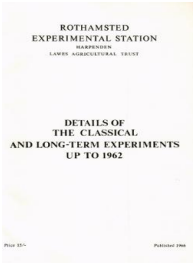
This work is licensed under a Creative Commons Attribution 4.0 International License.

Thank you for using eradoc, a platform to publish electronic copies of the Rothamsted Documents. Your requested document has been scanned from original documents. If you find this document is not readible, or you suspect there are some problems, please let us know and we will correct that.

Details of the Classical and Long-term Experiments Up to 1962



Full Table of Content

Default Title

Rothamsted Research

Rothamsted Research (1966) *Default Title ;* Details Of The Classical And Long-Term Experiments Up To 1962, pp 1 - 90 **- DOI: https://doi.org/10.23637/ERADOC-1-191**

This work is licensed under a Creative Commons Attribution 4.0 International License.

ROTHAMSTED EXPERIMENTAL STATION

HARPENDEN

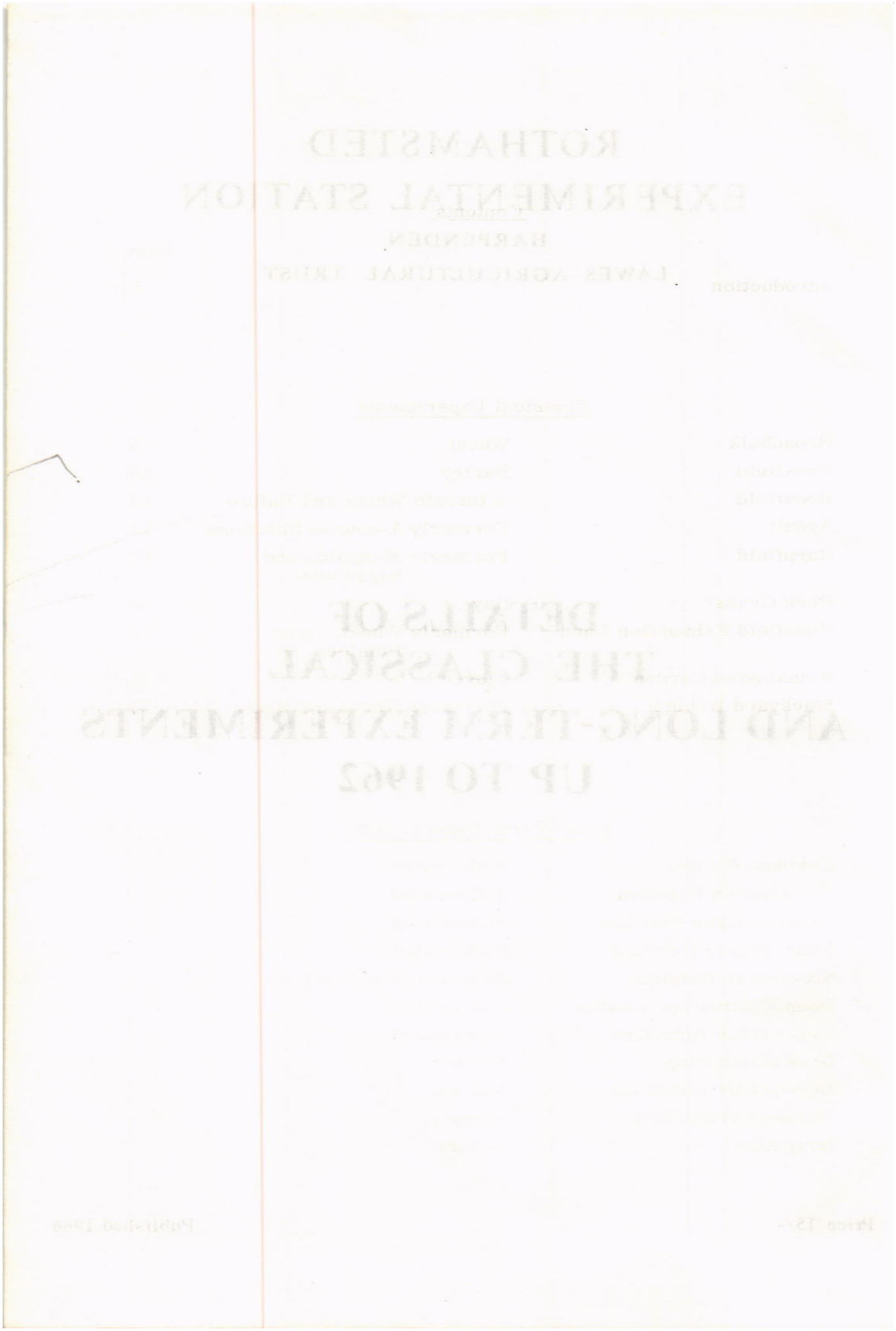
LAWES AGRICULTURAL TRUST

DETAILS OF THE CLASSICAL AND LONG-TERM EXPERIMENTS UP TO 1962

Price 15/-

Published 1966

This work is licensed under a Creative Commons Attribution 4.0 International License.



This work is licensed under a Creative Commons Attribution 4.0 International License.

Contents

		Page
Introduction		4
Classical Experiments		
Broadbalk	Wheat	5
Hoosfield	Barley	10
Hoosfield	Alternate Wheat and Fallow	13
Agdell	Formerly 4-course Rotations	14
Barnfield	Formerly Mangolds and Sugar beet	17
Park Grass	Hay	22
Hoosfield Exhaustion Land	Formerly Wheat, later Potatoes	27
Rothamsted Garden	Clover	31
Stackyard Woburn	Formerly Wheat and Barley	32
Long-Term Experiments		
Residual Values	Rothamsted	36
Two-course Rotation	Rothamsted	38
Three-course Rotation	Rothamsted	39
Four-course Rotation	Rothamsted	43
Six-course Rotation	Rothamsted and Woburn	46
Deep-Cultivation Rotation	Rothamsted	51
Ley-Arable Rotations	Rothamsted	53
Green-Manuring	Woburn	64
Ley-Arable Rotations	Woburn	72
Market Garden Soil	Woburn	78
Irrigation	Woburn	84

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

DETAILS OF THE CLASSICAL AND LONG-TERM EXPERIMENTS, UP TO 1962

INTRODUCTION

