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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

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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.

	5				199	1.1			15.			
			15th Season; 1870.	-	Cwts. 164 135 135 54 5	164 164 164 164 164 164 164 164 164 164	171 294 214 214 214 214 214 214 214 214 214 21	112 114	$42_{\frac{5}{2}}$	56 33 33 19 19 19 19 19	14§	
		er Acre, as Hay.	I4th Season; 1869.		Cwts. 61 354 38	50 55 55 50 55 50 55 50 50 50 50 50 50 50 50 50 50 50 50 5	54 56 56 56 56 56 56 56 56 56 56 56 56 56	387 387	$74\frac{3}{4}$	761 544 544 544	55 <sup>5</sup>	
		Produce I weighed	I3th Season; 1868.	Ì	Cwts. 412 362 175	$19\frac{3}{4}$ $29\frac{1}{4}$ $27\frac{1}{2}$ $27\frac{1}{2}$	2278 5274 6638 6838 6838 6838 6838 6838 6838 683	124 24	554		27 <u>3</u>	
(Answertig)       (Answertig)			Average Per Annum; 15 Years	1870.	Cwts. $46_{8}^{6}$ $41_{8}^{1}$ $22_{4}^{2}$	245 361 314 314	351 532 611		533	578 364 358 358	33 <mark>8</mark>	
	(Area under experiment, about 6 <sup>2</sup> acres.)	=	1 cwt. (numerewergur) = $\frac{1}{1000}$ Kilogrammes or 20-33 Centuer. 1 ton = $\frac{1}{10}$ tot 1.12 Kilogrammes er Hectare or 0.57 Zollyr. Pfth. per Pr. Morgen. 1 l.b. per acre = $\frac{1}{10}$ about) 125-5 Kilogrammes per Hectare or 0.64 Centuer per Pr. Morgen.		200 lbs. Ammonia-salts <sup>(0)</sup> [also, for the first 8 years, 1856-1863, 14 tons Farmyard Manure per acre per ammum]	Commanueor, continuousy	Sulphates of Potass, Soda, and Magnesia (9) ditto Sulphates of Potass, Soda, and Magnesia (9) ditto Sulphates of Potass, Soda, and Magnesia (9) ditto Sulphates of Potas and Magnesia (9) ditto Sulphates of Soda and Magnesia (9) ditto Sulphates of Soda and Magnesia (9) ditto Sulphates of Soda and Magnesia (9) ditto	Suppartes of Potass, Soda, and Magnesia (); ditto ; 800 lbs.() "Ammonia-salts; and 200 lbs. each, Silicate of Soda and Sulcate of Lune (); Sulphates of Potass, Soda, and Magnesia ();	Unmanured, continuously	Sulphates of Potass, Soda, and Magnesia <sup>(6)</sup> ; "Superphosphate of Lime" ; and 550 lbs. Nitrate of Soda <sup>(8)</sup>	none 1; Mixture supplying the quantity of Potass, Soda, Lime, Magnesia, Phosphorio Acid, Silica, and Nitrogen contained in 1 ton of hay (commencing in 1865)	<ol> <li>(b) Equal parts Sulphate and Muriate of Ammonia of Commerce.</li> <li>(c) Equal parts Sulphate and Muriate of Ammonia of Commerce.</li> <li>(e) Plotes (b), Bone-salp, 150 liss. Sulpharic Acid (Sp. gr. 1.7).</li> <li>(e) Plotes (c), and 10, had, besides the Manures specified, 2000 lise. Sawdust per acore per ammum for the first 7 years, 1856-1862, but without effect.</li> <li>(e) Sulphate of Sulphate of Soda (500 lise. in 1882 and 1863), and 100 lise. Sulphate of Magnesia.</li> <li>(e) 250 lise. Sulphate of Soda (500 lise. in 1885-60-61; and 100 lise. Sulphate of Magnesia.</li> <li>(f) Re application of Silicates did not commerce until 1862.</li> <li>(f) The application of Silicates did not commerce until 1862.</li> <li>(g) Average of 10 years only, as these experiments did not commence until 1853.</li> <li>(h) Average of 10 years only, as these experiments did not commence until 1853.</li> <li>(h) Average of 4 years only, as the experiment did not commence until 1853.</li> <li>(h) Average of 4 years only, as the experiment did not commence until 1853.</li> <li>(h) Average of 4 years only, as the experiment of N commence until 1853.</li> </ol>

