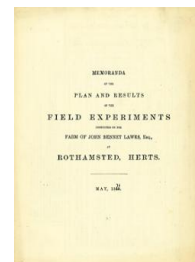


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Memoranda of the Plan and Results of the Field Experiments, May 1870



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Memoranda of the Plans and Results of the Field Experiments at Rothamsted May 1870

Rothamsted Research

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MEMORANDA
OF THE
PLAN AND RESULTS
OF THE
FIELD EXPERIMENTS
CONDUCTED ON THE
FARM OF JOHN BENNET LAWES, Esq.,
AT
ROTHAMSTED, HERTS.

MAY, 18~~60~~⁷⁶.

EXPERIMENTS WITH DIFFERENT MANURES ON PERMANENT MEADOW LAND.
THE PARK.

The Land has probably been laid down with Grass for some centuries. No fresh seed has been artificially sown within the last 30 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 uniform over all the Plots. 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.

(Area under experiment, about 6½ acres.)

PLOTS.	Manures, per acre; fourteenth season—1869.	Produce per Acre, weighed as Hay.			
		Average Annum; 15 Years 1856-1870.	13th Season; 1865.	14th Season; 1869.	15th Season; 1870.
1	200 lbs. Ammonia-salts ⁽¹⁾ [also, for the first 8 years, 1856-1863, 14 tons Farmyard Manure per acre per annum]	46½	41½	61	16½
2	Unmanured, 1864 and since [for the first 8 years, 1856-1863, 14 tons Farmyard Manure per acre per annum]	41½	36½	55½	13½
3	Unmanured, continuously	22½	17½	38	5½
4 ^(a)	Superphosphate of Lime ⁽²⁾	24½	19½	40½	7½
5 ^(b)	ditto	36½	29½	45½	8½
6 ^(c)	400 lbs. "Ammonia-salts"	28½	24	35½	5½
7	Sulphates of Potass, Soda, and Magnesia ⁽³⁾ ; and "Superphosphate of Lime" (previously, 1856-1863 inclusive, Ammonia-salts as Plot 5)	31½	27½	56½	16½
8	ditto	35½	38	54½	17½
9	ditto	32½	21½	46½	15½
10	400 lbs. "Ammonia-salts"	53½	59½	68½	23½
11 ^(a)	800 lbs. "Ammonia-salts"	49½	44½	57½	21½
12	800 lbs. "Ammonia-salts"	61½	63½	75½	42½
13	800 lbs. "Ammonia-salts"	64½	72½	78½	49½
14	Unmanured, continuously	25½	24	38½	11½
15	Sulphates of Potass, Soda, and Magnesia ⁽³⁾ ; "Superphosphate of Lime"	53½	55½	74½	42½
16	550 lbs. Nitrate of Soda ⁽⁴⁾	57½	69	76½	56½
17	550 lbs. ditto	36½	32	58½	15½
18	275 lbs. ditto	48½	51½	74½	33½
19	275 lbs. ditto	53½	29	54½	19½
20	Mixture supplying the quantity of Potass, Soda, Lime, Magnesia, Phosphoric Acid, Silica, and Nitrogen contained in 1 ton of hay (commencing in 1865)	33½	27½	55½	14½

(1) Equal parts Sulphate and Muriate of Ammonia of Commerce.
 (2) 200 lbs. Bone-ash, 150 lbs. Sulphuric Acid (Sp. gr. 1.7).
 (3) Plots 6, 8, and 10, had, besides the Manures specified, 2000 lbs. Sawdust per acre per annum for the first 7 years, 1856-1862, but without effect.
 (4) 300 lbs. Sulphate of Potass, 100 lbs. Sulphate of Soda (200 lbs. 1856-1863), and 100 lbs. Sulphate of Magnesia.
 (5) 250 lbs. Sulphate of Soda (500 lbs. in 1862 and 1863), and 100 lbs. Sulphate of Magnesia (Sulphate of Potass also, as on Plots 7, &c., 1856-1861).
 (6) 800 lbs. in 1856-7-8; only 400 lbs. in 1859-60-61; and 800 lbs. since.
 (7) The application of Silicates did not commence until 1862.
 (8) 550 lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 400 lbs. of "Ammonia-salts."
 (9) Average of 10 years only, as the manures specified were first applied in 1859 (previously, 1856-1868 inclusive, Sawdust only).
 (10) Average of 11 years only, as these experiments did not commence until 1858.
 (11) Average of 4 years only, as the experiment only commenced in 1865.