The following notes are for use with the "Numerical Results of the Field Experiments" published annually. They give the present (1962) treatments of the classical and long-term experiments, together with the more important changes in cropping, manuring, and cultivations that have taken place up to date.

References are given to publications in which minor, and for the most part unimportant, changes in procedure have been recorded. The long-period average yields for some of the experiments are included but not for those which have been summarised in recent publications. The standard publications which discuss in detail the results of the classical experiments from the beginning till the early years of the present century are:-

1. Gilbert, J. H. (1895). Agricultural investigations at Rothamsted, England. U.S. Dept. Agric. Bull. No. 22.
2. Lawes, J. B. & Gilbert, J. H. (1895). The Rothamsted experiments. Trans. Highl. Agric. Soc. Scot, 5th Series 7,1.
3. Hall, A.D. (1917). The book of the Rothamsted experiments. London: John Murray.
   This contains a list of all important papers relating to the Rothamsted experiments from 1845 to 1910.
4. Gilbert, J.H. (1901). Memoranda of the results of the field experiments.
   Detailed statement of the manurial treatments applied to the classical plots from 1843-1900. Yields and occasionally chemical analyses of the experimental produce. The yields are usually successive long-period means but in some experiments year by year yields are given.
5. Russell, E.J. & Voelcker, J.A. (1936). Fifty years of field experiments at the Woburn Experimental Station. Rothamsted Monographs of Agricultural Science. London: Longmans, Green & Co.

Period of Treatments

The convention used in these notes is:-
all years are "harvest years".
1906-1925 means that the treatment was first applied to the crop harvested in 1906, and was last applied to the crop harvested in 1925.
"Since 1885" means that the treatment in question was applied for the first time for the crop that was harvested in 1885.
"Until 1884" means that the treatment in question was applied for the last time to the crop harvested in 1884, e.g. plot 2A on Broadbalk would be described as unmanured until 1884, 14 tons dung since 1885.

