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Memoranda of the Plan and Results of the Rothamsted Field Experiments, May 1866



[Full Table of Content](#)

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MEMORANDA
OF THE
PLAN AND RESULTS
OF THE
ROTHAMSTED FIELD EXPERIMENTS.

MAY, 1866.

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 to the same Plots year after year.

(Area under experiment, about 6½ acres.)

PLOTS.	Manures, per acre ; eleventh season—1866.				Produce per Acre, weighed as Hay.	
	1 acre .. 1 lb. (pound avoird.) .. 1 cwt. (hundredweight) .. 1 ton .. 1 lb. per acre .. 1 cwt. per acre ..	0.40 Hectare 0.45 Kilogramme .. 51.0 .. 1016.0 .. 1.12 Kilogramme per Hectare .. 125.5 Kilogrammes per Hectare or	.. or or or or or or ..	1.59 Prussian Morgen. 0.91 Zollverein Pfund. 1.02 Centner. 20.33 Centner. 0.57 Zollv. Pfd. per Pr. Morgen. 0.64 Centner per Pr. Morgen.	Average per Annum ; 10 Years 1856-1865.	Tenth Season ; 1865.
1	200 lbs. Ammonia-salts (1) [also 14 tons Farmyard Manure per acre per annum, for 8 years, 1856-1863]	..	..	..	Cwts. 49½ (7)	32½
2	Unmanured, 1864 and since [14 tons Farmyard Manure per acre per annum, for 8 years, 1856-1863]	..	..	..	43 (7)	25½
3	Unmanured, continuously	..	..	..	22½	11½
4(a)	Superphosphate of Lime (2)	..	..	..	24½ (8)	11
5	ditto	..	..	..	39½ (8)	26
6	400 lbs. "Ammonia-salts" .. ditto	..	..	..	30½	15½
7	400 lbs. ditto	..	..	..	31½	16
8	Superphosphate of Lime (2) ; and "Superphosphate of Lime" .. ditto	..	..	..	34	22½
9	Sulphates of Potass, Soda, and Magnesia (3) ; Sulphates of Potass, Soda, and Magnesia (4) ; Sulphates of Potass, Soda, and Magnesia (5) ; Sulphates of Potass, Soda, and Magnesia (6) ; Sulphates of Potass, Soda, and Magnesia (7) ; Sulphates of Potass, Soda, and Magnesia (8) ;	..	..	..	33½	17
10	..	..	..	..	58½	54½
11	..	..	..	..	52½	52½
11a	..	..	..	..	61½	52
12	Unmanured, continuously	..	..	..	66½ (9)	55½
13	Sulphates of Potass, Soda, and Magnesia (6) ; "Superphosphate of Lime" .. ; 400 lbs. "Ammonia-salts" ; and 2000 lbs. Cut Wheat-straw	..	..	..	25	17½
14	Sulphates of Potass, Soda, and Magnesia (4) ; "Superphosphate of Lime" .. ; and 550 lbs. Nitrate of Soda ..	..	..	..	54½	41½
15	none	..	..	..	53	47½
16	Sulphates of Potass, Soda, and Magnesia (4) ; "Superphosphate of Lime" .. ; and 275 lbs. ditto	..	..	..	45½ (10)	36
17	none	..	..	..	34½	28½
18	Mixture supplying the quantity of Potass, Soda, Lime, Magnesia, Phosphoric Acid, Silica, and Nitrogen contained in 1 ton of hay (commencing in 1865)	..	..	..	...	21½

(1) Equal parts Sulphate and Muriate of Ammonia of Commerce.
 (2) Plots 6, 8, and 10, had, besides the Manures specified, 2000 lbs. Sawdust per acre per annum for 7 years, 1856-1862, but without effect.
 (3) 300 lbs. Sulphate of Potass, 100 lbs. Sulphate of Soda (200 lbs. 1856-1863), and 100 lbs. Sulphate of Magnesia.
 (4) 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).
 (5) 800 lbs. in 1856-7-8 ; only 400 lbs. in 1859-60-61 ; and 800 lbs. since.
 (6) Average of 8 years only, 1856-1863.
 (7) Average of 4 years only, the application of Silicates not being commenced until 1862.
 (8) Average of 7 years only, 1859-1865.
 (9) Average of 8 years only, as these experiments did not commence until 1858.

