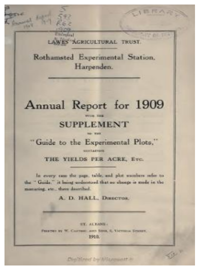
Annual Report for 1909 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre, Etc.



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Rothamsted Report for the Year 1909

Rothamsted Research

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ANNUAL REPORT

FOR THE YEAR 1909.

THE weather of 1909 was on the whole favourable to growth, though the constant rains and low temperatures prevailing in the summer resulted in prolonged vegetative development and unripened produce. Up to the end of 1908 the weather was very warm and open, and as somewhat severe weather set in towards the end of January, a good deal of winter killing of perennial plants and vegetables took place, although no very low temperatures were recorded. February was a cold month, indeed the minimum thermometer on the grass fell below freezing point on every night from the 6th of February until the 18th of March, the lowest temperature recorded being 13° on the 5th of March. April and May were favourable months and gave all the crops a good start. From June onwards there was an excess of rain, and particularly of rainy days, with day temperatures much below the average and a lack of sunshine, the exception being a fortnight of very bright weather at the beginning of August, with a maximum temperature of 82° on the 12th.

The harvest was only got in with considerable delay and difficulty, after which again wheat seeding was much delayed because of the continuance of damp and rainy weather throughout October and November.

The wheat on Broadbalk field was sown on October 24th, 1908, and grew into a good plant during the warm weather of April and May, 1909; later it began to show an excessive development of straw and became a good deal blighted and rusty, so that most of the plots were laid before harvest. The yield of grain was generally below the average, and that of straw was high. The quality of the grain also was poor, as shown by the exceptionally low weight per bushel. The unmanured and partially manured plots suffered most from the season. On the unmanured plot (66th successive crop of wheat, no manure since 1838) only 9·1 bushels of grain and 9·2 cwts. of straw were produced. The most noticeable feature in the season was the exceptional reduction of the crop wherever potash had been omitted from the manure. Plot 11, which received ammonium salts and superphosphate, gave a lower yield than the unmanured plot, viz., only 6·2 bushels of grain weighing as little as 55·4 lb. per

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bushel. It was on these non-potash plots that rust and other fungoid diseases were most rampant. As a rule potash shows its maximum effect in dry rather than in wet seasons like 1909.

The barley was sown on Hoosfield (the 58th successive crop) on April 6th, 1909. Owing to the favourable weather during April and May a good plant was obtained, and the yield was rather above the average, in fact considerably above the average of recent years. Many of the plots were laid, the dunged plot suffering most.

On the permanent grass plots the herbage was late in starting growth. The yields were generally below the average; the proportion of leguminous plants in the herbage was also below the average. Great contrasts are now to be observed between the limed and unlimed portions of the plots that have become acid through the long continued use of ammonium salts. The patches of dead herbage are extending on the acid portions, while the limed portions have come back to a normal appearance.

The Mangold field was sown on April 21st and 22nd, 1909, and though the seed was a little slow and irregular in germinating, eventually a good plant was obtained, except on the ammonium plots. The yield was generally above the average, especially on those plots receiving dung or rape cake. The usual fungoid attack of *Uromyces betae* on the plots receiving an excess of nitrogen was not so prominent this year.

On the Agdell field barley was grown. The yield was fair, but showed no special features.

Barley was also grown on Little Hoos field, where the duration of manurial residues is being tested. A good plant was obtained and the yields generally were high, although there was an excessive amount of straw and many of the plots were laid.

On Little Hoos field also some subsidiary plots were put down to demonstrate the comparative value of nitrogen in the new fertilisers — cyanamide and nitrate of lime — as compared with sulphate of ammonia and nitrate of soda. Each plot received 50 lbs. of nitrogen per acre, rather too large a quantity for the wet season, with the result that all the plots were laid. The yields from the four fertilisers were very similar, sulphate of ammonia being a little the best and cyanamide the worst, though the differences would fall within the limits of experimental error (see p. 14).