EXPERIMENTS ON THE GROWTH OF BARLEY YEAR AFTER YEAR ON THE SAME LAND, WITHOUT MANURE, AND WITH DIFFERENT KINDS OF MANURE. HOOS FIELD.

Previous Cropping—1847, Swedish Turnips, with Dung and Superphosphate of Lime, the Roots carted off; 1848, Barley; 1849, Clover; 1850, Wheat; 1851, Barley manured with Ammonia-salts. First Experimental Barley Crop in 1852. Barley every year since; and, unless stated to the contrary in the foot-notes, the same Manure has been applied year after year to the same Plot.

(Area under experiment, about 44 acres.)

PLOTS.	Manures, per acre; eighteenth Season—1869.	PRODUCE PER ACRE.					
		Average per Annum, over 17 Years, 1852-1868.			Dressed Corn.		
		Quantity.	Weight per Bushel.	Total Straw.	17th Season; 1868.	18th Season; 1869.	19th Season; 1870.
1 O.	Unmanured continuously	Bushels.	lbs.	cwts.	Bushels.	Bushels.	Bushels.
2 O.	Superphosphate of Lime ⁽¹⁾	20½	52½	12½	10½	15½	13½
3 O.	Mixed Alkalies ⁽²⁾	26½	53	14	18½	18½	18
4 O.	Ditto	23½	52½	12½	14½	18½	16½
1 A.	200 lbs. Ammonia-salts ⁽³⁾	28½	53	14½	17½	22½	18½
2 A.	200 lbs. ditto	32½	51½	18½	20½	27½	27½
3 A.	200 lbs. ditto	47½	53	28	25	41½	48
4 A.	200 lbs. ditto	35½	52½	20½	25	30½	30½
1 AA.	275 lbs. Nitrate of Soda	46½	53½	28½	34½	49½	38
2 AA.	275 lbs. ditto	37½	51½	22	27	32½	29½
3 AA.	275 lbs. ditto	48½	53½	30½	44	48½	46½
4 AA.	275 lbs. ditto	38	52	24½	27½	32½	32½
1 AAS.	275 lbs. ditto	50½	53½	33	45½	49½	44½
2 AAS.	275 lbs. ditto	38½	51½	23	29½	34½	35
3 AAS.	275 lbs. ditto	49½	52½	31	45	49½	44½
4 AAS.	275 lbs. ditto	40½	52½	25½	36½	40½	42½
1 C.	1000 lbs. Rape-cake	50½	52½	33½	46½	51½	47½
2 C.	1000 lbs. ditto	45½	53½	27½	37	42½	41½
3 C.	1000 lbs. ditto	47½	53½	28½	35½	43½	41½
4 C.	1000 lbs. ditto	43½	52½	27½	35	38½	38½
1 N.	275 lbs. Nitrate of Soda	47½	53	29½	36½	50	43½
2 N.	275 lbs. ditto	37½	52½	23	25½	35½	34½
3 N.	275 lbs. ditto	41½	52½	26	25½	38½	40½
5 O.	200 lbs. Sulphate of Potass.	23½	53	13½	15	23½	14½
5 A.	200 lbs. ditto	44½	53½	28	36½	49	41½
5 M.	100 lbs. each, Sulph. Soda and Sulph. Magnesia; and 200 lbs. "Ammonia-salts"	22½	53	12½	14½	16½	16½
6	Unmanured continuously	23	52½	12½	15½	15½	15½
7	Ashes (burnt soil, turf and weeds)	22½	52½	12½	16	15½	15½
7	Farm-yard dung (14 tons every year)	48	54	28½	48½	46½	47½