Tables of Mean Yields

Different numbers of years' results are grouped in the various experiments. For example for Broadbalk the period is 5 years (corresponding to one cycle of fallowing), for Park Grass 8 years (two cycles of liming).

In the tables the treatments are indicated by very brief symbols; full descriptions are given in the pages preceding each set of tables.

Note: Reference has been made to this publication in the (Numerical) Results of the Field Experiments as:- (a) Appendix Y 1950 (b) Details of the Classical and Long-Term Experiments 1956.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

BROADBALK WHEAT, 1843 ONWARDS

The first experimental crop was harvested in 1844 after a rotation of turnips (dunged) 1839, barley 1840, peas 1841, wheat 1842, oats 1843, the last four crops being entirely unmanured. Wheat has been grown experimentally every year since. The manurial treatments varied somewhat in the first eight years, but the experiment attained its permanent form in 1852. Most of the treatments, with certain exceptions noted below, have been applied to their respective plots year after year since that year.

Table 1. Manures applied per acre since 1852 unless otherwise stated

Plot Number	Treatment D tons	P P_2O_5 lb (1)	K K_2O lb (2)	Na lb (2)	Mg lb (2)	N N lb (3)	N′ N lb	R N lb	Notes
2A	14	-	-	-	-	-	-	-	(4)
2B	14	-	-	-	-	-	-	-	
3	-	-	-	-	-	-	-	-	(5)
5	-	65	98	100	100	-	-	-	
6	-	65	98	100	100	43(N_1)	-	-	
7	-	65	98	100	100	86(N_2)	-	-	
8	-	65	98	100	100	129(N_3)	-	-	
9	-	65	98	100	100	-	43(N'_1)	-	(6)
10	-	-	-	-	-	86	-	-	
11	-	65	-	-	-	86	-	-	
12	-	65	-	366	-	86	-	-	
13	-	65	98	-	-	86	-	-	
14	-	65	-	-	280	86	-	-	
15	-	65	98	100	100	86(N_2^+)	-	-	(9)
16	-	65	98	100	100	-	86(N'_2)	-	(7)
17	as plot 5 in odd years, as plot 10 in even years								
18	as plot 10 in odd years, as plot 5 in even years								
19	-	-	-	-	-	-	-	86	(10)
20	-	-	98	100	100	86	-	-	(11)

Plot sizes vary (8) but are approximately as follows:-
Full sections in fallowing cycle 0.10 acres, half sections 0.05 (approximately). Continuous wheat 0.028 acres.

Treatments: D: farmyard manure. P: superphosphate. K: sulphate of potash. Na: sulphate of soda. Mg: sulphate of magnesia. N. sulphate of ammonia. N′: nitrate of soda. R: castor meal.

https://doi.org/10.23637/ERADOC-1-191 *pp 6*

This work is licensed under a Creative Commons Attribution 4.0 International License.

BROADBALK

Notes:

(1) Until 1888 superphosphate was made from 200 lb. bone ash and 150 lb. sulphuric acid; from 1889-1897 it was made from mineral phosphate; from 1898-1902 basic slag was used in place of superphosphate.

(2) Until 1858 the dressing of sulphate of potash provided 147 lb. K_2O and the sulphate of soda was applied at 200 lb. per acre. On plot 12 the sulphate of soda was 550 lb. and on plot 14 the sulphate of magnesia was 420 lb.

(3) Until 1916 those plots which now receive sulphate of ammonia had a mixture of equal parts of ammonium sulphate and ammonium chloride (the "ammonium salts" of the early reports). The ammonium salts were all applied in autumn till 1877, they were all applied in spring till 1883. In 1884 the present method was adopted of giving 21 lb. N in the autumn and the remainder in spring. Except for the short period 1873-1877 plot 15 has always had the whole of its nitrogen in autumn.

(4) Since 1885.

(5) Since 1840.

(6) Plot 9 tested nitrate of soda at various rates (usually 550 lb.) with or without minerals since 1852-1893.

(7) Since 1884. Plot 16 received 800 lb. ammonium salts with "minerals" as on plot 5 from 1852-1864. It was then unmanured from 1865-1883.