In the Laboratory the investigations, by means of plants grown in pots, of the question of whether a plant unfits the soil for its repeated growth was continued, though no results can at present be reported. Drs. Russell and Hutchinson's investigation of the effect

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of heating soils or treating them with volatile antiseptics was continued, and a solution of the problem was reached which promises very interesting developments; an account of this is given later.

With the help of a special grant from the Board of Agriculture, an investigation was started into the causes of the superiority of certain pastures in Romney Marsh over the surrounding fields. An assistant took daily observations of the temperature, water level, and other factors, and also forwarded regular samples of the grass, soil, &c., to the Laboratory, which material is now being worked up.

Miss Brenchley's work on the changes in the composition of the wheat grain during its development and ripening having been concluded, she began work of the same character on barley.

Dr. Miller has been following up some earlier investigations on the amount of ammonia which can be absorbed from the atmosphere by a layer of acid or similar absorbent, and the results would seem to indicate that the amount thus obtainable has been exaggerated by previous observers, because of the intrusion of dust of an organic character. It is interesting to note that the amount of ammonia in the air above Broadbalk field was notably increased for some time after the application of ammoniacal manures. Dr. Miller is also estimating the amount of ammonia and nitric acid in rain water that is sent us regularly from the extreme West of Scotland, and obtains results much below those yielded by inland stations. This work, however, requires to be continued for several years before the results can be trusted.

The following papers have been published during the year in the Journal of Agricultural Science, Vol. 3, Part 2, reprints of which have been issued to our correspondents:—

"*The Effect of Partial Sterilisation of Soil on the Production of Plant Food,*" by Drs. E. J. Russell and H. B. Hutchinson. It had been known for some years that soils which had been subjected to a process of "sterilisation," as for example by heating to a temperature of 100 degrees for two hours, or exposure to the vapour of chloroform and other antiseptics, gains thereby a marked increase in its power of producing crops. In an earlier paper Dr. Russell has shown that heated soils yield about double the crop, and soils that have been exposed to toluene vapour yield about 30 per cent. more than the same soils untreated, when both are put to grow plants under identical conditions. These experiments have been repeated during the last year or two in our Laboratory, in connection with the investigation that is being made into the causes of land sickness. Taking advantage of this material,

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Drs. Russell and Hutchinson embarked upon a complete investigation of the condition of the soil after treatment, both from the bacterial and chemical standpoints.

The present paper deals with the causes of this increased productivity, and has revealed a new factor in the life of the soil, and one which promises to be of extreme interest and perhaps of practical importance. Various theories have been advanced to account for the increased availability of the plant food in the soil which results from treatment of this kind. S. U. Pickering, for example, has shown that the heating, and even the treatment with antiseptics, are followed by a marked increase in the amount of soluble nitrogen compounds that can be extracted from the soil, which extra available plant food he regarded as sufficient to account for the increase of crop. More generally it was supposed that some change in the bacterial flora of the soil had been effected which resulted in a greater availability of the original stock of nitrogen, but the mechanism was not clearly understood. Russell and Hutchinson, began by finding, in common with other observers, that the treatment to which the soil was subjected by no means effected complete sterilisation. The numbers of bacteria were enormously reduced by the process if they were counted immediately afterwards, but when the soil was moistened and put under conditions suitable for growth, the numbers gradually mounted up again, and eventually reached a magnitude which is never attained under normal conditions in the untreated soil. For example, one of the Rothamsted soils contained at the outset about 7,000,000 organisms per gram, a number which remains comparatively constant on storage ; after heating, the number had fallen to 400 per gram ; and after treating with toluene, to 2,600,000. After four days, however, these small numbers had risen in the case of the heated soil to over 6,000,000, after which it ceased to be possible to count the colonies ; in the case of the toluene the numbers rose to 40,000,000 in nine days. Pari passu with this increase in the number of the bacteria in the soil came an increase in the rate at which ammonia was produced by the breakdown of the more complex carbon compounds of nitrogen that were present in the soil. When no plants were present to take up the ammonia, it accumulated in the soils, because the bacteria which convert nitrites and nitrates had been completely destroyed. It thus appeared pretty clear that the increased fertility of the treated soils was due to the greater power of breaking down the complex organic matter of the soil to the state of ammonia, a form in which plants can assimilate nitrogen ; and this increased production of ammonia was due to an abnormal multiplication of the ammonia-splitting organisms which

