 lbs. Sulphate Potash	0	10	0	4	0	10	0	5	2	5	0	12	8	16	2	5	7	14	2	4
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (2)	0	10	0	4	0	14	0	5	1	16	0	10	7	18	2	2	6	6	1	12
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	0	9	0	4	1	0	0	9	0	4	0	2	0	14	0	17	0	12	0	13
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (3) .. .. .	..	..	..	..	..	..	..	..	2	8	0	19	..	..	..	..	..	..	..	..

AVERAGE OF 4 SEASONS, 1881, '82, '83 and 1884. (6)

1	Farmyard Manure (14 tons)	16	15	2	14	23	9	3	19	21	7	5	0	25	3	5	14	25	3	3	16
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	16	12	2	9	25	1	4	13	21	9	5	9	24	18	6	1	24	8	3	16
3	Without Manure (1846, and since)	4	17	0	18	12	18	2	19	6	0	2	18	9	19	3	13	11	3	2	19
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } Sodium (common salt), 200 lbs. Sulphate Magnesia	5	16	1	0	17	14	3	7	16	2	2	17	26	18	5	4	20	9	2	17
5	3½ cwts. Superphosphate	5	7	0	17	14	13	2	18	8	0	3	4	11	5	4	8	12	10	3	3
6	3½ cwts. Superphosphate, 500 lbs. Sulphate Potash	4	15	0	15	14	11	2	8	14	8	2	16	24	2	5	10	19	7	2	11
7	3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (2)	6	12	1	0	14	16	2	11	14	13	2	14	23	12	5	4	20	15	2	18
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	4	5	0	16	10	3	2	19	5	9	2	12	9	15	3	18	10	7	3	8
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (3) .. .. .	..	..	..	..	..	..	..	..	18	10	4	19	..	..	..	..	..	..	..	..

(1) "Superphosphate of Lime"—in all cases made from 200 lbs. Bone ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water).
 (2) Plot 9 sown on the flat instead of on ridges; plants ridged up afterwards; rows 22 inches apart, plants 10 inches apart in the rows.
 (3) Owing to dry weather much seed failed, especially on some Ammonia and Nitrate plots, and the blanks were filled up by transplanting.
 (4) In order to lessen possible loss by drainage, or injury to the seed or young plants, it was decided to top-dress the Nitrate of Soda and Ammonium-salts after the plant was well up, and for greater convenience the seed was sown on the flat; but owing to unfavourable weather, and to the unsatisfactory condition of the land where these manures had been applied without any organic matter for so many years, the plant almost entirely failed, and the Nitrate and Ammonium-salts were therefore not sown at all. On Series 4 and 5, however, where Rape-cake is usually applied, and the soil was more open, the seed germinated, and the plants grew fairly well.
 (5) Owing to the failure of the plant on many plots, and the irregularity of the crops in 1885, the produce of that year is not brought into the average.
 (6) "Ammonium-salts"—in each case equal parts Sulphate and Muriate of Ammonia of Commerce.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE MANGEL ROOTS, in the Sixth, Seventh, Eighth, Ninth, and Tenth Seasons, 1881, 1882, 1883, 1884, 1885. For particulars of the composition in the first 5 Years, 1876-1880, see pp. 58-9, and for those in succeeding seasons see pp. 66-7, 70-1, and 74-5.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Mangels, is given below. The dry matter, ash, and nitrogen, are of course determined in the roots themselves. The amounts of dry matter, ash, and nitrogen, have also, in many cases, been determined in the expressed juice. In many cases also, the amount of the nitrogen existing as albuminoids has been determined (by Church's method); and in some cases the amount as amides and as nitric acid. It may be observed that by far the larger proportion of both the mineral matter and the nitrogen of the roots is found in the juice; and of the nitrogen in the juice a variable proportion, ranging from less than one-fifth to not more than one-third of the total, is found to exist as albuminoids. When sugar has been estimated, it has been determined in the expressed juice, and calculated into its percentage in the roots, as described in more detail in the letterpress above the Table on p. 58.

In interpreting the figures, it must be borne in mind, that, with forty different experiments each year, and, in each year four, five, or more, times, as much produce on some plots as on others, it would be impossible to sample each at its best, and all in the same condition of ripeness. Each year the seed was sown on all the plots at the same time. The sample analysed was in each case a mixture of vertical sections of ten or fifteen roots, and all the samples were as a rule taken within a period of from one to two weeks; as far as practicable beginning with the ripest. It is obvious, however, that the smaller crops would be much riper than the larger ones; but, although the larger crops generally contain a lower percentage of sugar, they yield very much more sugar per acre.

MANURES, PER ACRE, PER ANNUM.

PLOTS.	ABBREVIATED DESCRIPTION OF STANDARD MANURES. For details, see pp. 60-1.	SERIES 1. Standard Manures only.				SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.				SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. Ammonium-salts.				SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. Ammonium-salts.				SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.			
		Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.

SIXTH SEASON, 1881.

Mean Per Cent. Total Dry Matter, Mineral Matter (Crude Ash), and Nitrogen, in the Roots.

1	Farmyard Manure	12.98	0.946	0.207	0.014	0.257	12.38	0.984	0.243	0.237	0.983	0.257	11.80	0.945	0.217	0.945	0.217
2	Farmyard Manure, & Super. ..	12.35	0.883	0.171	11.91	0.946	11.83	0.995	0.237	13.32	0.963	0.280	12.07	0.929	0.234	0.929	0.234
3	Unmanured (1846, & since) ..	17.88	0.700	0.205	13.98	0.864	17.13	0.801	0.333	15.94	0.722	0.320	15.93	0.675	0.257	0.675	0.257
4	Super., & Pot., Sod., & Mag. ..	15.11	0.839	0.134	12.77	1.020	14.10	0.977	0.192	13.02	1.037	0.255	13.35	0.979	0.190	0.979	0.190
5	Superphosphate	15.76	0.724	0.139	12.50	0.836	14.50	0.649	0.238	14.59	0.708	0.237	13.96	0.691	0.222	0.691	0.222
6	Super., & Potash	16.10	0.797	0.133	14.14	0.910	13.84	1.007	0.201	13.65	0.985	0.222	13.69	0.978	0.202	0.978	0.202
7	Super., Pot., & 36½ lb. Am.-sfts. Unmanured (1853, & since) ..	15.11	0.870	0.133	12.42	0.945	13.54	1.033	0.201	13.33	0.982	0.222	13.44	0.888	0.202	0.888	0.202
8	Super., Pot., & 36½ lb. Am.-sfts. Unmanured (1853, & since) ..	15.77	0.788	0.133	12.40	0.876	15.28	0.766	0.201	14.07	0.671	0.222	14.78	0.704	0.202	0.704	0.202
9	Farmyard Manure, & Super. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

SEVENTH SEASON, 1882.

1	Farmyard Manure	14.29	0.850	0.153	13.32	0.901	12.73	0.900	0.196	11.60	0.940	0.224	12.51	0.898	0.196	0.898	0.196
2	Farmyard Manure, & Super. ..	13.19	0.871	0.143	13.08	0.929	12.52	0.849	0.226	12.75	0.885	0.231	13.14	0.869	0.178	0.869	0.178
3	Unmanured (1846, & since) ..	17.08	0.746	0.153	14.78	0.817	15.43	0.745	0.282	14.37	0.675	0.293	15.67	0.677	0.250	0.677	0.250
4	Super., & Pot., Sod., & Mag. ..	15.41	0.820	0.144	12.45	0.882	14.26	0.882	0.144	12.81	0.885	0.166	13.32	0.811	0.140	0.811	0.140
5	Superphosphate	15.05	0.720	0.127	12.58	0.781	14.69	0.656	0.243	12.96	0.701	0.273	14.98	0.665	0.214	0.665	0.214
6	Super., & Potash	15.40	0.794	0.155	13.87	0.830	14.59	0.862	0.163	12.97	0.873	0.216	14.58	0.836	0.156	0.836	0.156
7	Super., Pot., & 36½ lb. Am.-sfts. Unmanured (1853, & since) ..	15.19	0.808	0.155	13.67	0.891	14.23	0.858	0.163	13.41	0.671	0.216	14.10	0.833	0.156	0.833	0.156
8	Super., Pot., & 36½ lb. Am.-sfts. Unmanured (1853, & since) ..	15.42	0.808	0.155	12.57	0.891	14.04	0.858	0.163	13.81	0.696	0.216	14.10	0.833	0.156	0.833	0.156
9	Farmyard Manure, & Super. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

EIGHTH SEASON, 1883.

1	Farmyard Manure	13.10	0.820	11.82	0.870	12.23	0.852	12.24	0.812	13.32	0.813
2	Farmyard Manure, & Super.	13.30	0.841	11.40	0.882	11.30	0.843	12.62	0.727	13.72	0.764
3	Unmanured (1846, & since)	17.24	0.707	13.53	0.720	14.56	0.714	13.38	0.668	14.58	0.585
4	Super., & Pot., Sod., & Mag.	15.18	0.764	0.114	0.897	0.152	0.882	13.44	0.930	0.172	0.860
5	Superphosphate	15.17	0.686	0.124	0.821	0.172	0.691	13.14	0.636	0.234	0.614
6	Super., & Potash	14.74	0.813	0.129	0.804	0.150	0.820	12.83	0.846	0.163	0.844
7	Super., Pot., & 36½ lb. Am.-sfts.	14.94	0.718	13.04	0.744	13.94	0.653	13.10	0.629	13.68	0.553
8	Unmanured (1853, & since)	15.26	..	11.85	..	14.36	..	13.98	..	..	..
9	Farmyard Manure, & Super.	..	..	..	..	12.74	..	..	..	..	..

NINTH SEASON, 1884.

1	Farmyard Manure	13.27	0.947	12.37	0.957	11.74	0.887	11.33	0.903	12.23	0.878
2	Farmyard Manure, & Super.	13.72	0.892	10.69	1.018	12.18	0.908	11.28	0.893	12.44	0.891
3	Unmanured (1846, & since)	16.41	0.748	13.89	0.973	16.30	0.794	14.61	0.722	15.58	0.716
4	Super., & Pot., Sod., & Mag.	14.45	0.934	0.125	1.100	0.205	1.123	0.180	1.113	0.244	0.952
5	Superphosphate	14.99	0.754	0.125	1.055	0.318	0.843	0.255	0.776	0.262	0.746
6	Super., & Potash	15.83	0.818	0.111	1.059	0.239	1.020	0.203	0.971	0.203	0.963
7	Super., Pot., & 36½ lb. Am.-sfts.	14.56	0.806	12.63	1.010	12.88	1.082	12.58	0.763	12.98	0.757
8	Unmanured (1853, & since)	15.59	..	13.10	..	14.91	0.898	13.70	..	..	..
9	Farmyard Manure, & Super.	..	..	12.74	..	13.27	..	..	..	..	..

TENTH SEASON, 1885.

1	Farmyard Manure	11.58	0.976	10.68	1.020	12.19	0.904	13.01	0.830	13.21	0.820
2	Farmyard Manure, & Super.	11.41	1.015	11.44	0.983	12.17	0.942	12.92	0.868	11.99	0.880
3	Unmanured (1846, & since)	14.21	1.160	13.97	1.016	15.06	0.963	16.57	0.820	16.84	0.820
4	Super., & Pot., Sod., & Mag.	14.34	1.094	0.261	1.104	0.251	1.047	0.247	0.842	0.162	0.840
5	Superphosphate	13.44	1.028	0.283	1.062	0.300 (14.22) ⁽²⁾	(0.729)	0.281	0.789	0.314	0.758
6	Super., & Potash	13.87	1.110	0.256	0.976	0.248	0.997	0.225	0.789	0.212	0.843
7	Super., Pot., & 36½ lb. Am.-sfts.	13.87	1.019	13.20	0.966	13.36	(1.112)	13.40	0.841	14.16	0.915
8	Unmanured (1853, & since)	15.09	..	13.02	..	14.57	1.027	16.81	..	..	..
9	Farmyard Manure, & Super.	..	..	..	..	13.66	..	..	..	..	..

AVERAGE OF 4 (1) SEASONS, 1881, '82, '83, and 1884. (3)

1	Farmyard Manure	13.41	0.891	12.44	0.936	0.216	0.906	0.220	0.910	0.240	0.884
2	Farmyard Manure, & Super.	13.14	0.872	11.77	0.944	0.208	0.899	0.232	0.867	0.256	0.863
3	Unmanured (1846, & since)	17.15	0.725	0.179	0.844	0.215	0.749	0.308	0.697	0.307	0.663
4	Super., & Pot., Sod., & Mag.	15.04	0.839	0.129	0.975	0.180	0.954	0.161	0.996	0.209	0.901
5	Superphosphate	15.24	0.721	0.129	0.873	0.214	0.710	0.237	0.705	0.259	0.679
6	Super., & Potash	14.52	0.806	0.127	0.901	0.188	0.927	0.179	0.919	0.201	0.905
7	Super., Pot., & 36½ lb. Am.-sfts.	14.95	0.780	13.06	0.880	13.65	0.794	13.11	0.690	14.04	0.669
8	Unmanured (1853, & since)	15.51	..	12.39	..	14.65	..	13.77	..	..	..
9	Farmyard Manure, & Super.	..	..	..	..	12.91	..	..	..	..	..

(1) For plots 1, 2, and 3, the average percentages of nitrogen are for two years only, 1881 and 1882, as no determinations were made in these plots in 1883 and 1884.
 (2) Owing to an accident, the determinations of dry matter were in these cases lost; the means of the percentages of dry matter in the four preceding years are therefore entered in parentheses, and are adopted in the calculation of the percentages of ash and nitrogen, which are also entered in parentheses.

(3) Owing to the failure of the plant on many plots, and the irregularity of the produce for that year is not brought into the average.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD (after SUGAR-BEET); commencing 1876—continued.

Below are given the particulars of the Manures and Produce, of the Eleventh, Twelfth, Thirteenth, Fourteenth, and Fifteenth seasons, 1886, 1887, 1888, 1889, and 1890. For the Manures and Produce of the 10 preceding seasons see pp. 56-7 and 60-1, and for those of succeeding seasons, pp. 68-9 and 72-3.

The arrangement of the plots, and of the Manures, is precisely the same as it was for the ten preceding years of Mangels (see pp. 56-7 and 60-1), and also the same as previously for all carted off; rows 26 inches apart; plants 11 inches apart in the rows. (C) Roots

(Area under experiment, about 8 acres.)

PLOTS.	MANURES PER ACRE PER ANNUM.									
	SERIES 1. Standard Manures only.		SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.		SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. "Ammonium-Salts." (C)		SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. "Ammonium-Salts." (C)		SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.	
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.

ELEVENTH SEASON, 1886. Seed dibbled May 7 and 8. Crop taken up, November 3-9.

PLOTS.	PRODUCE PER ACRE.											
	Roots.		Leaves.		Roots.		Leaves.		Roots.		Leaves.	
1	16	6	23	8	4	4	19	19	5	8	21	0
2	15	5	22	7	4	11	19	4	5	11	19	3
3	5	11	14	2	4	5	5	4	3	2	8	3
4	5	15	17	6	4	0	12	19	2	12	20	9
5	6	12	15	3	3	6	7	3	8	8	12	4
6	5	15	14	4	2	19	13	0	2	15	20	4
7	6	17	15	3	3	5	14	16	3	4	19	16
8	4	17	10	19	3	9	6	2	3	5	8	1
9	..	..	..	..	..	..	14	2	4	18	..	..

TWELFTH SEASON, 1887. Seed dibbled April 25-27. Plants failed on many plots, especially on the plots of Series 2 and 3. Crop taken up, October 25-27.

1	10	17	10	18	2	7	11	17	2	17	15	2
2	9	6	3	2	0	17	6	14	1	16	17	5
3	1	5	0	2	0	1	0	2	0	2	5	5
4	1	15	0	11	0	6	0	14	0	6	13	2
5	2	3	0	3	0	3	0	2	0	2	3	15
6	2	6	0	17	0	3	0	8	0	4	8	0
7	2	5	0	9	0	5	0	13	0	6	8	10
8	1	4	0	1	0	1	0	2	0	2	3	1
9	..	..	..	..	..	..	8	10	3	12	..	..

THIRTEENTH SEASON, 1888. Seed dibbled April 16; Plot 9 April 25. Plants to a great extent failed on the dung plots, and the Series 4 and 5 plots; seed resown, June 13. Crop taken up, November 17-20.

1	Farmyard Manure (14 tons) ..	5	16	3	2	7	8	3	10	7	8	4	2	7	2	4	0
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate ..	6	12	3	15	19	14	4	7	7	11	4	8	8	2	4	3
3	Without Manure (1846, and since) ..	1	7	1	2	20	7	3	0	2	16	1	17	4	2	2	1
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } Sodium (common salt), 200 lbs. Sulphate Magnesia ..	1	16	1	3	23	4	4	16	20	1	3	17	7	19	8	0
5	{ 3½ cwts. Superphosphate .. } Sulphate Potash ..	1	15	1	11	22	2	3	14	11	11	3	9	3	10	3	6
6	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (°) } Sulphate Potash ..	1	8	1	0	20	12	3	8	17	12	3	8	8	9	3	0
7	{ 3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (°) } Unmanured, 1853, and since; previously part Unman., part Superphos. ..	2	10	1	7	21	10	3	10	17	18	3	1	9	18	4	0
8	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (°) ..	1	10	0	13	15	19	3	13	4	12	2	4	5	14	2	19
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (°) ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

FOURTEENTH SEASON, 1889. Seed dibbled May 15 and 16; Plot 9 dibbled May 21 and 22. Crop taken up, November 8-12. (°)

1	Farmyard Manure (14 tons) ..	22	16	3	8	31	6	5	7	31	10	7	3	32	16	7	5
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate ..	27	0	3	19	33	19	5	16	31	10	6	15	33	5	8	3
3	Without Manure (1846, and since) ..	6	8	1	2	16	15	3	3	10	19	3	14	20	1	5	12
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } Sodium (common salt), 200 lbs. Sulphate Magnesia ..	7	9	1	6	(22 12)	(3 14)	18	13	2	11	37	2	6	16	31	1
5	{ 3½ cwts. Superphosphate .. } Sulphate Potash ..	6	13	1	4	(17 15)	(3 2)	12	7	3	8	21	8	6	7	21	9
6	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (°) } Sulphate Potash ..	5	18	1	2	(18 0)	(2 13)	17	11	2	12	30	13	7	2	26	4
7	{ 3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (°) } Unmanured, 1853, and since; previously part Unman., part Superphos. ..	6	9	1	5	(19 1)	(3 2)	17	17	2	17	30	16	7	3	25	11
8	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (°) ..	4	12	1	4	12	7	3	18	9	12	3	17	17	3	16	6
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (°) ..	..	..	..	..	..	..	..	..	19	1	6	2	..	..	..	..

FIFTEENTH SEASON, 1890. Seed dibbled April 23 and 24. Crop taken up, October 17-23.

1	Farmyard Manure (14 tons) ..	22	19	3	3	31	17	4	15	30	18	6	9	30	17	6	4
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate ..	23	9	3	9	33	13	5	11	30	2	6	0	30	13	6	13
3	Without Manure (1846, and since) ..	6	5	1	0	16	16	3	3	8	19	3	1	15	15	2	14
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } Sodium (common salt), 200 lbs. Sulphate Magnesia ..	7	1	1	4	27	1	4	4	21	16	3	7	33	5	5	14
5	{ 3½ cwts. Superphosphate .. } Sulphate Potash ..	6	9	1	1	21	18	3	8	10	4	3	4	15	5	4	7
6	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (°) } Sulphate Potash ..	5	13	0	18	21	12	2	16	19	11	2	17	30	19	5	6
7	{ 3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (°) } Unmanured, 1853, and since; previously part Unman., part Superphos. ..	7	4	1	2	22	5	2	18	22	7	3	7	33	12	6	7
8	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (°) ..	5	5	1	0	15	5	3	13	10	9	3	15	13	14	4	7
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (°) ..	..	..	..	..	..	..	..	..	28	11	5	14	..	..	..	..

AVERAGE OF 5 SEASONS, 1886, '87, '88, '89, and 1890.

1	Farmyard Manure (14 tons) ..	15	15	2	18	20	19	4	2	20	2	5	1	21	9	5	6
2	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate ..	16	7	3	4	22	11	4	6	19	15	4	18	21	11	5	15
3	Without Manure (1846, and since) ..	4	3	1	1	13	13	2	17	6	7	2	12	10	8	3	13
4	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride } Sodium (common salt), 200 lbs. Sulphate Magnesia ..	4	15	1	3	18	8	3	9	14	16	2	11	22	7	4	19
5	{ 3½ cwts. Superphosphate .. } Sulphate Potash ..	4	14	1	4	15	12	2	15	8	2	2	14	10	10	3	17
6	{ 3½ cwts. Superphosphate, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (°) } Sulphate Potash ..	4	4	1	0	15	4	2	9	13	13	2	7	19	13	4	14
7	{ 3½ cwts. Superphos., 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (°) } Unmanured, 1853, and since; previously part Unman., part Superphos. ..	5	1	1	4	15	16	2	12	14	14	2	11	20	10	5	1
8	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (°) ..	3	10	0	19	10	18	2	19	6	3	2	13	9	10	3	17
9	Farmyard Manure (14 tons), 3½ cwts. Superphosphate (°) ..	..	..	..	..	..	..	..	..	16	11	4	19	..	..	..	..

(1) "Superphosphate of Lime," 1886 and 1887, made from 200 lbs. Bone ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water); 1888, and since, made from high percentage mineral phosphates, and containing 37 per cent. or more, of soluble phosphate. (2) "Ammonium-salts," equal parts Sulphate and Nitrate of Ammonia of Commerce. (3) Plot 9 sown on the flat instead of on ridges; plants ridged up afterwards; rows 22 inches apart. Plants 10 inches apart in the rows. (4) 400 lbs. Ammonium-salts, consisting of equal parts of Sulphate and Nitrate of Ammonia of Commerce; excepting that for the crop of 1887, 450 lbs. Sulphate Ammonia containing an equal amount of Nitrogen, were applied instead. (5) Season 1889.—It will be seen that the produce of plots 4, 5, 6, and 7, of Series 2, is entered between parentheses thus (), the amounts being those actually obtained, but owing to a heavy rainfall in July, some of the soil, manure, and plants, were washed away. The produce of roots so lost, is estimated at about 1 ton per acre.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE MANGEL ROOTS, in the Eleventh, Twelfth, Thirteenth, Fourteenth, and Fifteenth Seasons, 1886, 1887, 1888, 1889, and 1890. For particulars of the composition in the first 10 Years, 1876-1885, see pp. 58-9 and 62-3, and for those in succeeding seasons, see pp. 70-1, and 74-5.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Mangels, is given below. The dry matter, ash, and nitrogen, are of course determined in the roots themselves. The amounts of dry matter, ash, and nitrogen, have also, in many cases, been determined in the expressed juice. In many cases also, the amount of the nitrogen existing as albuminoids has been determined (by Church's method); and in some cases the amount as amides and as nitric acid. It may be observed that by far the larger proportion of both the mineral matter and the nitrogen of the roots is found in the juice; and of the nitrogen in the juice a variable proportion, ranging from less than one-fifth to not more than one-third of the total, is found to exist as albuminoids. When sugar has been estimated, it has been determined in the expressed juice, and calculated into its percentage in the roots, as described in more detail in the letterpress above the Table on p. 58.

PLOTS.	ABBREVIATED DESCRIPTION OF STANDARD MANURES.	MANURES, PER ACRE, PER ANNUM.															
		SERIES 1.			SERIES 2.			SERIES 3.			SERIES 4.			SERIES 5.			
		Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.
1	Farmyard Manure	13.75	0.851	0.950	12.28	12.85	0.888	0.930	11.92	11.92	0.854	0.854	12.69	0.845	0.845	0.845	12.69
2	Farmyard Manure, & Super. ..	12.96	0.908	0.951	11.80	11.52	0.941	0.930	11.93	11.93	0.900	0.900	13.18	0.834	0.834	0.834	13.18
3	Unmanured (1846, & since) ..	16.07	0.750	0.953	12.67	14.93	0.799	0.799	13.76	13.76	0.734	0.734	14.08	0.687	0.687	0.687	14.08
4	Super., & Pot., Sod., & Mag. ..	14.72	0.878	0.966	12.02	13.77	0.909	0.909	13.00	13.00	0.947	0.947	12.50	0.885	0.885	0.885	12.50
5	Superphosphate	14.38	0.745	0.978	12.97	14.29	0.790	0.790	12.47	12.47	0.750	0.750	13.59	0.702	0.702	0.702	13.59
6	Super., & Potash	14.52	0.813	0.978	12.02	14.18	0.924	0.924	12.72	12.72	0.847	0.847	13.52	0.850	0.850	0.850	13.52
7	Super., Pot., & 36½ lb. Am.-sfts. Unmanured (1853, & since) ..	14.45	0.847	0.920	12.74	13.82	0.886	0.886	12.77	12.77	0.937	0.937	14.52	0.888	0.888	0.888	14.52
8	Farmyard Manure, & Super. ..	15.44	0.817	0.921	11.26	14.29	0.788	0.788	13.58	13.58	0.734	0.734	14.22	0.669	0.669	0.669	14.22
9	Farmyard Manure, & Super. ..	15.44	0.817	0.921	11.26	14.29	0.788	0.788	13.58	13.58	0.734	0.734	14.22	0.669	0.669	0.669	14.22
ELEVENTH SEASON, 1886.																	
Mean Per Cent. Total Dry Matter, Mineral Matter (Crude Ash), and Nitrogen in the Roots.																	
1	Farmyard Manure	13.66	1.042	1.066	14.56	14.56	1.040	0.930	14.95	14.95	0.953	0.953	15.00	0.981	0.981	0.981	15.00
2	Farmyard Manure, & Super. ..	14.47	1.044	1.118	14.82	14.82	1.051	0.944	15.48	15.48	0.944	0.944	14.79	0.943	0.943	0.943	14.79
3	Unmanured (1846, & since) ..	18.94	1.119	1.078	17.03	20.26	1.087	0.939	17.41	17.41	0.917	0.917	17.14	0.822	0.822	0.822	17.14
4	Super., & Pot., Sod., & Mag. ..	17.11	0.283	1.201	16.41	15.11	1.217	0.329	14.56	14.56	1.146	1.146	14.60	1.154	1.154	1.154	14.60
5	Superphosphate	16.81	0.946	1.056	15.60	19.00	0.952	0.359	17.44	17.44	0.868	0.868	17.34	0.810	0.810	0.810	17.34
6	Super., & Potash	16.92	1.093	1.286	17.89	15.69	1.230	0.286	15.50	15.50	1.102	1.102	14.77	1.093	1.093	1.093	14.77
7	Super., Pot., & 36½ lb. Am.-sfts. Unmanured (1853, & since) ..	16.76	1.143	1.167	15.98	15.64	1.281	0.64	15.86	15.86	1.144	1.144	15.31	1.088	1.088	1.088	15.31
8	Farmyard Manure, & Super. ..	17.74	1.077	1.134	18.13	19.24	1.004	0.861	17.88	17.88	0.861	0.861	18.32	0.823	0.823	0.823	18.32
9	Farmyard Manure, & Super. ..	17.74	1.077	1.134	18.13	19.24	1.004	0.861	17.88	17.88	0.861	0.861	18.32	0.823	0.823	0.823	18.32
TWELFTH SEASON, 1887.																	
1	Farmyard Manure	15.21	1.042	1.066	13.66	14.56	1.040	0.930	14.95	14.95	0.953	0.953	15.00	0.981	0.981	0.981	15.00
2	Farmyard Manure, & Super. ..	14.47	1.044	1.118	15.39	14.82	1.051	0.944	15.48	15.48	0.944	0.944	14.79	0.943	0.943	0.943	14.79
3	Unmanured (1846, & since) ..	18.94	1.119	1.078	17.03	20.26	1.087	0.939	17.41	17.41	0.917	0.917	17.14	0.822	0.822	0.822	17.14
4	Super., & Pot., Sod., & Mag. ..	17.11	0.283	1.201	16.41	15.11	1.217	0.329	14.56	14.56	1.146	1.146	14.60	1.154	1.154	1.154	14.60
5	Superphosphate	16.81	0.946	1.056	15.60	19.00	0.952	0.359	17.44	17.44	0.868	0.868	17.34	0.810	0.810	0.810	17.34
6	Super., & Potash	16.92	1.093	1.286	17.89	15.69	1.230	0.286	15.50	15.50	1.102	1.102	14.77	1.093	1.093	1.093	14.77
7	Super., Pot., & 36½ lb. Am.-sfts. Unmanured (1853, & since) ..	16.76	1.143	1.167	15.98	15.64	1.281	0.64	15.86	15.86	1.144	1.144	15.31	1.088	1.088	1.088	15.31
8	Farmyard Manure, & Super. ..	17.74	1.077	1.134	18.13	19.24	1.004	0.861	17.88	17.88	0.861	0.861	18.32	0.823	0.823	0.823	18.32
9	Farmyard Manure, & Super. ..	17.74	1.077	1.134	18.13	19.24	1.004	0.861	17.88	17.88	0.861	0.861	18.32	0.823	0.823	0.823	18.32

THIRTEENTH SEASON, 1888.

1	Farmyard Manure ..	13.54	1.104	11.67	1.095	13.30	1.126	14.27	1.116	13.55	1.066
2	Farmyard Manure, & Super.	13.29	1.114	12.36	1.062	13.77	0.950	13.11	1.110	13.59	1.091
3	Unmanured (1846, & since)	15.62	0.849	13.87	0.907	16.25	0.782	14.49	0.823	14.93	0.830
4	Super., & Pot., Sod., & Mag.	15.66	1.028	0.218	1.005	14.05	0.915	0.172	1.184	0.314	0.285
5	Superphosphate ..	15.72	0.883	0.254	0.885	14.48	0.705	0.231	0.890	0.279	0.900
6	Super., & Potash	15.28	1.006	0.277	0.904	14.78	0.848	0.142	1.010	0.269	0.978
7	Super., Pot., & 36½ lb. Am.-sfts.	16.04	0.933	13.81	0.897	14.53	0.751	14.32	0.960	14.45	1.019
8	Unmanured (1853, & since)	17.17	0.876	13.49	0.904	15.60	0.859	15.81	0.751	15.46	0.731
9	Farmyard Manure, & Super.	..	..	..	..	15.55	0.878	..	..	..	..