(8) The original plots consisted of 2 "lands" each of $\frac{1}{4}$ acre side by side. In the early days these lands sometimes carried different, but related, treatments. In 1894 the pairs of lands were thrown together to give $\frac{1}{2}$ acre plots each carrying a single treatment. It was these plots that were divided transversely into 5 equal sections in 1926.

(9) All in autumn.

(10) Castor meal since 1941, previously rape cake. From 1852-1878 the quantity of rape cake was 500 lb. in addition to superphosphate and ammonium salts. In 1879 the minerals were stopped and the rape cake dressing was increased to provide about 86 lb. N.

(11) Since 1906.

For more detailed description of the materials used and minor changes in procedure see Imp. Bur. Soil Sci. Tech. Commun. No. 40, (1940) pp. 162-163. Also Memoranda of the Field Experiments 1901, pp. 30-31; and J. agric. Sci. (1921), 11, 107.

Weeds have always been a serious problem on Broadbalk and in spite of regular hand-weeding and inter-row cultivation occasional bare fallows had to be given. The following is a record of the bare fallows and other cleaning operations:-

1889	The wheat on one half of the field was drilled in wide rows (about 16") to allow thorough inter-row cultivation.
1890	Same operation on the other half.
1904	Each plot was divided into halves longitudinally one half being cropped and the other bare fallowed.
1905	Strips reversed.
1906-1925	Crop grown on 12" rows to enable inter-row cultivation to be carried out.
1914	All the Western half bare fallowed.
1915	All the Eastern half fallowed.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

1926 The field was divided transversely into five sections.
1926, 1927 Sections I, II, III bare fallowed.
1928, 1929 Sections III, IV, V bare fallowed.
The whole field was cropped in 1930 and in 1931 a regular system of fallowing was started: the five sections being fallowed in turn, each section carrying four wheat crops in succession and then having one year's rest with sufficient summer cultivation to keep down weeds.

In 1956 Section I was divided into two: Ia nearest the farm was assigned to continuous wheat with weedkillers as required but no fallows, while Ib continued in the 5-year cycle. The situation in the years 1951-1961 inclusive is given in tabular form below.

System of Cropping and Fallowing

	Ia	Ib	II	III	IV	V
1951	F	F	4	1	2	3
1952	1	1	F	2	3	4
1953	2	2	1	3	4	F
1954	3	3	2	4	F	1
1955	4	4	3	F	1	2
1956	5	F	4	1	2	3
1957	6	1	F	2	3	4
1958	7	2	1	3	4	F
1959	8	3	2	4	F	1
1960	9	4	3	F	1	2
1961	10	F	4	1	2	3

1, 2, 3, 4.. . . . first, second, third, fourth . . . . crop after fallow (F).

Section Ia in cycle till 1955, then continuous cropping. The crop in Ia in 1956 is actually the 5th continuous crop on this land.

Wild oats (Avena ludoviciana) have been hand-pulled on Broadbalk regularly since 1943. For a summary of the results of the first 4 fallowing cycles, 1935-1954, see Rep. Rothamst. Exp. Sta. for 1955, pp. 161-165.

In recent years it was known that parts of Broadbalk were becoming acid. The acidity was partly due to position in the field but it mainly arose out of the continued use of ammonium salts and rape cake (now castor meal). In autumn 1954 a liming scheme was begun as follows:-

Yearly dressings:

(a) On plots receiving sulphate of ammonia, 100 lb. calcium carbonate per 14 lb. N as sulphate of ammonia.
(b) On plot receiving castor meal, 50 lb. calcium carbonate per 14 lb. N as castor meal.

In the first year the dressings of chalk on the ammonium sulphate and castor meal plots were applied at double the prescribed rates. Section V was divided transversely into two equal parts a and b which are harvested separately. Section Vb, nearest the drain, received a single corrective dressing of 5 tons of calcium carbonate per acre.

https://doi.org/10.23637/ERADOC-1-191 *pp 8*

This work is licensed under a Creative Commons Attribution 4.0 International License.

BROADBALK

For details of the liming on Broadbalk see Rep. Rothamst. exp. Sta. for 1954, pp. 146-148.