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constitute so large a proportion of the normal bacterial flora of the soil. The authors then carried out various experiments, which showed (1) that no stimulus could be supposed to have taken place through the treatment so as to make the bacteria remaining in the soil more active; (2) that there had been no selective destruction of organisms which would leave behind a population of a more active type than the usual flora of the soil. By other steps which need not be here set out, it became clear that the difference between the treated and untreated soils was due to some factor in the latter which normally limits the number of bacteria, and therefore the rate of production of ammonia. Search for this unknown factor disclosed the presence, in all soils so far examined, of numbers of protozoa and amoeba, which live on bacteria and keep their numbers down to the comparatively low limit specified. The heating or treatment with antiseptics kills off all these large organisms, but leaves unhurt some spores of the ammonia-producing bacteria, which afterwards can develop to a much greater extent because they are freed from their normal check.

The theory as it stands then assumes that, putting aside its physical characteristics, the fertility of a soil is determined by the activity, or rather by the number, of its ammonia-producing bacteria, and the number is kept in equilibrium by the activity of the protozoa for which these bacteria serve as food. Any cause which destroys or reduces the number of the protozoa enables the bacteria to extend their territory, and so raises the fertility of the soil. The authors have also carried out a number of collateral experiments, which show that the direct additions of these large organisms will rapidly reduce the activity of various fermenting media, but this and other positive evidence in favour of the theory have not as yet been published.

It is obvious that this work suggests the possibility of similarly increasing the productivity of soils in the open, if the injurious protozoa can be suppressed by methods that are not too costly. Experiments upon these lines have been designed and will be carried out during the coming season.

"*Direct assimilation of Ammonium Salts by Plants*," by Drs. H. B. Hutchinson and N. H. J. Miller. In this paper the authors describe an investigation of the question of whether the higher plants are capable of utilising ammonia directly without a previous conversion into nitrates. The authors succeeded in growing peas and wheat in water cultures under sterile conditions, so that neither nitrification nor other bacterial changes could take place in the nutrient supply. It was important to determine whether plants could thus make use of ammonia without previous nitrification in view of the fact that nitrification is at a standstill on the grass plots which have become acid through the continued application of ammonium salts, as described in the last report. The growth of grass still continues on these plots, and the nitrogen it contains must have been taken up as ammonia. The authors noticed certain differences in the habit of the plants that were feeding on ammonia only—for example, an increased percentage of nitrogen in the dry matter, a darker colour of the leaf, and a dwarfer habit. Similar differences may be seen in the habit of the wheat and barley plants growing on the Rothamsted plots with ammonium salts and nitrate of soda respectively; much greater length of straw is always obtained with nitrate of soda in our experiments.

It would thus appear that even in the open field at Rothamsted the ammonium salts are not wholly nitrified before they reach the plant.

"*The development of the Grain of Wheat,*" by A. D. Hall and W. E. Brenchley. This paper deals with the progressive changes in the composition of the grain of wheat during its formation and ripening, and represents the chemical side of the work, the botanical aspect of which was described in the last report. A large number of heads of wheat were marked on one day when they were just putting out their first flowers, so that it could be assumed that they were all of the same age, and at the same stage of development. One hundred or more of these marked heads were then taken at intervals of three days until the grain was fully ripe; the grain was extracted and analysed, and in one year the straw was also analysed.