(1) 200 lbs. Bone-ash, 150 lbs. Sulphuric acid (sp. gr. 1.7).
 (2) 200 lbs. Sulphate of Potass, 100 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia (for the first six years, 300 lbs., and 100 lbs., respectively).
 (3) Equal parts Sulphate and Muriate of Ammonia of Commerce.
 (4) First 6 years 1852-7, 400 lbs. Ammonia-salts per annum; next 10 years 1858-67, 200 lbs. Ammonia-salts per annum; Nitrate of Soda commenced in 1868. 275 lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 200 lbs. "Ammonia-salts."
 (5) The application of Silicates did not commence until 1864; in 1864-5-6 and 7, 200 lbs. Silicate of Soda and 200 lbs. Silicate of Lime were applied per acre, but in 1868, and since, 400 lbs. Silicate of Soda, and no Silicate of Lime; the 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 remaining halves; and, for the sake of comparison with the latter, the average produce is given for the whole period of 17 years, 1852-1868.
 (6) 2000 lbs. Rape-cake per annum for the first six years, and 1000 lbs. only, each year since.
 (7) 300 lbs. Sulphate of Potass, 200 lbs. Bone-ash, and 150 lbs. Sulphuric acid (sp. gr. 1.7), without Nitrate of Soda, the first year (1852); Nitrate alone each year since.
 (8) 550 lbs. Nitrate of Soda for 1853-4-5-6, and 7; and 275 lbs. only each year since.
 (9) 300 lbs. per annum for the first six years, and 200 lbs. each year since.
 (10) Ammonia-salts also the first year, but not since.
 (11) Average of 16 years only.
 (12) Average of 16 years only.
 (13) Average of 14 years only.

EXPERIMENTS ON THE GROWTH OF WHEAT YEAR AFTER YEAR ON THE SAME LAND; WITHOUT MANURE, AND WITH DIFFERENT KINDS OF MANURE. BROADBALK FIELD.

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 17 years.

(Area under experiment, about 13 acres.)

Plots.	Manures, per acre; twenty-sixth season—1868-9.	PRODUCE PER ACRE.			
		Average per Annum, over 17 Years, 1852-1868.		Dressed Corn.	
		Weight per Bushel.	Total Straw.	25th Season; 1868.	26th Season; 1869.
0	Superphosphate of Lime (three times as much as on No. 5 and succeeding Plots)	Bushels. 17½	cwts. 15½	Bushels. 22½	Bushels. 21½
1	Mixed Alkalies (twice as much as on No. 5 and succeeding Plots)	15½	14½	20½	16½
2	Farm-yard dung (14 tons every year)	35½	34	41½	38½
3	Unmanured continuously	14½	13½	16½	14½
4	Unmanured for Crop of 1852, and since; previously Superphosphate (with Muriatic Acid) and Sulphate Ammonia	16½	14½	17½	14½
5 (a and b)	Mixed Alkalies (1) ; and Superphosphate of Lime (2)	58½	16½	17½	15½
6 (a and b)	ditto ; and 200 lbs. Ammonia-salts (3)	59½	25½	21½	20½
7 (a and b)	ditto ; and 400 lbs. ditto	36½	36½	38½	34½
8 (a and b)	ditto ; and 600 lbs. ditto	59	42½	46½	45½
9 { a	ditto ; and 550 lbs. Nitrate of Soda (4)	58½	41½	47½	39
b	none since 1844 ; and 500 lbs. ditto	27½	29	27½	24½
10 { a	none (except 1844, '48, & '50) ; and 400 lbs. "Ammonia-salts"	23½	22½	24½	20½
b	ditto ; and 400 lbs. ditto	27½	26½	27½	19½
11 (a and b)	none ; "Superphosphate of Lime"	29½	28	33½	22½
12 (a and b)	366½ lbs. (5) Sulphate of Soda ; and 400 lbs. ditto	35	34	33½	35½
13 (a and b)	200 lbs. (6) Sulphate of Potass ; and 400 lbs. ditto	34½	34½	27½	37
14 (a and b)	280 lbs. (7) Sulphate of Magnesia ; and 400 lbs. ditto	34½	34	41½	35½
15 { a	"Mixed Alkalies" ; and 400 lbs. Sulphate Ammonia	33½	33	44½	38½
b	ditto (8) ; and 300 lbs. ditto ; and 500 lbs. Sulphate Ammonia	34½	34½	41½	38½
16 (a and b)	Unmanured in 1865, and since; previously, 1852-64 Mixed Alkalies, Superphosphate, and 800 lbs. Ammonia-salts	39½ (9)	46½ (9)	22½	16½
17 (a and b)	"Mixed Alkalies" ; and "Superphosphate of Lime"	32½ (9)	32½ (9)	37½ (11)	34½
18 (a and b)	none ; and 400 lbs. "Ammonia-Salts"	17½ (10)	16½ (10)	18½ (11)	19
19	none ; Superphosphate of Lime (9) ; 800 lbs. Sulphate Ammonia ; and 500 lbs. Rape-cake	31½	30½	37	23½
20	Unmanured continuously	14½ (12)	14½ (12)	..	13½
21	"Mixed Alkalies" ; "Superphosphate of Lime" ; and 100 lbs. Muriate Ammonia	21½	19½	26½	20½
22	ditto ; and 100 lbs. Sulphate Ammonia	21½	19½	25	16½