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, with one or two exceptions, the same Manures on the same Plots each year.

(Area under experiment, about 4½ acres.)

PLOTS.	Manures, per acre; fifteen Year Season—1866.	PRODUCE PER ACRE.					
		Average per Annum, over 14 Years, 1852-1865.			Fourteenth Season, 1865.		
		Dressed Corn.		Total Straw.	Dressed Corn.		Total Straw.
		Quantity, Bushels.	Weight per Bushel.	Quantity, Bushels.	Weight per Bushel.	Quantity, Bushels.	Weight per Bushel.
1 O.	Unmanured continuously	21½	52	12½	18	54	8
2 O.	Superphosphate of Lime (1)	27½	53½	14½	22½	53½	9
3 O.	Mixed Alkalies (2)	24½	52½	13½	22	54½	9½
4 O.	Do. do.	30½	53	15½	24½	54	10
6(1)	Unmanured continuously	24½	52½	13½	21	53½	8½
7	Ashes (burnt soil, turf, and weeds)	23½	52½	12½	19½	53½	8½
	Farm-yard dung (14 tons every year)	48½	52½	28½	52½	54½	25½
1 A.	200 lbs. Ammonia-salts (3)	34½	51½	19½	29½	53	13
2 A.	do. do.	48½	52½	28½	48½	52½	21½
3 A.	do. do.	36½	51½	21½	33½	54½	16
4 A.	do. do.	47½	52½	29½	46½	53½	22½
1 A.A.	do. do.	30½	51½	23½	33½	53	16
2 A.A.	do. do.	50½	52½	31½	47½	52½	23
3 A.A.	do. do.	39½	51½	25½	34½	54½	17
4 A.A.	do. do.	51	52½	34	49	53½	24½
1 A.A.S.	do. do.	39½	55½	24½	35	54½	22½
2 A.A.S.	do. do.	51	54½	28½	47½	52½	23½
3 A.A.S.	do. do.	45½	56	25½	41	54½	20½
4 A.A.S.	do. do.	54½	55	33½	50½	53	25½
1 C.	1000 lbs. (4) Rape-cake	46½	52½	28½	45	53	21½
2 C.	do. do.	48½	52½	30	46½	53½	22
3 C.	do. do.	44½	52½	28½	48½	53½	22
4 C.	do. do.	48½	52½	30½	48½	53½	22
1 N. (7)	275 lbs. Nitrate of Soda	38½ (11)	52½ (11)	23½ (11)	37	54	18½
2 N. (7)	do. do.	43 (11)	52 (11)	27½ (11)	39½	53½	21½
5 O.	200 lbs. (8) Sulphate of Potash	24½ (12)	52½ (12)	13½ (12)	23	54½	10½
	do. do.	46½ (12)	52½ (12)	29½ (12)	48½	54½	24½
M.	100 lbs. each, Sulph. Soda and Sulph. Magnesia; and	25½ (13)	52½ (13)	12½ (13)	19½	54½	9½

(1) 200 lbs. Bone-ash, 150 lbs. Sulphuric acid (sp. gr. 1.7). (2) 200 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, and 100 lbs. Magnesia (for the first six years, 300 lbs., 200 lbs., and 100 lbs., respectively).
 (3) Equal parts Sulphate and Muriate of Ammonia of Commerce. (4) 400 lbs. per annum for the first six years, and 200 lbs. only each year since.
 (5) The application of Silicates did not commence until 1864, so that the average produce given applies to two years only (1864 and 1865). These Silicated plots ("AAS") comprise, respectively, one half of the original "AA" plots, and, as will be seen, they continue to be, in other respects, manured in the same way as the remaining halves.
 (6) 2000 lbs. per annum for the first six years, and 1000 lbs. only, each year since. (7) 300 lbs. Sulphate of Potash, 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 13 years only. (12) Average of 11 years only. (13) Average of 11 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 14 years.