Harvesting: Until 1900 by hand; 1901-1956 by binder; commencing in 1957 the plots were harvested by combine harvester, one combine cut per plot being weighed. Straw weights are taken after baling but some of the chaff, small cavings and dust is left on the plots.

Weedkillers: On Section Ia only, 1957 MCPA, 1958 mecoprop, 1959 2,3,6 - TBA/MCPA mixture, 1960 mecoprop, 1961 and 1962 2,3,6 - TBA/MCPA. Also, to stubble in autumn 1959, 2, 4-D.

Variety: Squarehead's Master since 1900. Previously Old Red Lammas 1844-1848, Old Red Cluster 1849-1852, Red Rostock 1853-1881, Red Club 1882-1899.

Results: Russell, E.J. & Watson, D.J. (1940). The Rothamsted experiments on the growth of wheat. Imp. Bur. Soil Sci. Tech. Comm. No. 40.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 2

WHEAT - BROADBALK
Grain: cwt per acre
5 year means

years after fallow	Plot	Treatment Symbols	1935 - 39				1940 - 44				1945 - 49				1950 - 54				1955 - 59				Mean 1935 - 59				I A 1955-59
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
	2A	D	20.6	14.6	15.4	13.7	25.8	22.4	19.8	15.0	27.3	21.7	20.1	17.5	26.9	21.4	21.8	21.3	27.2	23.4	21.1	20.0	25.5	20.7	19.6	17.5	19.8
	2B	D	21.2	18.5	16.3	14.9	26.9	24.1	24.5	19.4	28.3	25.1	21.6	18.9	26.4	22.8	22.4	23.2	27.8	24.8	22.7	22.8	26.2	23.1	21.5	19.9	20.2
	3	O	12.5	6.4	7.1	7.1	19.0	10.0	10.6	10.6	16.5	10.2	8.0	7.9	16.4	9.4	9.1	9.0	17.3	10.4	11.0	11.0	16.3	9.3	9.2	9.1	12.0
	5	PKNaMg	16.3	9.5	7.9	7.5	21.4	10.1	11.7	11.6	20.3	10.5	9.5	10.1	17.8	11.0	9.0	11.9	18.4	10.5	11.2	13.6	18.8	10.3	9.8	10.9	15.4
	6	N_1PKNaMg	19.4	11.9	10.0	10.9	24.3	14.3	15.2	15.3	23.1	14.1	11.4	11.4	21.3	15.1	12.7	14.2	22.0	15.3	14.7	16.8	22.0	14.2	12.8	13.7	16.6
	7	N_2PKNaMg	19.9	15.8	14.2	14.0	27.7	20.7	21.7	21.3	26.1	19.0	14.7	16.1	22.8	19.5	17.6	17.7	23.0	22.0	19.1	19.9	23.9	19.4	17.5	17.8	20.3
	8	N_3PKNaMg	20.7	18.5	15.8	14.9	27.2	22.9	22.9	23.4	27.0	24.1	20.4	19.3	24.2	23.0	20.8	22.6	26.1	25.0	21.1	21.0	25.1	22.7	20.2	20.2	21.8
	9	N_1PKNaMg	19.2	13.6	11.5	12.3	25.4	17.3	16.5	18.4	21.7	15.8	12.6	12.7	20.5	16.1	15.9	16.1	22.9	18.4	17.5	15.5	21.9	16.2	14.8	15.0	15.8
	10	N_2	14.5	16.2	12.6	12.4	18.4	19.9	17.3	17.2	17.3	18.8	13.1	11.8	18.4	19.6	16.9	16.1	17.1	17.5	14.8	15.7	17.1	18.4	14.9	14.6	16.5
	11	N_2P	14.5	13.6	11.9	10.9	20.5	19.0	16.5	16.3	16.1	16.9	14.3	13.1	17.5	17.5	16.9	16.1	16.9	19.9	15.6	15.1	17.1	17.4	15.0	14.3	18.6
	12	N_2PNa	16.1	15.1	12.9	13.3	24.8	20.1	20.3	20.0	19.7	18.6	15.0	14.9	20.4	20.1	18.1	17.6	17.9	20.1	17.3	17.3	19.8	18.8	16.7	16.6	21.1
	13	N_2PK	19.4	14.8	13.3	14.4	28.3	19.3	19.1	19.4	26.0	18.3	14.6	14.3	23.6	19.5	17.0	17.5	23.3	20.4	18.6	18.5	24.1	18.4	16.5	16.8	19.3
	14	N_2PMg	16.3	15.5	13.0	13.9	26.5	19.8	19.4	19.2	20.7	21.2	16.1	15.1	22.3	18.5	19.0	17.1	18.8	20.0	16.8	17.0	20.9	19.0	16.8	16.5	20.7
	15	N_2^+PKNaMg	18.8	14.4	12.9	14.0	26.4	17.9	18.3	19.3	23.3	16.6	14.5	14.4	24.6	15.6	14.9	15.0	22.6	16.2	15.3	16.4	23.1	16.1	15.2	15.8	17.8
	16	N_2^-PKNaMg	20.0	17.3	15.5	15.5	29.6	23.5	24.2	23.4	26.2	21.5	18.3	18.3	24.4	22.8	20.5	20.9	24.7	23.7	22.6	22.1	25.0	21.7	20.2	20.0	21.2
	17 & 18C*	PKNaMg	15.2	8.1	6.4	7.5	22.4	9.5	8.6	9.2	17.8	9.1	7.2	6.8	19.8	10.6	8.2	6.6	17.3	10.0	9.0	8.9	18.5	9.4	7.9	7.8	8.7
	17 & 18N_2*	N_2	18.0	14.9	14.7	14.8	27.2	20.1	21.2	21.0	22.4	16.8	16.7	17.5	23.7	19.0	17.3	19.0	24.6	16.9	19.2	20.6	23.2	17.5	17.8	18.6	19.1
	19	R	19.1	15.2	12.5	13.3	28.3	19.3	17.7	18.0	22.5	18.1	15.2	15.3	20.5	16.8	14.2	15.5	21.9	16.4	13.9	16.3	22.5	17.2	14.7	15.7	16.8
	20§	N_2KNaMg	20.4	20.3	9.7	7.0	23.6	20.3	17.2	17.3	11.8	20.4	14.9	13.2	19.0	21.1	14.1	16.4	23.6	15.6	17.2	13.4	19.7	19.6	14.6	13.4	16.4