(1) Since 1858, 200 lbs. Sulphate of Potass, 100 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia ; for Crop of 1857-8, and previously, 300 lbs., 200 lbs., and 100 lbs., respectively.
 (2) 200 lbs. Bone-ash, 150 lbs. Sulphuric acid (sp. gr. 1.7).
 (3) Equal parts Sulphate and Muriate of Ammonia of Commerce.
 (4) 550 lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 400 lbs. "Ammonia-salts."
 (5) For 1858, and previously 1½ time as much.
 (6) With Muriatic instead of Sulphuric Acid.
 (7) The Manures of Plots 17 and 18 are, respectively, year by year transposed.
 (8) Average whilst manured, 13 years, 1852-1864.
 (9) Average of 17 years' Ammonia-salts, alternated with Mineral Manures.
 (10) Average of 17 years' Mineral Manures, alternated with Ammonia-salts.
 (11) Plots 17 had the Ammonia-salts for the Crop of 1868.
 (12) Plots 18 had the Mineral Manures for the Crop of 1868.
 (13) Average of 16 years, 1852-1867; in 1868, owing to a mistake at the time of sowing, the produce could not be ascertained.
 The Plots marked "(a and b)" are divided into duplicate portions, "a" and "b," respectively, which are 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, and since, cut straw (that produced in the previous season) has been applied (instead of Silicates) on the "a" portions of plots 5, 6, 7, 8, 11, 12, 13, 14, and 17 (or 18).

EXPERIMENTS ON THE GROWTH OF OATS YEAR AFTER YEAR ON THE SAME LAND; WITHOUT MANURE, AND WITH DIFFERENT KINDS OF MANURE.

GEESCROFT FIELD.

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; 1869, First Experimental Oat Crop in 1869.

(Area under Experiment, $\frac{2}{3}$ acre).