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

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-salks. 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 to Barley every year since; and, unless stated to the contrary in the foot-notes, the same Manure has been applied year after year HOOS FIELD.

1	1	.	0. i		ola Hoi Pao	( 3	) )	014004 K00004	গৰনক	10004-00	14-14-10	ut ut
	orn.		1, Season; 1870.	Bushels. 13 <sup>1</sup> /2 18 16 <sup>3</sup> /3 18 <sup>1</sup> /2 18 <sup>1</sup> /2	273 411 306 38	29414622 3223414644	35 44 44 44 42 45 84 84 84 84 84 84 84 84 84 84 84 84 84	414 3014 100 100 100 100 100 100 100 100 100	34 <u>8</u> 404	141 4182 161 81	154 154 474	he whole without
	Dressed Corn.		Loun Season; 1869.	Bushels, 157 1884 1882 1882 2244 2224	272 48 848 4948	3 2 2 4 2 8 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	349 49 51 25 21 25 25 25 24 25 24 25 24 25 24 25 25 25 25 25 25 25 25 25 25 25 25 25	44 44 50 16 88 44 70 16 88 44 800 10	00 00 00 00 00	238 497 168	1588 1588 468	is given for the gear since. (sp. gr. 1 <sup>.7</sup> ), ce.
R ACRE.	Dr	1.71	Season; 1868.	Busbels. 102 181 141 142 172 172	$20\frac{2}{37\frac{3}{4}}$ 25 $34\frac{3}{4}$	27 44 27 45 27	$29_{2}^{1}$ 45 $36_{2}^{1}$ $46_{4}^{2}$	37 354 354 364	251 253	$15 \\ 36 \\ 14 \\ 36 \\ 14 \\ 36 \\ 14 \\ 36 \\ 36 \\ 36 \\ 36 \\ 36 \\ 36 \\ 36 \\ 3$	$15_{4}^{1.54}$ $16_{433}^{4.33}$	oduce is given fi each year since. acid (sp. gr. 1 <sup>-</sup> ar since.
PRODUCE PER	n, over 1868.	1.11.11	Straw	cwts. 124 14 123 123 123	18 28 28 28 28 28	22 30 <u>분</u> 24 <sub>4</sub> 33	23 31 254 334 334	27 <b>분</b> 27 <b>분</b> 27 <u></u> 27	$\frac{23}{26} \left\{ (\mathrm{u}) \right.$	$\frac{12\frac{3}{28}}{228} \Big\} ( \mathbf{F} ) \\ 12\frac{3}{2} ( 13 )$	$\frac{12_3}{28_4}$	<i>erage proc</i> bs. only, e ulphuric a y each yea
PR	Average per Annum, ove 17 Years, 1852-1868.	Corn.	Weight Per Bushel.	1bs. 524 53 53 53 53	51 53 53 53 53 5 54 5 53 5 5 5 5 5 5 5 5 5	51 52 52 52 8	513 523 524 524 524	534 534 534	$52\frac{4}{52\frac{4}{4}}$ (11)	53 53} (19) 53 (19)	524 524 54	tter, the average pr and 1000 lbs, only, 150 lbs, Sulphuric since. 75 lbs, only each ye each year since.
	Average 17 Yes	Dressed Corn.	Quantity.	Bushels. 202 234 234 234 234 234 234 234	322 3514 4634 4634 4634 4	37월 87월 50월 50월	388 494 502440 50244	453 474 454 454 454 474 474 474	$\frac{37\frac{1}{4}}{41\frac{1}{2}}$ (P)	$\frac{23\frac{1}{44\frac{1}{2}}}{\frac{44\frac{1}{2}}{22\frac{1}{4}}}\binom{12}{13}$	23 22# 48	ith the la six years, -ash, and each year l 7; and 2 nd 200 lbs, since,