FOURTEENTH SEASON, 1889.

1	Farmyard Manure ..	13.87	0.863	14.20	0.866	12.89	0.852	12.83	0.840	13.76	0.834
2	Farmyard Manure, & Super.	14.51	0.786	12.93	0.934	13.27	0.840	13.07	0.876	14.16	0.835
3	Unmanured (1846, & since)	16.12	0.719	14.52	0.772	16.50	0.640	14.17	0.679	15.39	0.599
4	Super., & Pot., Sod., & Mag.	15.56	0.795	0.102	0.818	14.47	0.796	0.094	0.836	0.122	0.846
5	Superphosphate ..	15.04	0.666	0.090	0.739	14.97	0.584	0.133	0.687	0.200	0.641
6	Super., & Potash	15.40	0.762	0.084	0.739	14.72	0.778	0.082	0.809	0.171	0.808
7	Super., Pot., & 36½ lb. Am.-sfts.	15.51	0.787	13.51	0.877	15.23	0.759	14.94	0.834	13.63	0.804
8	Unmanured (1853, & since)	16.19	0.742	12.70	0.778	15.06	0.690	13.30	0.689	14.87	0.640
9	Farmyard Manure, & Super.	..	..	..	..	13.64	0.860	..	..	..	..

FIFTEENTH SEASON, 1890.

1	Farmyard Manure ..	14.34	0.725	13.86	0.836	13.42	0.734	13.12	0.751	13.63	0.794
2	Farmyard Manure, & Super.	14.27	0.794	13.29	0.831	13.81	0.789	14.58	0.833	13.65	0.763
3	Unmanured (1846, & since)	16.12	0.635	14.47	0.679	15.39	0.596	13.06	0.624	14.96	0.523
4	Super., & Pot., Sod., & Mag.	15.45	0.767	0.086	0.827	14.18	0.845	0.093	0.868	0.117	0.826
5	Superphosphate ..	15.28	0.632	0.084	0.695	14.31	0.570	0.157	0.641	0.200	0.534
6	Super., & Potash	15.44	0.752	0.094	0.751	14.79	0.779	0.112	0.755	0.115	0.702
7	Super., Pot., & 36½ lb. Am.-sfts.	15.45	0.711	13.99	0.767	14.89	0.765	13.87	0.768	13.91	0.759
8	Unmanured (1853, & since)	15.34	0.700	12.34	0.774	14.82	0.652	13.48	0.834	13.91	0.759
9	Farmyard Manure, & Super.	..	..	..	..	14.09	0.729	12.41	0.650	14.04	0.513

AVERAGE OF FIVE SEASONS, 1886, '87, '88, '89, AND 1890.

1	Farmyard Manure ..	14.14	0.917	13.13	0.963	13.41	0.928	13.42	0.903	13.69	0.904
2	Farmyard Manure, & Super.	13.90	0.929	13.19	0.933	13.44	0.914	13.63	0.933	13.87	0.893
3	Unmanured (1846, & since)	16.57	0.814	14.51	0.878	16.67	0.781	14.58	0.755	15.30	0.692
4	Super., & Pot., Sod., & Mag.	15.70	0.937	0.165	0.963	14.32	0.936	0.168	0.986	0.202	0.987
5	Superphosphate ..	15.45	0.764	0.161	0.833	15.40	0.702	0.231	0.751	0.261	0.717
6	Super., & Potash	15.51	0.885	0.165	0.935	14.83	0.912	0.159	0.905	0.212	0.886
7	Super., Pot., & 36½ lb. Am.-sfts.	15.64	0.894	14.12	0.926	14.80	0.904	14.07	0.941	14.11	0.912
8	Unmanured (1853, & since)	16.38	0.841	13.58	0.902	15.79	0.778	14.32	0.733	14.36	0.675
9	Farmyard Manure, & Super.	..	..	..	..	14.10	0.876	..	..	..	..

(1) 400 lbs. Ammonium-salts, consisting of equal parts of Sulphate and Muriate of Ammonia of Commerce; excepting that for the crop of 1887, 450 lbs. Sulphate Ammonia, containing an equal amount of Nitrogen, were applied instead.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD (after SUGAR-BEET) ; commencing 1876—continued.

Below are given the particulars of the Manures and Produce, of the Sixteenth, Seventeenth, Eighteenth, Nineteenth, and Twentieth Seasons, 1891, 1892, 1893, 1894, and 1895. For the Manures and Produce of the 15 preceding seasons, see pp. 56-7, 60-1, and 64-5, and for those of succeeding seasons, see pp. 72-3.

The arrangement of the plots, and of the manures, is precisely the same as it was for the fifteen preceding years of Mangels (see pp. 56-7, 60-1, and 64-5), and also the same as previously for Sugar-beet (see pp. 52-3) ; excepting that Plot 9, which was unmanured for

Sugar-beet, and also previously for Swedes, was brought in as a manured plot for Mangels. With this exception the manures are also substantially the same as previously for Sugar-beet ; in fact, precisely the same as for the Sugar-beet in 1872 and 1873. Seed, Yellow Globe; dibbled on ridges; rows 26 inches apart; plants 11 inches apart in the rows. (c) Roots all carted off; leaves weighed, spread on the respective plots, and ploughed in. In the spring of 1894 permanent division paths were laid out between plot and plot.

(Area under experiment, about 8 acres.)

MANURES PER ACRE PER ANNUM.

PLOTS.	SERIES 1. Standard Manures only.		SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda. (*)		SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. "Ammonium- Salts." (*)		SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. "Am- monium-Salts." (*)		SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.	
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.

SIXTEENTH SEASON, 1891. Seed dibbled April 16 and 17. Crop taken up, November 2-7.

	SERIES 1.		SERIES 2.		SERIES 3.		SERIES 4.		SERIES 5.	
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.
1	19	3	24	5	31	9	31	9	29	6
2	19	3	15	12	8	0	8	0	17	1
3	20	14	17	16	27	3	27	3	26	7
4	5	0	10	4	8	8	8	11	11	13
5	5	6	13	5	30	1	30	1	25	4
6	4	18	8	5	12	4	12	4	13	2
7	4	10	15	4	26	0	26	0	21	6
8	5	19	15	4	26	2	26	2	21	10
9	4	1	4	3	10	11	10	11	11	8
	..	..	..	..	23	16	..	..	..	..

PRODUCE PER ACRE.

	SERIES 1.		SERIES 2.		SERIES 3.		SERIES 4.		SERIES 5.	
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.
1	19	3	24	5	31	9	31	9	29	6
2	19	3	15	12	8	0	8	0	17	1
3	20	14	17	16	27	3	27	3	26	7
4	5	0	10	4	8	8	8	11	11	13
5	5	6	13	5	30	1	30	1	25	4
6	4	18	8	5	12	4	12	4	13	2
7	4	10	15	4	26	0	26	0	21	6
8	5	19	15	4	26	2	26	2	21	10
9	4	1	4	3	10	11	10	11	11	8
	..	..	..	..	23	16	..	..	..	..

SEVENTEENTH SEASON, 1892. Seed dibbled April 7 and 8. Crop taken up, October 26 to November 14.

	SERIES 1.		SERIES 2.		SERIES 3.		SERIES 4.		SERIES 5.	
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.
1	22	2	33	0	28	6	28	11	30	0
2	21	10	30	13	22	8	22	8	27	1
3	4	18	16	12	9	8	9	8	11	12
4	5	9	21	15	18	3	27	3	25	13
5	5	1	19	10	8	12	9	10	11	10
6	4	11	17	3	18	2	24	17	21	19
7	6	1	20	6	18	7	23	17	22	5
8	3	16	10	13	4	2	8	7	10	9
9	..	..	..	..	23	19	..	..	..	..

EIGHTEENTH SEASON, 1893. Seed dibbled April 13 and 14. Crop taken up, October 30 to November 4.

1	Farmyard Manure (14 tons)	15	13	3	12	18	10	6	1	13	13	4	10	16	14	5	3	20	7	5	12
2	Farmyard Manure (14 tons), and 3½ cwt. Superphosphate (¹)	14	5	3	10	17	14	5	18	11	5	4	6	13	16	4	16	18	8	5	9
3	Without Manure (1846, and since)	6	2	2	5	11	18	4	6	1	16	1	6	6	3	2	18	7	13	3	5
4	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride	4	7	1	2	6	0	3	4	5	16	2	13	16	5	4	12	19	15	3	10
5	Sodium (common salt), 200 lbs. Sulphate Magnesia	4	11	1	3	13	6	3	19	2	7	1	18	4	14	2	17	7	7	3	5
6	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash	3	12	0	19	6	15	2	16	8	4	2	15	16	11	4	7	15	17	3	3
7	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (²)	4	14	1	2	7	5	3	6	7	10	2	19	14	0	4	0	16	2	3	11
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	3	12	1	2	5	3	2	10	1	7	1	1	4	18	2	17	7	5	3	0
9	Farmyard Manure (14 tons), 3½ cwt. Superphosphate (³)	..	..	..	..	..	..	..	..	16	4	4	18	..	..	..	..	..	..	..	..

NINETEENTH SEASON, 1894. Seed dibbled April 6 and 7. Crop taken up, October 23 to November 9.

1	Farmyard Manure (14 tons)	25	15	3	7	38	11	6	13	29	17	7	4	31	13	7	5	31	10	7	3
2	Farmyard Manure (14 tons), and 3½ cwt. Superphosphate (¹)	26	11	4	4	39	8	7	6	30	14	7	16	30	19	7	11	32	1	7	2
3	Without Manure (1846, and since)	6	18	1	7	22	19	4	17	10	13	4	19	13	3	4	15	11	19	3	13
4	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride	5	7	1	4	29	7	5	5	25	7	3	16	35	12	6	15	28	7	3	19
5	Sodium (common salt), 200 lbs. Sulphate Magnesia	5	13	1	5	19	7	4	2	11	0	4	10	14	6	4	15	14	0	4	4
6	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash	5	3	1	1	21	16	3	14	23	10	3	11	31	4	7	6	25	1	3	14
7	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (²)	7	7	1	6	23	10	3	17	25	0	4	2	30	3	7	11	26	12	4	5
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	4	19	1	4	14	5	5	7	9	18	4	19	13	9	4	19	13	15	4	8
9	Farmyard Manure (14 tons), 3½ cwt. Superphosphate (³)	..	..	..	..	..	..	..	..	26	0	6	19	..	..	..	..	..	..	..	..

TWENTIETH SEASON, 1895. Seed dibbled April 17 and 18. Crop taken up, October 25-30.

1	Farmyard Manure (14 tons)	27	14	2	0	33	8	2	15	28	1	2	8	34	6	2	12	37	4	3	0
2	Farmyard Manure (14 tons), 3½ cwt. Super. (¹) and 500 lbs. Sul. Pot.	25	18	2	1	30	7	2	10	26	9	2	13	37	1	3	1	37	6	3	0
3	Without Manure (1846, and since)	(8 18)	9	0	18	(1 11	0	17	1	1	11	0	13	12	3	1	13	12	9	1	13
4	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride	5	1	0	16	0	5	0	11	1	0	1	2	84	6	3	5	31	13	2	14
5	Sodium (common salt), 200 lbs. Sulphate Magnesia	7	16	0	17	(²)	0	3	0	0	5	0	6	10	18	1	13	13	1	1	17
6	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash	6	7	0	13	0	4	0	6	1	12	1	2	30	7	2	14	27	7	1	19
7	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (²)	5	17	0	15	0	4	0	6	0	15	0	13	27	4	2	16	26	18	2	5
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	5	13	0	17	0	9	0	5	1	0	0	9	11	13	1	14	14	5	1	15
9	Farmyard Manure (14 tons), 3½ cwt. Superphosphate (³)	..	..	..	..	..	..	..	..	19	11	2	6	..	..	..	..	..	..	..	..

AVERAGE OF 5 SEASONS, 1891, '92, '93, '94, and 1895.

1	Farmyard Manure (14 tons)	22	4	3	2	29	13	5	8	25	0	5	13	28	11	6	4	29	16	5	10
2	Farmyard Manure (14 tons), 3½ cwt. Super. (¹) and 500 lbs. Sul. Pot. (²)	21	16	3	9	25	16	5	15	22	12	5	9	26	5	5	17	28	5	5	3
3	Without Manure (1846, and since)	6	7	1	6	(12	16	3	15	4	19	2	14	9	17	4	4	11	1	3	0
4	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash, 200 lbs. Chloride	5	2	1	2	14	4	3	18	12	16	3	2	28	13	5	16	26	3	3	15
5	Sodium (common salt), 200 lbs. Sulphate Magnesia	5	12	1	1	(³)	12	18	3	10	5	14	2	16	(⁴)	7	3	9	11	16	3
6	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash	4	17	0	18	12	1	3	0	12	16	3	2	25	16	5	13	22	6	3	3
7	3½ cwt. Superphosphate, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (²)	6	0	1	2	12	4	3	4	13	5	3	6	24	5	5	15	22	13	3	10
8	Unmanured, 1853, and since; previously part Unman., part Superphos.	4	8	1	1	(6	18	3	1	4	6	2	8	9	15	3	8	11	9	3	4
9	Farmyard Manure (14 tons), 3½ cwt. Superphosphate (³)	..	..	..	..	..	..	..	..	21	18	5	11	..	..	..	..	..	..	..	..

(¹) "Superphosphate of Lime," made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.
 (²) Plot 9 sown on the flat, instead of on ridges; plants ridged up afterwards; rows 22 inches apart, plants 10 inches apart in the rows.
 (³) 1892, Series 2, one-half the Nitrate of Soda = 275 lbs. only, applied at the time of sowing the seed, the other half sown broadcast, July 10.
 (⁴) Applied for the first time in 1895.
 (⁵) Owing to very heavy rains in November, 1894, flooding the lower parts of the Experimental Mangel Field, and washing soil from the Dung plots, especially on to Plot 3, Series 1, there is no doubt that this result is too high, and possibly also those given for Plots 5 and 6.
 (⁶) The plant failed on these plots owing to drought.
 (⁷) In the case of these plots the averages are given for the five years, though as the details show, there was failure of plant from drought, and scarcely any crop, in 1895.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE MANGEL ROOTS IN THE SIXTEENTH, SEVENTEENTH, EIGHTEENTH, NINETEENTH, AND TWENTIETH SEASONS, 1891, 1892, 1893, 1894, AND 1895.

For particulars of the composition in the first 15 Years, 1876-1890, see pp. 58-9, 62-3, and 66-7, and for those in succeeding seasons, see pp. 74-5.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Mangels, is given below. The dry matter, ash, and nitrogen, are of course determined in the roots themselves. The amounts of dry matter, ash, and nitrogen, have also, in many cases, been determined in the expressed juice. In many cases also, the amount of the nitrogen existing as albuminoids has been determined (by Church's method); and in some cases the amount as amides and nitric acid. It may be observed that by far the larger proportion of both the mineral matter and the nitrogen of the roots is found in the juice; and of the nitrogen in the juice a variable proportion, ranging from less than one-fifth to not more than one-third of the total, is found to exist as albuminoids. In former years when sugar has been estimated, it has been determined by polariscope in the expressed juice, and calculated into its percentage in the roots, as described in more detail in the letterpress above the Table on p. 58. In selected cases of the crops of the twentieth season, 1895, sugar was again determined; not, however, in the expressed juice as formerly, but in both an

aqueous, and in an alcoholic extract of the pulp, and the results given in the Table are the means of the determinations in the aqueous, and in the alcoholic extracts, which agreed very closely, calculated into their percentage in the original root.

In interpreting the figures, it must be borne in mind, that, with forty different experiments each year, and in each year four, five, or more, times, as much produce on some plots as on others, it would be impossible to sample each at its best, and all in the same condition of ripeness. Each year the seed was sown on all the plots at the same time. The sample analysed was in each case a mixture of vertical sections of ten or fifteen roots, and all the samples were as a rule taken within a period of from one to two weeks; as far as practicable beginning with the ripest. It is obvious, however, that the smaller crops would be much riper than the larger ones; but, although the larger crops generally contain a lower percentage of sugar, they yield very much more sugar per acre.

MANURES, PER ACRE, PER ANNUM.

PLOTS.	ABBREVIATED DESCRIPTION OF STANDARD MANURES.	SERIES 1.			SERIES 2.			SERIES 3.			SERIES 4.			SERIES 5.		
		Dry Matter.	Sugar.	Ash.	Dry Matter.	Sugar.	Ash.	Dry Matter.	Sugar.	Ash.	Dry Matter.	Sugar.	Ash.	Dry Matter.	Sugar.	Ash.
	For details, see pp. 68-9.	Standard Manures only.			Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.			Standard Manures, and Cross-dressed with 400 lbs. Ammonium-salts.			Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. Ammonium-salts.			Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.		

SIXTEENTH SEASON, 1891.

	Mean Per Cent. Total Dry Matter (Sugar 1895), Mineral Matter (Crude Ash), and Nitrogen in the Roots.															
	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.	Dry Matter.	Sugar.	Ash.	Nitro-gen.
1	13.32	0.792	0.845	0.108	12.99	0.845	0.845	0.108	13.04	0.788	0.788	0.108	11.97	0.823	0.823	0.108
2	13.80	0.801	0.919	0.124	12.41	0.919	0.919	0.124	12.39	0.936	0.936	0.124	11.95	0.775	0.775	0.124
3	16.84	0.699	0.821	0.108	14.21	0.821	0.821	0.108	14.78	0.730	0.730	0.108	13.73	0.650	0.650	0.108
4	15.39	0.764	0.908	0.124	11.75	0.908	0.908	0.124	13.48	0.852	0.852	0.124	12.03	0.901	0.901	0.124
5	14.73	0.615	0.095	0.095	12.51	0.852	0.852	0.095	13.51	0.649	0.649	0.095	13.31	0.615	0.615	0.095
6	14.96	0.754	0.106	0.106	12.55	0.902	0.902	0.106	14.31	0.806	0.806	0.106	13.52	0.787	0.787	0.106
7	15.15	0.745	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

SEVENTEENTH SEASON, 1892.

1	14.07	0.774	0.831	0.124	13.25	0.831	0.831	0.124	12.49	0.886	0.886	0.124	13.13	0.778	0.778	0.124
2	13.53	0.758	0.855	0.124	12.77	0.855	0.855	0.124	12.77	0.815	0.815	0.124	12.94	0.872	0.872	0.124
3	15.80	0.666	0.841	0.124	13.25	0.841	0.841	0.124	14.70	0.678	0.678	0.124	12.89	0.708	0.708	0.124
4	15.22	0.793	0.904	0.124	13.99	0.904	0.904	0.124	14.06	0.843	0.843	0.124	11.26	0.997	0.997	0.124
5	15.03	0.625	0.122	0.122	12.13	0.741	0.741	0.122	14.31	0.639	0.639	0.122	13.48	0.633	0.633	0.122
6	14.70	0.757	0.120	0.120	13.78	0.866	0.866	0.120	14.35	0.819	0.819	0.120	13.55	0.905	0.905	0.120
7	14.94	0.779	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

EIGHTEENTH SEASON, 1893.

1	Farmyard Manure	12.88	0.871	11.50	1.004	12.18	0.852	11.64	0.865	12.82	0.914
2	Farmyard Manure, & Super. ..	12.41	0.949	11.08	1.073	12.20	0.936	12.75	0.911	12.73	0.886
3	Unmanured (1846, & since) ..	14.88	0.685	11.20	0.935	14.03	0.679	13.74	0.756	13.97	0.649
4	Super., & Pot., Sod., & Mag. ..	14.04	0.899	0.184	1.128	0.266	1.135	0.287	1.186	0.287	0.201
5	Superphosphate	15.10	0.647	0.134	0.769	0.218	0.743	0.276	0.766	0.316	0.237
6	Super., & Potash	14.90	0.787	0.168	1.003	0.240	1.122	0.256	1.046	0.269	0.236
7	Super., Pot., & 36½ lb. Am.-sfts. ..	14.78	0.877	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
8	Unmanured (1853, & since) ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
9	Farmyard Manure, & Super. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..

NINETEENTH SEASON, 1894.

1	Farmyard Manure	13.46	0.809	11.73	0.870	12.42	0.765	11.47	0.843	12.56	0.779
2	Farmyard Manure, & Super. ..	13.62	0.756	11.21	0.942	12.21	0.788	11.47	0.839	12.10	0.768
3	Unmanured (1846, & since) ..	15.82	0.607	12.00	0.745	13.75	0.586	13.23	0.575	13.93	0.589
4	Super., & Pot., Sod., & Mag. ..	15.28	0.781	0.092	0.939	0.146	0.918	0.140	0.946	0.177	0.134
5	Superphosphate	15.62	0.581	0.113	0.770	0.157	0.595	0.208	0.631	0.230	0.205
6	Super., & Potash	15.64	0.691	0.093	0.881	0.144	0.851	0.147	0.858	0.201	0.139
7	Super., Pot., & 36½ lb. Am.-sfts. ..	15.40	0.724	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
8	Unmanured (1853, & since) ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
9	Farmyard Manure, & Super. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..

TWENTIETH SEASON, 1895.

1	Farmyard Manure	11.68	0.834	10.21	5.81	9.69	5.28	10.01	5.24	10.76	6.27
2	Farmyard Manure, Super., & Pot. ..	10.85	0.902	8.82	3.83	9.88	5.36	10.02	4.98	10.48	6.22
3	Unmanured (1846, & since) ..	12.18	0.738	.. ..	.. ..	.. ..	.. ..	10.86	5.88	11.60	6.29
4	Super., & Pot., Sod., & Mag. ..	11.66	0.970	0.117	0.969	0.186	0.937	0.144	0.981	0.144	0.112
5	Superphosphate	13.76	0.666	0.097	0.666	0.097	0.666	0.097	0.675	0.212	0.207
6	Super., & Potash	13.69	0.791	0.096	0.791	0.096	0.791	0.096	0.873	0.184	0.142
7	Super., Pot., & 36½ lb. Am.-sfts. ..	13.18	0.841	.. ..	.. ..	.. ..	.. ..	10.93	6.14	11.71	6.90
8	Unmanured (1853, & since) ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
9	Farmyard Manure, & Super. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..

AVERAGE OF FIVE SEASONS, 1891, '92, '93, '94, and 1895.

1	Farmyard Manure	13.08	0.816	11.94	0.891	11.96	0.836	11.64	0.827	12.71	0.818
2	Farmyard Manure, Super., & Pot. ..	12.84	0.832	11.26	0.957	11.89	0.861	11.83	0.850	12.42	0.819
3	Unmanured (1846, & since) ..	15.00	0.679	12.67	0.836	14.32	0.668	12.89	0.676	13.75	0.637
4	Super., & Pot., Sod., & Mag. ..	14.32	0.841	0.125	0.969	0.186	0.937	0.169	1.002	0.194	0.145
5	Superphosphate	14.85	0.627	0.112	0.783	0.186	0.657	0.209	0.664	0.231	0.221
6	Super., & Potash	14.78	0.756	0.117	0.913	0.180	0.900	0.168	0.894	0.207	0.160
7	Super., Pot., & 36½ lb. Am.-sfts. ..	14.69	0.793	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
8	Unmanured (1853, & since) ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
9	Farmyard Manure, & Super. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..

(1) The plant failed on these plots, owing to drought, and hence no particulars of composition are given.
 (2) In the case of these plots the averages are for only four years, owing to the failure of the plant from drought in 1895.

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD (after SUGAR-BEET); commencing 1876—continued.

Below are given the particulars of the Manures for the Twenty-first, Twenty-second, and Twenty-third Seasons, 1896, 1897, and 1898; and of the Produce of the Twenty-first and Twenty-second Seasons, 1896 and 1897. For the Manures and Produce of the 20 preceding seasons, see pp. 56-7, 60-1, 64-5, and 68-9.

The arrangement of the plots, and of the manures, is substantially the same as it was for the 20 preceding years of Mangels (see pp. 56-7, 60-1, 64-5, and 68-9), and also practically the same as previously for Sugar-beet (see pp. 52-3); excepting that

Plot 9, which was unmanured for Sugar-beet, and also previously for Svedes, was brought in as a manured plot for Mangels. In 1896 and since, however, Basic Slag was substituted for Superphosphate of Lime. Seed, Yellow Globe; dibbled or drilled on ridges; rows 26 inches apart; plants 11 inches apart in the rows (?). Roots all carted off; leaves weighed, spread on the respective plots, and ploughed in.

In the spring of 1894 permanent division paths were laid out between plot and plot.

(Area under experiment, about 8 acres.)

MANURES PER ACRE PER ANNUM.

PLOTS.	SERIES 1. Standard Manures only.		SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.		SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. "Ammonium- Salts."		SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. "Am- monium-Salts."		SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.	
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.

TWENTY-FIRST SEASON, 1896. Seed drilled May 6 and 7; Plot 9, dibbled May 8. Crop taken up, November 3-10.

	SERIES 1.		SERIES 2.		SERIES 3.		SERIES 4.		SERIES 5.	
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.
1	18	11	27	18	19	3	19	13	5	4
2	21	7	31	0	24	4	23	18	6	5
3	(7 12 ^s)	1	20	11	6	3	6	17	2	13
4	7	2	22	1	16	19	23	12	3	14
5	5	9	19	1	5	2	5	6	2	8
6	5	8	19	5	15	17	20	17	4	19
7	6	8	17	19	16	13	21	13	4	18
8	3	12	11	9	5	0	6	19	2	14
9	..	..	..	..	17	19	..	..	..	..

TWENTY-SECOND SEASON, 1897. Seed drilled May 4 and 5; Plot 9, dibbled May 5 and 6. Crop taken up, October 11-23.

	SERIES 1.		SERIES 2.		SERIES 3.		SERIES 4.		SERIES 5.	
	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.	Roots.	Leaves.
1	15	16	25	6	19	5	20	4	8	7
2	17	5	27	1	23	3	25	4	8	14
3	(5 8 ^s)	1	17	4	7	8	8	17	5	9
4	4	5	17	8	11	14	24	13	7	5
5	4	0	16	3	8	7	7	18	4	19
6	3	2	14	4	11	4	18	6	18	16
7	3	17	14	4	10	17	19	7	6	15
8	1	13	7	10	3	12	5	16	4	10
9	..	..	..	..	13	14	..	..	..	..

TWENTY-THIRD SEASON, 1898. Seed drilled April 13; Plot 9, dibbled April 14; Crop taken up,

1	Farmyard Manure (14 tons)	.. .. .	.. .. .	.. .. .	.. .. .
2	Farmyard Manure (14 tons), 400 lbs. Basic Slag, and 500 lbs. Sul. Pot.	.. .. .	.. .. .	.. .. .	.. .. .
3	Without Manure (1846, and since)	.. .. .	.. .. .	.. .. .	.. .. .
4	400 lbs. Basic Slag, 500 lbs. Sulphate Potash, 200 lbs. Chloride	.. .. .	.. .. .	.. .. .	.. .. .
5	Sodium (common salt), 200 lbs. Sulphate Magnesia	.. .. .	.. .. .	.. .. .	.. .. .
6	400 lbs. Basic Slag	.. .. .	.. .. .	.. .. .	.. .. .
7	400 lbs. Basic Slag, 500 lbs. Sulphate Potash	.. .. .	.. .. .	.. .. .	.. .. .
8	400 lbs. Basic Slag, 500 lbs. Sulphate Potash, 36½ lbs. Am.-salts (1)	.. .. .	.. .. .	.. .. .	.. .. .
9	Unmanured, 1853, and since; previously part Unman., part Superphos.	.. .. .	.. .. .	.. .. .	.. .. .
	Farmyard Manure (14 tons), 400 lbs. Basic Slag (2)	.. .. .	.. .. .	.. .. .	.. .. .

EXPERIMENTS ON SUGAR BEET IN 1898 (VILMORIN'S WHITE GREEN TOP BRABANT).

Plots 1-8. On ridges; rows 26 inches apart; plants 8 inches apart in the rows. Seed sown April 19-20. Crops taken up Plot 9. On the flat; rows 15 inches apart; plants 8 inches apart in the rows. Seed sown May 12-13. Crops taken up Manures, Produce, and Composition—see below. For arrangement of plots, see Plan, p. 48.

MANURES PER ACRE.

PLOTS.	ABBREVIATED DESCRIPTION OF "STANDARD MANURES."	SERIES 1.			SERIES 2.			SERIES 3.		
		Roots.	Leaves.	Produce.	Roots.	Leaves.	Produce.	Roots.	Leaves.	Produce.
1-8	For details of Plots 1-8, see Manures for Mangels above.	Standard Manures only.			Standard Manures and 2 cwt. Sulphate Ammonia.			Standard Manures and 27½ lb. Nitrate of Soda.		

PRODUCE PER ACRE—ROOTS AND LEAVES.

PLOTS.	ABBREVIATED DESCRIPTION OF "STANDARD MANURES."	SERIES 1.			SERIES 2.			SERIES 3.		
		Roots.	Leaves.	Produce.	Roots.	Leaves.	Produce.	Roots.	Leaves.	Produce.
1	Farmyard Manure	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
2	Farmyard Manure, Slag, & Pot.	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
3	Unmanured (1846, & since)	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
4	Basic Slag, & Pot., Sod., & Mag.	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
5	Basic Slag..	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
6	Basic Slag, & Potash	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
7	Slag, Pot., & 36½ lb. Am.-salts	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
8	Unmanured (1853, & since)	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
9	{ 1876-97, Dung & Phosphate, 1898, 400 lb. Slag, & 500 lb. Sul. Pot. }	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .

PERCENTAGE COMPOSITION OF THE ROOTS.

PLOTS.	ABBREVIATED DESCRIPTION OF "STANDARD MANURES."	SERIES 1.			SERIES 2.			SERIES 3.		
		Dry Matter.	Sugar.	Nitrogen.	Dry Matter.	Sugar.	Nitrogen.	Dry Matter.	Sugar.	Nitrogen.
1	Farmyard Manure	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
2	Farmyard Manure, Slag, & Pot.	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
3	Unmanured (1846, & since)	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
4	Basic Slag, & Pot., Sod., & Mag.	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
5	Basic Slag..	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
6	Basic Slag, & Potash	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
7	Slag, Pot., & 36½ lb. Am.-salts	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
8	Unmanured (1853, & since)	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .
9	{ 1876-97, Dung & Phosphate, 1898, 400 lb. Slag, & 500 lb. Sul. Pot. }	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .

EXPERIMENTS ON MANGEL WURZEL.—BARN FIELD.—continued.—SUMMARY OF THE COMPOSITION OF THE MANGEL ROOTS IN THE TWENTY-FIRST, AND TWENTY-SECOND SEASONS, 1896, AND 1897.

For particulars of the composition in the first 20 Years, 1876-1895, see pp. 58-9, 62-3, 66-7, and 70-1.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Mangels, is given below. The dry matter, ash, and nitrogen, are of course determined in the roots themselves. The amounts of dry matter, ash, and nitrogen, have also, in many cases, been determined in the expressed juice. In many cases also, the amount of the nitrogen existing as albuminoids has been determined (by Church's method); and in some the amount as amides and as nitric acid. It may be observed that by far the larger proportion of both the mineral matter and the nitrogen of the roots is found in the juice; and of the nitrogen in the juice a variable proportion, ranging from less than one-fifth to not more than one-third of the total, is found to exist as albuminoids. In former years when sugar has been estimated, it has been determined by polariscope in the expressed juice, and calculated into its percentage in the roots, as described in more detail in the letterpress above the Table on p. 58. In selected cases of the crops of the twentieth and twenty-second seasons, 1895 and 1897, sugar was again determined; not, however, in

the expressed juice as formerly, but in both an aqueous, and in an alcoholic extract of the pulp, and the results given in the Table are the means of the determinations in the aqueous, and in the alcoholic extracts, which agreed very closely, calculated into their percentage in the original root. In interpreting the figures, it must be borne in mind, that, with forty different experiments each year, and in each year four, five, or more, times, as much produce on some plots as on others, it would be impossible to sample each at its best, and all in the same condition of ripeness. Each year the seed was sown on all the plots at the same time. The sample analysed was in each case a mixture of vertical sections of ten or fifteen roots, and all the samples were as a rule taken within a period of from one to two weeks; as far as practicable beginning with the ripest. It is obvious, however, that the smaller crops would be much riper than the larger ones; but, although the larger crops generally contain a lower percentage of sugar, they yield very much more sugar per acre.

MANURES, PER ACRE, PER ANNUM.

PLOTS.	ABBREVIATED DESCRIPTION OF STANDARD MANURES. For details, see pp. 72-3.	SERIES 1. Standard Manures only.			SERIES 2. Standard Manures, and Cross-dressed with 550 lbs. Nitrate Soda.			SERIES 3. Standard Manures, and Cross-dressed with 400 lbs. Ammonium-salts.			SERIES 4. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake and 400 lbs. Ammonium-salts.			SERIES 5. Standard Manures, and Cross-dressed with 2000 lbs. Rape-cake.		
		Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.

TWENTY-FIRST SEASON, 1896.

	Mean Per Cent. Total Dry Matter, Sugar, Mineral Matter (Crude Ash), and Nitrogen in the Roots.	SERIES 1.			SERIES 2.			SERIES 3.			SERIES 4.			SERIES 5.		
		Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.	Dry Matter.	Sugar.	Nitro-gen.
1		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
		10.73	0.915	0.029	8.69	9.61	0.908	9.56	0.901	10.36	0.944	10.36	0.901	10.36	0.944	10.36
		14.91	0.873	0.185	9.03	10.66	1.026	10.46	1.033	10.10	1.012	10.10	1.033	10.10	1.012	10.10
		16.65	0.670	0.147	10.70	13.63	0.789	12.29	0.731	11.77	0.755	11.77	0.731	11.77	0.755	11.77
		15.89	10.11	0.865	10.70	11.02	1.005	9.38	1.056	10.15	0.986	10.15	1.056	10.15	0.986	10.15
		15.91	10.08	0.671	9.29	12.84	0.780	11.77	0.803	12.30	0.755	12.30	0.803	12.30	0.755	12.30
		15.28	9.56	0.785	10.22	11.40	0.938	10.78	1.018	10.36	0.919	10.36	1.018	10.36	0.919	10.36
		15.95	0.856	0.132	..	..	..	..	..	..	..	..	..	..	..	..
	
	

TWENTY-SECOND SEASON, 1897.

1		14.91	0.834	0.187	13.79	8.87	0.819	13.61	0.821	0.259	13.29	0.850	0.256
2		14.80	0.878	0.185	12.99	8.03	0.953	12.92	0.967	0.249	13.85	0.812	0.229
3		16.65	0.670	0.147	14.32	15.48	0.589	14.26	0.634	0.212	14.54	0.609	0.209
4		15.89	10.11	0.865	13.76	8.53	0.996	13.32	0.944	0.212	13.46	0.901	0.188
5		15.91	10.08	0.671	14.23	9.03	0.826	14.03	0.608	0.299	14.51	0.629	0.264
6		15.28	9.56	0.785	13.17	8.05	0.958	13.47	0.947	0.227	14.72	0.834	0.206
7		15.95	0.856	0.132	..	..	..	..	..	..	..	..	..
8		..	..	..	..	..	..	..	..	..	..	..	..
9		..	..	..	13.61	..	0.795	..	..	..	..	..	..

TWENTY-THIRD SEASON, 1898.

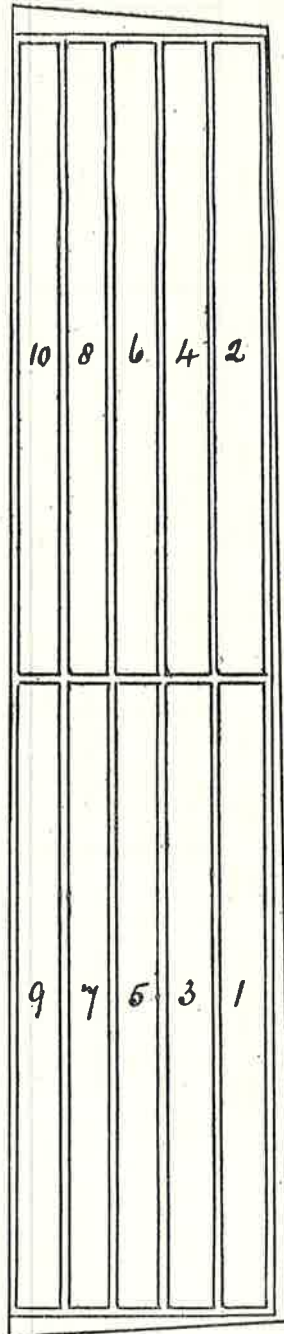
1	Farmyard Manure																			
2	Farmyard Manure, Slag, & Pot.																			
3	Unmanured (1846, & since) .. .																			
4	Basic Slag, & Pot., Sod., & Mag.																			
5	Basic Slag																			
6	Basic Slag, & Potash																			
7	Slag, Pot., & 367 lb. Am-sils.																			
8	Unmanured (1858, & since) .. .																			
9	Farmyard Manure, & Basic Slag																			

(76)

PLAN OF THE PLOTS IN HOOS FIELD,
ON WHICH EXPERIMENTS HAVE BEEN MADE
ON POTATOES,
WITHOUT MANURE, AND WITH VARIOUS MANURES.

23 years, 1876-98.

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



Total area of ploughed land about $2\frac{1}{10}$ acre.

Area of each plot $\frac{1}{5}$ acre.

The double lines indicate division paths between plot and plot.

[For details of the manuring and produce, see pp. 78-97.]

RESULTS OF EXPERIMENTS MADE IN HOOS FIELD, ON THE GROWTH OF POTATOES.

These experiments were commenced in 1876, so that 1898 is the 23rd year of their continuance. The descriptions grown were "Rock," 4 years, "Champion," 11 years, "Sutton's Abundance," 5 years, "Bruce," 1 year, and "White Beauty of Hebron," 1897, and 1898. The question was not as to the comparative merits of different descriptions, and different sorts were selected on the supposition that in growing the crop year after year change was desirable, especially with a view to the avoidance or lessening of disease. The special object was to ascertain the manurial requirements of the crop, and the comparative characters and composition of the produce.

The crop was grown continuously without manure, with various artificial manures, and also with farmyard manure, both alone and with some artificial manures. There were 10 differently manured plots, and under each of the 10 conditions the crop more or less declined over the later compared with the earlier years. The average produce per acre of total tubers over the 20 years was—without manure, only 1 ton, 11½ cwt.; with ammonium-salts alone, 1 ton, 18½ cwt.; with nitrate of soda alone, 2 tons, 8 cwt.; with superphosphate alone, 3 tons, 2½ cwt.; with mixed mineral manure, including potash, 3 tons, 6½ cwt. Thus, purely nitrogenous manures yielded less than purely mineral manures, indicating that there was a deficiency of ash-constituents rather than of available nitrogen within the soil. With the mixed mineral manure and ammonium-salts together, the average produce of total tubers was nearly 6 tons, and with the mixed mineral manure and nitrate of soda rather over 6 tons per acre. The better result by the nitrate of soda is doubtless due to its nitrogen being more immediately available, and more rapidly distributed within the soil, and so inducing a more extended development of feeding root. The average produce by the mineral and nitrogenous manures together, over 20 years of continuous growth, was very nearly that of the estimated average produce of Great Britain under ordinary cultivation, and much more than that of Ireland. It was also more than the average of any other country in Europe, much more than many of them, and about 3 times as much as that of the United States.

The plots receiving farmyard manure containing about 200 lb. of nitrogen, gave less produce than the mixture of mineral manure and ammonium-salts, or nitrate of soda, supplying only 86 lb. of nitrogen. In fact, only a small proportion of the nitrogen of farmyard manure is rapidly available, that due to undigested matter being more slowly available, and that in the litter remaining a long time inactive. Farmyard manure is, however, often applied in very large quantities for potatoes, the process being to a great extent one of forcing, and there remains a great amount of unexhausted manure-residue within the soil.

The percentage of nitrogen in potato tubers is much increased by the application of nitrogenous manures, but the less so the riper the crop. Without manure there is a comparatively low percentage of mineral matter and a medium percentage of nitrogen. With mineral manure alone there is the highest percentage of mineral matter, and the lowest of nitrogen. With purely nitrogenous manures there is the lowest percentage of mineral matter, and the highest of nitrogen. Lastly, with mineral and nitrogenous manures together, there are intermediate percentages, both of mineral matter and of nitrogen, in the tubers. More than 80 per cent. of the total nitrogen of the tubers exists in the juice. A comparatively small but variable proportion of the nitrogen of the tubers exists as albuminoids in the solid portion; perhaps on the average only about 15 per cent.; whilst from 40 to 50 per cent. of the total nitrogen may exist as soluble albuminoids in the juice, so that about or nearly two-thirds of the total nitrogen may exist as albuminoids, by far the larger proportion being, however, in the juice. The non-albuminoid nitrogenous matter exists chiefly as amides.

The characteristic effect of nitrogenous manures, provided there be a sufficient available supply of ash-constituents, and especially of potash, is to increase the amount of the non-nitrogenous substance—starch, in the tubers. Thus, the produce of starch per acre was about 1100 lb. without manure, nearly 2000 lb. with purely mineral manure, and with nitrogenous and mineral manures together about 3400 lb., or about 1½ ton. In other words, the increased produce of starch by the use of the mineral and nitrogenous manures together was more than 1 ton per acre. That is, there was a great increase in the production of the non-nitrogenous constituent—starch, by the use of nitrogen in manure, just as there is an increase in the produce of the non-nitrogenous constituent—sugar, by the use of nitrogenous manures to root crops. The increased production of non-nitrogenous substances by nitrogenous manures, is equally striking in cereal crops; the result in their case being an increased production of starch in the grain, and of cellulose in the straw. Indeed, it is for the production of the non-nitrogenous substances—starch, sugar, and cellulose—that our direct nitrogenous manures are chiefly used.

It is well known that season has much to do with the development of the potato disease; and there was on the average much more disease in the wetter seasons. As regards the influence of manure, the proportion of diseased tubers was the least where there was no supply of nitrogen; that is, where there was the least luxuriance, the most restricted growth, and where the ripening was early developed. On the other hand, with liberal supply of nitrogen, and luxuriant growth, there was the greatest proportion of diseased tubers; these being the conditions in which the juice is relatively rich in nitrogenous and mineral matters. Indeed, when the unsuitable weather comes, those tubers suffer the most which have the richest juice, that is, the least fixity of composition. It was found that there was always a higher, and sometimes a much higher, percentage of nitrogen in the dry substance of the diseased than in that of the sound tubers, indicating a loss of non-nitrogenous constituents. In many cases the still white, and also the separated discoloured portion of the diseased tubers, were analysed. Whilst the juice of the white portion contained approximately the normal amount of nitrogen, that of the discoloured portion contained very much less. On the other hand, the washed "Mare" of the white portion contained very little nitrogen, whilst that of the discoloured portion contained very much more. The distribution of the mineral matter to a great extent followed that of the nitrogen. The juice had obviously suffered exhaustion of much of both its nitrogen and its mineral matter in the development of the fungus. Further, there was more sugar (partly cane and partly glucose) in the diseased potatoes, which probably contributed to the development of the fungus. Apparently the first material change in the development of the disease is the destruction of starch and the formation of sugar. There is also a considerable loss of organic, and chiefly non-nitrogenous substance, due in part to the decomposition of the produced sugar, but probably in part to the evolution of carbonic acid, as a coincident of the growth of the fungus at the expense of ready-formed organic substance, this being a characteristic of the growth of such non-chlorophyllous plants. Thus the results adduced as to the course of the disease are quite consistent with the fact that it develops the more in tubers grown by highly nitrogenous manures, and having a highly nitrogenous juice.

A full available supply of ash-constituents is essential for the successful growth of the potato, but these being provided, the amount of produce is largely dependent on the available supply of nitrogen. In ordinary practice, farmyard manure is mainly relied upon. It is used in very large quantities, and it is sometimes supplemented by liberal dressings of artificial manures, both mineral and nitrogenous. The potato removes, however, a less proportion of the nitrogen supplied than any other farm crop.

For particulars of the manuring and produce, and to some extent of the composition of the differently grown tubers, see pages 78-97.

EXPERIMENTS ON POTATOES.—HOOS FIELD; commencing 1876.

Below are given the particulars of the Manures and Produce of each of the first 5 Seasons, 1876-1880; also the *average* Produce of those first 5 Seasons. For continuation, 1881 and since, see pp. 82-3, 86-7, 90-1, and 94-5.

The Land had been under experiments with Wheat, differently manured, from 1856 to 1874; and was followed in 1875.

Plots 1, 2, 3, and 4 had been unmanured for the Wheat. Plots 5 and 6 had received the same quantity of Ammonium-salts alone every year for the Wheat, as Plot 5 now receives for potatoes: Plot 6 now receiving the same amount of nitrogen, but as Nitrate of Soda, instead of Ammonium-salts. Plots 7 and 8 received the same amount of complex mineral manure, and Ammonium-salts, for the Wheat, as Plot 7

now receives for potatoes; and Plot 8 now receives the same complex mineral manures, and the same amount of nitrogen, but as Nitrate of Soda instead of Ammonium-salts. Plots 9 and 10 received the same complex mineral manures alone for the Wheat as Plot 10 now receives for potatoes; Plot 9 now receives superphosphate only. (3) Description of Potatoes, in 1876, 1877, 1878, and 1879, the "Rock" (White); and in those years the rows were 25 inches apart; with 12 inches from plant to plant in the rows. In 1880, the description was the "Champion" (White); and the rows were 25 inches apart, with 14 inches from plant to plant in the rows.

(Area under experiment, 2 acres.)

PLOTS.	MANURES PER ACRE PER ANNUM.	PRODUCE PER ACRE.					
		Tubers.			Tops.		
		Good.	Small.	Diseased.	TOTAL.		
FIRST SEASON, 1876. Potatoes planted, June 10-13; Crop taken up, Oct. 30-31.							
1	Unmanured	3 61	0 51	0 51	3 17 1/2	3 17 1/2	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Farmyard Manure (14 tons)	3 18 1/2	0 4	0 3 1/2	4 5 1/2	4 5 1/2	
3	Farmyard Manure (14 tons), and 3 1/2 cwts. Superphosphate (1)	4 14 1/2	0 6 1/2	0 5 1/2	5 6 1/2	5 6 1/2	
4	Farmyard Manure (14 tons), 3 1/2 cwts. Superphosphate, and 550 lbs. Nitrate of Soda	5 9 1/2	0 5 1/2	0 19 1/2	6 14 1/2	6 14 1/2	
5	400 lbs. Ammonium-salts (2)	2 5 1/2	0 6 1/2	0 6 1/2	2 18	2 18	
6	550 lbs. Nitrate of Soda	3 2	0 5 1/2	0 9 1/2	3 17 1/2	3 17 1/2	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	6 12 1/2	0 9 1/2	1 8 1/2	8 2	8 2	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	6 17 1/2	0 10	1 8 1/2	8 15 1/2	8 15 1/2	
9	3 1/2 cwts. Superphosphate	4 18 1/2	0 8 1/2	0 13 1/2	6 1	6 1	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	5 3 1/2	0 6 1/2	0 13 1/2	6 3 1/2	6 3 1/2	
SECOND SEASON, 1877. Potatoes planted, April 27-28; Crop taken up, Oct. 8-10.							
1	Unmanured	2 11 1/2	0 6 1/2	0 2 1/2	3 0 1/2	3 0 1/2	Withered, not weighed, each lot spread on its own Plot, (Oct. 14th) but high wind blew all off, before ploughing.
2	Farmyard Manure (14 tons)	5 0 1/2	0 11 1/2	0 6	5 18	5 18	
3	Farmyard Manure (14 tons), and 3 1/2 cwts. Superphosphate (1)	4 13 1/2	0 7 1/2	0 4	5 4 1/2	5 4 1/2	
4	Farmyard Manure (14 tons), 3 1/2 cwts. Superphosphate, and 550 lbs. Nitrate of Soda	6 18 1/2	0 7	0 17 1/2	8 3 1/2	8 3 1/2	
5	400 lbs. Ammonium-salts (2)	3 9 1/2	0 7 1/2	0 4	4 1	4 1	
6	550 lbs. Nitrate of Soda	4 14 1/2	0 6 1/2	0 5 1/2	7 1/2	7 1/2	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	6 12	0 11 1/2	0 14 1/2	7 17 1/2	7 17 1/2	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	7 18 1/2	0 8 1/2	0 16 1/2	8 13 1/2	8 13 1/2	
9	3 1/2 cwts. Superphosphate	2 12 1/2	0 11 1/2	0 1 1/2	3 6	3 6	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	3 6 1/2	0 7 1/2	0 1 1/2	3 15 1/2	3 15 1/2	

THIRD SEASON, 1878. Potatoes planted, April 29. Crop taken up, Sept. 18-21; Tops weighed, and spread on the Plots.

1	Unmanured	2	6 1/2	0	8 1/2	0	2	17 1/2	0	3 1/2
2	Farmyard Manure (14 tons)	4	11	0	12 1/2	0	2	17 1/2	0	6 1/2
3	Farmyard Manure (14 tons), and 3 1/2 cwts. Superphosphate (1)	5	18 1/2	0	14 1/2	0	13 1/2	6	0	11
4	Farmyard Manure (14 tons), 3 1/2 cwts. Superphosphate, and 550 lbs. Nitrate of Soda	6	11 1/2	0	11 1/2	0	6 1/2	8	9 1/2	1
5	400 lbs. Ammonium-salts (2)	2	16 1/2	0	8 1/2	0	7	3	10 1/2	0
6	550 lbs. Nitrate of Soda	3	16 1/2	0	7	0	9 1/2	4	13 1/2	0
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	7	6 1/2	0	9 1/2	0	1	8	17 1/2	0
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	1	11 1/2	0	9 1/2	0	1	3 1/2	4 1/2	0
9	3 1/2 cwts. Superphosphate	3	5 1/2	0	9 1/2	0	0	3 1/2	18 1/2	0
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	3	8	0	9	0	0	4	1 1/2	0

FOURTH SEASON, 1879. Potatoes planted, May 2; Crop taken up, Oct. 13-16.

1	Unmanured	0	11 1/2	0	4	0	0	0 1/2	0	16 1/2	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Farmyard Manure (14 tons)	1	13 1/2	0	4 1/2	0	0	10 1/2	2	8 1/2	
3	Farmyard Manure (14 tons), and 3 1/2 cwts. Superphosphate (1)	1	14	0	6	0	10 1/2	2	10 1/2	2	
4	Farmyard Manure (14 tons), 3 1/2 cwts. Superphosphate, and 550 lbs. Nitrate of Soda	2	16	0	5 1/2	0	12 1/2	3	14 1/2	3	
5	400 lbs. Ammonium-salts (2)	0	17 1/2	0	4	0	1 1/2	1	3	3	
6	550 lbs. Nitrate of Soda	0	14 1/2	0	4 1/2	0	2	1	0 1/2	1	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	2	4 1/2	0	5	0	6	2	15 1/2	2	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	1	13 1/2	0	4 1/2	0	6 1/2	2	9	2	
9	3 1/2 cwts. Superphosphate	0	17 1/2	0	3 1/2	0	1 1/2	1	1	2	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	0	16 1/2	0	3	0	1 1/2	1	1 1/2	1	

FIFTH SEASON, 1880. Potatoes planted, April 13; Crop taken up, Plots 5 and 6, Sept. 9th; other Plots, Sept. 23-30.

1	Unmanured	0	14 1/2	0	6 1/2	0	0	0 1/2	1	1 1/2	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Farmyard Manure (14 tons)	4	13 1/2	0	6	0	5	5	4 1/2	4 1/2	
3	Farmyard Manure (14 tons), and 3 1/2 cwts. Superphosphate (1)	5	6 1/2	0	5 1/2	0	10 1/2	6	2 1/2	6	
4	Farmyard Manure (14 tons), 3 1/2 cwts. Superphosphate, and 550 lbs. Nitrate of Soda	5	4	0	9 1/2	0	1 1/2	6	10 1/2	6	
5	400 lbs. Ammonium-salts (2)	0	8 1/2	0	0	0	0	0	17 1/2	0	
6	550 lbs. Nitrate of Soda	0	11 1/2	0	10	0	0	1	1 1/2	1	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	5	15 1/2	0	5 1/2	0	13	6	14	6	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	6	3 1/2	0	6 1/2	1	1	7	11 1/2	1	
9	3 1/2 cwts. Superphosphate	3	9	0	6 1/2	0	3 1/2	3	19	3	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	3	7 1/2	0	6	0	3 1/2	3	16 1/2	3	

AVERAGE OF 5 SEASONS, 1876, '77, '78, '79, and 1880.

1	Unmanured	1	18	0	6 1/2	0	0	2 1/2	2	6 1/2	In each year the Tops were spread on the respective Plots. For particulars see above.
2	Farmyard Manure (14 tons)	3	13 1/2	0	7 1/2	0	6 1/2	4	13 1/2	4	
3	Farmyard Manure (14 tons), and 3 1/2 cwts. Superphosphate (1)	4	9 1/2	0	8	0	3 1/2	5	6 1/2	5	
4	Farmyard Manure (14 tons), 3 1/2 cwts. Superphosphate, and 550 lbs. Nitrate of Soda	5	8	0	7	0	19 1/2	6	14 1/2	6	
5	400 lbs. Ammonium-salts (2)	1	19 1/2	0	7 1/2	0	3 1/2	2	10 1/2	2	
6	550 lbs. Nitrate of Soda	2	11 1/2	0	6 1/2	0	5 1/2	3	4	3	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	5	14 1/2	0	8 1/2	0	14 1/2	6	17 1/2	6	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	5	19 1/2	0	7 1/2	0	19 1/2	7	6 1/2	7	
9	3 1/2 cwts. Superphosphate	3	0 1/2	0	8	0	4 1/2	3	13 1/2	3	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	3	4 1/2	0	6 1/2	0	4 1/2	3	15 1/2	3	

(1) "Superphosphate of Lime" - in all cases made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water).

(2) "Ammonium-salts" - in each case equal parts Sulphate and Muriate Ammonia of Commerce.

(3) The complex mineral manure having been sown in October 1874, but the Wheat not put in, and therefore no crop taken in 1876, no mineral manures are sown afresh on Plots 7, 8, 9, and 10, for the first crop of potatoes, 1876.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE "GOOD" TUBERS, in each of the first 5 Seasons, 1876-1880; also the average composition over those first 5 Seasons. For the composition in 1881 and since, see pp. 84-5, 88-9, 92-3, and 96-7.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Potatoes, is given below. The specific gravity of the tubers is also given. In the tubers the dry matter, nitrogen, and ash have been determined; and in some cases complete analyses of the ash have been made. Besides the results obtained relating to the composition of the tubers themselves, the dry matter, the sugar, the nitrogen, and the ash, in the expressed juice have in many cases been determined; in some cases the amount of the nitrogen existing as albuminoids has been determined; and in some, complete analyses of the ash of the juice have been made. It may be remarked, that by far the larger proportion of both the mineral matter, and the nitrogen, is found to exist in the juice; and of the nitrogen in the juice, as a rule, not much more than half exists as albuminoids. In the majority of cases, the small potatoes have been submitted to the same methods of analysis as the good potatoes. And in a large number of cases, similar methods of examination have been applied to the still white, and also to the separated discoloured portions of the diseased potatoes. With regard to these latter results, it may be observed, that whilst the juice of the white portion of the diseased potatoes contained approximately the normal amount of nitrogen, that of the discoloured portion contained very much less. On the other hand, the washed, or exhausted

"marc" of the white portion, contained very little nitrogen, whilst that of the discoloured portion contained very much more. The distribution of the mineral matter was much in the same order as that of the nitrogen. It was obvious that the juice had suffered exhaustion of much of both its nitrogen and its mineral matter, in the development of the fungus. There was an increased amount of sugar found in the diseased potatoes, the result of diseased action, and it probably also contributed to the development of the fungus.

The results given in the Table relate to the "good" potatoes only. In interpreting the figures it must be borne in mind that in each year, the seed was planted on all the plots at the same time, and that all the crops were taken up at the same time; and as there was several times as much produce in some cases as in others, it is obvious that the crops would not each be at its best, and all in the same condition of maturity, when taken up. Then, again, the analyses were not performed immediately after taking up the crops, but some time afterwards, in weighed samples which had been kept in a cool place for some weeks or months; and in the following only preliminary statement of results, no correction is made for any change from the original weight of the samples, the results being calculated upon the fresh weights as finally taken for analysis.

PLOTS.	MANURES PER ACRE, PER ANNUM. (For Produce, see pp. 78-9.)	Specific Gravity of the Tubers.	Composition of the "Good" Tubers.				
			Dry Matter.	Mineral Matter (Ash).		Nitrogen.	
				In Fresh Tubers.	In Dry Matter.		In Fresh Tubers.	In Dry Matter.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
FIRST SEASON, 1876.							
1	Unmanured	1.097	23.9	0.84	3.53	0.269	1.13
2	Farmyard Manure (14 tons)	1.091	23.4	0.96	4.11	0.223	0.95
3	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	1.097	23.5	1.00	4.27	0.191	0.81
4	Farmyard Manure (14 tons), 3½ cwts. Superphosphate, and 550 lbs. Nitrate of Soda	1.085	21.2	0.83	3.92	0.295	1.89
5	400 lbs. Ammonium-salts (2)	1.087	22.1	0.81	3.67	0.332	1.50
6	550 lbs. Nitrate of Soda	1.091	22.0	0.79	3.59	0.327	1.49
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.090	20.9	0.98	4.71	0.266	1.27
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.088	21.9	0.98	4.46	0.292	1.33
9	3½ cwts. Superphosphate	1.103	23.5	1.10	4.72	0.199	0.84
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1.102	22.9	1.06	4.64	0.171	0.74
SECOND SEASON, 1877.							
1	Unmanured	1.119	33.0	1.05	3.17	0.302	0.91
2	Farmyard Manure (14 tons)	1.103	26.5	1.06	4.00	0.212	0.80
3	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	1.103	26.0	1.11	4.26	0.207	0.80
4	Farmyard Manure (14 tons), 3½ cwts. Superphosphate, and 550 lbs. Nitrate of Soda	1.112	27.2	1.06	3.90	0.301	1.11
5	400 lbs. Ammonium-salts (2)	1.107	22.0	0.67	3.07	0.281	1.28
6	550 lbs. Nitrate of Soda	1.116	25.9	0.74	2.85	0.301	1.16
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.103	28.4	1.23	4.33	0.270	0.95
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.112	27.3	1.16	4.26	0.268	0.98
9	3½ cwts. Superphosphate	1.109	26.5	1.18	4.44	0.203	0.76
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1.109	26.8	1.21	4.52	0.208	0.78

THIRD SEASON, 1878.

1	Unmanured	1.107	26.0	0.85	3.26	0.228	0.88
2	Farmyard Manure (14 tons)	1.100	24.4	1.02	4.20	0.209	0.86
3	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	1.090	23.8	1.03	4.35	0.205	0.86
4	Farmyard Manure (14 tons), 3½ cwts. Superphosphate, and 550 lbs. Nitrate of Soda	1.078	21.9	0.97	4.45	0.269	1.23
5	400 lbs. Ammonium-salts (2)	1.099	24.9	0.78	3.12	0.310	1.25
6	550 lbs. Nitrate of Soda	1.105	23.5	0.67	2.64	0.326	0.95
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.093	23.6	1.08	4.57	0.223	0.95
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.097	24.4	1.08	4.41	0.228	0.94
9	3½ cwts. Superphosphate	1.097	24.1	1.14	4.74	0.165	0.68
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.098	23.7	1.16	4.90	0.167	0.71

FOURTH SEASON, 1879.

1	Unmanured	1.103	24.3	0.96	3.95	0.242	1.00
2	Farmyard Manure (14 tons)	1.103	23.7	0.99	4.16	0.220	0.93
3	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	1.099	24.0	1.02	4.26	0.218	0.91
4	Farmyard Manure (14 tons), 3½ cwts. Superphosphate, and 550 lbs. Nitrate of Soda	1.102	24.6	0.91	3.69	0.254	1.04
5	400 lbs. Ammonium-salts (2)	1.103	24.6	0.76	3.06	0.270	1.10
6	550 lbs. Nitrate of Soda	1.104	25.0	0.76	3.05	0.300	1.20
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.098	23.1	0.95	4.13	0.241	1.05
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.102	23.9	1.04	4.36	0.272	1.14
9	3½ cwts. Superphosphate	1.099	23.6	1.10	4.65	0.219	0.93
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.099	23.5	1.15	4.89	0.211	0.90

FIFTH SEASON, 1880.