PLOTS.		PRODUCE PER ACRE.											
		1ST SEASON, 1869.						2ND SEASON, 1870.					
		Dressed Corn.			Total Straw.			Dressed Corn.			Total Straw.		
		Quantity.	Weight per Bushel.	Total.	Quantity.	Weight per Bushel.	Total.	Quantity.	Weight per Bushel.	Total.	Quantity.	Weight per Bushel.	Total.
1	Unmanured	Bushels, 36 $\frac{3}{4}$	lbs. 36 $\frac{3}{4}$	cwts. 19 $\frac{1}{2}$	Bushels, 10 $\frac{3}{4}$	lbs. 35	cwts. 9 $\frac{1}{2}$	Bushels, 36 $\frac{3}{4}$	lbs. 36 $\frac{3}{4}$	cwts. 19 $\frac{1}{2}$	Bushels, 10 $\frac{3}{4}$	lbs. 35	cwts. 9 $\frac{1}{2}$
2	Mixed Alkalies (1) ; and Superphosphate of Lime (2)	45	38 $\frac{1}{2}$	24 $\frac{1}{2}$	19 $\frac{1}{2}$	35 $\frac{1}{2}$	9 $\frac{1}{2}$	45	38 $\frac{1}{2}$	24 $\frac{1}{2}$	19 $\frac{1}{2}$	35 $\frac{1}{2}$	9 $\frac{1}{2}$
3	400 lbs. Ammonia-salts (3)	56 $\frac{1}{2}$	37 $\frac{1}{2}$	36 $\frac{3}{4}$	30	34 $\frac{3}{4}$	17 $\frac{1}{2}$	56 $\frac{1}{2}$	37 $\frac{1}{2}$	36 $\frac{3}{4}$	30	34 $\frac{3}{4}$	17 $\frac{1}{2}$
4	400 lbs. Ammonia-salts ; "Mixed Alkalies" ; and "Superphosphate of Lime"	75 $\frac{1}{2}$	39 $\frac{1}{2}$	54	50 $\frac{3}{4}$	36	28 $\frac{3}{4}$	75 $\frac{1}{2}$	39 $\frac{1}{2}$	54	50 $\frac{3}{4}$	36	28 $\frac{3}{4}$
5	550 lbs. Nitrate of Soda (4)	62 $\frac{1}{2}$	38 $\frac{1}{2}$	42 $\frac{3}{4}$	36 $\frac{3}{4}$	35 $\frac{1}{2}$	23	62 $\frac{1}{2}$	38 $\frac{1}{2}$	42 $\frac{3}{4}$	36 $\frac{3}{4}$	35 $\frac{1}{2}$	23
6	550 lbs. Nitrate of Soda ; "Mixed Alkalies" ; and "Superphosphate of Lime"	69 $\frac{3}{4}$	39 $\frac{1}{2}$	49 $\frac{1}{2}$	50	35 $\frac{3}{4}$	28 $\frac{3}{4}$	69 $\frac{3}{4}$	39 $\frac{1}{2}$	49 $\frac{1}{2}$	50	35 $\frac{3}{4}$	28 $\frac{3}{4}$

(1) 200 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia.

(2) 200 lbs. Bone-ash, 150 lbs. Sulphuric Acid (sp. gr. 1.7).

(3) Equal parts Sulphate and Muriate of Ammonia of Commerce.

(4) 550 lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 400 lbs. "Ammonia-salts."

EXPERIMENTS ON THE GROWTH OF LEGUMINOUS CROPS.

I.—BEANS, PEAS, AND TARES.

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

Experiments with BEANS were continued 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, and since, beans have been grown, with much the same manures on the same plots, each year, as in 1862.

The general result of the experiments with BEANS has been, that mineral constituents added as manure (more particularly potass, and, to some extent, phosphoric acid also), increased the crop very much during the early years; and, to a certain extent, afterwards, whenever the season was favourable for the crop. Ammonia-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 Graminaceous one grown under parallel circumstances. Nitrate of soda, however, has produced very striking effects. But Leguminous crops grown too frequently on the same land seem to be peculiarly subject to disease, which no combination of manuring that we have hitherto tried seems 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 above described.

In alternating WHEAT with BEANS, the remarkable result has been 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 were also soon abandoned, for the same reason; beans being at first substituted, with some variation in the description of the manures employed; but of late this experiment has likewise been abandoned.

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

Experiments on the growth of Clover, with different descriptions of manure, were commenced in 1849, and, with the occasional interposition of a corn-crop, or fallow, have been continued up to the present time. As with beans, the result was, that mineral constituents applied as manures (particularly potass, and, more or less, phosphoric acid also), considerably increased the early crops; whereas ammonia-salts had little or no effect. But since the first few years all attempts to grow Clover year after year on this land have failed to give anything like a fair crop, or a plant that would stand the usual time on the ground, notwithstanding that fresh seed has been sown again and again.

In one year a portion of the land was trenched 2 feet deep; one-third of the manure being applied at a depth of 16 inches, one-third at a depth of 8 inches, and the remainder on the surface.

The general result of the experiments is, that neither ammonia-salts, nor nitrate of soda, nor organic matter rich in carbon as well as other constituents, nor mineral manures, nor a complex mixture, has availed to restore the clover-yielding capabilities of the land.

It is, however, worthy of remark that, in 1854, Red Clover was sown in a kitchen-garden only a few hundred yards distant from the experimental field, on soil which has been under ordinary garden cultivation for, probably, two or three centuries, and it has every year since shown very luxuriant growth; and, after re-sowing three times during the period (in 1860, 1865, and 1868), there is, at the present time, little or no indication of failure.