* treatments in alternate years

§ Means of 2 years only per cycle

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

HOOSFIELD BARLEY

1852 ONWARDS

Before the experiment started the land carried turnips (dung and superphosphate) 1847, barley 1848, clover 1849, wheat 1850, barley (ammonium salts) 1851. The first experimental crop was harvested in 1852, and with the exception of 1912, 1933, and 1943, when the plots were bare fallowed, barley has been grown every year since. The manurial treatments are:

Table 3

Manures per acre 1852 onwards unless otherwise stated

Plot Number	Treatment D tons	P P_2O_5 lb. (1)	K K_2O lb. (2)	Na lb. (2)	Mg lb.	Si lb. (5)	N lb.N (3)	N lb.N (4)	R lb.N (6)	Notes
1.0	-	-	-	-	-	-	-	-	-	
2.0	-	65	-	-	-	-	-	-	-	
3.0	-	-	98	100	100	-	-	-	-	
4.0	-	65	98	100	100	-	-	-	-	(7)
5.0	-	65	98	-	-	-	-	-	-	
1A	-	-	-	-	-	-	43	-	-	
2A	-	65	-	-	-	-	43	-	-	
3A	-	-	98	100	100	-	43	-	-	
4A	-	65	98	100	100	-	43	-	-	
1AA	-	-	-	-	-	-	-	43	-	
2AA	-	65	-	-	-	-	-	43	-	
3AA	-	-	98	100	100	-	-	43	-	
4AA	-	65	98	100	100	-	-	43	-	
1AAS	-	-	-	-	-	400	-	43	-	
2AAS	-	65	-	-	-	400	-	43	-	
3AAS	-	-	98	100	100	400	-	43	-	
4AAS	-	65	98	100	100	400	-	43	-	
1C	-	-	-	-	-	-	-	-	43	
2C	-	65	-	-	-	-	-	-	43	
3C	-	-	98	100	100	-	-	-	43	
4C	-	65	98	100	100	-	-	-	43	
7-1	-	-	-	-	-	-	-	-	-	(8)
7-2	14	-	-	-	-	-	-	-	-	
6-1	-	-	-	-	-	-	-	-	-	
6-2	-	-	-	-	-	-	-	-	-	(9)
1N	-	-	-	-	-	-	-	43	-	(10)
2N	-	-	-	-	-	-	-	43	-	(11)