Plots.	Manures, per acre; twenty-third season—1866.	PRODUCE PER ACRE.					
		Average per Annum, over 14 Years, 1852-1865.			Twenty-second Season, 1865.		
		Dressed Corn.		Total Straw.	Dressed Corn.		Total Straw.
		Quantity.	Weight per Bushel.	Quantity.	Weight per Bushel.	Quantity.	Weight per Bushel.
0	Superphosphate of Lime (three times as much as on No. 5 and succeeding Plots)	Bushels.	cvts.	Bushels.	lbs.	cvts.	
1	Mixed Alkalies (twice as much as on No. 5 and succeeding Plots)	18	15½	12½	59	10¼	
2	Farm-yard dung (14 tons every year)	16	15	12½	59	9½	
3	Unmanured continuously	35½	34	37½	61½	27½	
4	Unmanured for Crop of 1852, and since (previously Superphosphate and Ammonia-salts)	15½	14½	14½	60½	9½	
5 (a and b)	Mixed Alkalies ⁽¹⁾ ; and Superphosphate of Lime ⁽²⁾	16½	16½	14½	61	10½	
6 (a and b)	ditto	18	16½	14½	61	10½	
7 (a and b)	ditto	28½	26½	25	61	18	
8 (a and b)	ditto	37½	37½	40	61½	32½	
9 { a	ditto	39½	42½	43½	61½	41	
10 { b	ditto	36½	40½	44	61	41½	
11 (a and b)	none since 1844	26½	28½	29½	59½	28	
12 (a and b)	none (except 1844, '48 and '50); none since 1844	23½	23½	25½	59½	21½	
13 (a and b)	none (except 1844, '48 and '50); none (except 1844, '48, & '50);	27½	27½	30½	59½	24	
14 (a and b)	Superphosphate of Lime	30	28½	27½	57½	22½	
15 { a	Superphosphate of Lime	35½	33	34½	60	27½	
16 (a and b)	Superphosphate of Lime	39	35	37	61	30½	
17 (a and b)	Superphosphate of Lime	35½	35½	36½	60½	28½	
18 (a and b)	Superphosphate of Lime	33½	33½	35½	60½	28	
19	Superphosphate of Lime	35½	35½	36½	61½	30½	
20	Superphosphate of Lime	32½	31	32½	58½	26½	
21	Superphosphate of Lime	15½	14½	13½	60½	11½	
22	Superphosphate of Lime	22	20½	18½	58	13	
	Superphosphate of Lime	21½	20	19½	58½	13½	

(1) Since 1858, 200 lbs. Sulphate of Soda, 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) For 1858, and previously 1½ time as much. (5) With Hydrochloric instead of Sulphuric Acid. (6) The Manures of 17 and 18 alternate. (7) Average of 14 years' Ammonia-salts alternated with Mineral Manures. (8) Average of 14 years' Mineral Manures alternated with Ammonia-salts. (9) Plots 17 had the Mineral Manures for the Crop of 1865. (10) Plots 18 had the Ammonia-salts for the Crop of 1865. The Plots marked "(a and b)" are divided into duplicate portions, "a" and "b," respectively, which are manured alike; excepting that, for the crop of 1864, and since, the "a" portions of plots 5, 6, 7, 8, 9, 16, and 17 (or 18), have received a mixture of soluble Silicates in addition to the other Manures, but, hitherto, without any material effect.

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 9 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 as in 1862.

The general result of the experiments with BEANS was, 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 Gramineous 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 8 crops of wheat in alternation with the highly nitrogenous beans, as in 16

crops of wheat grown consecutively without manure, and also nearly as much as were obtained in another field in 8 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 ammoniacal-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 two 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 ammoniacal-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 twice during the period (in 1860 and 1865), there is, at the present time, little or no indication of failure.

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 (1866) is the 19th experimental one, or the third crop of the Fifth 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, and Fourth 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 uneaten 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.