1	Unmanured	1.123	28.8	0.77	2.66	0.382	1.33
2	Farmyard Manure (14 tons)	1.114	27.6	0.98	3.56	0.287	1.04
3	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	1.117	27.8	0.98	3.52	0.275	0.99
4	Farmyard Manure (14 tons), 3½ cwts. Superphosphate, and 550 lbs. Nitrate of Soda	1.102	25.2	0.88	3.48	0.357	1.41
5	400 lbs. Ammonium-salts (2)	1.114	28.5	0.84	2.95	0.430	1.51
6	550 lbs. Nitrate of Soda	1.117	28.8	0.88	3.06	0.415	1.44
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.097	25.9	0.97	3.73	0.327	1.26
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.118	26.7	0.96	3.59	0.318	1.19
9	3½ cwts. Superphosphate	1.114	27.2	1.03	3.81	0.247	0.91
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.116	27.3	1.06	3.86	0.236	0.87

AVERAGE OF 5 SEASONS, 1876 '77, '78, '79, and 1880.

1	Unmanured	1.110	27.2	0.89	3.31	0.285	1.05
2	Farmyard Manure (14 tons)	1.103	25.1	1.00	4.01	0.231	0.92
3	Farmyard Manure (14 tons), and 3½ cwts. Superphosphate (1)	1.101	25.0	1.03	4.13	0.220	0.88
4	Farmyard Manure (14 tons), 3½ cwts. Superphosphate, and 550 lbs. Nitrate of Soda	1.096	24.0	0.93	3.89	0.296	1.24
5	400 lbs. Ammonium-salts (2)	1.102	24.4	0.77	3.17	0.326	1.33
6	550 lbs. Nitrate of Soda	1.107	25.4	0.77	3.04	0.335	1.32
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.096	24.4	1.04	4.29	0.266	1.10
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.103	24.8	1.04	4.22	0.276	1.12
9	3½ cwts. Superphosphate	1.104	25.0	1.11	4.47	0.207	0.88
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.105	24.8	1.13	4.56	0.199	0.80

(1) "Superphosphate of Lime"—in all cases made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water).
 (2) "Ammonium-salts"—in each case equal parts Sulphate and Muriate Ammonia of Commerce.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.

Below are given the particulars of the Manures and Produce of the Sixth, Seventh, Eighth, Ninth, and Tenth Seasons, 1881, 1882, 1883, 1884, and 1885. For the Manures and Produce of the 5 preceding years, see pp. 78-9, and of succeeding years, 1886 and since, see pp. 86-7, 90-1, and 94-5.

The Land had been under experiments with Wheat, differently manured, from 1856 to 1874; and was fallowed in 1875.

Plots 1, 2, 3, and 4 had been unmanured for the Wheat. Plots 5 and 6 had received the same quantity of Ammonium-salts alone every year for the Wheat, as Plot 5 now receives for potatoes; Plot 6 now receiving the same amount of nitrogen, but as Nitrate of Soda, instead of Ammonium-salts. Plots 7 and 8 received the

same amount of complex mineral manure, and Ammonium-salts, for the Wheat, as Plot 7 now receives for potatoes; and Plot 8 now receives the same complex mineral manures, and the same amount of nitrogen, but as Nitrate of Soda instead of Ammonium-salts. Plots 9 and 10 received the same complex mineral manures alone for the Wheat as Plot 10 now receives for potatoes; Plot 9 now receives superphosphate only. Description of Potatoes, in 1876, 1877, 1878, and 1879, the "Rock" (White); and in those years the rows were 25 inches apart, with 12 inches from plant to plant in the rows. In 1881, 1882, 1883, 1884, and 1885, the description was the "Champion" (White); and the rows were 25 inches apart, with 14 inches from plant to plant in the rows.

(Area under experiment, 2 acres.)

PLOTS.	MANURES PER ACRE PER ANNUM.	PRODUCE PER ACRE.				
		Tubers.		Tops.		
		Good.	Small.	Diseased.	TOTAL.	
SIXTH SEASON, 1881. Potatoes planted, March 31; Crop taken up, October 5, 6 and 7.						
1	Unmanured, in 1876, and each year since	1 17½	0 3½	0 0½	2 0½	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Farmyard Manure (14 tons)	7 14½	0 3½	0 1½	8 0	
3	Farmyard Manure (14 tons), and 3½ cwt. Superphosphate (°)	6 14½	0 4	0 1½	6 19½	
4	Farmyard Manure (14 tons), 3½ cwt. Superphosphate, and 550 lbs. Nitrate of Soda	8 6½	0 5½	0 9½	9 1½	
5	400 lbs. Ammonium-salts (°)	2 6	0 4½	0 0	2 10½	
6	550 lbs. Nitrate of Soda	2 19½	0 3½	0 0½	3 3½	
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	10 10½	0 3½	0 1½	10 16	
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	9 12½	0 4	0 3½	10 0	
9	3½ cwt. Superphosphate	5 7½	0 3½	0 0½	5 11½	
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	5 14½	0 2½	0 1	5 18½	
SEVENTH SEASON, 1882. Potatoes planted, March 21. Crop taken up, September 25-27.						
1	Unmanured, in 1876, and each year since	1 15½	0 3½	0 0½	1 19	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882. Previously Farmyard Manure (14 tons)	3 19½	0 2½	0 2	4 0	
3	Farmyard Manure (14 tons), and 3½ cwt. Superphosphate (°)	5 8	0 4½	0 3½	5 15½	
4	Farmyard Manure (14 tons), 3½ cwt. Superphosphate. In 1881, and previously, 550 lbs. Nitrate of Soda also ..	4 7½	0 11½	0 4	4 12½	
5	400 lbs. Ammonium-salts (°)	1 18½	0 3	0 0½	2 2½	
6	550 lbs. Nitrate of Soda	1 18½	0 3	0 0½	2 2½	
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	7 15½	0 3½	0 11½	8 10½	
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	6 16½	0 3½	0 2½	7 2½	
9	3½ cwt. Superphosphate	4 12	0 2½	0 1½	4 15½	
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	4 7½	0 2½	0 0½	4 10	

EIGHTH SEASON, 1883. Potatoes planted, March 22. Crop taken up October 22-25.

1	Unmanured, in 1876, and each year since	2	4 1/2	0	6 1/2	0	1 1/2	2	12	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) alone 1883; previously 3 1/2 cwts. Superphosphate also (1)	4	5 1/2	1	0 1/2	0	4 1/2	5	9 3/4	
3	Farmyard Manure (14 tons) alone 1883. In 1882, and previously, 3 1/2 cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	5	6 1/2	0	9 1/2	0	4 1/2	6	0 1/2	
4	Farmyard Manure (14 tons) alone 1883. In 1882, and previously, 3 1/2 cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	4	0 1/2	0	11 1/2	0	1 1/2	4	13 1/2	
5	400 lbs. Ammonium-salts (2)	2	13 1/2	0	8 1/2	0	2 1/2	3	4 1/2	
6	550 lbs. Nitrate of Soda	2	13 1/2	0	7 1/2	0	1 1/2	3	2 1/2	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	7	16 1/2	0	14	0	8 1/2	8	19	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	7	9 1/2	0	9 1/2	0	3 1/2	8	2 1/2	
9	3 1/2 cwts. Superphosphate	4	8 1/2	0	7 1/2	0	3 1/2	4	19 1/2	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	4	9 1/2	0	7 1/2	0	1 1/2	4	13 1/2	

NINTH SEASON, 1884. Potatoes planted, March 21. Crop taken up, September 24-26.

1	Unmanured, in 1876, and each year since	2	0 1/2	0	4 1/2	0	1	2	6	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) alone 1883-4, previously 3 1/2 cwts. Superphosphate also (1)	2	5 1/2	0	4 1/2	0	2 1/2	2	11 1/2	
3	Farmyard Manure (14 tons) alone 1883-4. In 1882, and previously, 3 1/2 cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	3	10 1/2	0	5 1/2	0	2 1/2	3	13 1/2	
4	Farmyard Manure (14 tons) alone 1883-4. In 1882, and previously, 3 1/2 cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	3	12 1/2	0	6 1/2	0	2 1/2	4	1 1/2	
5	400 lbs. Ammonium-salts (2)	2	0 1/2	0	7 1/2	0	0 1/2	2	8 1/2	
6	550 lbs. Nitrate of Soda	1	16 1/2	0	3 1/2	0	2 1/2	0	0	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	4	19 1/2	0	10 1/2	0	2 1/2	5	12	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	3	13 1/2	0	7	0	2 1/2	4	19 1/2	
9	3 1/2 cwts. Superphosphate	3	13 1/2	0	5	0	1 1/2	3	19 1/2	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	3	13	0	5	0	1 1/2	3	13 1/2	

TENTH SEASON, 1885. Potatoes planted, March 17 and 18. Crop taken up, September 24-26.

1	Unmanured in 1876, and each year since	0	16 1/2	0	4 1/2	0	1	1	1	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) alone 1883 and since; previously 3 1/2 cwts. Superphosphate also (1)	1	13	0	3 1/2	0	0	1	17 1/2	
3	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 1/2 cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	2	6 1/2	0	5 1/2	0	0 1/2	2	12 1/2	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 1/2 cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	2	11	0	4 1/2	0	0 1/2	2	15 1/2	
5	400 lbs. Ammonium-salts (2)	1	6 1/2	0	5 1/2	0	0	1	12	
6	550 lbs. Nitrate of Soda	1	7 1/2	0	5	0	0 1/2	1	13 1/2	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	4	2	0	6 1/2	0	0	4	9 1/2	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	3	16 1/2	0	4 1/2	0	1 1/2	4	2 1/2	
9	3 1/2 cwts. Superphosphate	2	1 1/2	0	3 1/2	0	0 1/2	2	5 1/2	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	2	0	0	2 1/2	0	0 1/2	2	3 1/2	

AVERAGE OF 5 SEASONS, 1881, '82, '83, '84, and 1885.

1	Unmanured in 1876, and each year since	1	14 1/2	0	4 1/2	0	0 1/2	1	19 1/2	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) alone 1883 and since; previously 3 1/2 cwts. Superphosphate also (1)	3	18 1/2	0	6 1/2	0	2 1/2	4	7 1/2	
3	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 1/2 cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	4	13 1/2	0	5 1/2	0	2 1/2	5	1 1/2	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 1/2 cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	4	11 1/2	0	6 1/2	0	3 1/2	5	0 1/2	
5	400 lbs. Ammonium-salts (2)	2	0 1/2	0	6	0	0 1/2	2	7 1/2	
6	550 lbs. Nitrate of Soda	2	3	0	4 1/2	0	0 1/2	2	8 1/2	
7	400 lbs. Ammonium-salts, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	6	9	0	5 1/2	0	2 1/2	6	17 1/2	
8	550 lbs. Nitrate of Soda, 3 1/2 cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	4	0 1/2	0	4 1/2	0	1 1/2	4	6 1/2	
9	3 1/2 cwts. Superphosphate	4	0 1/2	0	4 1/2	0	1 1/2	4	6 1/2	
10	3 1/2 cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	4	0 1/2	0	4 1/2	0	1 1/2	4	6	

(1) "Superphosphate of Lime"—in all cases made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water).
 (2) "Ammonium-salts"—in each case equal parts Sulphate and Muriate Ammonia of Commerce.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE "GOOD" TUBERS, in the Sixth, Seventh, Eighth, Ninth, and Tenth Seasons, 1881, 1882, 1883, 1884, and 1885. For the particulars of the composition in the first 5 years, 1876-1880, see pp. 80-1, and for those in succeeding years, 1886 and since, see pp. 88-9, 92-3, and 96-7.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Potatoes, is given below. The specific gravity of the tubers is also given. In the tubers the dry matter, nitrogen, and ash have been determined; and in some cases complete analyses of the ash have been made. Besides the results obtained relating to the composition of the tubers themselves, the dry matter, the sugar, the nitrogen, and the ash, in the expressed juice have in many cases been determined; in some cases the amount of the nitrogen existing as albuminoids has been determined; and in some, complete analyses of the ash of the juice have been made. It may be remarked, that by far the larger portion of both the mineral matter, and the nitrogen, is found to exist in the juice; and of the nitrogen in the juice, as a rule, not much more than half exists as albuminoids. In many cases, the small potatoes have been submitted to the same methods of analysis as the good potatoes. And in some cases, similar methods of examination have been applied to the still white, and also to the separated discoloured portions of the diseased potatoes. With regard to these latter results, it may be observed, that whilst the juice of the white portion of the diseased potatoes contained approximately the normal amount of nitrogen, that of the discoloured portion contained very much less. On the

other hand, the washed, or exhausted "marc" of the white portion, contained very little nitrogen, whilst that of the discoloured portion contained very much more. The distribution of the mineral matter was much in the same order as that of the nitrogen. It was obvious that the juice had suffered exhaustion of much of both its nitrogen and its mineral matter, in the development of the fungus. There was an increased amount of sugar found in the diseased potatoes, the result of diseased action, and it probably also contributed to the development of the fungus.

The results given in the Table relate to the "good" potatoes only. In interpreting the figures it must be borne in mind that in each year, the seed was planted on all the plots at the same time, and that all the crops were taken up at the same time; and as there was several times as much produce in some cases as in others, it is obvious that the crops would not each be at its best, and all in the same condition of maturity when taken up. Then, again, the analyses were not performed immediately after taking up the crops, but sometime afterwards, in weighed samples which had been kept in a cool place for some weeks or months; and in the following only preliminary statement of results, no correction is made for any change from the original weight of the samples, the results being calculated upon the fresh weights as finally taken for analysis.

PLOTS.	MANURES PER ACRE, PER ANNUM. (For Produce, see pp. 82-3.)	Specific Gravity of the Tubers.	Composition of the "Good" Tubers.					
			Dry Matter.		Mineral Matter (Ash).		Nitrogen.	
			In Fresh Tubers.	In Dry Matter.	In Fresh Tubers.	In Dry Matter.	In Fresh Tubers.	In Dry Matter.
SIXTH SEASON, 1881.								
1	Unmanured, in 1876, and each year since	1.125	30.5	2.82	0.86	0.389	1.28	
2	Farmyard Manure (14 tons)	1.116	29.1	3.41	0.99	0.294	1.01	
3	Farmyard Manure (14 tons), and 3½ cwt. Superphosphate (1)	1.113	28.1	3.81	1.07	0.295	1.05	
4	Farmyard Manure (14 tons), 3½ cwt. Superphosphate, and 550 lbs. Nitrate of Soda	1.107	26.0	3.51	0.91	0.359	1.39	
5	400 lbs. Ammonium-salts (2)	1.115	27.9	3.03	0.84	0.375	1.35	
6	550 lbs. Nitrate of Soda	1.114	28.0	2.70	0.76	0.379	1.36	
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	1.110	26.7	3.97	1.06	0.306	1.15	
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	1.107	25.3	3.89	0.98	0.341	1.35	
9	3½ cwt. Superphosphate	1.123	29.0	3.92	1.14	0.242	0.83	
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1.122	28.3	4.13	1.17	0.225	0.80	
SEVENTH SEASON, 1882.								
1	Unmanured, in 1876, and each year since	1.127	29.5	3.82	0.83	0.296	1.00	
2	Unmanured in 1882. Previously Farmyard Manure (14 tons)	1.131	30.3	3.01	0.91	0.260	0.86	
3	Farmyard Manure (14 tons), and 3½ cwt. Superphosphate (1)	1.122	28.7	3.39	0.97	0.261	0.91	
4	Farmyard Manure (14 tons), 3½ cwt. Superphosphate. In 1881, and previously, 550 lbs. Nitrate of Soda also.	1.116	26.6	3.48	0.93	0.313	1.18	
5	400 lbs. Ammonium-salts (2)	1.119	27.9	2.78	0.77	0.372	1.34	
6	550 lbs. Nitrate of Soda	1.119	27.9	2.82	0.79	0.408	1.46	
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	1.120	27.5	3.49	0.96	0.305	1.11	
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	1.123	28.2	3.46	0.98	0.336	1.19	
9	3½ cwt. Superphosphate	1.128	29.3	3.53	1.03	0.209	0.71	
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1.125	29.1	3.71	1.08	0.229	0.79	

EIGHTH SEASON, 1883.

1	Unmanured, in 1876, and each year since	1-123	28-5	0-79	2-78	0-312	1-10
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1-128	28-3	0-88	3-10	0-276	0-97
3	Farmyard Manure (14 tons) alone 1883; previously 3½ cwt. Superphosphate also (¹)	1-117	26-6	0-95	3-56	0-289	1-09
4	Farmyard Manure (14 tons) alone 1883. In 1882, and previously, 3½ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1-109	26-2	0-93	3-53	0-320	1-22
5	400 lbs. Ammonium-salts (²)	1-117	26-8	0-75	2-81	0-968	1-37
6	500 lbs. Nitrate of Soda	1-118	26-8	0-71	2-64	0-393	1-47
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1-113	26-2	0-96	3-67	0-282	1-37
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1-111	26-2	0-97	3-86	0-359	1-07
9	3½ cwt. Superphosphate	1-123	27-2	1-02	3-76	0-208	0-77
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1-122	27-2	1-05	3-86	0-197	0-73

NINTH SEASON, 1884.

1	Unmanured, in 1876, and each year since	1-117	27-0	0-75	2-78	0-360	1-33
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1-115	26-9	0-80	2-99	0-361	1-34
3	Farmyard Manure (14 tons) alone 1883-4; previously 3½ cwt. Superphosphate also (¹)	1-102	24-6	0-91	3-69	0-390	1-59
4	Farmyard Manure (14 tons) alone 1883-4. In 1882, and previously, 3½ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1-099	23-8	0-92	3-88	0-382	1-61
5	400 lbs. Ammonium-salts (²)	1-107	25-8	0-67	2-58	0-456	1-77
6	550 lbs. Nitrate of Soda	1-105	25-2	0-66	2-61	0-443	1-76
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1-099	24-3	0-95	3-89	0-387	1-59
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1-098	23-8	0-89	3-72	0-440	1-85
9	3½ cwt. Superphosphate	1-117	26-6	1-01	3-78	0-260	0-98
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1-118	26-8	1-07	3-98	0-233	0-88

TENTH SEASON, 1885.

1	Unmanured, in 1876, and each year since	1-123	28-7	0-82	2-85	0-390	1-36
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1-124	27-9	0-83	2-99	0-388	1-39
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwt. Superphosphate also (¹)	1-114	26-5	0-96	3-63	0-394	1-49
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1-113	26-9	0-97	3-61	0-418	1-56
5	400 lbs. Ammonium-salts (²)	1-115	27-5	0-83	3-01	0-474	1-73
6	550 lbs. Nitrate of Soda	1-119	27-4	0-74	2-70	0-482	1-76
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1-111	26-6	0-96	3-59	0-408	1-53
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1-116	27-7	0-93	3-37	0-408	1-47
9	3½ cwt. Superphosphate	1-127	28-6	1-02	3-36	0-340	1-19
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1-119	27-6	1-10	3-97	0-299	1-08

AVERAGE OF 5 SEASONS, 1881, '82, '83, '84, and 1885.

1	Unmanured in 1876, and each year since.	1-123	28-8	0-81	2-81	0-349	1-21
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1-123	28-5	0-88	3-10	0-316	1-11
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwt. Superphosphate also (¹)	1-114	26-9	0-97	3-62	0-326	1-23
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1-109	25-9	0-93	3-60	0-358	1-39
5	400 lbs. Ammonium-salts (²)	1-115	27-2	0-77	2-84	0-409	1-51
6	550 lbs. Nitrate of Soda	1-115	27-1	0-73	2-69	0-421	1-56
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1-111	26-3	0-98	3-72	0-338	1-29
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1-111	26-2	0-95	3-66	0-377	1-45
9	3½ cwt. Superphosphate	1-124	28-1	1-04	3-71	0-252	0-90
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1-121	27-8	1-09	3-93	0-238	0-86

(¹) "Superphosphate of Lime"—in all cases made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water).
 (²) "Ammonium-salts"—in each case equal parts Sulphate and Muriate Ammonia of Commerce.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.

Below are given the particulars of the Manures and Produce, of the Eleventh, Twelfth, Thirteenth, Fourteenth, and Fifteenth Seasons, 1886, 1887, 1888, 1889, and 1890. For the Manures, description of Potatoes grown, and the Produce, in the 10 preceding years, see pp. 78-9, and 82-3, and in succeeding years, pp. 90-1, and 94-5. The arrangement of the plots is precisely the same as for the 10 preceding potato crops. The manures are the same as for the crops of 1883, 1884 and 1885, excepting that for the crop of 1887 Sulphate Ammonia was applied instead of equal parts of Sulphate and Muriate Ammonia, as in former years and since (see foot-note No. 2). Description of Potato, "The Champion" (White). Rows 25 inches apart; 14 inches from plant to plant in the rows.

(Area under experiment, 2 acres.)

PLOTS.	MANURES PER ACRE PER ANNUM.		PRODUCE PER ACRE.			
			Tubers.		Tops.	
	Good.	Small.	Diseased.	TOTAL.		
ELEVENTH SEASON, 1886. Potatoes planted, April 10. Crop taken up, September 30, and October 1 and 2.						
1	Unmanured in 1876, and each year since		Tons. cwts.	Tons. cwts.	Tons. cwts.	
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)		0 13½	0 0¼	0 18	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)		1 17	0 0	2 1	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also		2 15	0 1	2 19½	
5	400 lbs. Ammonium-salts (2)		2 12½	0 1½	2 16½	
6	550 lbs. Nitrate of Soda		1 2½	0 1	1 8	
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.		1 2½	0 0¼	1 6½	
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.		3 10	0 1	3 14½	
9	3½ cwts. Superphosphate		3 6½	0 0½	3 10½	
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia		1 17½	0 0¼	2 1	Withered, not weighed, each lot
			2 2½	0 0½	2 5½	spread on its own Plot and ploughed in.
TWELFTH SEASON, 1887. Potatoes planted, March 24. Crop taken up, October 17-19.						
1	Unmanured in 1876, and each year since		3½	0 0½	1 7½	
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)		2 2½	0 0½	2 6	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)		3 18	0 1	4 3½	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also		4 14	0 3	5 1¾	
5	450 lbs. Sulphate Ammonia (2)		1 9½	0 0¼	1 13½	
6	550 lbs. Nitrate of Soda		1 18½	0 0½	2 2	
7	450 lbs. Sulph. Ammonia, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.		4 11	0 0½	4 6½	
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.		4 18	0 4	5 4½	
9	3½ cwts. Superphosphate		1 16½	0 1	2 1½	
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia		2 3½	0 3½	2 9	Withered, not weighed, each lot
						spread on its own Plot and ploughed in.

THIRTEENTH SEASON, 1888. Potatoes planted, April 17. Crop taken up, October 11-17.

1	Unmanured in 1876, and each year since ..	0	12 $\frac{1}{2}$	0	2 $\frac{1}{2}$	0	0 $\frac{1}{2}$	0	15 $\frac{1}{2}$	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) ..	1	10 $\frac{1}{2}$	0	2 $\frac{1}{2}$	0	0	1	14	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3 $\frac{1}{2}$ cwt. Superphosphate also (?) ..	2	9	0	2 $\frac{1}{2}$	0	6	2	11 $\frac{1}{2}$	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 $\frac{1}{2}$ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also ..	2	3 $\frac{1}{2}$	0	1 $\frac{1}{2}$	0	6	2	11 $\frac{1}{2}$	
5	400 lbs. Ammonium-salts (?) ..	0	19 $\frac{1}{2}$	0	2	0	0 $\frac{1}{2}$	1	2 $\frac{1}{2}$	
6	550 lbs. Nitrate of Soda ..	1	7	0	2 $\frac{1}{2}$	0	1 $\frac{1}{2}$	1	10 $\frac{1}{2}$	
7	400 lbs. Ammonium-salts, 3 $\frac{1}{2}$ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. ..	2	8 $\frac{1}{2}$	0	1 $\frac{1}{2}$	0	8 $\frac{1}{2}$	2	18 $\frac{1}{2}$	
8	550 lbs. Nitrate of Soda, 3 $\frac{1}{2}$ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. ..	3	2 $\frac{1}{2}$	0	1 $\frac{1}{2}$	0	13 $\frac{1}{2}$	3	17 $\frac{1}{2}$	
9	3 $\frac{1}{2}$ cwt. Superphosphate ..	1	11 $\frac{1}{2}$	0	1 $\frac{1}{2}$	0	0	1	13 $\frac{1}{2}$	
10	3 $\frac{1}{2}$ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1	12 $\frac{1}{2}$	0	1 $\frac{1}{2}$	0	0	1	15 $\frac{1}{2}$	

FOURTEENTH SEASON, 1889. Potatoes planted, March 28 and 29. Crop taken up, September 16-18.

1	Unmanured in 1876, and each year since ..	0	13 $\frac{1}{2}$	0	2 $\frac{1}{2}$	0	0 $\frac{1}{2}$	0	16 $\frac{1}{2}$	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) ..	1	9 $\frac{1}{2}$	0	2 $\frac{1}{2}$	0	0 $\frac{1}{2}$	1	19 $\frac{1}{2}$	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3 $\frac{1}{2}$ cwt. Superphosphate also (?) ..	1	9 $\frac{1}{2}$	0	3	0	7 $\frac{1}{2}$	1	13 $\frac{1}{2}$	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 $\frac{1}{2}$ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also ..	2	10 $\frac{1}{2}$	0	3	0	5	2	18 $\frac{1}{2}$	
5	400 lbs. Ammonium-salts (?) ..	1	11	0	2 $\frac{1}{2}$	0	0 $\frac{1}{2}$	1	4 $\frac{1}{2}$	
6	550 lbs. Nitrate of Soda ..	1	7	0	2 $\frac{1}{2}$	0	2 $\frac{1}{2}$	1	12	
7	400 lbs. Ammonium-salts, 3 $\frac{1}{2}$ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. ..	3	2 $\frac{1}{2}$	0	2 $\frac{1}{2}$	0	0	3 $\frac{1}{2}$	9	
8	550 lbs. Nitrate of Soda, 3 $\frac{1}{2}$ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. ..	3	6 $\frac{1}{2}$	0	2	0	2 $\frac{1}{2}$	3	11 $\frac{1}{2}$	
9	3 $\frac{1}{2}$ cwt. Superphosphate ..	1	15 $\frac{1}{2}$	0	2	0	1	1	18 $\frac{1}{2}$	
10	3 $\frac{1}{2}$ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	2	2 $\frac{1}{2}$	0	1 $\frac{1}{2}$	0	0	2	5 $\frac{1}{2}$	

FIFTEENTH SEASON, 1890. Potatoes planted, April 3. Crop taken up, September 9-11.

1	Unmanured in 1876, and each year since ..	0	18 $\frac{1}{2}$	0	6	0	0 $\frac{1}{2}$	0	5	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) ..	2	4	0	7	0	1 $\frac{1}{2}$	2	13 $\frac{1}{2}$	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3 $\frac{1}{2}$ cwt. Superphosphate also (?) ..	6	1	0	8 $\frac{1}{2}$	0	6	6	15 $\frac{1}{2}$	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 $\frac{1}{2}$ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also ..	6	2 $\frac{1}{2}$	0	8 $\frac{1}{2}$	0	5 $\frac{1}{2}$	6	17	
5	400 lbs. Ammonium-salts (?) ..	1	9 $\frac{1}{2}$	0	10 $\frac{1}{2}$	0	0 $\frac{1}{2}$	2	0 $\frac{1}{2}$	
6	550 lbs. Nitrate of Soda ..	2	2	0	6 $\frac{1}{2}$	0	0 $\frac{1}{2}$	2	9 $\frac{1}{2}$	
7	400 lbs. Ammonium-salts, 3 $\frac{1}{2}$ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. ..	5	13 $\frac{1}{2}$	0	6 $\frac{1}{2}$	0	7 $\frac{1}{2}$	6	7 $\frac{1}{2}$	
8	550 lbs. Nitrate of Soda, 3 $\frac{1}{2}$ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. ..	5	14	0	6 $\frac{1}{2}$	0	3 $\frac{1}{2}$	6	3 $\frac{1}{2}$	
9	3 $\frac{1}{2}$ cwt. Superphosphate ..	2	6	0	5 $\frac{1}{2}$	0	0 $\frac{1}{2}$	2	12 $\frac{1}{2}$	
10	3 $\frac{1}{2}$ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	2	16 $\frac{1}{2}$	0	6 $\frac{1}{2}$	0	0	3	3	

AVERAGE OF 5 SEASONS, 1886, '87, '88, '89, and 1890.

1	Unmanured in 1876, and each year since ..	0	16 $\frac{1}{2}$	0	3 $\frac{1}{2}$	0	0 $\frac{1}{2}$	0	0 $\frac{1}{2}$	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) ..	1	16 $\frac{1}{2}$	0	3 $\frac{1}{2}$	0	0 $\frac{1}{2}$	2	1 $\frac{1}{2}$	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3 $\frac{1}{2}$ cwt. Superphosphate also (?) ..	3	5 $\frac{1}{2}$	0	4 $\frac{1}{2}$	0	4 $\frac{1}{2}$	3	13 $\frac{1}{2}$	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 $\frac{1}{2}$ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also ..	3	12 $\frac{1}{2}$	0	4 $\frac{1}{2}$	0	4 $\frac{1}{2}$	4	1	
5	400 lbs. Ammonium-salts (?) ..	1	4 $\frac{1}{2}$	0	4 $\frac{1}{2}$	0	0 $\frac{1}{2}$	1	9 $\frac{1}{2}$	
6	550 lbs. Nitrate of Soda ..	1	11 $\frac{1}{2}$	0	3 $\frac{1}{2}$	0	1	1	16	
7	400 lbs. Ammonium-salts, 3 $\frac{1}{2}$ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. ..	3	15 $\frac{1}{2}$	0	3 $\frac{1}{2}$	0	4 $\frac{1}{2}$	4	3 $\frac{1}{2}$	
8	550 lbs. Nitrate of Soda, 3 $\frac{1}{2}$ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. ..	4	1 $\frac{1}{2}$	0	3 $\frac{1}{2}$	0	4 $\frac{1}{2}$	4	3 $\frac{1}{2}$	
9	3 $\frac{1}{2}$ cwt. Superphosphate ..	1	17 $\frac{1}{2}$	0	3	0	0 $\frac{1}{2}$	2	1 $\frac{1}{2}$	
10	3 $\frac{1}{2}$ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	2	3 $\frac{1}{2}$	0	3 $\frac{1}{2}$	0	0	1	7 $\frac{1}{2}$	

(1) "Superphosphate of Lime," 1886 and 1887, made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water); 1888, and since, made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.