acre = (about) 0.40 Hectare	$ \begin{array}{llllllllllllllllllllllllllllllllllll$	bushel per acre	Manures, per acre ; eighteenth Season—1869	Unmanured continuously	200 Ibs. Annonia-salts <sup>(3)</sup>	275 lbs. Nitrate of Soda       : and "Superphosphate of Line"       :	ditto	Rape-cake	275 lbs. Nitrate of Soda	200 lbs. <sup>(0)</sup> Sulphate of Potass. ; and "Superphosphate of Lime <sup>, 00)</sup>	Unmanured continuously	<ol> <li>(1) 200 lbs. Bone-ash, 150 lbs. Sulphate of (sp. gr. 1-7).</li> <li>(2) 200 lbs. Sulphate of Fotass, 100 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Fotass, 200 lbs. Hape-cake per annum for the first six years, and 1000 lbs. only. each year since.         <ul> <li>(5) 2000 lbs. Sulphate of Fotass, 200 lbs. Sulphate of Soda, and 100 lbs. only. each year since.</li> <li>(6) 2000 lbs. Rape-cake per annum for the first six years, and 1000 lbs. only. each year since.</li> <li>(7) 300 lbs. Sulphate of Fotass, 200 lbs. Bone-ash, and 150 lbs. Sulpharic action (1582); Nitrate of Soda in Scalar stress, and 100 lbs. only each year since.</li> <li>(7) 300 lbs. Sulphate of Fotas, 200 lbs. Base each year since.</li> <li>(8) Sulphate of Soda, the first year (1582); Nitrate alone each year since.</li> <li>(9) 300 lbs. Sulphate of Soda for 151 bs. Nitrate of Soda in 156 lbs. Nitrate of Soda for 151 bs. only each year since.</li> <li>(9) 300 lbs. per annum for the first six years, and 200 lbs. each year since.</li> <li>(9) 300 lbs. per annum for the first six years, and 200 lbs. each year since.</li> <li>(9) 200 lbs. the annum for the first six years, and 200 lbs. each year since.</li> <li>(9) 200 lbs. the annum for the first six years, and 200 lbs. each year since.</li> <li>(9) 200 lbs. per annum for the first year, but not since.</li> <li>(10) 200 lbs. the annum for the first year, but not since.</li> <li>(10) 200 lbs. the first year, but not since.</li> <li>(10) 200 lbs. the annum for the first year, but not since.</li> <li>(10) Amonizealts and the first year, but not since.</li> <li>(10) Amonizealts and the first year, but not since.</li> <li>(10) Amonizealts and the first year, but not since.</li> <l< td=""></l<></ul></li></ol>
		2	2	Unmanured confir Superphosphate of Mixed Alkalies <sup>(3)</sup> Ditto	200 Ibs. / 200 Ibs. 200 Ibs. 200 Ibs.		<ul> <li>S. 275 Ibs.</li> <li>S. 275 Ibs.</li> <li>S. 275 Ibs.</li> <li>S. 275 Ibs.</li> </ul>	1000 lbs. 1000 lbs. 1000 lbs. 1000 lbs.	275 lbs. 1 275 lbs. (6	200 Ibs. ( 200 Ibs. ( 100 Ibs. e	Unmanur Ashes (bi Farm-yar	<ul> <li>200 lbs, Bone</li> <li>200 lbs, Sulpl</li> <li>200 lbs, Sulpl</li> <li>200 lbs, 200</li> <li>Equal parts Si</li> <li>First 6 years</li> <li>First 6 years</li> <li>The application</li> </ul>
	e e	FLOIS.		1000 0000	12254 224	() (1 AA (1 AA	() (1 AAS. 3 AAS. 4 AAS.	6 1026 000 000	$ \oplus \begin{cases} 1 & N. \\ 2 & N. \end{cases} $	5 A. M.	${6 \choose 2}{7}$	() (2) (2) (3) (3) (3) (4) (4) (4) (4) (4) (4) (5)