On examination of the curves expressing the results the authors distinguish three stages—the formation of the pericarp, the filling of the endosperm, and the ripening process. The material forming the pericarp contains a larger proportion of nitrogen in the dry matter, and a smaller proportion of phosphoric acid in the ash, than does the endosperm material. As soon as the endosperm begins to fill, the plant moves into it material that is practically uniform in composition at all stages, early and late in the filling. There appears to be no justification for the opinion usually held that the proteins are moved in first and the carbohydrates later. The ripening process is in the main one of desiccation, although there is some change from non-protein to protein. The authors incidentally show that both the nutrition and assimilation of the plant continue to a much later date than has been usually supposed. The total amount of dry matter, nitrogen, and ash in the plant increases to within a fortnight of harvest. The authors conclude that it would be safe to

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cut wheat at an earlier stage than is usual, whereby certain mechanical losses by shedding, birds, &c., might be avoided, though it is not certain that a fresh difficulty might not be introduced if an increased time were required to bring the cut corn into a fit condition for stacking.

"*The amount of free Lime and the composition of the soluble Phosphates in Basic Slag*," by C. G. T. Morison. In this paper the author reports an examination of the amount of free lime contained in basic slag. He found, instead of the large amount usually reported, only from 5·29 down to 1·28 per cent. in the freshly ground samples he examined. After trying various methods for the estimation of the free lime, the author obtained the best results by extracting the finely ground slag with cold water free from carbon dioxide, and titrating the extract. Probably the basic slag made in the earlier years of the industry contained a greater proportion of free lime, just as it was generally less rich in phosphoric acid.

Morison also discusses the nature of the phosphoric acid compound in basic slag, and from analyses of the crystals obtained from unground cinder, and from the solubility of the slag and of these crystals in weak solvents, he concludes the compound is (CaO_5), FeO, P_2O_5, SiO_2, instead of the (CaO_4), P_2O_5 usually described. This agrees with some previously published analyses of Stead, who also failed to find crystals of tetra-basic phosphate of lime in most of the slags he examined. The compound in question forms pale green or blue needle-shaped crystals in the cinder.

"*Estimation of Calcium Carbonate in Soils*," by F. S. Marr. In this paper the author describes a re-examination of a process for determining calcium carbonate, which was worked out in the Rothamsted Laboratory by Mr. A. Amos. He shows that with certain soils rich in organic matter, especially those of an acid character, whenever strong acid is boiled with the soil, because some of the organic matter splits up and yields carbon dioxide. The error can be minimised by using hydrochloric acid of only 5 per cent. strength and boiling under reduced pressure. Mr. Marr, the author of this paper, was a Carnegie scholar of the University of Aberdeen, and worked in the Rothamsted Laboratory from October, 1907, to July, 1908. He left us to work at Breslau, under Dr. Th. Pfeiffer, where he unhappily died, after a short illness, on May 13th, 1909.

CROPS GROWN IN ROTATION. AGDELL FIELD.

PRODUCE PER ACRE.

Year.	CROP.		O. Unmanured. 5. Fallow.	O. Unmanured. 6. Beans or Clover.	M. Mineral Manure. 3. Fallow.	M. Mineral Manure. 4. Beans or Clover.	C. Complete Mineral and Nitrogenous Manure. 1. Fallow.	C. Complete Mineral and Nitrogenous Manure. 2. Beans or Clover.
	LAST COMPLETE COURSE (15th), 1904-7.							
1904	Roots (Swedes) ...	Cwt.	16·8	6·4	151·2	171·4	318·6	203·2
1905	Barley Grain ...	Bus.	15·5	7·3	16·0	15·2	23·1	31·4
	Barley Straw ...	Cwt.	10·6	8·0	10·5	11·3	13·5	20·1
1906	Clover Hay ...	Cwt.	—	4·1	—	41·0	—	9·5*
1907	Wheat Grain ...	Bus.	16·3	21·4	19·1	36·8	25·1	29·3
	Wheat Straw ...	Cwt.	21·4	27·1	28·6	49·6	35·3	35·1
	CURRENT COURSE (16th), 1908- .							
1908	Roots (Swedes) ...	Cwt.	21·6	6·4	179·0	235·8	395·4	314·0
1909	Barley Grain ...	Bus.	11·4	10·0	17·4	22·1	26·8	33·4
	Barley Straw ...	Cwt.	10·1	11·3	12·7	16·9	18·7	23·8

* The plant almost entirely failed on this plot, and new seed was sown broadcast on May 1st, 1906.