(2) "Ammonium-salts" — in each case equal parts Sulphate and Muriate Ammonia of Commerce.

(3) 450 lbs. Sulphate Ammonia is estimated to contain the same amount of Nitrogen as the 200 lbs. Sulphate and 200 lbs. Muriate of Ammonia applied in former years, and since.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE "GOOD" TUBERS, in the Eleventh, Twelfth, Thirteenth, Fourteenth, and Fifteenth Seasons, 1886, 1887, 1888, 1889, and 1890. For particulars of the composition in the first 10 years, 1876-1885, see pp. 80-1, and 84-5, and for those in succeeding years, 1891 and since, see pp. 92-3, and 96-7.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Potatoes, is given below. The specific gravity of the tubers is also given. In the tubers the dry matter, nitrogen, and ash have been determined; and in some cases complete analyses of the ash have been made. Besides the results obtained relating to the composition of the tubers themselves, the dry matter, the sugar, the nitrogen, and the ash, in the expressed juice have in many cases been determined; in some cases the amount of the nitrogen existing as albuminoids has been determined; and in some, complete analyses of the ash of the juice have been made. It may be remarked, that by far the larger proportion of both the mineral matter, and the nitrogen, is found to exist in the juice; and of the nitrogen in the juice, as a rule, not much more than half exists as albuminoids. In many cases, the small potatoes have been submitted to the same methods of analysis as the good potatoes. And in some cases, similar methods of examination have been applied to the still white, and also to the separated discoloured portions of the diseased potatoes. With regard to these latter results, it may be observed, that whilst the juice of the white portion of the diseased potatoes contained approximately the normal amount of nitrogen, that of the discoloured portion contained very much less. On the other hand, the

washed, or exhausted "marc" of the white portion, contained very little nitrogen, whilst that of the discoloured portion contained very much more. The distribution of the mineral matter was much in the same order as that of the nitrogen. It was obvious that the juice had suffered exhaustion of much of both its nitrogen and its mineral matter, in the development of the fungus. There was an increased amount of sugar found in the diseased potatoes, the result of diseased action, and it probably also contributed to the development of the fungus.

The results given in the Table relate to the "good" potatoes only. In interpreting the figures it must be borne in mind that in each year, the seed was planted on all the plots at the same time, and that all the crops were taken up at the same time; and as there were several times as much produce in some cases as in others, it is obvious that the crops would not each be at its best, and all in the same condition of maturity when taken up. Then, again, the analyses were not performed immediately after taking up the crops, but sometime afterwards, in weighed samples which had been kept in a cool place for some weeks or months; and in the following only preliminary statement of results, no correction is made for any change from the original weight of the samples, the results being calculated upon the fresh weights as finally taken for analysis.

PLOTS.	MANURES PER ACRE, PER ANNUM. (For Produce, see pp. 86-7.)	Specific Gravity of the Tubers.	Composition of the "Good" Tubers.					
			Dry Matter.		Mineral Matter (Ash).		Nitrogen.	
			In Fresh Tubers.	In Dry Matter.	In Fresh Tubers.	In Dry Matter.	In Fresh Tubers.	In Dry Matter.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
1	Unmanured in 1876, and each year since ..	1.125	28.9	0.77	2.68	0.403	1.89	
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.125	29.1	0.87	3.00	0.420	1.44	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwt. Superphosphate also (¹)	1.112	26.7	0.98	3.69	0.385	1.44	
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously 3½ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also ..	1.115	26.7	0.93	3.47	0.423	1.59	
5	400 lbs. Ammonium-salts (²) ..	1.118	28.7	0.75	2.62	0.468	1.68	
6	550 lbs. Nitrate of Soda ..	1.119	28.6	0.77	2.68	0.468	1.64	
7	400 lbs. Ammonium-salts, 3½ cwt. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.111	27.4	1.01	3.67	0.401	1.46	
8	550 lbs. Nitrate of Soda, 3½ cwt. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.116	28.2	0.98	3.48	0.395	1.40	
9	3½ cwt. Superphosphate ..	1.123	28.4	0.97	3.41	0.328	1.16	
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.122	28.5	1.08	3.79	0.299	1.05	
ELEVENTH SEASON, 1886.								
1	Unmanured in 1876, and each year since ..	1.121	28.0	0.83	2.97	0.434	1.55	
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.121	28.2	0.87	3.07	0.424	1.50	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwt. Superphosphate also (¹) ..	1.106	25.1	1.00	3.98	0.396	1.58	
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwt. Superphosphate, and in 1881 and previously, 550 lbs. Nitrate of Soda also ..	1.107	25.2	0.97	3.85	0.374	1.48	
5	450 lbs. Sulphate Ammonia (²) ..	1.115	27.3	0.78	2.85	0.475	1.74	
6	550 lbs. Nitrate of Soda ..	1.115	27.4	0.77	2.80	0.460	1.68	
7	450 lbs. Sulph. Ammonia, 3½ cwt. Superphos., (lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.106	26.3	1.12	4.23	0.409	1.55	
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Mag.	1.108	25.5	0.99	3.90	0.431	1.69	
9	3½ cwt. Superphosphate ..	1.118	27.6	1.08	3.92	0.370	1.34	
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.111	26.3	1.12	4.27	0.353	1.35	
TWELFTH SEASON, 1887.								

THIRTEENTH SEASON, 1888.

1	Unmanured in 1876, and each year since	1.114	27.6	0.84	3.02	0.360	1.30
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.119	27.9	0.85	3.04	0.345	1.24
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)	1.105	25.3	1.03	4.09	0.390	1.54
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.104	25.4	1.04	4.10	0.362	1.43
5	400 lbs. Ammonium-salts (2)	1.110	26.8	0.78	2.92	0.440	1.64
6	550 lbs. Nitrate of Soda	1.114	26.6	0.83	3.13	0.431	1.63
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.106	25.5	1.00	3.90	0.340	1.38
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.109	25.6	0.97	3.79	0.332	1.29
9	3½ cwts. Superphosphate	1.116	27.0	1.09	4.02	0.321	1.19
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.112	26.8	1.11	4.14	0.313	1.17

FOURTEENTH SEASON, 1889.

1	Unmanured in 1876, and each year since	1.119	28.4	0.81	2.84	0.423	1.49
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) ..	1.119	27.9	0.82	2.94	0.394	1.41
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)	1.109	26.0	1.05	4.05	0.391	1.50
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.114	26.5	1.05	3.98	0.387	1.46
5	400 lbs. Ammonium-salts (2)	1.120	28.1	0.84	3.00	0.392	1.40
6	550 lbs. Nitrate of Soda	1.121	27.7	0.76	2.74	0.405	1.46
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.112	26.1	0.99	3.78	0.364	1.40
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.114	26.5	0.99	3.74	0.382	1.44
9	3½ cwts. Superphosphate	1.118	27.5	1.05	3.83	0.360	1.31
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.115	26.9	1.10	4.08	0.303	1.13

FIFTEENTH SEASON, 1890.

1	Unmanured in 1876, and each year since.	1.125	28.9	0.81	2.80	0.381	1.32
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) ..	1.125	30.0	0.82	2.75	0.380	1.27
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)	1.117	26.8	1.00	3.75	0.293	1.09
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.116	27.5	1.06	3.84	0.284	1.03
5	400 lbs. Ammonium-salts (2)	1.118	28.5	0.81	2.84	0.405	1.42
6	550 lbs. Nitrate of Soda	1.119	28.4	0.82	2.88	0.430	1.51
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.100	25.6	0.97	3.78	0.369	1.44
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.115	27.3	0.98	3.59	0.348	1.27
9	3½ cwts. Superphosphate	1.122	28.7	1.01	3.53	0.298	1.04
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.121	28.2	1.13	4.00	0.245	0.87

AVERAGE OF 5 SEASONS, 1886, '87, '88, '89, and 1890.

1	Unmanured in 1876, and each year since ..	1.121	28.4	0.81	2.86	0.400	1.41
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.122	28.6	0.85	2.96	0.393	1.37
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)	1.110	26.0	1.01	3.91	0.371	1.43
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.111	26.3	1.01	3.85	0.366	1.40
5	400 lbs. Ammonium-salts (2)	1.116	27.9	0.79	2.85	0.436	1.57
6	550 lbs. Nitrate of Soda	1.118	27.8	0.79	2.85	0.439	1.58
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.107	26.2	1.01	3.87	0.377	1.44
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.112	26.6	0.98	3.70	0.378	1.42
9	3½ cwts. Superphosphate	1.119	27.8	1.04	3.74	0.335	1.20
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.116	27.3	1.11	4.06	0.303	1.11

(1) "Superphosphate of Lime," 1886 and 1887, made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid, sp. gr. 1.7 (and water); 1888, and since, made from high percentages mineral phosphates, and containing 37 per cent, or more, of soluble phosphate.

(2) "Ammonium-salts"—in each case equal parts Sulphate and Murrate Ammonia of Commerce.

(3) 450 lbs. Sulphate Ammonia is estimated to contain the same amount of Nitrogen as the 200 lbs. Sulphate and 200 lbs. Murrate of Ammonia applied in former years, and since.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.

Below are given the particulars of the Manures and Produce, for the Sixteenth, Seventeenth, Eighteenth, Nineteenth, and Twentieth Seasons, 1891, 1892, 1893, 1894, and 1895. For the Manures, description of Potatoes grown, and the Produce, of the 15 preceding years, see pp. 78-9, 82-3, and 86-7, and of the succeeding years, pp. 94-5.

The arrangement of the plots is precisely the same as for the 15 preceding potato (Area under experiment, 2 acres.)

PLOTS.	MANURES PER ACRE PER ANNUM.	PRODUCE PER ACRE.			
		Tubers.			Tops.
		Good.	Small.	Diseased.	TOTAL.
SIXTEENTH SEASON, 1891. Potatoes planted, April 1. Crop taken up, September 28-30.					
1	Unmanured in 1876, and each year since	Tons. cwts.	Tons. cwts.	Tons. cwts.	Tons. cwts.
2	Unmanured in 1882, and since. Previously Farnyard Manure (14 tons)	0 13	0 0 $\frac{1}{2}$	0 0 $\frac{1}{2}$	0 14
3	Farnyard Manure (14 tons) alone 1883 and since; previously 3 $\frac{1}{2}$ cwts. Superphosphate also (1)	1 14 $\frac{1}{2}$	0 1	0 1	1 16 $\frac{1}{2}$
4	Farnyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 $\frac{1}{2}$ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	5 16 $\frac{1}{2}$	0 1	0 10 $\frac{1}{2}$	6 8
5	400 lbs. Ammonium-salts (?)	5 11 $\frac{1}{2}$	0 1 $\frac{1}{2}$	0 13	6 6
6	550 lbs. Nitrate of Soda	1 2 $\frac{1}{2}$	0 1	0 0 $\frac{1}{2}$	1 3 $\frac{1}{2}$
7	400 lbs. Ammonium-salts, 3 $\frac{1}{2}$ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	2 3	0 1 $\frac{1}{2}$	0 1 $\frac{1}{2}$	2 5 $\frac{1}{2}$
8	550 lbs. Nitrate of Soda, 3 $\frac{1}{2}$ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	4 17 $\frac{1}{2}$	0 1 $\frac{1}{2}$	0 3	5 2
9	3 $\frac{1}{2}$ cwts. Superphosphate	5 3 $\frac{1}{2}$	0 1 $\frac{1}{2}$	0 4 $\frac{1}{2}$	5 9 $\frac{1}{2}$
10	3 $\frac{1}{2}$ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	2 10 $\frac{1}{2}$	0 1	0 0 $\frac{1}{2}$	2 12
		2 12 $\frac{1}{2}$	0 1 $\frac{1}{2}$	0 1 $\frac{1}{2}$	2 14 $\frac{1}{2}$
SEVENTENTH SEASON, 1892. Potatoes planted, April 4 and 5. Crop taken up, September 29, October 7 and 8.					
1	Unmanured in 1876, and each year since	0 15 $\frac{1}{2}$	0 2 $\frac{1}{2}$	0 0 $\frac{1}{2}$	0 18 $\frac{1}{2}$
2	Unmanured in 1882, and since. Previously Farnyard Manure (14 tons)	1 18 $\frac{1}{2}$	0 2 $\frac{1}{2}$	0 8 $\frac{1}{2}$	2 9 $\frac{1}{2}$
3	Farnyard Manure (14 tons) alone 1883 and since; previously 3 $\frac{1}{2}$ cwts. Superphosphate also (1)	4 11	0 2	0 9 $\frac{1}{2}$	5 2 $\frac{1}{2}$
4	Farnyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 $\frac{1}{2}$ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	5 0 $\frac{1}{2}$	0 2	0 6 $\frac{1}{2}$	5 9 $\frac{1}{2}$
5	400 lbs. Ammonium-salts (?)	1 3	0 2 $\frac{1}{2}$	0 0 $\frac{1}{2}$	1 6 $\frac{1}{2}$
6	550 lbs. Nitrate of Soda	1 19	0 2 $\frac{1}{2}$	0 0 $\frac{1}{2}$	2 2
7	400 lbs. Ammonium-salts, 3 $\frac{1}{2}$ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	5 3 $\frac{1}{2}$	0 2 $\frac{1}{2}$	0 5 $\frac{1}{2}$	5 12
8	550 lbs. Nitrate of Soda, 3 $\frac{1}{2}$ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	6 15 $\frac{1}{2}$	0 2	0 5 $\frac{1}{2}$	7 2 $\frac{1}{2}$
9	3 $\frac{1}{2}$ cwts. Superphosphate	2 13 $\frac{1}{2}$	0 2 $\frac{1}{2}$	0 0 $\frac{1}{2}$	2 17
10	3 $\frac{1}{2}$ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	3 12 $\frac{1}{2}$	0 2	0 3	3 17 $\frac{1}{2}$

Withered, not weighed, each lot spread on its own Plot and ploughed in.

Withered, not weighed, each lot spread on its own Plot and ploughed in.

EIGHTEENTH SEASON, 1893. Potatoes planted, March 28. Crop taken up, September 12-14.

1	Unmanured in 1876, and each year since	0	18½	0	1½	0	1	1	1	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	0	8½	0	2½	0	2	2	2	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)	0	8½	0	2½	0	2	2	2	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	6	2	0	2	0	9	6	13	
5	400 lbs. Ammonium-salts (2)	1	2½	0	1½	0	1½	1	5½	
6	550 lbs. Nitrate of Soda	1	12½	0	1½	0	3	4	16½	
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	4	4	0	2	0	3	4	9	
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	4	7½	0	1½	0	4½	4	13½	
9	3½ cwts. Superphosphate	1	19	0	2	0	3½	2	4½	
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	2	4½	0	1½	0	3	2	9½	

NINETEENTH SEASON, 1894. Potatoes planted, April 9. Crop taken up, September 21-28.

1	Unmanured in 1876, and each year since	0	18½	0	1½	0	4½	1	4	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1	12½	0	1½	0	4½	1	18½	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)	6	3½	0	1½	2	6	8	11½	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	6	6½	0	2	0	8	8	8½	
5	400 lbs. Ammonium-salts (2)	1	8½	0	1½	0	4½	1	14½	
6	550 lbs. Nitrate of Soda	2	16½	0	1	0	5½	3	3	
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	5	3½	0	1½	1	10½	6	15½	
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	5	7½	0	1	1	0½	6	9	
9	3½ cwts. Superphosphate	2	4½	0	1½	0	4½	2	10	
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	2	4½	0	1½	0	5½	2	11½	

TWENTIETH SEASON, 1895. Potatoes planted, April 6. Crop taken up, September 10-12.

1	Unmanured in 1876, and each year since	0	16½	0	2½	0	0	0	19½	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1	5	0	3½	0	1½	1	10	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)	4	9½	0	4	0	14½	5	7½	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	5	5	0	4½	1	1½	6	10½	
5	400 lbs. Ammonium-salts (2)	1	1½	0	3	0	0½	1	5½	
6	550 lbs. Nitrate of Soda	1	4½	0	3½	0	2½	1	10½	
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	3	6½	0	2½	0	5	3	14	
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	3	16	0	3½	0	10½	4	9½	
9	3½ cwts. Superphosphate	1	11½	0	2½	0	1½	1	16	
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	2	7½	0	3½	0	2	2	12½	

AVERAGE OF 5 SEASONS, 1891, '92, '93, '94, and 1895.

1	Unmanured in 1876, and each year since	0	16½	0	2	0	1½	0	19½	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1	11½	0	2½	0	3½	1	17½	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwts. Superphosphate also (1)	5	7½	0	2½	0	17½	6	7½	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	5	13½	0	2½	0	18	6	13½	
5	400 lbs. Ammonium-salts (2)	1	3½	0	2	0	1½	1	7½	
6	550 lbs. Nitrate of Soda	1	19	0	2	0	2½	2	3½	
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	4	11	0	2	0	9½	5	22½	
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	5	2	0	1½	0	9½	5	13	
9	3½ cwts. Superphosphate	2	3½	0	2	0	2½	2	8	
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	2	12½	0	1½	0	3	2	17½	

(1) "Superphosphate of Lime," made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.
 (2) "Ammonium-salts"—in each case equal parts Sulphate and Muriate Ammonia of Commerce.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE "GOOD" TUBERS IN THE SIXTEENTH, SEVENTEENTH, EIGHTEENTH, NINETEENTH, AND TWENTIETH SEASONS, 1891, 1892, 1893, 1894, and 1895. For particulars of the composition in the first 15 years, 1876-1890, see pp. 80-1, 84-5, and 88-9, and for those in succeeding seasons, see pp. 96-7.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Potatoes, is given below. The specific gravity of the tubers is also given. In the tubers the dry matter, nitrogen, and ash have been determined; and in some cases complete analyses of the ash have been made. Besides the results obtained relating to the composition of the tubers themselves, the dry matter, the sugar, the nitrogen, and the ash, in the expressed juice have in many cases been determined; in some cases the amount of the nitrogen existing as albuminoids has been determined; and in some, complete analyses of the ash of the juice have been made. It may be remarked, that by far the larger proportion of both the mineral matter, and the nitrogen, is found to exist in the juice; and of the nitrogen in the juice, as a rule, not much more than half exists as albuminoids. In many cases, the small potatoes have been submitted to the same methods of analysis as the good potatoes. And in some cases, similar methods of examination have been applied to the still white, and also to the separated discoloured portions of the diseased potatoes. With regard to these latter results, it may be observed, that whilst the juice of the white portion of the diseased potatoes contained approximately the normal amount of nitrogen, that of the discoloured portion contained very much less. On the other hand, the washed or exhausted "marc" of the white portion,

contained very little nitrogen, whilst that of the discoloured portion contained very much more. The distribution of the mineral matter was much in the same order as that of the nitrogen. It was obvious that the juice had suffered exhaustion of much of both its nitrogen and its mineral matter, in the development of the fungus. There was an increased amount of sugar found in the diseased potatoes, the result of diseased action, and it probably also contributed to the development of the fungus.

The results given in the Table relate to the "good" potatoes only. In interpreting the figures it must be borne in mind that in each year, the seed was planted on all the plots at the same time, and that all the crops were taken up at the same time; and as there was several times as much produce in some cases as in others, it is obvious that the crops would not each be at its best, and all in the same condition of maturity when taken up. Then, again, the analyses were not performed immediately after taking up the crops, but some time afterwards, in weighed samples which had been kept in a cool place for some weeks or months; and in the following only preliminary statement of results, no correction is made for any change from the original weight of the samples, the results being calculated upon the fresh weights as finally taken for analysis.

Composition of the "Good" Tubers.

Plots.	MANURES PER ACRE, PER ANNUM. (For Produce, see pp. 90-1.)	Specific Gravity of the Tubers.	Composition of the "Good" Tubers.					
			Dry Matter.	Mineral Matter (Ash).		Nitrogen.		
				In Fresh Tubers.	In Dry Matter.	In Fresh Tubers.	In Dry Matter.	
SIXTEENTH SEASON, 1891.								
1	Unmanured in 1876, and each year since.	1.107	Per cent. 25.5	Per cent. 3.11	Per cent. 0.379	Per cent. 1.48		
2	Unmanured in 1882, and since. Previously Farnyard Manure (14 tons)	1.111	26.6	3.02	0.356	1.36		
3	Farnyard Manure (14 tons) alone 1883 and since: previously 3½ cwt. Superphosphate also ()	1.097	22.6	4.46	0.311	1.38		
4	Farnyard Manure (14 tons) alone 1883 and since. In 1882, and previously 3½ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.099	23.4	0.95	4.08	0.286		
5	400 lbs. Ammonium-salts ()	1.095	25.7	0.80	3.10	0.434		
6	550 lbs. Nitrate of Soda	1.102	24.5	0.73	2.96	0.417		
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.092	22.7	0.95	4.15	0.365		
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.095	23.0	0.93	4.05	0.345		
9	3½ cwt. Superphosphate	1.110	26.2	0.99	3.78	0.300		
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.100	25.4	1.14	4.48	0.252		
SEVENTEENTH SEASON, 1892.								
1	Unmanured in 1876, and each year since	1.104	25.9	0.83	3.22	0.385		
2	Unmanured in 1882, and since. Previously Farnyard Manure (14 tons)	1.108	26.5	0.75	2.83	0.361		
3	Farnyard Manure (14 tons) alone 1883 and since: previously 3½ cwt. Superphosphate also ()	1.101	23.8	1.05	4.37	0.279		
4	Farnyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.100	23.5	1.05	4.47	0.352		
5	400 lbs. Ammonium-salts ()	1.103	25.2	0.84	3.33	0.419		
6	550 lbs. Nitrate of Soda	1.101	25.0	0.71	2.84	0.437		
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.096	23.2	0.93	4.02	0.346		
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.097	23.0	0.96	4.17	0.363		
9	3½ cwt. Superphosphate	1.111	26.6	0.95	3.58	0.301		
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.110	25.6	1.09	4.26	0.253		

EIGHTEENTH SEASON, 1893.

1	Unmanured in 1876, and each year since	1.117	28.0	0.81	2.91	0.396	1.41
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.116	27.9	0.80	2.86	0.394	1.41
3	Farmyard Manure (14 tons) alone 1883 and since: previously 3½ cwts. Superphosphate also (1)	1.097	23.7	1.09	4.59	0.358	1.51
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.096	23.5	1.05	4.48	0.366	1.56
5	400 lbs. Ammonium-salts (2)	1.115	28.3	0.81	2.88	0.438	1.55
6	550 lbs. Nitrate of Soda	1.108	26.8	0.80	2.99	0.443	1.55
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.104	25.7	1.07	4.18	0.360	1.40
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.099	24.6	1.10	4.47	0.403	1.63
9	3½ cwts. Superphosphate	1.115	28.1	1.02	3.62	0.338	1.20
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.110	26.9	1.19	4.42	0.304	1.13

NINETEENTH SEASON, 1894.

1	Unmanured in 1876, and each year since..	1.110	26.3	0.82	3.13	0.343	1.31
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.115	27.2	0.79	2.90	0.342	1.26
3	Farmyard Manure (14 tons) alone 1883 and since: previously 3½ cwts. Superphosphate also (1)	1.100	24.2	1.08	4.46	0.279	1.15
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.101	24.8	1.07	4.33	0.290	1.17
5	400 lbs. Ammonium-salts (2)	1.109	27.0	0.74	2.75	0.433	1.60
6	550 lbs. Nitrate of Soda	1.106	25.9	0.75	2.91	0.437	1.68
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.103	24.9	0.99	3.98	0.338	1.35
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.100	24.1	0.96	3.99	0.331	1.37
9	3½ cwts. Superphosphate	1.113	27.0	0.99	3.66	0.263	0.98
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.108	25.3	1.13	4.49	0.247	0.98

TWENTIETH SEASON, 1895.

1	Unmanured in 1876, and each year since	1.121	29.0	0.87	3.00	0.375	1.30
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.124	29.4	0.89	3.01	0.387	1.32
3	Farmyard Manure (14 tons) alone 1883 and since: previously 3½ cwts. Superphosphate also (1)	1.099	23.9	1.08	4.53	0.344	1.44
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.101	23.3	1.05	4.50	0.336	1.44
5	400 lbs. Ammonium-salts (2)	1.126	28.9	0.86	2.97	0.424	1.46
6	550 lbs. Nitrate of Soda	1.113	27.2	0.81	2.98	0.435	1.60
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.106	25.1	1.07	4.27	0.366	1.43
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.104	24.3	1.06	4.36	0.380	1.56
9	3½ cwts. Superphosphate	1.117	28.1	1.08	3.85	0.333	1.19
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.111	26.0	1.19	4.60	0.286	1.10

AVERAGE OF 5 SEASONS, 1891, '92, '93, '94, and 1895.

1	Unmanured in 1876, and each year since	1.112	26.9	0.83	3.07	0.376	1.40
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.115	27.5	0.80	2.92	0.368	1.34
3	Farmyard Manure (14 tons) alone 1883 and since: previously 3½ cwts. Superphosphate also (1)	1.099	23.6	1.06	4.48	0.314	1.33
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwts. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.099	23.7	1.04	4.37	0.326	1.38
5	400 lbs. Ammonium-salts (2)	1.110	27.0	0.81	3.01	0.430	1.59
6	550 lbs. Nitrate of Soda	1.106	25.9	0.76	2.94	0.434	1.68
7	400 lbs. Ammonium-salts, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.100	24.3	1.00	4.12	0.355	1.46
8	550 lbs. Nitrate of Soda, 3½ cwts. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.099	23.8	1.00	4.21	0.364	1.53
9	3½ cwts. Superphosphate	1.113	27.2	1.01	3.70	0.307	1.13
10	3½ cwts. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia ..	1.108	25.8	1.15	4.45	0.268	1.04

(1) "Superphosphate of Lime," made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.

(2) "Ammonium-salts"—in each case equal parts Sulphate and Muriate Ammonium of Commerce.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.

Below are given the particulars of the Manures for the Twenty-first, Twenty-second, and Twenty-third Seasons, 1896, 1897, and 1898; and of the produce of the Twenty-first and Twenty-second Seasons, 1896 and 1897. For the Manures, description of Potatoes grown, and the Produce, of the 20 preceding years, see pp. 78-9, 82-3, 86-7, and 90-1.

The manures are the same as for the crops of 1883, and since; excepting that for the crops of 1897, and since, Basic Slag has been used instead of Superphosphate. Description of Potato, in 1896, "Bruce" (White); in 1897, and in 1898, "Beauty of Hebron" (White). Rows 25 inches apart; 14 inches from plant to plant in the rows. In the spring of 1894 permanent division paths were laid out between plot and plot.

The arrangement of the plots is precisely the same as for the 20 preceding potato crops.

(Area under experiment, 2 acres.)

PLOTS.	MANURES PER ACRE PER ANNUM.	PRODUCE PER ACRE.				
		Tubers.			Tops.	
		Good.	Small.	Diseased.		
TENTY-FIRST SEASON, 1896. Potatoes planted, April 10. Crop taken up, October 23-30.						
1	Unmanured in 1876, and each year since	1 11 1/2	0	2 2 1/2	1 4 1/2	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1 11 1/2	0	2 2 1/2	1 15 1/2	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3 1/2 cwt. Superphosphate also (?)	5 6 1/2	0	1 12 1/2	7 0	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 1/2 cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	4 11 1/2	0	2 1 1/2	6 8 1/2	
5	400 lbs. Ammonium-salts (?)	1 17 1/2	0	1 2 1/2	2 1 1/2	
6	550 lbs. Nitrate of Soda	2 1 1/2	0	0 3 1/2	2 6	
7	400 lbs. Ammonium-salts, 3 1/2 cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	5 6 1/2	0	2 1 1/2	6 4 1/2	
8	550 lbs. Nitrate of Soda, 3 1/2 cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	3 6 1/2	0	1 1 1/2	6 3 1/2	
9	3 1/2 cwt. Superphosphate	2 10 1/2	0	0 3 1/2	2 15	
10	3 1/2 cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Soda, and 100 lbs. Sulphate Magnesia	2 14 1/2	0	1 1 1/2	2 19 1/2	
TENTY-SECOND SEASON, 1897. Potatoes planted, April 8. Crop taken up, September 13-15.						
1	Unmanured in 1876, and each year since	0 8 1/2	0	3	0 11 1/2	Withered, not weighed, each lot spread on its own Plot and ploughed in.
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1 2 1/2	0	3 3 1/2	1 6	
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3 1/2 cwt. Superphosphate also (?)	3 15 1/2	0	0 1 1/2	3 19	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3 1/2 cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	3 15	0	0 3 1/2	3 19 1/2	
5	400 lbs. Ammonium-salts (?)	0 11 1/2	0	0 4 1/2	0 16 1/2	
6	550 lbs. Nitrate of Soda	0 19 1/2	0	0 4 1/2	1 3 1/2	
7	400 lbs. Ammonium-salts, 400 lbs. Basic Slag, 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	3 2 1/2	0	0 1 1/2	3 7 1/2	
8	550 lbs. Nitrate of Soda, 400 lbs. Basic Slag, 300 lbs. Sulph. Potash, 100 lbs. Soda, 100 lbs. Sulph. Mag.	3 11 1/2	0	0 1 1/2	3 16 1/2	
9	400 lbs. Basic Slag	1 8 1/2	0	0 4 1/2	1 13 1/2	
10	400 lbs. Basic Slag, 300 lbs. Sulphate Potash, 100 lbs. Soda, and 100 lbs. Sulphate Magnesia	1 11 1/2	0	0 4 1/2	1 16	

TWENTY-THIRD SEASON, 1898. Potatoes planted, March 21 and 22. Crop taken up,

1	Unmanured in 1876, and each year since .. .. .	..	..	..	..	..	..	..	..	..
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons) .. .. .	..	..	..	..	..	..	..	..	..
3	Farmyard Manure (14 tons) alone 1883 and since; previously 3½ cwt. Superphosphate also (?) .. .. .	..	..	..	..	..	..	..	..	..
4	{ Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwt. Superphosphate, and in } 1881, and previously, 550 lbs. Nitrate of Soda also .. .. .	..	..	..	..	..	..	..	..	..
5	400 lbs. Ammonium-salts (?) .. .. .	..	..	..	..	..	..	..	..	..
6	550 lbs. Nitrate of Soda .. .. .	..	..	..	..	..	..	..	..	..
7	400 lbs. Ammonium-salts, 400 lbs. Basic Slag, 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. .. .. .	..	..	..	..	..	..	..	..	..
8	550 lbs. Nitrate of Soda, 400 lbs. Basic Slag, 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag. .. .. .	..	..	..	..	..	..	..	..	..
9	400 lbs. Basic Slag .. .. .	..	..	..	..	..	..	..	..	..
10	400 lbs. Basic Slag, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia .. .. .	..	..	..	..	..	..	..	..	..
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

(1) " Superphosphate of Lime," made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.
 (2) " Ammonium-salts "—in each case equal parts Sulphate and Muriate Ammonia of Commerce.