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 Farnyard 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—

-	1		I	PRODUCE PER	R ACRE.		
-	0.35 Hectolitre or 0.96 0.45 Kilogramme or 0.91	Average F	Average per Annum, ov 17 Years, 1852–1868.	, over 868	Dres	Dressed Corn.	
PLOTS.	bout) 51.0 Allogrammes or bout) 0.9 Hectolitre per Hectare or bout) 1.13 Kilogramme per Hectare or	Dressed Corn.	Jorn.				
	bout) 125.5 Kilogrammes per Hectare or		Weight	Total		26th Season;	27th Season;
	Manures, per acre; twenty-sixth season-1368-9.	Quantity.	Per Bushel.		1868.	1869.	1870.
Supe	Superphosphate of Lime (three times as much as on No. 5 and succeeding Plots)	Bushels. $17\frac{3}{4}$ $15\frac{1}{2}$	1bs. 58 <u>1</u> 58	cwts. 15葉 14畫	Bushels. 224 20 <u>4</u>	Bushels. 154 128	Bushels. 215 165
Farn Unm Unm	Parm-yard dung (14 tons every year)	35 <u>5</u> 148 164	$60 \\ 57\frac{1}{384}$	34 132 144	418 1688 1744	$\frac{381}{14\frac{4}{4}}$	$\frac{36_{\frac{1}{2}}}{15_{\frac{1}{2}}}$
$\begin{pmatrix} a \text{ and } b \\ a \text{ and } b \\ (a \text{ and } b) \\ (a \text{ and } b) \end{pmatrix}$	Mixed Alkalies (0)       ; and Superphosphate of Lime <sup>(2)</sup> ;       : <th:< th=""> <th:< th=""> <th: .<="" td=""><td>177 27744 3634444</td><td>559 599448 599448</td><td>15<u>분</u> 25분 36분 42분</td><td>177 200 200 200 200 200 200 200 200 200 2</td><td><math>\frac{15_{3}}{28_{6}}</math></td><td>2001 2002 2002 2002 2002 2002 2002 2002</td></th:></th:<></th:<>	177 27744 3634444	559 599448 599448	15 <u>분</u> 25분 36분 42분	177 200 200 200 200 200 200 200 200 200 2	$\frac{15_{3}}{28_{6}}$	2001 2002 2002 2002 2002 2002 2002 2002
$\begin{array}{c c} 0 & \alpha \\ b \\ 10 & \beta \\ b \\ 10 \end{array} $ none	ditto i and 550 lbs. Nitrate of Soda <sup>(4)</sup>	361 2688 2381 2732	581 562 571 581 581	$\begin{array}{c} 411\\ 29\\ 29\\ 22_{4}\\ 26_{4}\\ 26_{4} \end{array}$	4 7 7 2 4 2 4 2 4 2 2 2 2 2 2 2 2 2 2 2	2412	252 2168 2108 2108 2108 2108 2108 2108 2108 210
and b) and b) (d bua (d bua bua d b)	3664 Ibs.(0) Sulphate of Soda       "Superphosphate of Lime", and 400 Ibs.       ditto	293 35 343 43 43 43 43 43 43 43 43 43 43 43 43	572 591 594 594 594	28 34 34 <sup>38</sup> 34	4 3332 1942 1884 4184 4184 4184 4184 4184 4184 41	224 274 274 278	$25_{4}$ $35_{4}$ 37 $35_{6}$
	" Mixed Alkalies" ; ditto(6) ; and 400 lbs. Sulphate Ammonia ditto(5) ; ditto(6) ; and 500 lbs. Rape-cake	331 344 344	59 <u>1</u> 59 <u>3</u>	33 34 <sup>3</sup>	$\frac{444}{41\frac{1}{2}}$	26 <u>1</u> 273	00 00 00 00 00 00 00 00
(q put	Unmanured in 1865, and since; previously, 1852-64 Mixed Alkalies, Superphosphate, and 800 lbs. Ammonia-salts	( <sub>8</sub> ) <del>7</del> 68	58 ( <sup>s</sup> )	$46\frac{1}{2}(^{8})$	$22\frac{3}{4}$	191	$18_{4}^{1}$
$(x) \begin{cases} 17 \ (a \text{ and } b) \\ 18 \ (a \text{ and } b) \end{cases}$	" Mixed Alkalies" ; and "Superphosphate of Lime" ; and 400 lbs." Ammonia-Salts."	$\frac{32\frac{1}{4}}{17\frac{3}{4}} \binom{9}{10}$	$59\frac{1}{2}\binom{9}{2}$	$\begin{array}{c} 32\frac{1}{4} \left( \begin{smallmatrix} 9 \\ 1 \end{smallmatrix}  ight) \\ 16\frac{1}{2} \left( \begin{smallmatrix} 1 \end{smallmatrix}  ight) \end{array}$	$rac{37\frac{1}{2}}{18\frac{3}{4}} \left( 1^{1}  ight)$	$\frac{16^{\mathrm{l}}_{\mathrm{B}}}{22^{\mathrm{d}}_{\mathrm{S}}}$	$34\frac{1}{19}$