METEOROLOGICAL RECORDS, 1909.

(*See* " *Guide*," *page* 16, *Table IX.*)

	Rain.			Drainage through soil.			Bright Sunshine.	Temperature.	
	Total Fall.		No. of Rainy Days.						
	5-inch Funnel Gauge.	$\frac{1}{1000}$th Acre Gauge.	$\frac{1}{1000}$th Acre Gauge.	20 ins. deep.	40 ins. deep.	60 ins. deep.		Max.	Min.
	Inches.	Inches.	No.	Inches.	Inches.	Inches.	Hours.	°F.	°F.
January	0·868	0·978	10	1·045	1·107	1·068	76·1	42·7	32·0
February ...	0·370	0·430	8	0·029	0·072	0·038	93·0	42·7	28·6
March	3·420	3·742	24	2·920	3·021	2·858	69·3	43·8	32·8
April	1·734	1·822	12	0·118	0·181	0·136	237·2	57·9	36·8
May	1·267	1·315	10	0·118	0·120	0·136	296·7	62·1	39·6
June	3·963	4·097	17	2·041	1·956	1·922	116·0	59·7	46·4
July	3·000	3·097	19	0·560	0·613	0·546	193·3	66·5	51·0
August	2·643	2·739	11	1·116	1·112	1·042	225·5	68·8	50·8
September ...	1·809	1·943	18	0·154	0·088	0·062	108·7	60·4	47·2
October	4·896	5·187	27	4·054	3·835	3·838	86·6	57·0	46·0
November ...	1·150	1·245	14	0·851	0·834	0·824	90·6	46·1	34·6
December ...	3·263	3·416	25	3·164	3·201	3·192	59·1	44·7	33·4
Total or Mean	28·383	30·011	195	16·170	16·140	15·662	1652·1	54·4	39·9

MANGOLDS, BARN FIELD, 1909.

(*See* " *Guide*," *page* 11, *Table VI.*)

Strip.	Strip Manures.	Cross-dressings.				
		O.	N.	A.	A.C.	C.
		None.	Nitrate of Soda.	Ammonium Salts.	Rape-cake & Ammonium Salts.	Rape Cake.
		Tons.	Tons.	Tons.	Tons.	Tons.
1	Dung only ...	R. 24·44 L. 1·98	37·79 3·08	31·28 3·72	34·09 4·39	32·80 3·59
2	Dung, Super., Potash	R. 24·76 L. 2·21	38·10 4·06	36·84 5·07	38·41 5·92	37·64 4·43
4	Complete Minerals	R. 5·72 L. 0·86	22·38 26·26 2·23 2·18	19·70 1·83	37·66 4·22	28·66 2·52
5	Superphosphate only	R. 4·89 L. 0·81	19·78 2·04	5·59 1·89	9·32 2·07	12·37 1·89
6	Super. and Potash	R. 4·88 L. 0.72	23·80 1·99	19·13 1·98	31·31 4·47	25·33 2·17
7	Super., Sulph, Mag. & Chloride Sodium	R. 5·50 L. 0·80	26·76 2·63	20·56 1·92	34·04 4·18	27·42 2·88
8	None	R. 4·38 L. 0·87	17·06 3·33	5·58 2·63	9·76 2·71	11·89 2·48

HAY. THE PARK GRASS PLOTS, 1909.