EXPERIMENTS ON POTATOES.—HOOS FIELD—continued.—SUMMARY OF THE COMPOSITION OF THE "GOOD" TUBERS IN THE TWENTY-FIRST, AND TWENTY-SECOND SEASONS, 1896 AND 1897. For particulars of the composition in the first 20 years, 1876-1895, see pp. 80-1, 84-5, 88-9, and 92-3.

An abstract of the analytical results obtained, illustrating the influence of different manures, and of different seasons, on the composition of Potatoes, is given below. The specific gravity of the tubers is also given. In the tubers the dry matter, nitrogen, and ash have been determined; and in some cases complete analyses of the ash have been made. Besides the results obtained relating to the composition of the tubers themselves, the dry matter, the sugar, the nitrogen, and the ash, in the expressed juice have in many cases been determined; in some cases the amount of the nitrogen existing as albuminoids has been determined; and in some, complete analyses of the ash of the juice have been made. It may be remarked, that by far the larger proportion of both the mineral matter, and the nitrogen, is found to exist in the juice; and of the nitrogen in the juice, as a rule, not much more than half exists as albuminoids. In many cases, the small potatoes have been submitted to the same methods of analysis as the good potatoes. And in some cases, similar methods of examination have been applied to the still white, and also to the separated discoloured portions of the diseased potatoes. With regard to these latter results, it may be observed, that whilst the juice of the white portion of the diseased potatoes contained approximately the normal amount of nitrogen, that of the discoloured portion contained very much less. On the other hand, the washed or exhausted "mare" of the white portion,

contained very little nitrogen, whilst that of the discoloured portion contained very much more. The distribution of the mineral matter was much in the same order as that of the nitrogen. It was obvious that the juice had suffered exhaustion of much of both its nitrogen and its mineral matter, in the development of the fungus. There was an increased amount of sugar found in the diseased potatoes, the result of diseased action, and it probably also contributed to the development of the fungus.

The results given in the Table relate to the "good" potatoes only. In interpreting the figures it must be borne in mind that in each year, the seed was planted on all the plots at the same time, and that all the crops were taken up at the same time; and as there was several times as much produce in some cases as in others, it is obvious that the crops would not each be at its best, and all in the same condition of maturity when taken up. Then, again, the analyses were not performed immediately after taking up the crops, but some time afterwards, in weighed samples which had been kept in a cool place for some weeks or months; and in the following only preliminary statement of results, no correction is made for any change from the original weight of the samples, the results being calculated upon the fresh weights as finally taken for analysis.

MANURES PER ACRE, PER ANNUM.
(For Produce, see pp. 94-5.)

Plots.

Plots.	MANURES PER ACRE, PER ANNUM. (For Produce, see pp. 94-5.)	Specific Gravity of the Tubers.	Composition of the "Good" Tubers.					
			Dry Matter.	Mineral Matter (Ash).			Nitrogen.	
				In Fresh Tubers.	In Dry Matter.	In Fresh Tubers.	In Dry Matter.	In Fresh Tubers.	In Dry Matter.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	Unmanured in 1876, and each year since	1.109	25.7	0.76	2.98	0.380	1.48	
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.109	25.5	0.76	2.96	0.376	1.47	
3	Farmyard Manure (14 tons) alone 1883 and since: previously 3½ cwt. Superphosphate also (?)	1.096	22.0	0.99	4.49	0.339	1.54	
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwt. Superphosphate, and in 1881, and previously, 530 lbs. Nitrate of Soda also	1.090	21.6	0.98	4.53	0.322	1.49	
5	400 lbs. Ammonium-salts (?)	1.102	24.8	0.74	2.99	0.405	1.63	
6	550 lbs. Nitrate of Soda	1.085	23.2	0.78	3.36	0.416	1.79	
7	400 lbs. Ammonium-salts, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.092	22.0	0.99	4.51	0.372	1.69	
8	550 lbs. Nitrate of Soda, 3½ cwt. Superphos., 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.095	21.5	0.96	4.46	0.356	1.65	
9	3½ cwt. Superphosphate	1.109	25.8	0.91	3.53	0.356	1.38	
10	3½ cwt. Superphosphate, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1.107	23.3	1.08	4.62	0.312	1.34	

TWENTY-FIRST SEASON, 1896.

TWENTY-SECOND SEASON, 1897.

1	Unmanured in 1876, and each year since	1.100	23.7	0.74	3.13	0.344	1.45
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	1.109	25.7	0.76	2.95	0.381	1.48
3	Farmyard Manure (14 tons) alone 1883 and since: previously 3½ cwt. Superphosphate also (?)	1.101	23.4	0.97	4.14	0.369	1.58
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, 3½ cwt. Superphosphate, and in 1881, and previously, 550 lbs. Nitrate of Soda also	1.098	23.5	1.00	4.26	0.385	1.64
5	400 lbs. Ammonium-salts (?)	1.102	24.6	0.75	3.05	0.451	1.83
6	550 lbs. Nitrate of Soda	1.103	24.5	0.73	2.96	0.475	1.94
7	400 lbs. Ammonium-salts, 400 lbs. Basic Slag, 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.094	23.0	0.96	4.19	0.423	1.84
8	550 lbs. Nitrate of Soda, 400 lbs. Basic Slag, 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	1.098	23.0	0.95	4.12	0.441	1.91
9	400 lbs. Basic Slag	1.112	26.5	0.89	3.37	0.325	1.23
10	400 lbs. Basic Slag, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	1.108	25.2	1.06	4.21	0.294	1.17

TWENTY-THIRD SEASON, 1898.

1	Unmanured in 1876, and each year since	..	..	..	..	..	..	..	..	..
2	Unmanured in 1882, and since. Previously Farmyard Manure (14 tons)	..	..	..	..	..	..	..	..	..
3	Farmyard Manure (14 tons) alone 1883 and since: previously $3\frac{1}{2}$ cwt. Superphosphate also (1)	..	..	..	..	..	..	..	..	..
4	Farmyard Manure (14 tons) alone 1883 and since. In 1882, and previously, $3\frac{1}{2}$ cwt. Superphosphate, and in	..	..	..	..	..	..	..	..	..
5	1881, and previously, 550 lbs. Nitrate of Soda also	..	..	..	..	..	..	..	..	..
6	400 lbs. Ammonium-salts (2)	..	..	..	..	..	..	..	..	..
7	550 lbs. Nitrate of Soda	..	..	..	..	..	..	..	..	..
8	400 lbs. Ammonium-salts, 400 lbs. Basic Slag, 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	..	..	..	..	..	..	..	..	..
9	550 lbs. Nitrate of Soda, 400 lbs. Basic Slag, 300 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag.	..	..	..	..	..	..	..	..	..
10	400 lbs. Basic Slag	..	..	..	..	..	..	..	..	..
1	400 lbs. Basic Slag, 300 lbs. Sulphate Potash, 100 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia	..	..	..	..	..	..	..	..	..
2										
3										
4										
5										
6										
7										
8										
9										
10										

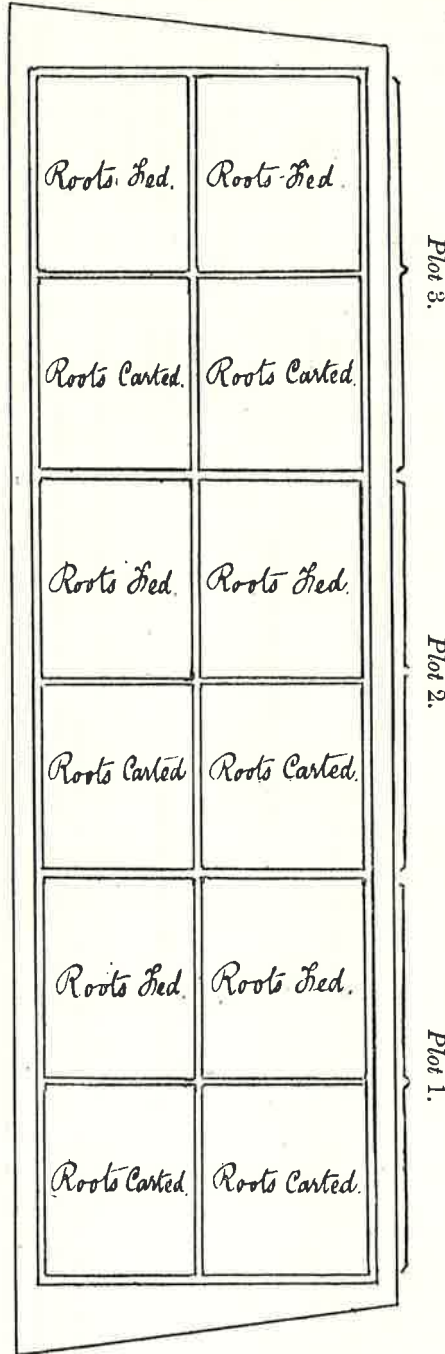
(1) " Superphosphate of Lime," made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.
 (2) " Ammonium-salts,"—in each case equal parts Sulphate and Murriate Ammonia of Commerce.

H

PLAN OF THE PLOTS IN AGDELL FIELD,
ON WHICH EXPERIMENTS HAVE BEEN MADE
ON FOUR-COURSE ROTATION.

51 years, commencing 1848.

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



Total area of ploughed land about 3 acres.
Area of each of the 12 divisions $\frac{1}{2}$ acre.

- The 4 lower divisions, Unmanured continuously (Plot 1).
- The 4 middle divisions, Mineral Manure, for the Roots, each Course (Plot 2).
- The 4 upper divisions, Mineral and Nitrogenous Manure, for the Roots, each Course (Plot 3).
- The 6 left-hand divisions, Clover (or Beans), 3rd year each Course.
- The 6 right-hand divisions, Fallow, 3rd year each Course.

The double lines indicate division paths between plot and plot.

[For details of the manuring and produce, see pp. 100-109.]

RESULTS OF EXPERIMENTS MADE IN AGDELL FIELD, ON
THE ROTATION OF CROPS.

The experiments were commenced in 1848; so that 1898 is the 51st year of their continuance, and the third year of the 13th Course. In the experiments in other fields, some of the most important crops of rotation have been grown, each separately, for many years in succession—without manure, with farmyard manure, and with various artificial manures. But besides such experiments, others have been made on the growth of the crops in an actual course of rotation, without manure, and with different manures. The results with the individual crops throw much light on the characteristic requirements of each particular crop; whilst those on the growth of the crops in rotation serve to confirm and control those with the individual crops.

The rotation selected for investigation was the well known and typical four-course rotation of—1. Turnips; 2. Barley; 3. Leguminous Crops (or Fallow); 4. Wheat; that is, an alternation of Root-crops and of Leguminous Crops with cereals; which is the basis of most of the various rotations adopted in different parts of our own country, and also in many other countries. One portion of the land was left entirely without manure each course; another received mineral manure only, for the turnips of each course; and a third mixed mineral and nitrogenous manures, also only for the turnips of each course.

1. *The Swedish Turnips commencing each Course.*—When various root-crops were grown year after year on the same land without manure, they soon reverted to the uncultivated condition; and the experiments on rotation show that the Swedish turnips grown once in four years in unmanured rotation, came down to only about 1 ton per acre. The results further show, that mineral manures alone applied for the root-crops gave considerable increase, but that mineral and nitrogenous manures together gave more still. Without manure, the average produce of roots was less over the last 3 than over the preceding 8 courses; but with mineral manure alone (including potash in the last 3 courses) it was higher, and with mineral and nitrogenous manures together much higher, over the last 3 courses; the result being, however, largely due to more favourable seasons. Indeed, in 1888 and 1892, the years of root-crop in the 11th and 12th courses, although the produce without manure was less, that by each of the two descriptions of manure was considerably more than the average of the preceding courses; that is, both the reversion to the uncultivated condition without manure, and the increased growth with suitable manures, were very marked. In fact, without manure the produce of roots was as restricted in rotation as in continuous growth; with purely mineral manure it was greater in rotation than in continuous growth, the exhaustion of the available nitrogen of the soil being less under rotation; and with the mixed mineral and nitrogenous manure much more produce was obtained under rotation than with continuous growth. Lastly, the results conclusively show how artificial a product is the cultivated root-crop, and how dependent it is for its successful growth on an abundant supply of available food—nitrogenous as well as mineral—within the soil.

2. *The Barley Crops.*—Barley, without manure, succeeded the differently manured Swedish turnip crops of each course. Although the average produce of the root-crops was greater over the last 3 (10th, 11th, and 12th) than over the preceding 8 courses, the succeeding barley crops were much less over the last 3 courses. This was the case, not only where the root-crops had been carted off, but also where they had not been so removed. As, however, the produce of barley in the 3 years in question (1885, 1889, 1893) was also less than the average in Hoos Field where the crop is grown year after year, the result is doubtless mainly due to the seasons. Then, the average produce of barley over the 8 courses was actually less after the carted off roots grown by mineral manure (superphosphate) than after those grown without manure. The explanation is—that as there was practically no produce of roots without manure the unmanured plot was practically fallow for the barley; whilst with the mineral manure fair crops of roots were grown and removed, leaving the surface soil the more exhausted of its available nitrogen and other constituents. In the later years, however, after such long continued exhaustion, the unmanured plot has yielded less barley after the removal of the roots than the mineral manured plot. On the other hand, where the roots were not removed from the land, the mineral manured plot has generally yielded more barley than the unmanured. Further, under all conditions of treatment, the plots with mixed mineral and nitrogenous manure have yielded more barley than those with the mineral manure alone. In fact, the effects of the manurial and other treatment of the first crop of the course are clearly manifested in the produce of the second crop. Lastly, both without manure, and with the mineral manure alone, there was more produce of barley in rotation than in continuous growth, but with mixed mineral and nitrogenous manure there was more produce when the crop was grown continuously, the supply of nitrogen in that case being somewhat larger and annually applied for the crop.

3. *The Leguminous Crops (or Fallow).*—Under equal conditions as to manuring, the Leguminous crops, especially the clover, bring much more nitrogen into the course than either of the other crops. Further, the amount of nitrogen so brought into the rotation is much greater under the influence of mineral manures, and especially of potash manures, than without manure; whilst under the influence of the mixed mineral and nitrogenous manure the yield of nitrogen is greater still, the leguminous crop utilising the unexhausted nitrogenous manure- and crop-residue. For the successful growth of leguminous crops, however, a liberal supply of available mineral constituents within the soil, especially potash and lime, is essential. Judging from comparable cases, the amount of nitrogen accumulated by the Leguminous crops was much greater when they were grown in rotation, that is only occasionally, than when grown continuously. With fallow instead of a Leguminous crop, there is very much less nitrogen yielded in the rotation, and more liability to loss of it by drainage, and hence so much less brought into the circulation of the farm for food or manure. Lastly, most of the nitrogen of the leguminous crop is retained on the farm; and there is more or less, and sometimes much nitrogenous crop-residue left in the soil for succeeding crops.

4. *The Wheat Crops.*—There was very much more produce of wheat both without manure and with mineral manure, and considerably more with the mineral and nitrogenous manure, when it was grown in rotation than under comparable conditions continuously. Taking the quantities of produce by the mixed mineral and nitrogenous manure the result was that the two cereal crops produced approximately equal amounts of dry substance, and each considerably more than either of the assumed restorative crops—the roots or the leguminous crops. The supply of nitrogen within the soil available to the wheat crop is increased both by fallow and by the growth of a leguminous crop, especially of clover; and the accumulation is the greater when the soil and subsoil are not abnormally exhausted of organic nitrogen.

Upon the whole the results show that the benefits of rotation are very various. They depend on the varying requirements, habits of growth, and capabilities of gathering and assimilating the necessary constituents, of the different crops. The difference in the amounts available within the soil of the various mineral constituents, is one element in the explanation; but the facts relating to the amount, and to the sources, of the nitrogen of the different crops, are of still greater significance. The uses of the different crops have also to be taken into account. The cereals yield more produce for sale in the season of growth in rotation than when grown continuously. The crops alternated with them accumulate very much more of mineral constituents and of nitrogen in their produce; but by far the greater proportion of those constituents remains in circulation in the manure of the farm, whilst the remainder yields highly valuable products for sale in meat and milk. Again, with a variety of crops, the operations of the farm are better distributed over the year, and are therefore more economically performed. Lastly, the opportunities which alternate cropping afford for cleaning the land constitute a prominent element of advantage.

For details of the manuring and produce of the different plots, see pages 100–109.

AGDELL FIELD.

(Area under experiment, about 3 acres.)

EXPERIMENTS ON AN ACTUAL COURSE OF ROTATION—TURNIPS, BARLEY, LEGUMINOUS CROP (OR FALLOW), AND WHEAT.

These Experiments were commenced in 1848; so that the present season (1898) is the 51st, and the growing crop (Beans) is the third of the Thirteenth Course.

One-third of the land has been continuously unmanured. One-third has, for the first Nine Courses, or 36 years, 1848-83, been manured with Superphosphate of Lime alone, once every four years, that is for the turnip-crop commencing each course; but for the Tenth, Eleventh, Twelfth, and Thirteenth Courses, a complex mineral manure has been applied, as described in foot-note, No. 2. Lastly, one-third has been manured (also for the turnip-crop only), with a complex mineral and Nitrogenous manure, as described in the foot-note No. 3.

From half of each of the three differently manured plots the turnip-crops (roots and leaves) are removed; and on the other half they are either consumed on the land by sheep, or spread and ploughed in. In the case of all the other crops, the total produce is removed from the land.

TABLE I. (below), gives the results relating to the portions of each plot from which the turnip-crops were entirely removed; and on which clover or beans were grown.

Years.	Description of Crop.	PRODUCE PER ACRE.				Total Produce. (5)	Straw (or Leaf).	Corn (4) (or Roots).	Total Produce. (3)	Straw (or Leaf).	Corn (4) (or Roots).	Total Produce. (5)									
		1 lb. (pound avoird.) per acre = (about) 1.12 Kilogramme per Hectare, or 0.57 Zollverein Pfund. per Prussian Morgen.	1 cwt. (hundredweight) per acre = (about) 125.5 Kilogrammes per Hectare, or 0.64 Centner per Pr. Morgen.	Unmanured continuously.	Plot 1.								Plot 2.	Plot 3.							
		1st Course, 1848-51.				2nd Course, 1852-55.				3rd Course, 1856-59.				4th Course, 1860-63.				5th Course, 1864-67.			
		Superphosphate of Lime alone (1) Courses 1-9, Complex Mineral Manure (2) Courses 10-13, for the Turnip Crops only.				Complex Mineral and Nitrogenous Manure, (3) for the Turnip Crops only.															
1848	Norfolk White Turnips	65½ cwts.	45½ cwts.	111¼ cwts.	225½ cwts.	106½ cwts.	332 cwts.	218 cwts.	396½ cwts.	218 cwts.	332 cwts.	218 cwts.	396½ cwts.	151½ cwts.	369½ cwts.						
1849	Barley	44½ bush.	2985 lbs.	5656 lbs.	29½ bush.	2111 lbs.	3941 lbs.	28½ bush.	364 bush.	28½ bush.	3941 lbs.	28½ bush.	364 bush.	2088 lbs.	3794 lbs.						
1850	Clover (calc'd. as hay) (6)	28½ bush.	3431 lbs.	5389 cwts.	28 bush.	3371 lbs.	564 cwts.	28½ bush.	364 bush.	28½ bush.	564 cwts.	28½ bush.	364 bush.	3552 lbs.	614 cwts.						
1851	Wheat.														5500 lbs.						
1852	Swedish Turnips.	26 cwts.	44 cwts.	304 cwts.	223½ cwts.	904 cwts.	2431 cwts.	396½ cwts.	2604 cwts.	396½ cwts.	2431 cwts.	396½ cwts.	2604 cwts.	364 cwts.	433 cwts.						
1853	Barley	34½ bush.	2430 lbs.	4464 lbs.	28½ bush.	1873 lbs.	3560 lbs.	364 bush.	2604 lbs.	364 bush.	3560 lbs.	364 bush.	2604 lbs.	2435 lbs.	4873 lbs.						
1854	Beans	5½ bush.	1055 lbs.	1445 lbs.	54 bush.	1103 lbs.	1584 lbs.	12½ bush.	25½ bush.	12½ bush.	1584 lbs.	12½ bush.	25½ bush.	1355 lbs.	2065 lbs.						
1855	Wheat	35½ bush.	3619 lbs.	5559 lbs.	35½ bush.	3525 lbs.	5759 lbs.	37½ bush.	3942 bush.	37½ bush.	5759 lbs.	37½ bush.	3942 bush.	3942 lbs.	6371 lbs.						
1856	Swedish Turnips.	32 cwts.	2600 lbs.	334 cwts.	136 cwts.	74 cwts.	142½ cwts.	533½ cwts.	48 bush.	533½ cwts.	142½ cwts.	48 bush.	533½ cwts.	124 cwts.	346½ cwts.						
1857	Barley	48½ bush.	1100 lbs.	5337 lbs.	28½ bush.	1475 lbs.	3976 lbs.	48 bush.	3976 lbs.	48 bush.	3976 lbs.	48 bush.	3976 lbs.	2435 lbs.	5163 lbs.						
1858	Beans	64 bush.	1100 lbs.	1515 lbs.	64 bush.	1155 lbs.	1605 lbs.	48½ bush.	12½ bush.	48½ bush.	1605 lbs.	48½ bush.	12½ bush.	1320 lbs.	2357 lbs.						
1859	Wheat	35½ bush.	4030 lbs.	6262 lbs.	34½ bush.	3930 lbs.	6120 lbs.	38½ bush.	38½ bush.	38½ bush.	6120 lbs.	38½ bush.	38½ bush.	4610 lbs.	7154 lbs.						
1860	Swedish Turnips.	1 cwt.	(64 lbs.)	1 cwt.	136 cwts.	74 cwts.	142½ cwts.	533½ cwts.	87½ cwts.	533½ cwts.	142½ cwts.	87½ cwts.	533½ cwts.	54 cwts.	90½ cwts.						
1861	Barley	38½ bush.	2522 lbs.	4718 lbs.	28½ bush.	2000 lbs.	3775 lbs.	60½ bush.	3775 lbs.	60½ bush.	3775 lbs.	60½ bush.	3775 lbs.	3940 lbs.	7381 lbs.						
1862	Beans	29 bush.	1840 lbs.	1689 lbs.	29½ bush.	2150 lbs.	4040 lbs.	48½ bush.	48½ bush.	48½ bush.	4040 lbs.	48½ bush.	48½ bush.	3280 lbs.	5980 lbs.						
1863	Wheat	34½ bush.	3468 lbs.	5621 lbs.	34½ bush.	3380 lbs.	5619 lbs.	46½ bush.	46½ bush.	46½ bush.	5619 lbs.	46½ bush.	46½ bush.	4698 lbs.	7627 lbs.						
1864	Swedish Turnips.	84 cwts.	94 cwts.	94 cwts.	68 cwts.	44 cwts.	72½ cwts.	176½ cwts.	84 cwts.	176½ cwts.	72½ cwts.	84 cwts.	176½ cwts.	84 cwts.	185 cwts.						
1865	Barley	39 bush.	2154 lbs.	4182 lbs.	33½ bush.	1615 lbs.	3394 lbs.	47½ bush.	2595 lbs.	47½ bush.	3394 lbs.	47½ bush.	2595 lbs.	2595 lbs.	5148 lbs.						
1866	Beans	104 bush.	1013 lbs.	1689 lbs.	74 bush.	978 lbs.	1463 lbs.	204 bush.	204 bush.	204 bush.	1463 lbs.	204 bush.	204 bush.	1990 lbs.	3343 lbs.						
1867	Wheat	21 bush.	2143 lbs.	3473 lbs.	194 bush.	1966 lbs.	3222 lbs.	234 bush.	3003 lbs.	234 bush.	3222 lbs.	234 bush.	3003 lbs.	3003 lbs.	4567 lbs.						

6th Course, 1869-71.

1868	Swedish Turnips	Failed, and ploughed up.	Failed, and ploughed up.	Failed, and ploughed up.
1869	Barley	24 bush. 1948 lbs.	28 bush. 3698 lbs.	48 bush. 3309 lbs.
1870	Beans	13 bush. 738 lbs.	15 bush. 768 lbs.	24 bush. 1036 lbs.
1871	Wheat	20 bush. 2739 lbs.	23 bush. 4092 lbs.	34 bush. 3440 lbs.

7th Course, 1872-75.

1872	Swedish Turnips	34 cwt. 1343 lbs.	42 cwt. 2717 lbs.	39 cwt. 1723 lbs.
1873	Barley	23 bush. 740 lbs.	25 bush. 874 lbs.	31 bush. 1655 lbs.
1874	Beans	21 bush. 740 lbs.	25 bush. 874 lbs.	31 bush. 1655 lbs.
1875	Wheat	21 bush. 740 lbs.	25 bush. 874 lbs.	31 bush. 1655 lbs.

8th Course, 1876-79.

1876	Swedish Turnips	17 cwt. 1291 lbs.	22 cwt. 2623 lbs.	35 cwt. 3890 lbs.
1877	Barley	23 bush. 740 lbs.	25 bush. 874 lbs.	31 bush. 1655 lbs.
1878	Beans	21 bush. 740 lbs.	25 bush. 874 lbs.	31 bush. 1655 lbs.
1879	Wheat	21 bush. 740 lbs.	25 bush. 874 lbs.	31 bush. 1655 lbs.

9th Course, 1880-83.

1880	Swedish Turnips	14 cwt. 1484 lbs.	19 cwt. 2114 lbs.	43 cwt. 4823 lbs.
1881	Barley	26 bush. 1484 lbs.	21 bush. 1259 lbs.	35 bush. 1853 lbs.
1882	Beans	29 bush. 2280 lbs.	36 bush. 3021 lbs.	45 bush. 4024 lbs.
1883	Wheat	29 bush. 2280 lbs.	36 bush. 3021 lbs.	45 bush. 4024 lbs.

10th Course, 1884-87.

1884	Swedish Turnips	5 cwt. 1270 lbs.	17 cwt. 1934 lbs.	28 cwt. 350 lbs.
1885	Barley	12 bush. 1270 lbs.	19 bush. 2538 lbs.	34 bush. 426 lbs.
1886	Beans	25 bush. 1859 lbs.	32 bush. 44 lbs.	42 bush. 6103 lbs.
1887	Wheat	25 bush. 1859 lbs.	32 bush. 44 lbs.	42 bush. 6103 lbs.

11th Course, 1888-91.

1888	Swedish Turnips	24 cwt. 931 lbs.	20 cwt. 2283 lbs.	45 cwt. 5184 lbs.
1889	Barley	11 bush. 603 lbs.	21 bush. 2405 lbs.	26 bush. 1683 lbs.
1890	Beans	7 bush. 2598 lbs.	24 bush. 3441 lbs.	16 bush. 1102 lbs.
1891	Wheat	29 bush. 2598 lbs.	42 bush. 3995 lbs.	44 bush. 4373 lbs.

12th Course, 1892-95.

1892	Swedish Turnips	6 cwt. 1440 lbs.	8 cwt. 2064 lbs.	12 cwt. 485 lbs.
1893	Barley	16 bush. 1440 lbs.	15 bush. 2295 lbs.	20 bush. 2880 lbs.
1894	Beans	23 bush. 1713 lbs.	37 bush. 5034 lbs.	39 bush. 698 lbs.
1895	Wheat	23 bush. 1713 lbs.	37 bush. 5034 lbs.	39 bush. 698 lbs.

13th Course, 1896-99.

1896	Swedish Turnips	7 cwt. 1251 lbs.	8 cwt. 1927 lbs.	53 cwt. 397 lbs.
1897	Barley	11 bush. 1251 lbs.	14 bush. 1790 lbs.	23 bush. 2323 lbs.
1898	Beans	11 bush. 1251 lbs.	14 bush. 1790 lbs.	23 bush. 2323 lbs.
1899	Wheat	11 bush. 1251 lbs.	14 bush. 1790 lbs.	23 bush. 2323 lbs.

(1) First Course—100 lbs. Bone-ash, and 100 lbs. Sulphuric Acid (sp. gr. 1.7); Second Course—150 lbs. Bone-ash, 120 lbs. Sulphuric Acid; Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, and Tenth Courses—made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.
 (2) For the Tenth Course, in addition to the Superphosphate for the Swedish Turnips—300 lbs. Sulphate of Potash, and 100 lbs. Sulphate of Magnesia were applied February 29, 1884, and harrowed in; and the same quantities were applied again before the final ploughing and preparation of the land for the sowing of the seed in May. For the Swedes of the Eleventh and Twelfth Courses the same mineral manures (which are the same as the mineral manures of Plot 3 for the third and subsequent Courses) were again applied, but only once for each of these two Courses. For the Swedes of the Thirteenth Course—500 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 200 lbs. Sulphate of Magnesia, and 600 lbs. Basic Slag, per acre.
 (3) First Course—100 lbs. Pearl-ash, 100 lbs. Bone-ash, 100 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Muriate of Ammonia, and 1000 lbs. Rape-Cake; Second Course—300 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 100 lbs. Sulphate of Magnesia, 100 lbs. Bone-ash, 120 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Muriate of Ammonia, and 2000 lbs. Rape-cake; Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, and Tenth Courses—300 lbs. Sulphate of Potash, 200 lbs. Sulphate of Soda, 100 lbs. Sulphate of Magnesia, 200 lbs. Bone-ash, 150 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Muriate of Ammonia, and 2000 lbs. Rape-cake, per acre; Eleventh and Twelfth Courses—the same in other respects as in Courses 3-10, but the Superphosphate made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate. For the Swedes of the Thirteenth Course—500 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 200 lbs. Sulphate of Magnesia, 600 lbs. Basic Slag, 2000 lbs. Rape-cake, 100 lbs. Sulphate of Ammonia, and 100 lbs. Muriate of Ammonia, per acre.
 (4) The quantities given in *Bulletin* represent the *Dressed* Corn only.
 (5) The "Total Produce" of the Corn-crops includes Dressed Corn, Offal Corn, Straw, and Chaff. (6) Two cuttings. (7) Three cuttings.
 [For Summary Table of the above results, see pp. 108-9.]