Lastly, in the winter of 1867-8, small portions of the experimental land 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 manurial mixtures. From other similarly sized plots the soil was removed to the depths of 9, 18, and 27 inches respectively, and replaced by soil from the same kitchen-garden border, on a portion of which Clover has been successfully grown since 1854, as above referred to. Clover was sown in April, 1868, over the whole of these, and some other portions not so treated; but the plant has, for the most part, died off during the winter, and Clover has been again sown (April, 1869).

EXPERIMENTS ON THE GROWTH OF ROOT-CROPS.

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" 1843-1848, 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 equalize 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 then arranged, having regard to the character of the manures previously applied on the different plots, and to the results previously obtained. This second series was commenced in 1856, and is still in progress.

It is impossible adequately to state the bearing of the results in a few words, but the following are some of the most characteristic indications:—

1. Without manure of any kind, the produce of roots was reduced in a few years to a few cwts. per acre; but the diminutive plants (both root and leaf) contained a very unusually high percentage of nitrogen.

2. Of "mineral" constituents, phosphoric acid (in the form of superphosphate of lime) was by far the most effective manure; but, when this manure is used alone, the immediately available nitrogen of the soil is rapidly exhausted.

3. Really large crops of turnips can only be obtained when the soil supplies a liberal amount of both carbonaceous and nitrogenous matter (as well as mineral constituents); and when they are already available within the soil, or are supplied in the form of farmyard manure, rape-cake, Peruvian guano, ammonia-salts, &c., the rapidity of growth and the amount of the crop are greatly increased by the use of superphosphate of lime applied near to the seed.

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

AGDELL FIELD.

These Experiments were commenced in 1848; so that the present crop (1869) is the 22nd experimental one, or the second crop of the Sixth Course One-third of the land has been continuously unmanured; one-third manured with Superphosphate of Lime alone once every four years, that is for the turnip-crop commencing each course; and one-third manured (also for the turnip-crop only) with a complex manure, as described in the foot-note, No. 2.

In the Second, Third, Fourth, and Fifth Courses, instead of clover, half of each plot was sown with beans, and the other half left fallow. From half of each of the three plots the whole turnip-crop (roots and leaves) was removed; and on the other half the roots were eaten on the land by sheep, and the uncuten leaves were spread and ploughed in. In the case of all the other crops, the total produce was removed from the land. The abstract of results given below relates to the portions of each plot from which the turnip-crops were entirely removed; and on which, in the later courses, beans (not fallow) replaced the clover.

(Area under experiment, about 2½ acres.)