(*See "Guide," page* 19, *Table XI.*)

Plot.	Manuring.	Yield of Hay per Acre. 1st Crop.	2nd Crop.	Total.
		Cwt.	Cwt.	Cwt.
3	Unmanured	8·7	1·3	10·0
12		11·9	3·8	15·7
2	Unmanured (1)	9·8	2·0	11·8
1	Ammonium Salts alone (1)	11·2	7·5	18·7
4-1	Superphosphate of Lime	10·9	3·1	14·0
8	Mineral Manure without Potash ..	14·7	5·6	20·3
7	Complete Mineral Manure	29·6	14·2	43·8
6	As 7, 1869 and since (2)	24·3	10·7	35·0
15	As 7, 1876 and since (3)	24·1	10·0	34·1
5	Superphosphate and Potash, 1898 and since	12·2	5·2	17·4
17	Nitrate of Soda alone...	23·8	1·9	25·7
4-2	Superphosphate and Amm.-salts ...	20·4	7·5	27·9
10	Mineral Manure (without Potash) and Amm.-salts	24·1	9·5	33·6
9	Complete Mineral Manure and Amm.-salts	37·0	9·6	46·6
13	Dung and Fish Guano, once in 4 years	23·8	13·7	37·5
11-1	Complete Mineral Manure and extra Amm.-salts	49·1	18·3	67·4
11-2	As 11-1, and Silicate Soda	53·7	16·1	69·8
16	Complete Mineral Manure and Nit. Soda=43 lb. N.	31·1	8·3	39·4
14	Do. do. do. and Nit. Soda=86 lb. N.	48·5	9·0	57·5

Quick Lime (ground) at the rate of 2000 lb. per acre, applied to the South half of plots 1 to 4-2, 7 to 11-2, 13 and 16, in January, 1907.

(1) Received Farmyard Dung, 8 yrs., 1856-63. (3) Nitrate of Soda alone previously.
(2) Ammonium salts alone, previous to 1869.

BOTANICAL COMPOSITION, PER CENT.

First Crop, 1909.

(*See "Guide," page* 20, *Table XII.*)

Plot.	Manuring.	Gramineæ.	Leguminosæ.	Other Orders.
		Per cent.	Per cent.	Per cent.
3	Unmanured	65·0	6·2	28·8
4-1	Superphosphate of Lime	55·9	6·2	37·9
8	Mineral Manure without Potash ...	45·1	13·4	41·5
7	Complete Mineral Manure	52·2	29·6	18·2
6	As 7, 1869 and since (2)	53·9	26·4	19·7
15	As 7, 1876 and since (3)	54·5	22·3	23·2

WHEAT. BROADBALK FIELD, 1909.

(*See* " *Guide*," *page* 26, *Table XIV.*)

Plot.	Manuring.	Dressed Grain. Yield.	Dressed Grain. Weight per Bushel.	Straw.
		Bushels.	lbs.	Cwt.
2	Farmyard Manure	31·6	60·9	49·0
3	Unmanured	9·1	60·8	9·2
5	Complete Mineral Manure	10·4	60·5	12·2
6	As 5, and single Amm.-salts ...	17·4	59·2	22·2
7	As 5, and double do.	28·9	58·8	35·8
8	As 5, and treble do.	32·3	59·5	47·0
9	As 5, and single Nitrate Soda ...	24·3	59·9	29·9
10	Double Amm.-salts alone	10·5	57·6	17·4
11	As 10, and Superphosphate... ...	6·2	55·4	16·5
12	,, and Super and Sulph. Soda...	19·6	55·9	29·1
13	,, and Super and Sulph. Potash	27·8	60·5	39·7
14	,, and Super and Sulph. Mag.	16·1	55·8	26·4
15	Double Amm.-salts in Autumn and Minerals	25·8	60·9	38·6
16	Double Nitrate and Minerals ...	26·9	59·4	42·8
17	Minerals alone, or Double Amm.-	*9·1	*60·5	*11·4
18	salts alone, in alternate years	†29·9	†60·5	†35·5
19	Rape Cake alone	20·0	59·8	29·6

* Produce by Minerals. † Produce by Ammonium-salts.

BARLEY. HOOS FIELD, 1909.