A GDELL FIELD.
(Area under experiment, about 3 acres.)

EXPERIMENTS ON AN ACTUAL COURSE OF ROTATION—TURNIPS, BARLEY, LEGUMINOUS CROP (OR FALLOW), AND WHEAT.
These experiments were commenced in 1848; so that the present season, 1898, is the 51st, and the growing crop (beans) is the third of the Thirtieth Course.
One-third of the land has been continuously unmanured. One-third has, for the first Nine Courses, or 36 years, 1848-83, been manured with Superphosphate of Lime alone, once every four years, that is for the turnip-crop commencing each course; but for the Tenth, Eleventh, Twelfth, and Thirteenth Courses, a complex mineral manure has been applied, as described in foot-note, No. 2. Lastly, one-third has been manured (also for the turnip-crop only), with a complex mineral and Nitrogenous manure, as described in the foot-note, No. 3.
From half of each of the three differently manured plots, the turnip-crops (roots and leaves) are removed; and on the other half they are either consumed on the land by sheep, or spread and ploughed in. In the case of all the other crops, the total produce is removed from the land.

TABLE II. (below), gives the results relating to the portions of each plot from which the turnip-crops were entirely removed; and on which, in the third year of each course (excepting the first, 1850, when clover was grown), the land was left fallow.

Years.	Description of Crop.	PRODUCE PER ACRE.														
		Plot 1. Unmanured continuously.					Plot 2. Superphosphate of Lime alone (1), Courses 1-9, Complex Mineral Manure (2), Courses 10-13, for the Turnip Crops only.					Plot 3. Complex Mineral and Nitrogenous Manure (3), for the Turnip Crops only.				
		Corn (1) (or Roots).	Straw (or Leaf).	Total Produce (1).	Corn (2) (or Roots).	Straw (or Leaf).	Total Produce (2).	Corn (3) (or Roots).	Straw (or Leaf).	Total Produce (3).	Corn (4) (or Roots).	Straw (or Leaf).	Total Produce (4).			
		1st Course, 1848-51.														
1848	Swedish Turnips	175½ cwt.	19½ cwt.	195 cwt.	292 cwt.	35 cwt.	327 cwt.	384½ cwt.	46½ cwt.	441 cwt.						
1849	Barley	33½ bush.	2200 lbs.	4149 lbs.	29½ bush.	1870 lbs.	3575 lbs.	37 bush.	2342 lbs.	5026 lbs.						
1850	Clover (calcd as hay) (5)	..	..	57½ cwt.	..	..	604 cwt.	..	..	654 cwt.		
1851	Wheat	30½ bush.	3273 lbs.	5280 lbs.	31½ bush.	3497 lbs.	5617 lbs.	30½ bush.	3610 lbs.	5642 lbs.						
		2nd Course, 1852-55.														
1852	Swedish Turnips	37 cwt.	5½ cwt.	42½ cwt.	256½ cwt.	22½ cwt.	279½ cwt.	403½ cwt.	40 cwt.	448½ cwt.						
1853	Barley	32½ bush.	2187 lbs.	4046 lbs.	32 bush.	2003 lbs.	3376 lbs.	37½ bush.	2595 lbs.	4349 lbs.						
1854	Fallow	..	..	..	..	..	..	..	..	..
1855	Wheat	37½ bush.	4295 lbs.	6735 lbs.	35½ bush.	4236 lbs.	6756 lbs.	38½ bush.	4952 lbs.	7428 lbs.						
		3rd Course, 1856-59.														
1856	Swedish Turnips	45½ cwt.	24 cwt.	47½ cwt.	170½ cwt.	8 cwt.	176½ cwt.	323½ cwt.	11½ cwt.	339½ cwt.						
1857	Barley	43½ bush.	2330 lbs.	4777 lbs.	30½ bush.	1545 lbs.	3272 lbs.	47½ bush.	2400 lbs.	5091 lbs.						
1858	Fallow	..	..	..	..	..	..	..	..	..
1859	Wheat	35½ bush.	4315 lbs.	6582 lbs.	37½ bush.	4310 lbs.	6671 lbs.	42½ bush.	5330 lbs.	8066 lbs.						
		4th Course, 1860-63.														
1860	Swedish Turnips	14 cwt.	0½ cwt.	14½ cwt.	32½ cwt.	2 cwt.	35½ cwt.	87½ cwt.	3½ cwt.	91 cwt.						
1861	Barley	35½ bush.	2190 lbs.	4248 lbs.	32½ bush.	1954 lbs.	3507 lbs.	60½ bush.	3920 lbs.	7419 lbs.						
1862	Fallow	..	..	..	..	..	..	..	..	..
1863	Wheat	45 bush.	4563 lbs.	7446 lbs.	46 bush.	4690 lbs.	7626 lbs.	52½ bush.	5495 lbs.	8537 lbs.						
		5th Course, 1864-67.														
1864	Swedish Turnips	7½ cwt.	0½ cwt.	8½ cwt.	52½ cwt.	4½ cwt.	57½ cwt.	182½ cwt.	9 cwt.	191½ cwt.						
1865	Barley	34½ bush.	1828 lbs.	3659 lbs.	31½ bush.	1509 lbs.	3170 lbs.	44½ bush.	2398 lbs.	4799 lbs.						
1866	Fallow	..	..	..	..	..	..	..	..	..
1867	Wheat	27½ bush.	2694 lbs.	4330 lbs.	20½ bush.	2774 lbs.	4420 lbs.	22½ bush.	2850 lbs.	4323 lbs.						

6th Course, 1868-71.

1868	Swedish Turnips	Failed, and ploughed up.	Failed, and ploughed up.	Failed, and ploughed up.
1869	Barley	21½ bush.	25½ bush.	39½ bush.
1870	Fallow	1628 lbs.	1873 lbs.	3064 lbs.
1871	Wheat	2075 lbs.	2128 lbs.	2628 lbs.
		3004 lbs.	3133 lbs.	3747 lbs.

7th Course, 1872-75.

1872	Swedish Turnips	60 cwts.	14½ cwts.	156½ cwts.
1873	Barley	2986 lbs.	1370 lbs.	314 cwts.
1874	Fallow	4412 lbs.	3230 lbs.	5065 lbs.
1875	Wheat	2833 lbs.	29½ bush.	3623 lbs.
		8½ cwts.	29½ bush.	3623 lbs.
		1374 lbs.	3230 lbs.	5443 lbs.

8th Course, 1876-79.

1876	Swedish Turnips	31½ cwts.	17 cwts.	308½ cwts.
1877	Barley	23 bush.	1084 lbs.	1625 lbs.
1878	Fallow	1244 lbs.	1956 lbs.	2905 lbs.
1879	Wheat	1493 lbs.	14½ bush.	12½ bush.
		2162 lbs.	1956 lbs.	1691 lbs.
		364 cwts.	17 cwts.	344½ cwts.
		2602 lbs.	1084 lbs.	3406 lbs.

9th Course, 1880-83.

1880	Swedish Turnips	32½ cwts.	12½ cwts.	450½ cwts.
1881	Barley	29½ bush.	1239 lbs.	33½ bush.
1882	Fallow	1556 lbs.	3686 lbs.	6208 lbs.
1883	Wheat	33½ bush.	33½ bush.	37½ bush.
		5140 lbs.	3686 lbs.	3689 lbs.
		36½ cwts.	12½ cwts.	36 cwts.
		3170 lbs.	1239 lbs.	1756 lbs.
		2576 lbs.	3686 lbs.	3689 lbs.
		450½ cwts.	37½ bush.	6132 lbs.

10th Course, 1884-87.

1884	Swedish Turnips	17½ cwts.	18½ cwts.	288½ cwts.
1885	Barley	15½ bush.	1043 lbs.	19 bush.
1886	Fallow	2505 lbs.	3465 lbs.	6103 lbs.
1887	Wheat	34½ bush.	41½ bush.	39½ bush.
		1518 lbs.	41½ bush.	3308 lbs.
		2402 lbs.	18½ cwts.	55½ cwts.
		4689 lbs.	1043 lbs.	1528 lbs.
		74 cwts.	3465 lbs.	3308 lbs.
		1518 lbs.	41½ bush.	5894 lbs.

11th Course, 1888-91.

1888	Swedish Turnips	15 cwts.	14½ cwts.	431½ cwts.
1889	Barley	15½ bush.	965 lbs.	20 bush.
1890	Fallow	2941 lbs.	3586 lbs.	5742 lbs.
1891	Wheat	32 bush.	36 bush.	41 bush.
		4363 lbs.	3586 lbs.	4238 lbs.
		74 cwts.	154 cwts.	377 cwts.
		953 lbs.	1775 lbs.	1231 lbs.
		2941 lbs.	3586 lbs.	4238 lbs.
		15 cwts.	14½ cwts.	469½ cwts.

12th Course, 1892-95.

1892	Swedish Turnips	9½ cwts.	4½ cwts.	523½ cwts.
1893	Barley	19½ bush.	1203 lbs.	18½ bush.
1894	Fallow	1614 lbs.	2188 lbs.	4011 lbs.
1895	Wheat	21½ bush.	28½ bush.	32½ bush.
		1650 lbs.	2188 lbs.	2368 lbs.
		11 cwts.	4½ cwts.	15½ cwts.
		2784 lbs.	1203 lbs.	1597 lbs.
		3066 lbs.	2188 lbs.	2368 lbs.
		9½ cwts.	4½ cwts.	538½ cwts.

13th Course, 1896-99.

1896	Swedish Turnips	16½ cwts.	8½ cwts.	345 cwts.
1897	Barley	11½ bush.	969 lbs.	21½ bush.
1898	Fallow	1609 lbs.	1677 lbs.	1465 lbs.
1899	Wheat	9¼ lbs.	8½ cwts.	85 cwts.
		34 cwts.	969 lbs.	1465 lbs.
		13½ cwts.	8½ cwts.	380 cwts.
		1609 lbs.	1677 lbs.	2639 lbs.

(1) First Course—100 lbs. Bone-ash, and 100 lbs. Sulphuric Acid (sp. gr. 1.7); Second Course—160 lbs. Bone-ash, 120 lbs. Sulphuric Acid; Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, Tenth, Eleventh, Twelfth, Thirteenth, Fourteenth, Fifteenth, Sixteenth, Seventeenth, Eighteenth, Nineteenth, Twentieth Courses—made from high percentage mineral phosphates, and containing 37 per cent. or more of soluble phosphates.
 (2) For the Tenth Course, in addition to the Superphosphate for the Swedish Turnips—300 lbs. Sulphate Potash, 200 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia, were applied February 23, 1884, and harrowed in; and the same quantities were applied again before the first ploughing and preparation of the land for the sowing of the seed in May. For the Swedes of the Eleventh and Twelfth Courses the same mineral manures (which are the same as the mineral manures of Plot 3 for the Third and subsequent Courses) were again applied, but only once for each of these two Courses. For the Swedes of the Thirteenth Course—500 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 200 lbs. Sulphate of Magnesia, and 600 lbs. Basic Slag, per acre.
 (3) First Course—100 lbs. Bone-ash, 100 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, and 100 lbs. Muriate of Ammonia, and 1000 lbs. Rape-cake; Second Course—300 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 100 lbs. Sulphate of Magnesia, 160 lbs. Bone-ash, 120 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Muriate of Ammonia, and 2000 lbs. Rape-cake; Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, Tenth Courses—300 lbs. Sulphate of Potash, 200 lbs. Sulphate of Soda, 100 lbs. Sulphate of Magnesia, 2000 lbs. Rape-cake, 150 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Muriate of Ammonia, and 2000 lbs. Bone-ash, per acre; Eleventh and Twelfth Courses—the same in other respects as in Courses 3-10, but the Superphosphate made from high percentage mineral phosphates, and containing 37 per cent. or more, of soluble phosphates. For the Swedes of the Thirteenth Course—500 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 200 lbs. Sulphate of Magnesia, 600 lbs. Basic Slag, 2000 lbs. Rape-cake, 100 lbs. Sulphate of Ammonia, and 100 lbs. Muriate of Ammonia, per acre.
 (4) The quantities given in *Bushels* represent the *Dressed* Corn only.
 (5) The "Total Produce" of the Corn-crops includes Dressed Corn, Offal Corn, Straw, and Chaff.
 (6) Two cuttings.

[For Summary Table of the above results, see pp. 108-9.]

A G D E L L F I E L D .

(Area under experiment, about 3 acres.)

EXPERIMENTS ON AN ACTUAL COURSE OF ROTATION—TURNIPS, BARLEY, LEGUMINOUS CROP (OR FALLOW), AND WHEAT.

These experiments were commenced in 1848; so that the present season, 1898, is the 51st, and the growing crop (Beans) is the third of the Thirteenth Course. One-third of the land has been continuously unmanured. One-third has, for the first Nine Courses, or 36 years, 1848-83, been manured with Superphosphate of Lime alone, once every four years, that is, for the turnip-crop commencing each course; but for the Tenth, Eleventh, Twelfth, and Thirteenth Courses, a complex mineral manure has been applied, as described in foot-note, No. 2. Lastly, one-third has been manured (also for the turnip-crop only), with a complex mineral and Nitrogenous manure, as described in the foot-note, No. 3. From half of each of the three differently manured plots, the turnip-crops (roots and leaves) are removed; and on the other half they are either consumed on the land by sheep, or spread and ploughed in. In the case of all the other crops, the total produce is removed from the land.

TABLE III. (below), gives the results relating to the portions of each plot on which the turnip-crops were either fed off by sheep, or cut and spread on the land; and on which clover or beans were grown.

Years.	Description of Crop.	Plot 1. Unmanured continuously.				Plot 2. Superphosphate of Lime alone(1), Courses 1-9, Complex Mineral Manure(2), Courses 10-13, for the Turnip Crops only.				Plot 3. Complex Mineral and Nitrogenous Manure(3), for the Turnip Crops only.			
		Corn (1) (or Roots).	Straw (or Leaf).	Total Produce.(3)		Corn (4) (or Roots).	Straw (or Leaf).	Total Produce.(5)		Corn (1) (or Roots).	Straw (or Leaf).	Total Produce.(3)	
1st Course, 1848-51.													
1848	Norfolk White Turnips	109 cwts.	673 cwts.	1764 cwts.	2204 cwts.	90 cwts.	3104 cwts.	229 cwts.	1514 cwts.	3504 cwts.			
1849	Barley	48 bush.	3225 lbs.	6046 lbs.	424 bush.	3327 lbs.	5885 lbs.	452 bush.	3646 lbs.	6206 lbs.			
1850	Clover (called as hay) (6)			484 cwts.			484 cwts.			604 cwts.			
1851	Wheat	304 bush.	3760 lbs.	5556 lbs.	32 bush.	4014 lbs.	6176 lbs.	314 bush.	4035 lbs.	6169 lbs.			
2nd Course, 1852-55.													
1852	Swedish Turnips	194 cwts.	34 cwts.	224 cwts.	2504 cwts.	22 cwts.	2724 cwts.	386 cwts.	33 cwts.	419 cwts.			
1853	Barley	234 bush.	2077 lbs.	3317 lbs.	38 bush.	2756 lbs.	5058 lbs.	354 bush.	2981 lbs.	5190 lbs.			
1854	Beans	7 bush.	953 lbs.	1367 lbs.	104 bush.	1378 lbs.	2124 lbs.	133 bush.	1605 lbs.	2544 lbs.			
1855	Wheat	344 bush.	3351 lbs.	5226 lbs.	364 bush.	3611 lbs.	5921 lbs.	404 bush.	4370 lbs.	6392 lbs.			
3rd Course, 1856-59.													
1856	Swedish Turnips	204 cwts.	14 cwts.	214 cwts.	196 cwts.	144 cwts.	2104 cwts.	3414 cwts.	114 cwts.	353 cwts.			
1857	Barley	404 bush.	2312 lbs.	4558 lbs.	524 bush.	2750 lbs.	5741 lbs.	634 bush.	3105 lbs.	6930 lbs.			
1858	Beans	54 bush.	965 lbs.	1307 lbs.	34 bush.	1320 lbs.	1895 lbs.	144 bush.	1760 lbs.	2754 lbs.			
1859	Wheat	304 bush.	3355 lbs.	5265 lbs.	374 bush.	4320 lbs.	6639 lbs.	384 bush.	4955 lbs.	7417 lbs.			
4th Course, 1860-63.													
1860	Swedish Turnips	1 cwt.	(5 lbs.)	1 cwt.	334 cwts.	14 cwt.	404 cwts.	72 cwts.	44 cwts.	764 cwts.			
1861	Barley	294 bush.	1970 lbs.	3635 lbs.	424 bush.	2553 lbs.	4932 lbs.	544 bush.	3940 lbs.	7143 lbs.			
1862	Beans	274 bush.	1845 lbs.	3546 lbs.	30 bush.	407 lbs.	4027 lbs.	414 bush.	2945 lbs.	5520 lbs.			
1863	Wheat	304 bush.	3008 lbs.	4941 lbs.	414 bush.	3888 lbs.	6562 lbs.	444 bush.	4919 lbs.	7721 lbs.			
5th Course, 1864-67.													
1864	Swedish Turnips	84 cwts.	1 cwt.	94 cwts.	784 cwts.	44 cwts.	834 cwts.	1684 cwts.	84 cwts.	1774 cwts.			
1865	Barley	274 bush.	1460 lbs.	2961 lbs.	414 bush.	2244 lbs.	4457 lbs.	434 bush.	2968 lbs.	5303 lbs.			
1866	Beans	84 bush.	905 lbs.	1435 lbs.	10 bush.	1355 lbs.	2481 lbs.	244 bush.	2155 lbs.	3732 lbs.			
1867	Wheat	154 bush.	1524 lbs.	2506 lbs.	25 bush.	2648 lbs.	4212 lbs.	214 bush.	1654 lbs.	3023 lbs.			

6th Course, 1868-71.

1868	Swedish Turnips	Failed, and ploughed up.	Failed, and ploughed up.	Failed, and ploughed up.
1869	Barley	25½ bush.	384 bush.	42½ bush.
1870	Beans	17½ bush.	878 lbs.	1008 lbs.
1871	Wheat	21½ bush.	2980 lbs.	3644 lbs.

7th Course, 1872-75.

1872	Swedish Turnips	7½ cwts.	19½ cwts.	39 cwts.
1873	Barley	1495 lbs.	1841 lbs.	2456 lbs.
1874	Clover (alc ^d as hay) ⁽⁷⁾	22½ cwts.	3575 lbs.	45½ bush.
1875	Wheat	2353 lbs.	3928 lbs.	5984 lbs.

8th Course, 1876-79.

1876	Swedish Turnips	21 cwts.	25½ cwts.	63 cwts.
1877	Barley	23½ bush.	1894 lbs.	49½ bush.
1878	Beans	7½ bush.	1320 lbs.	26½ bush.
1879	Wheat	8½ bush.	1771 lbs.	14 bush.

9th Course, 1880-83.

1880	Swedish Turnips	24 cwts.	22½ cwts.	44½ cwts.
1881	Barley	1468 lbs.	1430 lbs.	3078 lbs.
1882	Clover (alc ^d as hay) ⁽⁶⁾	22½ cwts.	70½ cwts.	50½ bush.
1883	Wheat	3741 lbs.	5901 lbs.	4505 lbs.

10th Course, 1884-87.

1884	Swedish Turnips	12 cwts.	23 cwts.	63½ cwts.
1885	Barley	1379 lbs.	4193 lbs.	5946 lbs.
1886	Clover (weight ^d as hay) ⁽⁶⁾	11½ cwts.	42 cwts.	52½ cwts.
1887	Wheat	1844 lbs.	6332 lbs.	6409 lbs.

11th Course, 1888-91.

1888	Swedish Turnips	8 cwts.	27½ cwts.	40½ cwts.
1889	Barley	865 lbs.	3250 lbs.	2030 lbs.
1890	Beans	81 bush.	1630 lbs.	25½ bush.
1891	Wheat	26½ bush.	5017 lbs.	1059 lbs.

12th Course, 1892-95.

1892	Swedish Turnips	6½ cwts.	4½ cwts.	8½ cwts.
1893	Barley	1385 lbs.	1466 lbs.	2100 lbs.
1894	Clover (weight ^d as hay) ⁽⁶⁾	17½ cwts.	64½ cwts.	83½ cwts.
1895	Wheat	1619 lbs.	5325 lbs.	5292 lbs.

13th Course, 1896-99.

1896	Swedish Turnips	11½ cwts.	24½ cwts.	61½ cwts.
1897	Barley	986 lbs.	4919 lbs.	3353 lbs.
1898	Clover or Beans	11½ bush.	42½ bush.	42½ bush.
1899	Wheat	114 bush.	2794 lbs.	380½ cwts.

(1) First Course—100 lbs. Bone-ash, and 100 lbs. Sulphuric Acid (sp. gr. 1.7); Second Course—160 lbs. Bone-ash, 120 lbs. Sulphuric Acid; Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, and Tenth Courses—made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.

(2) For the Tenth Course, in addition to the Superphosphate for the Swedish Turnips—300 lbs. Sulphate of Potash, 200 lbs. Sulphate Soda, and 100 lbs. Sulphate Magnesia were applied February 29, 1884, and harrowed in; and the same quantities were applied again before the final ploughing and preparation of the land for the sowing of the seed in May. For the Swedes of the Eleventh and Twelfth Courses the same mineral manures (which are the same as the mineral manures of Plot 3 for the Third and subsequent Courses) were again applied, but only once for each of these two Courses. For the Swedes of the Thirteenth Course—500 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 200 lbs. Sulphate of Magnesia, and 600 lbs. Basic Slag, per acre.

(3) First Course—100 lbs. Pearl-ash, 100 lbs. Bone-ash, 100 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Marinate of Ammonia, and 1000 lbs. Rape-cake; Second Course—300 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 100 lbs. Sulphate of Magnesia, 160 lbs. Bone-ash, 200 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Marinate of Ammonia, and 800 lbs. Rape-cake; Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, and Tenth Courses—300 lbs. Sulphate of Potash, 200 lbs. Sulphate of Soda, 100 lbs. Sulphate of Magnesia, 200 lbs. Bone-ash, 150 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Marinate of Ammonia, and 2000 lbs. Rape-cake, per acre; Eleventh and Twelfth Courses—the same in other respects as in Courses 3-10, but the Superphosphate made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate. For the Swedes of the Thirteenth Course—500 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 200 lbs. Sulphate of Magnesia, 600 lbs. Basic Slag, 2000 lbs. Rape-cake, 100 lbs. Sulphate of Ammonia, and 100 lbs. Marinate of Ammonia, per acre.

(4) The quantities given in *Swedes* represent the *Dressed Corn* only.

(5) The "Total Produce" of the Corn-crops includes Dressed Corn, Offal Corn, Straw, and Chaff.

(6) Two cuttings.

(7) Three cuttings.

[For Summary Table of the above results, see pp. 108-9.]

AGDELL FIELD.

(Area under experiment, about 3 acres.)

EXPERIMENTS ON AN ACTUAL COURSE OF ROTATION—TURNIPS, BARLEY, LEGUMINOUS CROP (OR FALLOW), AND WHEAT.

These Experiments were commenced in 1848; so that the present season, 1898, is the 51st, and the growing crop (Beans) is the third of the Thirteenth Course. One-third has for the first Nine Courses, or 36 years, 1848-83, been manured with Superphosphate of Lime alone, once every four years, that is for the turnip-crop commencing each course; but for the Tenth, Eleventh, Twelfth, and Thirteenth Courses, a complex mineral manure has been applied, as described in foot-note, No. 2. Lastly, one-third has been manured (also for the turnip-crop only), with a complex mineral and Nitrogenous manure, as described in the foot-note, No. 3.

From half of each of the three differently manured plots, the turnip-crops (roots and leaves) are removed; and on the other half they are either consumed on the land by sheep, or spread and ploughed in. In the case of all the other crops, the total produce is removed from the land.

TABLE IV. (below), gives the results relating to the portions of each plot on which the turnip-crops were either fed off by sheep, or cut and spread on the land; and on which, in the third year of each course (excepting the first, 1850, when clover was grown), the land was left fallow.

Years.	Description of Crop.	PRODUCE PER ACRE.														
		Plot 1. Unmanured continuously.					Plot 2. Superphosphate of Lime alone, (1) Courses 1-9, Complex Mineral Manures (2) Courses 10-13; for the Turnip Crops only.					Plot 3. Complex Mineral and Nitrogenous Manure, (3) for the Turnip Crops only.				
		Corn (1) (or Roots).	Straw (or Leaf).	Total Produce. (2)	Corn (4) (or Roots).	Straw (or Leaf).	Total Produce. (5)	Corn (1) (or Roots).	Straw (or Leaf).	Total Produce. (3)	Corn (4) (or Roots).	Straw (or Leaf).	Total Produce. (5)			
		1 lb. (pound avoird.) per acre = (about) 1.12 Kilogramme per Hectare, or 0.57 Zollverein Pfund, per Prussian Morgen. 1 cwt. (hundredweight) per acre = (about) 125.5 Kilogrammes per Hectare, or 0.64 Centner per Pr. Morgen.														
		1st Course, 1848-51.														
1848	Swedish Turnips	17½ cwt.	20½ cwt.	193½ cwt.	34½ cwt.	39½ cwt.	384½ cwt.	429 cwt.	463 cwt.	475½ cwt.	429 cwt.	463 cwt.	475½ cwt.			
1849	Barley	44½ bush.	3139 lbs.	5755 lb.	41 bush.	3209 lbs.	6704 lbs.	444 bush.	3709 lbs.	6344 lbs.	444 bush.	3709 lbs.	6344 lbs.			
1850	Clover (calcd as hay) (6)	31½ bush.	3498 lbs.	5584 lbs.	32½ bush.	3534 lbs.	6062 lbs.	27½ bush.	3969 lbs.	65 cwt.	27½ bush.	3969 lbs.	65 cwt.			
1851	Wheat	27½ cwt.	4070 lbs.	6473 lbs.	37½ bush.	4492 lbs.	6961 lbs.	37½ bush.	5107 lbs.	5801 lbs.	37½ bush.	5107 lbs.	5801 lbs.			
		2nd Course, 1852-55.														
1852	Swedish Turnips	27½ cwt.	4 cwt.	31½ cwt.	273½ cwt.	22½ cwt.	295½ cwt.	390½ cwt.	37½ cwt.	428½ cwt.	390½ cwt.	37½ cwt.	428½ cwt.			
1853	Barley	33 bush.	2210 lbs.	4161 lbs.	39½ bush.	2739 lbs.	5110 lbs.	37½ bush.	3323 lbs.	5672 lbs.	37½ bush.	3323 lbs.	5672 lbs.			
1854	Fallow	37½ bush.	4070 lbs.	6473 lbs.	37½ bush.	4492 lbs.	6961 lbs.	37½ bush.	5107 lbs.	7499 lbs.	37½ bush.	5107 lbs.	7499 lbs.			
1855	Wheat	34 cwt.	4070 lbs.	6473 lbs.	37½ bush.	4492 lbs.	6961 lbs.	37½ bush.	5107 lbs.	7499 lbs.	37½ bush.	5107 lbs.	7499 lbs.			
		3rd Course, 1856-59.														
1856	Swedish Turnips	34 cwt.	2 cwt.	36 cwt.	193½ cwt.	12½ cwt.	206 cwt.	332½ cwt.	12½ cwt.	351½ cwt.	332½ cwt.	12½ cwt.	351½ cwt.			
1857	Barley	44½ bush.	2430 lbs.	4912 lbs.	48½ bush.	2585 lbs.	5326 lbs.	66½ bush.	3570 lbs.	7261 lbs.	66½ bush.	3570 lbs.	7261 lbs.			
1858	Fallow	35½ bush.	4045 lbs.	6270 lbs.	39½ bush.	4720 lbs.	7242 lbs.	40½ bush.	5545 lbs.	8136 lbs.	40½ bush.	5545 lbs.	8136 lbs.			
1859	Wheat	1½ cwt.	4295 lbs.	6909 lbs.	49½ bush.	5051 lbs.	8194 lbs.	49 bush.	5638 lbs.	8747 lbs.	49 bush.	5638 lbs.	8747 lbs.			
		4th Course, 1860-63.														
1860	Swedish Turnips	1½ cwt.	1 cwt.	1½ cwt.	40½ cwt.	2 cwt.	42½ cwt.	87 cwt.	5½ cwt.	92½ cwt.	87 cwt.	5½ cwt.	92½ cwt.			
1861	Barley	33 bush.	2018 lbs.	3871 lbs.	40½ bush.	2415 lbs.	4803 lbs.	57½ bush.	4175 lbs.	7654 lbs.	57½ bush.	4175 lbs.	7654 lbs.			
1862	Fallow	42 bush.	4295 lbs.	6909 lbs.	49½ bush.	5051 lbs.	8194 lbs.	49 bush.	5638 lbs.	8747 lbs.	49 bush.	5638 lbs.	8747 lbs.			
1863	Wheat	9 cwt.	4295 lbs.	6909 lbs.	49½ bush.	5051 lbs.	8194 lbs.	49 bush.	5638 lbs.	8747 lbs.	49 bush.	5638 lbs.	8747 lbs.			
		5th Course, 1864-67.														
1864	Swedish Turnips	9 cwt.	1809 lbs.	3695 lbs.	79½ cwt.	5½ cwt.	84½ cwt.	185½ cwt.	9½ cwt.	195 cwt.	185½ cwt.	9½ cwt.	195 cwt.			
1865	Barley	35½ bush.	1809 lbs.	3695 lbs.	39½ bush.	2043 lbs.	4122 lbs.	46½ bush.	3274 lbs.	5753 lbs.	46½ bush.	3274 lbs.	5753 lbs.			
1866	Fallow	23½ bush.	2538 lbs.	4126 lbs.	27½ bush.	2989 lbs.	4702 lbs.	19½ bush.	2905 lbs.	4180 lbs.	19½ bush.	2905 lbs.	4180 lbs.			
1867	Wheat	23½ bush.	2538 lbs.	4126 lbs.	27½ bush.	2989 lbs.	4702 lbs.	19½ bush.	2905 lbs.	4180 lbs.	19½ bush.	2905 lbs.	4180 lbs.			