	none ; Superphosphate of Lime <sup>(3)</sup> ; 300 lbs. Sulphate Ammonia; and 500 lbs. Rape-cake	313	58 <u>4</u>		37	$23_8$	324
Uni	Unmanured continuously	$14\frac{3}{4}(^{13})$	574 (**)		1	13	148
	"Mixed Alkalies" ; "Superphosphate of Lime" ; and 100 lbs. Muriate Ammonia	21 <u>4</u> 214	583 583	$19\frac{3}{2}$ $19\frac{3}{2}$	26 <del>4</del> 25	$20_8^2 \\ 15_8^1$	$26\frac{4}{2}$
(1) Since 1858, 20 (1) Since 1858, 20 (2) 200 lbs. Bone- (2) 200 lbs. Bone- (3) Equal parts 53 (4) 550 lbs. Nitra (5) For 1858, and (5) With Muriadio (7) The Manures ( (9) Average whils)	<ol> <li>(1) Since 1858, 200 lbs. Sulphate of Fods, and 100 lbs. Sulphate of Sods, and 100 lbs. Sulphate of Sods, and 100 lbs. Sulphate of Sods, and 100 lbs. respectively.</li> <li>(1) Flots 17 had the Amnonis-silts for the Crop of 1868.</li> <li>(2) Dits. Brone-sul, 150 lbs. Sulpharie of Ammonia of Commerce.</li> <li>(3) Singla perts Sulphate and Muritet of Ammonia of Commerce.</li> <li>(4) Since 1855, and previously 15 time as much.</li> <li>(5) Sin lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 400 lbs. " Ammonia-sells."</li> <li>(2) Dis. Sulphate and Muritet of Ammonia of Commerce.</li> <li>(3) Sin lbs. Sulphate and Muritet of Ammonia of Commerce.</li> <li>(4) 550 lbs. Nitrate of Soda is reckoned to contain the same amount of Nitrogen as 400 lbs. " Ammonia-sells."</li> <li>(2) Nith Muritet instead of Sulphuric Acid.</li> <li>(3) The Manures of Flots 17 and 18 are, respectively. year: theread of Sulphuric Acid.</li> <li>(4) The Manures of Plots 17 and 18 are, respectively. year transposed.</li> <li>(5) Areage of 16 years, 1852–1867; in 1868, owing to a mistake at the time of carting, the " a" portions of plots 5, 6, 7, 8, 11, 12, 20, 2000.</li> <li>(5) Areage wills manured allike; eccepting that, for the crops of 1864-5-6 and 7, the " a" portions of plots 5, 6, 7, 8, 11, 12, 20, 2000.</li> <li>(6) Areage wills manured all 18 are, respectively. year transposed.</li> <li>(7) The Manures of Plots 17 and 18 group that for the crops of 1864-5-6 and 7, the " a" portions of plots 5, 6, 7, 8, 11, 12, 20, 2000.</li> <li>(7) Areage will the previous sector) has been applied (intread of Silicates) on the "a" portions of plots 5, 6, 7, 8, 11, 12, 20, 2000.</li> </ol>	(fineral Manures, alternated with A amin-sails for the Crop of 1868. al Manures for the Crop of 1868. 1852-1867; in 1868, owing to ())" are divided into duplicate por ())" are divided into duplicate por hat, for the crops of 1864-5-6 and at a mixture of soluble Silicates effect; and for the crops of 1868 pplied (instead of Silicates) on the' pplied (instead of Silicates) on the'	mated wit p of 1868. rop of 1868. s, owing s, duplicate 1864-5-6 ble Silicat rops of 1 cates) on t	h Ammonia S. S. to a mista portions, 4, and 7, the ' tes in addit tes in addit tes in addit he ' α ' por	mmonite-salts. a mistake at the time of carting, the tions, " $a$ " and " $b_i$ " respectively, which 7, the " $a$ " portions of plots 5, 6, 7, 8, in addition to the other Manures, but, and since, cut straw (that produced in " a" portions of plots 5, 6, 7, 8, 11, 12,	ime of can respective s of plots 5 ther Manu w (that pr	ting, thuild, thuild, which is a set of the