(*See* " *Guide*," *page* 33, *Table XVI.*)

Plot.	Manuring.	Dressed Grain. Yield.	Dressed Grain. Weight per Bushel.	Straw.
		Bushels.	lbs.	Cwt.
1 O	Unmanured	13·0	53·6	7·4
2 O	Superphosphate only	25·4	54·5	13·2
3 O	Alkali salts only	15·9	52·7	12·4
4 O	Complete Minerals	22·0	53·2	16·6
1 A	Amm.-salts only	21·3	53·2	15·3
2 A	Superphos. and Amm.-salts ...	29·2	54·0	22·5
3 A	Alkali salts and Amm.-salts ...	22·4	52·0	19·7
4 A	Complete Minerals and Amm.-salts	44·3	53·0	36·4
1 N	Nitrate of Soda alone	23·4	54·3	19·0
2 N	Superphos. and Nitrate Soda ...	37·9	55·0	28·8
3 N	Alkali Salts and Nitrate Soda ...	18·3	53·7	17·3
4 N	Complete Minerals and Nitrate Soda	41·6	53·6	37·4
1 C	Rape Cake alone	37·9	55·3	28·7
2 C	Superphos. and Rape Cake ...	41·0	53·7	32·0
3 C	Alkali Salts and Rape Cake ...	38·3	54·8	27·2
4 C	Complete Minerals and Rape Cake	45·2	53·1	33·2
7-1	Unmanured (after Dung, 1852-71)...	22·6	54·4	16·8
7-2	Farmyard Dung	46·3	53·8	40·1

BARLEY. HOOS FIELD, 1909.

(Previous cropping: Potatoes, 1876-1901; Barley, 1902 and 1903; Oats, 1904; Barley, 1905 and since).

(*See* " *Guide*," *page* 40, *Table XIX*.)

Plot.	Manures applied to the Potatoes, 1876-1901. Unmanured since.	Dressed Grain.		Straw.	Total Produce.
		Yield.	Weight per Bushel.		
		Bushels.	lbs.	Cwt.	lbs.
1	Unmanured	9·7	54·4	8·5	1605
2	Unmanured 1882 to 1901, previously Dung only ...	14·7	53·4	11·2	2160
3	Dung 1883-1901	24·1	53·9	19·5	3680
4	Dung 1883-1901	24·8	53·6	21·0	3861

WHEAT AFTER FALLOW (without manure 1851 and since). HOOS FIELD, 1909.

See " *Guide*," *page* 41, *Table* 20.

Dressed Grain	Yield—12·9 bushels. Weight per bushel—55·4 lbs.
Straw	13·7 cwt.
Total Produce	2326 lbs.

COMPARATIVE TEST OF NITROGENOUS FERTILISERS. BARLEY. LITTLE HOOS FIELD, 1909.

Plot.	Manuring.	Dressed Grain.	Offal Grain.	Straw.	Weight per bushel of Dressed Grain.	Proportion of Offal to 100 of Dressed Grain.	Proportion of Grain to 100 of Straw.
		Bushels.	lb.	Cwt.	lb.		
1	Superphosphate alone	27·7	101	22·4	54·0	6·8	63·6
6	Do. do.	29·7	182	24·4	55·3	11·1	66·8
2	Super and Nitrate Soda=50 lb. N.	44·6	277	30·6	50·0	12·4	73·1
7	Do. do. do.	51·6	316	38·7	54·9	11·2	72·6
3	Super and Nitrate Lime=50 lb. N.	45·2	364	42·9	53·5	15·1	57·9
8	Do. do. do.	47·1	321	36·5	55·1	12·4	71·3
4	Super & Sulph. Ammonia=50 lb. N.	49·3	280	26·3	54·4	10·4	100·7
9	Do. do. do.	48·8	270	36·5	54·8	10·1	71·9
5	Super and Cyanamide=50 lb. N....	43·9	182	39·9	54·4	7·6	57·5
10	Do. do. do. ...	46·5	300	31·1	54·8	11·8	81·7

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LITTLE HOOS FIELD, 1904-09.

RESIDUAL VALUE OF VARIOUS MANURES.

(*See " Guide," pages* 41 *and* 42).

TOTAL PRODUCE—Grain and Straw, or Roots and Leaves, per acre.