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 (1), alone, for the Turnip Crops only.			PLOT 3. Complex Manure (2), for the Turnip Crops only.		
		Corn (3) (or Roots).	Straw (or Leaf).	Total Produce (4).	Corn (3) (or Roots).	Straw (or Leaf).	Total Produce (4).	Corn (3) (or Roots).	Straw (or Leaf).	Total Produce (4).
1ST COURSE, 1848-51.										
1848	Norfolk White Turnips	65½ cwt.	45½ cwt.	111½ cwt.	225½ cwt.	106½ cwt.	332 cwt.	218 cwt.	151½ cwt.	369½ cwt.
1849	Barley	44½ bush.	2983 lbs.	5656 lbs.	29½ bush.	2111 lbs.	3841 lbs.	28½ bush.	2088 lbs.	379½ lbs.
1850	Clover (calcd. as hay)	..	..	54 cwt.	..	..	57½ cwt.	..	..	63 cwt.
1851	Wheat	28½ bush.	3431 lbs.	5389 lbs.	29½ bush.	3371 lbs.	5253 lbs.	28½ bush.	3552 lbs.	5500 lbs.
2ND COURSE, 1852-55.										
1852	Swedish Turnips	26 cwt.	4½ cwt.	30½ cwt.	223½ cwt.	20½ cwt.	243½ cwt.	396½ cwt.	56½ cwt.	433 cwt.
1853	Barley	34½ bush.	2430 lbs.	4465 lbs.	28½ bush.	1873 lbs.	3560 lbs.	32½ bush.	2604 lbs.	4873 lbs.
1854	Beans	5½ bush.	1055 lbs.	1445 lbs.	5½ bush.	1103 lbs.	1534 lbs.	9½ bush.	1355 lbs.	2065 lbs.
1855	Wheat	35½ bush.	3619 lbs.	5859 lbs.	33½ bush.	3525 lbs.	5789 lbs.	37½ bush.	3942 lbs.	6371 lbs.
3RD COURSE, 1856-59.										
1856	Swedish Turnips	32 cwt.	2½ cwt.	34½ cwt.	136 cwt.	7½ cwt.	143½ cwt.	333½ cwt.	12½ cwt.	346½ cwt.
1857	Barley	48½ bush.	2600 lbs.	5337 lbs.	23½ bush.	1475 lbs.	3076 lbs.	48 bush.	2433 lbs.	5163 lbs.
1858	Beans	6½ bush.	1100 lbs.	1515 lbs.	6½ bush.	1155 lbs.	1605 lbs.	12½ bush.	1520 lbs.	2357 lbs.
1859	Wheat	35½ bush.	4030 lbs.	6282 lbs.	34½ bush.	3930 lbs.	6120 lbs.	39½ bush.	4610 lbs.	7154 lbs.
4TH COURSE, 1860-63.										
1860	Swedish Turnips	1 cwt.	(6½ lbs.)	1 cwt.	29½ cwt.	1½ cwt.	30½ cwt.	87½ cwt.	3½ cwt.	90½ cwt.
1861	Barley	38½ bush.	2522 lbs.	4718 lbs.	30½ bush.	2000 lbs.	3775 lbs.	60½ bush.	3940 lbs.	7391 lbs.
1862	Beans	29 bush.	1840 lbs.	3661 lbs.	29½ bush.	2150 lbs.	4040 lbs.	43½ bush.	3280 lbs.	5990 lbs.
1863	Wheat	44½ bush.	3467 lbs.	6350 lbs.	34½ bush.	3390 lbs.	5619 lbs.	46½ bush.	4697 lbs.	7626 lbs.
5TH COURSE, 1864-67.										
1864	Swedish Turnips	8½ cwt.	0½ cwt.	9½ cwt.	63 cwt.	4½ cwt.	72½ cwt.	176½ cwt.	8½ cwt.	185 cwt.
1865	Barley	39 bush.	2154 lbs.	4182 lbs.	33½ bush.	1615 lbs.	3394 lbs.	47½ bush.	2395 lbs.	5148 lbs.
1866	Beans	10½ bush.	1013 lbs.	1689 lbs.	7½ bush.	978 lbs.	1463 lbs.	12½ bush.	1990 lbs.	3343 lbs.
1867	Wheat	21 bush.	2143 lbs.	3473 lbs.	19½ bush.	1966 lbs.	3222 lbs.	23½ bush.	3003 lbs.	4567 lbs.
SUMMARY—AVERAGE OF THE 5 COURSES, 1848-1867.										
1848, '52, '56, '60, '64	Swedish Turnips	26½ cwt.	10½ cwt.	37½ cwt.	136½ cwt.	28 cwt.	164½ cwt.	242½ cwt.	42½ cwt.	285 cwt.
1849, '53, '57, '61, '65	Barley	41½ bush.	2538 lbs.	4872 lbs.	30½ bush.	1815 lbs.	3529 lbs.	44½ bush.	2732 lbs.	5275 lbs.
1850, '54 '58, '62, '66	(Clover, 1850 (calcd. as hay) Beans . . . . .	.. 12½ bush.	.. 1252 lbs.	54 cwt. 2078 lbs.	.. 12½ bush.	.. 1347 lbs.	57½ cwt. 2161 lbs.	.. 21½ bush.	.. 2036 lbs.	63 cwt. 3439 lbs.
1851, '55, '59, '63, '67	Wheat	33 bush.	3338 lbs.	5467 lbs.	30½ bush.	3236 lbs.	5200 lbs.	35½ bush.	3961 lbs.	6244 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, and Sixth Courses—200 lbs. Bone-ash, and 150 lbs. Sulphuric Acid, per acre.
 (2) 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 Potass, 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, and Sixth Courses—300 lbs. Sulphate of Potass, 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.
 (3) The quantities given in Bushels represent the Dressed Corn only.
 (4) The "Total Produce" of the Corn-crops includes Dressed Corn, Offal Corn, and Total Straw.