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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. First Experimental Oat Crop in 1869.

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or       1:53 Prussian Morgen.         or       0:65 Prussian Morgen.         or       0:050 Strutterian Scheftell.         or       0:012 Zollversin Scheftell.         or       1:02 Contaen.         or       1:02 Contaen.         or       0:052 Zollv. Pfth. Jaer Pr. Morgen.         or       0:052 Zollv. Pfth. Jaer Pr. Morgen.         or       0:054 Centaer per Pr. Morgen.         or       0:65 Centaer per Pr. Morgen.         or       0:65 Centaer per Pr. Morgen.         or       0:66 Sola, Pr. Pr. Morgen.         0:055 Subplet       Bushels.         1568       10:72         0:058       365         0:059       363         0:051       363         0:051       363         0:052       383         0:053       393	
or       1:59       Frussian Morgen.       PRODUCE       PER       J         or       0:66       Californian Scheftil.       Isr       Staasoxy, 1869.       D         or       0:910       Zalifornian Pftmdl.       Isr       Staasoxy, 1869.       D         or       0:92       Zalifornian Pftmdl.       Isr       D       D       D         or       0:92       Zalifornian Pftmdl.       D       D       D       D       D         or       0:92       Zalifornian Pftmdl.       D       D       D       D       D         or       0:92       Zalifornian Pftmdl.       D       D       D       D       D         or       0:64       Centurer per Pr. Morgen.       D       D       D       D       D         or       0:64       Salifolian       D       D       D       D       D       D       D       D         or       0:65       Salifolian       D       <	
or       1:59 Frussian Morgen.         or       0:91 Zellvastin Scheftel.         or       0:91 Zellvastin Scheftel.         or       0:91 Zellvastin Scheftel.         or       1:02 Centuer.         or       0:57 Zellv. Scheftel.         or       0:57 Zellv. Scheftel.         or       0:57 Zellv. Fft. per Pr. Morgen.         or       0:57 Zellv. Fft. per Pr. Morgen.         or       0:64 Centuer per Pr. Morgen.         or       0:64 Centuer per Pr. Morgen.         or       0:64 Centuer per Pr. Morgen.         or       0:64 Self.         in       0:04 Self.         in	
or       1:59 Prussian Morgen, or       0:06 Evaluation Schefiel, or       0:0168 Prussian Morgen, or       0:018 Prussian Schefiel, or       0:018 Prussian Schefiel, or       0:018 Prussian Schefiel, or       0:018 Prussian Schefiel, or       0:018 Prussian         0:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian         0:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian         1:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian         1:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian         1:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian         1:018 Prussian       0:018 Prussian       0:018 Prussian       0:018 Prussian       0:019 Prussian	
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or 1.59 Frussian Morgen, or 0.66 Prussian Morgen, or 0.91 Splverin Frindl, or 1.02 Centner, or 0.57 20hv Pdt, per Pr. Morgen, or 0.64 Centner per Pr. Morgen, or 0.64 Centner per Pr. Morgen, and 0.64 Centner per Pr. Morgen, in the per Pr. Morgen, or 0.64 Centner per Pr. Morgen, or 0.65 Centner per Pr. Pr. Pr. Pr. Pr. Pr. Pr. Pr. Pr. Pr	(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."
or 1:59 Prussian Morgen. or 0:66 Prussian Sheffel. or 0:91 Zollvarein Scheffel. or 1:02 Centaer. or 0:42 Pr. Scheffel per Pr. Morgen. or 0:64 Centaer per Pr. Morgen. J.869. 1869.	Amtnoni
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#### 6)