Series and Plot.	Manuring.	Swedes 1904.	Barley 1905.	Man-golds 1906.	Spring Wheat 1907.	Swedes 1908.	Barley 1909.
		Tons.	lbs.	Tons.	lbs.	Tons.	lbs.
A 1	Unmanured	10·3	2323	17·1	3650	14·0	3792
2	Dung (ordinary), 1904 and 1908	**13·1**	4649	18·2	4673	**19·1**	5128
3	,, ,, 1905 and 1909	8·8	**3501**	17·5	5393	14·5	**5544**
4	,, ,, 1906 only ...	8·8	2269	**18·2**	5471	15·5	4057
5	,, ,, 1907 ,,	9·8	2402	14·9	**6903**	17·3	4581
B 1	Dung (cake-fed), 1904 and 1908	**15·7**	4177	19·4	4319	**22·4**	5362
2	Unmanured	10·0	2417	16·2	4025	14·3	3862
3	Dung (cake-fed), 1905 and 1909	9·5	**5530**	18·5	5497	14·2	**6641**
4	,, ,, 1906 only ...	11·4	2772	**25·6**	6489	16·9	4400
5	,, ,, 1907 ,, ...	9·4	2649	14·4	**9407**	19·0	4298
C 1	Shoddy, 1904 and 1908 ...	**14·7**	3656	21·0	4667	**19·7**	3969
2	,, 1905 and 1909 ...	11·1	**4363**	23·6	4550	16·3	**4558**
3	Unmanured	10·6	2588	17·7	4334	15·1	3850
4	Shoddy, 1906 only	10·7	2512	**24·2**	6231	19·1	4466
5	,, 1907 ,, ...	10·3	2615	16·9	**7495**	22·2	5448
D 1	Guano, 1904 and 1908... ...	**14·6**	2550	20·1	4056	**20·9**	3608
2	,, 1905 and 1909... ...	11·0	**5176**	19·7	4165	15·3	**6834**
3	,, 1906 only	10·9	2857	**25·6**	4846	15·9	4053
4	Unmanured	10·6	2985	18·7	4618	17·4	4510
5	Guano, 1907 only	10·6	2680	17·4	**7375**	15·7	4014
E 1	Rape-cake, 1904 and 1908 ...	**14·1**	2674	17·8	3887	**19·7**	3750
2	,, 1905 and 1909 ...	11·2	**4185**	17·9	4326	15·1	**5203**
3	,, 1906 only	9·5	2645	**22·7**	4584	14·5	3866
4	,, 1907 ,, ...	10·5	2734	19·4	**6619**	15·2	4661
5	Unmanured	10·8	2769	19·5	4527	14·7	4155
F 1	Unmanured	11·7	3132	22·9	4749	14·1	4814
2	Superphosphate, 1904 and 1908	**12·2**	3025	23·2	5064	**16·9**	4726
3	,, 1905 and 1909	10·2	**3949**	23·6	4956	14·6	**4973**
4	,, 1906 only ...	9·7	3913	**24·1**	5419	16·0	5280
5	,, 1907 ,, ...	9·7	4221	23·6	**5698**	16·4	5641
G 1	Bone Meal, 1904 and 1908 ...	**12·9**	3176	23·1	5203	**16·7**	4445
2	,, ,, 1905 and 1909 ...	10·1	**3636**	22·1	5821	14·3	**4922**
3	Unmanured	10·2	3495	20·6	5491	12·7	4247
4	Bone Meal, 1906 only	9·9	3450	**22·6**	6043	14·2	4711
5	,, ,, 1907 ,, ...	9·2	3525	22·1	**6276**	19·9	5285
H 1	Basic Slag, 1904 and 1908 ...	**11·8**	4400	20·5	6285	**13·8**	4182
2	,, ,, 1905 and 1909 ...	10·4	**4002**	21·3	5930	13·6	**4530**
3	,, ,, 1906 only	9·4	3662	**21·4**	5860	13·6	4431
4	,, ,, 1907 ,, ...	9·1	3624	17·0	**5816**	14·4	3860
5	Unmanured	8·6	3293	17·4	5933	11·4	4511

The yields on the plots to which the manure was applied in any given year are printed in heavy type.