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 (or roots).	Straw (or Leaf).	Total Produce.	Corn (or Roots).	Straw (or Leaf).	Total Produce.	Corn (or Roots).	Straw (or Leaf).	Total Produce.	Corn (or Roots).	Straw (or Leaf).	Total Produce.										
1ST COURSE, 1848-51.																							
1848	Swedish Turnips	175½ cwt.	19½ cwt.	195 cwt.	292 cwt.	35 cwt.	327 cwt.	394½ cwt.	46½ cwt.	441 cwt.													
1849	Barley	1706 lbs.	2088 lbs.	3794 lbs.	1705 lbs.	1870 lbs.	3575 lbs.	2673 lbs.	2983 lbs.	5656 lbs.													
1850	Clover (weighed green)	..	..	1944 cwt.	..	..	139¼ cwt.	..	..	219½ cwt.							
1851	Wheat	1958 lbs.	3431 lbs.	5389 lbs.	1882 lbs.	3371 lbs.	5253 lbs.	1948 lbs.	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.	36½ cwt.	433 cwt.													
1853	Barley	2035 lbs.	2430 lbs.	4465 lbs.	1687 lbs.	1873 lbs.	3560 lbs.	2269 lbs.	2604 lbs.	4873 lbs.													
1854	Beans	390 lbs.	1055 lbs.	1445 lbs.	431 lbs.	1103 lbs.	1534 lbs.	710 lbs.	1355 lbs.	2065 lbs.													
1855	Wheat	2240 lbs.	3619 lbs.	5859 lbs.	2264 lbs.	3525 lbs.	5789 lbs.	2429 lbs.	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	2737 lbs.	2600 lbs.	5337 lbs.	1601 lbs.	1475 lbs.	3076 lbs.	2733 lbs.	2435 lbs.	5163 lbs.													
1858	Beans	415 lbs.	1100 lbs.	1515 lbs.	450 lbs.	1155 lbs.	1605 lbs.	897 lbs.	1520 lbs.	2357 lbs.													
1859	Wheat	2232 lbs.	4030 lbs.	6262 lbs.	2190 lbs.	3930 lbs.	6120 lbs.	2544 lbs.	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	2196 lbs.	2522 lbs.	4718 lbs.	1775 lbs.	2000 lbs.	3775 lbs.	345½ lbs.	3940 lbs.	7891 lbs.													
1862	Beans	1821 lbs.	1840 lbs.	3661 lbs.	1800 lbs.	2150 lbs.	4040 lbs.	2710 lbs.	3280 lbs.	5990 lbs.													
1863	Wheat	2883 lbs.	3467 lbs.	6350 lbs.	2229 lbs.	3380 lbs.	5619 lbs.	2929 lbs.	4697 lbs.	7626 lbs.													
5TH COURSE, 1864-67.																							
1864	Swedish Turnips	8½ cwt.	3½ cwt.	9½ cwt.	68 cwt.	4½ cwt.	72½ cwt.	176½ cwt.	8½ cwt.	185 cwt.													
1865	Barley	2028 lbs.	2154 lbs.	4182 lbs.	1779 lbs.	1615 lbs.	3394 lbs.	2553 lbs.	2595 lbs.	5148 lbs.													
1866	Beans	676 lbs.	1013 lbs.	1689 lbs.	485 lbs.	970 lbs.	1463 lbs.	1353 lbs.	1990 lbs.	3243 lbs.													
1867	Wheat	1330 lbs.	2143 lbs.	3473 lbs.	1256 lbs.	1966 lbs.	3222 lbs.	1564 lbs.	3023 lbs.	4567 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 and Fifth Courses—200 lbs. Bone-ash, and 150 lbs. Sulphuric Acid per acre.
 (2) First Course—100 lbs. Bone-ash, 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. Muriate of Ammonia, and 2000 lbs. Rape-cake; Third, Fourth and Fifth 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, and 2000 lbs. Muriate of Ammonia, and 2000 lbs. Rape-cake, per acre.