#### 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 ordi-nary 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. Å 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, ammoniasalts, &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.

### (7)

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 uncaten 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 course, there follow 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 21 acres.)

S.	1 lb. (pound avoir 1 cwt. (hundredwe		••• = (about) = (about)	1·12 Kilog 125·5 Kilog	amme per Hec ammes per He	tare, or 0.57 ctare, or 0.64	Zollverein Pfu Centner per P	nd. per Prussia r. Morgen.	m Morgen.		
					Р	NODUCE PER ACI	ıE.				
Years,	Description of Crop.	Unn	PLOT 1.	ously.	Superphosph T	PLOT 2. ate of Lime (1), 'urnip Crops onl	alone, for the y.	Complex .	PLOT <b>3.</b> Manure <sup>(2)</sup> , for t Crops only.	he Turnip	
		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 1849 1850 1831	Norfolk White Turnips Barley Clover (calcd, as hay) Wheat.	654 cwts. 443 bush. 284 bush.	453 cwts. 2983 lbs. 3431 lbs.	1114 cwts. 5656 lbs. 54 cwts. 5389 lbs.	2253 cwts. 297 bush. 23 bush.	1064 cwts. 2111 lbs. 3371 lbs.	332         cwts.           3841         lbs.           57%         cwts.           5253         lbs.	218 cwts, 287 bush, 287 bush,	1514 cwts. 2088 Ibs. 3552 Ibs.	3693 cwts. 3794 lbs. 63 cwts. 5500 lbs.	
				2nd Cou	rse, 1852–55	ŏ.					
1852 1853 1854 1855	Swedish Turnips. Barley . Beans . Wheat .	26 cwis. 34§ bush. 5§ bush. 35§ bush.	41 cwts. 2430 lbs. 1055 lbs. 3619 lbs.	301 cwfs, 4465 lbs, 1445 lbs, 5859 lbs,	223≩ cwts. 28∦ bush. 57 bush. 35≩ bush.	204 cwts. 1873 lbs. 1103 lbs. 3525 lbs.	243½ cwts. 3560 lbs. 1534 lbs. 5789 lbs.	396‡ cwts. 38‡ bush. 97 bush. 373 bush.	36½ cwts. 2604 lbs. 1355 lbs. 3942 lbs.	433 cwts, 4873 lbs. 2065 lbs. 6371 lbs.	
				3rd Cou	r <b>se, 1</b> 856-58	).					