6th Course, 1868-71.

1868	Swedish Turnips	Failed and ploughed up.	Failed and ploughed up.	Failed and ploughed up.
1869	Barley	21 bush.	30½ bush.	38½ bush.
1870	Fallow	1643 lbs.	2343 lbs.	3244 lbs.
1871	Wheat	1946 lbs.	2340 lbs.	2363 lbs.
		14½ bush.	15½ bush.	17½ bush.
				2863 lbs.
				3925 lbs.

7th Course, 1872-75.

1872	Swedish Turnips	49½ cwts.	167½ cwts.	331½ cwts.
1873	Barley	20½ bush.	27 bush.	47 bush.
1874	Fallow	1311 lbs.	1611 lbs.	184½ cwts.
1875	Wheat	2851 lbs.	3525 lbs.	5443 lbs.
		24½ bush.	30½ bush.	30 bush.
				4085 lbs.
				5942 lbs.

8th Course, 1876-79.

1876	Swedish Turnips	32½ cwts.	208½ cwts.	377½ cwts.
1877	Barley	22½ bush.	31½ bush.	44½ bush.
1878	Fallow	1275 lbs.	1706 lbs.	224½ cwts.
1879	Wheat	1612 lbs.	1843 lbs.	2755 lbs.
		11½ bush.	14½ bush.	10½ bush.
				1426 lbs.
				2100 lbs.

9th Course, 1880-83.

1880	Swedish Turnips	33½ cwts.	238½ cwts.	447½ cwts.
1881	Barley	31½ bush.	28½ bush.	47½ bush.
1882	Fallow	1565 lbs.	1500 lbs.	251½ cwts.
1883	Wheat	3231 lbs.	4110 lbs.	6773 lbs.
		34½ bush.	40½ bush.	38½ bush.
				4023 lbs.
				6536 lbs.

10th Course, 1884-87.

1884	Swedish Turnips	20½ cwts.	172½ cwts.	298½ cwts.
1885	Barley	22½ bush.	17½ bush.	32½ bush.
1886	Fallow	1768 lbs.	1430 lbs.	191½ cwts.
1887	Wheat	2655 lbs.	3480 lbs.	6105 lbs.
		33½ bush.	40½ bush.	41 bush.
				3763 lbs.
				6410 lbs.

11th Course, 1888-91.

1888	Swedish Turnips	23 cwts.	166 cwts.	423½ cwts.
1889	Barley	16½ bush.	19½ bush.	23½ bush.
1890	Fallow	996 lbs.	1135 lbs.	182 cwts.
1891	Wheat	2898 lbs.	4103 lbs.	6509 lbs.
		31½ bush.	40 bush.	45½ bush.
				4938 lbs.
				7610 lbs.

12th Course, 1892-95.

1892	Swedish Turnips	12½ cwts.	269½ cwts.	500½ cwts.
1893	Barley	19 bush.	15½ bush.	25½ bush.
1894	Fallow	1639 lbs.	1245 lbs.	267½ cwts.
1895	Wheat	1728 lbs.	2403 lbs.	4423 lbs.
		22½ bush.	32 bush.	32½ bush.
				2575 lbs.
				4651 lbs.

13th Course, 1896-99.

1896	Swedish Turnips	24½ cwts.	177½ cwts.	331½ cwts.
1897	Barley	13½ bush.	19½ bush.	35½ bush.
1898	Fallow	1153 lbs.	1425 lbs.	188½ cwts.
1899	Wheat	1945 lbs.	2530 lbs.	4551 lbs.
		4 cwts.	11½ cwts.	48 cwts.
				2570 lbs.
				4551 lbs.

(1) First Course—100 lbs. Bone-ash, and 100 lbs. Sulphuric Acid (sp. gr. 1.7); Second Course—160 lbs. Bone-ash, 120 lbs. Sulphuric Acid; Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, and Tenth Courses—200 lbs. Bone-ash, and 160 lbs. Sulphuric Acid, per acre; Eleventh and Twelfth Courses—made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate.

(2) For the Tenth Course, in addition to the Superphosphate for the Swedish Turnips—300 lbs. Sulphate of Potash, 200 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia were applied February 29, 1884, and narrowed in; and the same quantities were applied again before the final ploughing and preparation of the land for the sowing of the seed in May. For the Swedes of the Eleventh and Twelfth Courses the same mineral manures (which are the same as the mineral manures of Plot 3 for the Third and subsequent Courses) were again applied, but only once for each of these two Courses. For the Swedes of the Thirteenth Course—500 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 200 lbs. Sulphate of Magnesia, and 600 lbs. Basic Slag, per acre.

(3) First Course—100 lbs. Bone-ash, 100 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Muriate of Ammonia, and 1000 lbs. Rape-cake; Second Course—300 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 100 lbs. Sulphate of Magnesia, 160 lbs. Bone-ash, 120 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Muriate of Ammonia, and 2000 lbs. Rape-cake; Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, and Tenth Courses—300 lbs. Sulphate of Potash, 200 lbs. Sulphate of Soda, 100 lbs. Sulphate of Magnesia, 160 lbs. Bone-ash, 160 lbs. Sulphuric Acid, 100 lbs. Sulphate of Ammonia, 100 lbs. Muriate of Ammonia, and 2000 lbs. Rape-cake, per acre; Eleventh and Twelfth Courses—the same in other respects as in Courses 3-10, but the Superphosphate made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate. For the Swedes of the Thirteenth Course—500 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, 200 lbs. Sulphate of Magnesia, 600 lbs. Basic Slag, 2000 lbs. Rape-cake, 100 lbs. Sulphate of Ammonia, and 100 lbs. Muriate of Ammonia, per acre.

(4) The quantities given in *Bioscience* represent the *Dressed Corn* only.

(5) The "Total Produce" of the Corn-crops includes Dressed Corn, Offal Corn, Straw, and Chaff.

(6) Two cuttings.

[For Summary Table of the above results, see pp. 108-9.]

AGDELL FIELD.

(Area under experiment, about 3 acres.)

EXPERIMENTS ON AN ACTUAL COURSE OF ROTATION—TURNIPS, BARLEY, LEGUMINOUS CROP (OR FALLOW), AND WHEAT.

SUMMARIES OF THE RESULTS GIVEN IN TABLES I, II, III, AND IV. (pp. 100-1, 102-3, 104-5, and 106-7), RESPECTIVELY.

As the Table shows, averages are given for each of the four portions of the experimental land, for which Tables I, II, III, and IV, respectively, give the details. The averages are given, first of the produce of the eight intermediate Courses (Courses 2-9, 1852-1883); that is, excluding the First Course, when the land was in somewhat uneven condition, and when (as the detailed Tables show), on some portions Norfolk Whites, and on others Swedish Turnips, were grown; excluding also the Tenth, Eleventh, and Twelfth

Courses, on account of the change in the Mineral Manures used on Plot 2. Averages are also given of the produce of the Tenth, Eleventh, and Twelfth Courses, that is, after the change in the Mineral Manures applied to Plot 2. For full particulars of the manures applied to Plot 2, and also of those applied to Plot 3, see Foot-Notes 1, 2, and 3, on pages 101, 103, 105, or 107.

1 lb. (pound avoird.) per acre = (about) 1.12 Kilogramme per Hectare, or 0.57 Zollverein Pfund. per Prussian Morgen
 1 cwt. (hundredweight) per acre = (about) 125.5 Kilogrammes per Hectare, or 0.64 Centner per Pr. Morgen.

Years.	Description of Crop.	PRODUCE PER ACRE.					
		Plot 1. Unmanured continuously.		Plot 2. Superphosphate of Lime, alone, Courses 1-9, Complex Mineral Manure, Courses 10-12, for the Turnip Crops only.		Plot 3. Complex Mineral and Nitrogenous Manure, for the Turnip Crops only.	
		Corn (1) (or Roots).	Straw (or Leaf).	Total Produce. (2)	Corn (1) (or Roots).	Straw (or Leaf).	Total Produce. (2)
AVERAGE OF 8 COURSES (COURSES 2-9), 1852-1883.							
1852, '56, '60, '64, '72, '76, '80	Swedish Turnips	16 1/2 cwt.	3 cwt.	19 1/2 cwt.	128 1/2 cwt.	11 1/2 cwt.	138 3/4 cwt.
1853, '57, '61, '65, '69, '73, '77, '81	Barley	32 3/4 bush.	1971 lbs.	3780 lbs.	27 1/2 bush.	1623 lbs.	3196 lbs.
1854, '58, '62, '66, '70, '74, '78, '82	{ Clover, 1874, and '82 (as hay)	12 1/2 bush.	1081 lbs.	1867 lbs.	12 1/2 bush.	1200 lbs.	1996 lbs.
1855, '59, '63, '67, '71, '75, '79, '83	{ Beans	26 bush.	2762 lbs.	4407 lbs.	28 1/2 bush.	3023 lbs.	4841 lbs.
	{ Wheat						
AVERAGE OF 3 COURSES (COURSES 10, 11, AND 12), 1884-1895.							
1884, 1888 and 1892	Swedish Turnips	4 1/2 cwt.	1 1/2 cwt.	6 1/4 cwt.	194 1/2 cwt.	15 1/2 cwt.	209 1/2 cwt.
1885, 1889 and 1893	Barley	13 3/4 bush.	1214 lbs.	1972 lbs.	19 1/2 bush.	1334 lbs.	2412 lbs.
1886, 1890 and 1894	{ Clover, 1886 and 1894 (as hay)	7 bush.	603 lbs.	1079 lbs.	24 1/2 bush.	1764 lbs.	3441 lbs.
1887, 1891 and 1895	{ Beans, 1890	26 1/2 bush.	2057 lbs.	3707 lbs.	40 1/2 bush.	3314 lbs.	5888 lbs.
	{ Wheat						

SUMMARY OF TABLE I. (pp. 100-1).—Results relating to the portions of each plot from which the turnip-crops were entirely removed; and on which clover or beans were grown.

SUMMARY of TABLE II. (pp. 102-3).—Results relating to the portions of each plot from which the turnip-crops were entirely removed; and on which, in the third year of each course (excepting the first, 1850, when clover was grown), the land was left fallow.

Year	AVERAGE OF 8 COURSES (COURSES 2-9), 1852-1883.												
	Swedish Turnips	Barley	Fallow	Wheat	26 cwts. 30 bush.	3½ cwts. 1792 lbs.	29½ cwts. 3497 lbs.	134½ cwts. 27½ bush.	10½ cwts. 1568 lbs.	144½ cwts. 3131 lbs.	262½ cwts. 40½ bush.	21½ cwts. 2423 lbs.	283½ cwts. 4755 lbs.
1852, '56, '60, '64, '72, '76, '80	•	•	•	•	•	•	•	•	•	•	•	•	•
1853, '57, '61, '65, '69, '73, '77, '81	•	•	•	•	•	•	•	•	•	•	•	•	•
1854, '58, '62, '66, '70, '74, '78, '82	•	•	•	•	•	•	•	•	•	•	•	•	•
1855, '59, '63, '67, '71, '75, '79, '83	•	•	•	•	•	•	•	•	•	•	•	•	•
	AVERAGE OF 3 COURSES (COURSES 10, 11, AND 12), 1884-1895.												
Year	Swedish Turnips	Barley	Fallow	Wheat	14½ cwts. 17 bush.	5½ cwts. 1362 lbs.	19½ cwts. 2233 lbs.	176½ cwts. 33½ bush.	12½ cwts. 1070 lbs.	188½ cwts. 1869 lbs.	417½ cwts. 19½ bush.	36½ cwts. 1452 lbs.	453½ cwts. 2587 lbs.
1884, 1888 and 1892	•	•	•	•	•	•	•	•	•	•	•	•	•
1885, 1889 and 1893	•	•	•	•	•	•	•	•	•	•	•	•	•
1886, 1890 and 1894	•	•	•	•	•	•	•	•	•	•	•	•	•
1887, 1891 and 1895	•	•	•	•	•	•	•	•	•	•	•	•	•

SUMMARY OF TABLE III. (pp. 104-5).—Results relating to the portions of each plot on which the turnip-crops were either fed off by sheep, or cut and spread on the land; and on which clover or beans were grown.

Year	AVERAGE OF 8 COURSES (COURSES 2-9), 1852-1883.												
	Swedish Turnips	Barley	Fallow	Wheat	15½ cwts. 28 bush.	2½ cwts. 1758 lbs.	17½ cwts. 3351 lbs.	150½ cwts. 38 bush.	12½ cwts. 2250 lbs.	168½ cwts. 4417 lbs.	262½ cwts. 47½ bush.	24½ cwts. 3146 lbs.	287½ cwts. 5903 lbs.
1852, '56, '60, '64, '72, '76, '80	•	•	•	•	•	•	•	•	•	•	•	•	•
1853, '57, '61, '65, '69, '73, '77, '81	•	•	•	•	•	•	•	•	•	•	•	•	•
1854, '58, '62, '66, '70, '74, '78, '82	•	•	•	•	•	•	•	•	•	•	•	•	•
1855, '59, '63, '67, '71, '75, '79, '83	•	•	•	•	•	•	•	•	•	•	•	•	•
	AVERAGE OF 3 COURSES (COURSES 10, 11, AND 12), 1884-1895.												
Year	Swedish Turnips	Barley	Fallow	Wheat	8½ cwts. 14½ bush.	2½ cwts. 1201 lbs.	11½ cwts. 1997 lbs.	236 cwts. 27½ bush.	18½ cwts. 1812 lbs.	253½ cwts. 3373 lbs.	344½ cwts. 31½ bush.	37½ cwts. 2505 lbs.	381½ cwts. 4350 lbs.
1884, 1888 and 1892	•	•	•	•	•	•	•	•	•	•	•	•	•
1885, 1889 and 1893	•	•	•	•	•	•	•	•	•	•	•	•	•
1886, 1890 and 1894	•	•	•	•	•	•	•	•	•	•	•	•	•
1887, 1891 and 1895	•	•	•	•	•	•	•	•	•	•	•	•	•

SUMMARY OF TABLE IV. (pp. 106-7).—Results relating to the portions of each plot on which the turnip-crops were either fed off by sheep, or cut and spread on the land; and on which, in the third year of each course (excepting the first, 1850, when clover was grown), the land was left fallow.

Year	AVERAGE OF 8 COURSES (COURSES 2-9), 1852-1883.												
	Swedish Turnips	Barley	Fallow	Wheat	24 cwts. 1784 lbs.	2½ cwts. 3081 lbs.	26½ cwts. 3491 lbs.	150½ cwts. 38½ bush.	11 cwts. 2116 lbs.	161½ cwts. 4148 lbs.	269½ cwts. 48½ bush.	22½ cwts. 3253 lbs.	292 cwts. 6018 lbs.
1852, '56, '60, '64, '72, '76, '80	•	•	•	•	•	•	•	•	•	•	•	•	•
1853, '57, '61, '65, '69, '73, '77, '81	•	•	•	•	•	•	•	•	•	•	•	•	•
1854, '58, '62, '66, '70, '74, '78, '82	•	•	•	•	•	•	•	•	•	•	•	•	•
1855, '59, '63, '67, '71, '75, '79, '83	•	•	•	•	•	•	•	•	•	•	•	•	•
	AVERAGE OF 3 COURSES (COURSES 10, 11, AND 12), 1884-1895.												
Year	Swedish Turnips	Barley	Fallow	Wheat	18½ cwts. 19½ bush.	5½ cwts. 1468 lbs.	25½ cwts. 2871 lbs.	200½ cwts. 17½ bush.	13½ cwts. 1287 lbs.	213½ cwts. 2828 lbs.	406½ cwts. 27½ bush.	37½ cwts. 2178 lbs.	444½ cwts. 3745 lbs.
1884, 1888 and 1892	•	•	•	•	•	•	•	•	•	•	•	•	•
1885, 1889 and 1893	•	•	•	•	•	•	•	•	•	•	•	•	•
1886, 1890 and 1894	•	•	•	•	•	•	•	•	•	•	•	•	•
1887, 1891 and 1895	•	•	•	•	•	•	•	•	•	•	•	•	•

(1) The quantities given in *Bushels* represent the *Dressed* Corn only. (2) The "Total Produce" of the Corn-crops includes Dressed Corn, Oat, Corn, Straw, and Chaff.

RESULTS OF EXPERIMENTS WITH DIFFERENT DESCRIPTIONS OF

DESCRIPTIONS OF WHEAT.	1871;	1872;	1873;	1874;	1875;
	Sawpit Field; 3 cwt. Guano; after Mangels, carted off.	Foster's Field; 2 cwt. Super-phosphate, 2 cwt. Nitrate Soda; after Roots, carted off.	Long Hoos Field; 1½ cwt. Nitrate; after Mangels (with Dung), carted off.	Upper Harpenden Field; 2 cwt. Nitrate; after Mangels (with Dung), carted off.	Little Knott-Wood Field; 1½ cwt. Nitrate Soda; after Mangels (with Dung), 1874, carted off.
DRESSED CORN					
1. White-chaff (Red) .. .. .	.. ..	.. ..	40 ³ / ₈	55 ¹ / ₈	40 ¹ / ₄
2. Rivett's (Red) .. .. .	.. ..	.. ..	48 ¹ / ₈	67	48 ³ / ₈
3. Chubb Wheat (Red)	28 ³ / ₈	40	35 ³ / ₈	50 ¹ / ₂	38 ¹ / ₄
4. Red-chaff (White)	32 ³ / ₈	37	35 ¹ / ₂	48 ³ / ₈	34 ¹ / ₄
5. Browick (Red)	35 ¹ / ₂	40 ¹ / ₂	38 ¹ / ₂	51 ¹ / ₈	38 ¹ / ₂
6. Red Wonder	31 ¹ / ₂	43 ³ / ₈	37 ¹ / ₈	55 ¹ / ₈	33 ¹ / ₄
7. Burwell (Old Red Lammas) ..	31 ¹ / ₈	41 ¹ / ₄	35 ¹ / ₈	47 ¹ / ₄	38 ¹ / ₂
8. Bristol Red	29 ³ / ₈	44 ³ / ₈	39 ¹ / ₂	53 ³ / ₈	31 ³ / ₈
9. Red Nursery	34 ¹ / ₈	45 ¹ / ₂	27 ¹ / ₈	41 ¹ / ₈	39
10. Red Langham	30 ³ / ₈	43 ³ / ₈	34 ¹ / ₈	53 ¹ / ₈	34 ⁷ / ₈
11. Woolly Ear (White)	31 ¹ / ₄	42 ³ / ₈	37	51 ¹ / ₂	36 ¹ / ₂
12. Hardcastle (White) .. .. .	.. ..	40 ¹ / ₂	42	49 ³ / ₈	33 ⁷ / ₈
13. Golden Drop (Red), Hallett's	39 ¹ / ₂	49 ³ / ₈	44 ¹ / ₄	51 ³ / ₈	38 ¹ / ₂
14. Victoria White, Hallett's ..	33 ³ / ₈	45 ¹ / ₄	38 ¹ / ₄	44 ¹ / ₄	33 ³ / ₄
15. Hunter's White, Hallett's ..	26 ³ / ₈	39 ³ / ₈	38 ³ / ₈	45 ³ / ₈	26 ³ / ₈
16. Original Red, Hallett's ..	30	35 ¹ / ₄	36 ³ / ₈	43 ³ / ₈	26
17. White Chiddam	26 ³ / ₈	38 ³ / ₈	31 ³ / ₈	42	32 ³ / ₈
18. Red Rostock	37	.. ..	46 ¹ / ₂	53 ³ / ₈	37 ³ / ₈
19. Casey's White	29 ³ / ₈	42 ¹ / ₄	37 ¹ / ₂	52 ¹ / ₈	39
20. Golden Rough-chaff (Red) ..	33	39 ¹ / ₄	38 ¹ / ₂	52 ¹ / ₈	38 ³ / ₈
21. Bole's Prolific (Red)	33 ³ / ₈	42 ³ / ₈	45 ¹ / ₄	48 ¹ / ₈	43 ³ / ₈
22. Club Wheat (Red)	36	45 ³ / ₈	47 ¹ / ₂	59 ³ / ₈	46 ³ / ₈
23. Main's Standing White .. ..	.. ..	.. ..	.. ..	.. ..	.. ..
24. Main's Rough-chaff (White) ..	.. ..	.. ..	.. ..	.. ..	.. ..
25. Belgian (White) .. .. .	.. ..	.. ..	.. ..	.. ..	.. ..
26. Webb's Challenge (White) ..	.. ..	.. ..	.. ..	.. ..	.. ..
Means	32 ¹ / ₂	42 ¹ / ₄	38 ⁷ / ₈	50 ³ / ₈	36 ¹ / ₂

WEIGHT PER					
1. White-chaff (Red) .. .. .	.. ..	.. ..	58 ¹ / ₂	61 ⁵ / ₈	61
2. Rivett's (Red) .. .. .	.. ..	.. ..	57 ¹ / ₈	58 ¹ / ₈	58 ³ / ₈
3. Chubb Wheat (Red)	60 ¹ / ₄	61 ⁷ / ₈	59 ¹ / ₈	61 ¹ / ₈	59 ¹ / ₂
4. Red-chaff (White)	61 ⁵ / ₈	62 ³ / ₈	60 ³ / ₈	61 ¹ / ₂	60 ¹ / ₂
5. Browick (Red)	60	61 ³ / ₈	59 ¹ / ₂	61 ¹ / ₄	59 ³ / ₈
6. Red Wonder	59	60 ⁷ / ₈	60	62 ¹ / ₄	60 ³ / ₈
7. Burwell (Old Red Lammas) ..	62	63	61 ¹ / ₂	63 ³ / ₈	61 ¹ / ₂
8. Bristol Red	60 ³ / ₈	61 ¹ / ₂	60 ¹ / ₂	61 ³ / ₈	60 ¹ / ₂
9. Red Nursery	63	65	62	65 ¹ / ₂	62 ¹ / ₂
10. Red Langham	60 ³ / ₈	61 ¹ / ₄	60 ¹ / ₂	63	60 ³ / ₈
11. Woolly Ear (White)	61 ¹ / ₈	62 ¹ / ₈	61 ¹ / ₈	62 ³ / ₈	57 ³ / ₈
12. Hardcastle (White) .. .. .	.. ..	61 ⁷ / ₈	59 ³ / ₈	63	59 ⁷ / ₈
13. Golden Drop (Red), Hallett's	61 ³ / ₈	63	59 ³ / ₈	63	61 ¹ / ₈
14. Victoria White, Hallett's ..	61	62 ³ / ₈	59 ³ / ₈	62 ¹ / ₄	61 ³ / ₈
15. Hunter's White, Hallett's ..	59 ¹ / ₄	61 ³ / ₈	57 ¹ / ₄	61 ¹ / ₈	60 ¹ / ₂
16. Original Red, Hallett's ..	58 ⁵ / ₈	60	56 ¹ / ₈	60 ³ / ₈	58 ³ / ₈
17. White Chiddam	62 ¹ / ₂	63	59 ¹ / ₂	62 ³ / ₈	61 ³ / ₈
18. Red Rostock	60 ¹ / ₈	.. ..	56 ³ / ₈	59 ³ / ₈	59 ³ / ₈
19. Casey's White	60 ³ / ₈	61 ¹ / ₂	58 ³ / ₈	60 ³ / ₈	60
20. Golden Rough-chaff (Red) ..	61 ⁵ / ₈	62 ¹ / ₂	59 ³ / ₈	62 ³ / ₈	61 ³ / ₈
21. Bole's Prolific (Red)	61 ¹ / ₂	62 ³ / ₈	57 ¹ / ₂	62	60 ⁷ / ₈
22. Club Wheat (Red)	60 ³ / ₈	61 ⁵ / ₈	58 ¹ / ₂	61 ⁷ / ₈	61 ³ / ₈
23. Main's Standing White .. ..	.. ..	.. ..	.. ..	.. ..	.. ..
24. Main's Rough-chaff (White) ..	.. ..	.. ..	.. ..	.. ..	.. ..
25. Belgian (White) .. .. .	.. ..	.. ..	.. ..	.. ..	.. ..
26. Webb's Challenge (White) ..	.. ..	.. ..	.. ..	.. ..	.. ..
Means	60 ³ / ₄	62 ¹ / ₈	59 ¹ / ₂	61 ⁷ / ₈	60 ¹ / ₂

(1) All the crops were more or less affected by wire-worm, large bare patches appearing on many plots; and much grain was immature and blighted.

(2) Owing doubtless in great part to the imperfect development of the grain from the crop of 1879, much of the wheat sown for the crop of 1880 did not germinate at all, and of that which did come up a great deal was afterward destroyed by wire-worm, so that up to the end of March it was a question whether there would be a plant left in the field worth saving. With the thin wheat plant there was an extraordinary growth of weeds, which the wet month of July much favoured and made it impossible to keep under. The white

WHEAT, 12 YEARS, 1871-1882, EACH YEAR IN A DIFFERENT FIELD.

1876; Harpenden Field; 2 cwt. Nitrate Soda; after Mangels (with Dung), 1875, carted off.	1877; Sawpit Field; 1½ cwt. Nitrate Soda; after Mangels (with Dung), 1876, carted off.	1878; Foster's Field; 2 cwt. Nitrate, after White Turnips (with Dung and Artificial), 1877, part Fed, part carted off.	1879; (1) Little Knott-Wood Field; 2 cwt. Nitrate; after Clover. First and second Crops, as Hay; afterwards Fed.	1880; (2) Harpenden Field; 50 bushels of Soot; after Clover unmanured. One Crop as Hay; afterwards Fed.	1881; Rickyard Field; 1½ cwt. Nitrate Soda; after Mangels (with Dung and Guano), 1880, carted off.	1882; (4) Foster's Field; 2 cwt. Nitrate Soda; after Fallow 1881.	(3) Averages, 8 Years, 1871 to 1878 inclusive.	Nos.
PER ACRE. Bushels.								
49½	48¾	59	22¾	28½	54½		48¾	1
42½	49¾	66½	16	22¾	52½		53¾	2
40½	41½	55½	20¾	14¾	.. ..		41½	3
43¾	41	.. ..	.. ..	.. ..	.. ..		39	4
39½	40¾	49½	24	19½	47½		41¾	5
44½	41¾	52½	22	28½	45¾		42¾	6
38¾	39	46½	27	27	44¾		39¾	7
42¾	44½	52½	21¾	30¾	46½		42¾	8
37½	40¾	47¾	30¾	27½	46		39½	9
42½	42¾	50¾	25¼	28¾	48½		41¾	10
46¾	37½	48½	20	21	44¾		41¾	11
44	42½	54	21½	24¾	45¾		44¾	12
48¾	49½	52¾	21	18¾	50¾		46¾	13
41½	42¾	43¾	14¾	15¾	44		40¾	14
43½	40	42½	17¾	22¾	.. ..		37¾	15
40½	44¾	.. ..	.. ..	.. ..	.. ..		36½	16
37½	37¾	49¾	11½	27¾	47½		37½	17
40	46¾	57	8½	28¾	45¾		45½	18
45½	43	47¾	15¾	24½	42¾		42½	19
38¾	36¾	46¾	14¾	31½	41¾		40¾	20
41¾	44¾	52¾	31	24½	46¾		44	21
47¾	49½	61	23½	16¾	43¾		49½	22
.. ..	.. ..	50½	32½	16½	44½		50½	23
.. ..	.. ..	50¾	24	15¾	39¾		50¾	24
.. ..	.. ..	52½	21¾	9¾	.. ..		52½	25
.. ..	.. ..	.. ..	.. ..	30½	39½		.. ..	26
42½	42¾	51¾	21½	23½	45¾		43½	Means.
BUSHEL. Lbs.								
63	60¾	60¾	51¾	54¾	57¾		61	1
59¾	60¼	58¾	49¾	55¾	56¾		58¾	2
62¾	60½	61½	53	53¾	.. ..		60¾	3
63½	60½	.. ..	.. ..	.. ..	.. ..		61¾	4
62½	60¾	62½	52¾	54¾	60½		61	5
63	61½	63	52½	56¾	60½		61½	6
64¾	61½	64	55¼	58½	61		62¾	7
62¾	59¾	63½	54¾	57½	60¾		61½	8
66	58¾	62¾	57¼	59¾	61¾		63½	9
63¾	61½	63½	54½	56¾	59		61¾	10
63¾	59¾	62½	52¾	55¾	60¾		61¾	11
63½	59¾	61½	52¾	55¾	60½		61¾	12
64¾	61¾	63½	52¾	55¾	61½		62½	13
63¾	61	61¾	51½	56½	60¾		61¾	14
63¾	59½	62½	55	59¼	.. ..		60¾	15
62¾	59	.. ..	.. ..	.. ..	.. ..		59¾	16
64¾	61½	61½	54½	58	60¾		62	17
63½	59½	60½	54	56¾	60¾		59¾	18
63½	59¾	60¾	55¾	58½	61¾		60¾	19
65½	60¾	61¾	54½	57¾	62½		62	20
63¾	60½	63½	55½	55¾	61¾		61½	21
63¼	59¾	62½	52¾	55¾	60¾		61½	22
.. ..	.. ..	61¾	56½	57½	61		61¾	23
.. ..	.. ..	61¾	53½	56½	61½		61¾	24
.. ..	.. ..	60¾	51¾	53¾	.. ..		60¾	25
.. ..	.. ..	.. ..	.. ..	59½	58¾		.. ..	26
63½	60½	62	53½	56¾	60¾		61½	Means.

wheats appeared to suffer most, either from imperfectly developed seed, wire-worm, or blight. The most satisfactory crop was Webb's Challenge, the seed for which was obtained direct from the seedsmen, not grown on the farm, as were the others.
 (3) Owing to the produce of 1879 and 1880 being so exceptionally bad, that of those years is not included in the averages; nor is that of 1881.
 (4) The crop of 1882 was completely beaten down by the high winds and heavy rains of July, which greatly interfered with the proper maturation of the grain; the produce was therefore not kept separate or weighed; and in some places not even threshed.