1856 1857 1858 1859	Swedish Tarnips Barley Beans Wheat	32 cwts. 48½ bush. 6½ bush. 35½ bush.	24 cwts. 2600 lbs. 1100 lbs. 4030 lbs.	341 ewts, 5337 lbs, 1515 lbs, 6262 lbs,	136 cwts, 28± bush. 6½ bush. 34≩ bush.	7½ cwts. 1475 1bs. 1155 1bs. 3930 1bs.	1431 cwts. 3076 lbs. 1605 lbs. 6120 lbs,	3334 cwts. 48 bush. 124 bush. 394 bush.	12½ cwts, 2435 lbs. 1520 lbs. 4610 lbs.	3461 cwts, 5163 lbs, 2357 lbs, 7154 lbs,	
			-	4тн Cou	RSE, 1860-63	3.					
1860 1861 1862 1863	Swedish Turnips.	1 cwt. 384 bush. 29 bush. 447 bush.	(64 lbs.) 2522 lbs. 1840 lbs. 3467 lbs.	1 cwt. 4718 lbs. 3661 lbs. 6350 lbs.	29월 cwts. 30월 bush. 29를 bush. 34월 bush.	11 cwts. 2000 lbs. 2150 lbs. 3390 lbs.	304 cwts, 3775 lbs. 4040 lbs. 5619 lbs.	87½ cwts. 60% bush. 43% bush. 46% bush.	34 cwts, 3940 lbs. 3280 lbs. 4697 lbs.	904 cwts. 7891 Ibs. 5990 Ibs. 7626 Ibs.	
				5TH COU	rse, 1864-67						
1364 1865 1866 1867	Swedish Turnips Barley Beans Wheat	84 cwts. 39 bush. 104 bush. 21 bush.	04 cwts. 2154 lbs. 1013 lbs. 2143 lbs.	94 cwts. 4132 lbs. 1689 lbs. 3473 lbs.	68 cwts. 334 bush. 78 bush. 194 bush.	44 cwts, 1615 Ibs. 978 Ibs. 1966 Ibs,	724 cwts, 3394 lbs, 1463 lbs, 3222 lbs,	1761 cwts. 471 bush. 201 bush. 231 bush.	84 cwts. 2595 1bs. 1990 1bs. 3003 1bs,	185 cwts, 5148 lbs, 3343 lbs, 4567 lbs,	
SUMMARY-AVERAGE OF THE 5 COURSES, 1848-1867.											
1848, '52, '56, '60, '64 1849, '53, '57, '61, '65 1850, '54 '58, '62, '66 1851, '55, '59, '63, '67	Swedish Turnips Barley (Clover,1850 (calcd.as hay) Beans Wheat	264 cwts. 411 bush. 124 bush. 33 bush.	10 <sup>4</sup> cwts. 2538 lbs. 1252 lbs. 3338 lbs.	374 cwts. 4872 lbs. 54 cwts. 2078 lbs. 5467 lbs.	1364 cwts. 305 bush. 125 bush. 302 bush.	28 cwts. 1815 lbs. 1347 lbs. 3236 lbs.	1644 cwts, 3529 lbs. 574 cwts. 2161 lbs. 5200 lbs.	2421 cwts. 448 bush. 211 bush. 351 bush.	42 <sup>1</sup> / <sub>2</sub> cwts. 2732 lbs. 2036 lbs. 3961 lbs.	285 cwts. 5275 lbs. 63 cwts. 3439 lbs. 6244 lbs.	

(i) 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 160 lbs. Sulphuric Acid, 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 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,

 (3) The quantities given in Bushel's represent the Dressed Corn only.
 (4) The "Total Produce" of the Corn-crops includes Dressed Corn, Offal Corn, and Total Straw,