Plot areas: Mostly 0.18 acres, none less than 0.09 acres.

Treatments: D: farmyard manure. P: superphosphate. K: sulphate of potash. Na: sulphate of soda. Mg: sulphate of magnesia. Si: silicate of soda. N: sulphate of ammonia. N´:nitrate of soda. R: castor meal.

https://doi.org/10.23637/ERADOC-1-191 *pp 11*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Notes:
(1) Until 1887 made from 200 lb. bone ash and 150 lb. sulphuric acid. 1888-1897 from rock phosphate. 1898-1902 basic slag.
(2) From 1852-1857 the K_2O was 147 lb. and the sulphate of soda 200 lb. per acre.
(3) Until 1916 the ammonium salts were equal parts of ammonium sulphate and chloride. From 1917 onwards only ammonium sulphate has been used.
(4) The nitrate of soda treatment in the AA and AAS series started in 1868. Originally ammonium salts at 86 lb. N 1852-1857; the dressing of ammonium salts was halved from 1858-1867.
(5) Silicate at 200 lb. sodium silicate and 200 lb. calcium silicate per acre was first applied in 1862: since 1868 400 lb. sodium silicate was given.
(6) 2000 lb. rape cake per acre until 1857, 1000 lb. until 1940, 1000 lb. castor meal 1941-1954; since 1955 the castor meal was adjusted to supply 43 lb. N per acre.
(7) Ammonium salts also in 1852 only.
(8) 1852-1871 14 tons dung.
(9) Until 1932 this plot received ashes from the laboratory furnace, subsequently no manure of any kind has been given.
(10) In 1852 plots 1N and 2N had 65 lb. P_2O_5 and 147 lb. K_2O but no nitrogen; the nitrate of soda treatment began in 1853.
(11) 86 lb. N 1853-1857.

Variety: From 1917 onwards the variety has been Plumage Archer. Previously Chevalier 1852-1880, Archers Stiff Straw 1881-1890, Carters Paris Prize 1891-1897, Archers Stiff Straw 1898-1916. In 1929-1932 the plots were drilled in 18" rows to allow inter-row cultivation. Alternate strips of Plumage Archer and Spratt Archer were compared during this period.

Weed Control: Commencing in 1944 the barley was sprayed with DNOC until 1956; since 1957 various selective weedkillers have been used. 1958 and 1959 the stubble was sprayed in autumn with 2,4-D to check coltsfoot (Tussilago farfara).

Plot areas were reduced by pre-harvest cuts in 1948, 1952, 1954, and 1955 to control wild oats (Avena fatua) which were hand pulled in the reduced area taken for yield. In 1953 the wild oats were so bad that the whole field was cut green and the produce removed.

Liming: In winter 1954-1955 5 tons of chalk per acre were applied to Strips 3 and 4 including plots 5A and 5.0. Regular chalk supplements to all plots receiving sulphate of ammonia and castor meal were prescribed at the rate of 100 lb. $CaCO_3$ per 14 lb. N as ammonium sulphate and 50 lb. $CaCO_3$ per 14 lb. N as castor meal. These supplements are given every 5 years at a rate corresponding to all the sulphate of ammonia and castor meal used over this period. The first dressing was applied in spring 1955. See Rep. Rothamst. exp. Sta. for 1954, pp. 146-148.

Harvesting: Commencing in 1958 the plots were harvested by combine harvester.

For further information on manurial dressings see Memoranda of the Field Experiments 1901, pp. 26-27.

Results: Russell, E.J. & Watson, D.J. (1938). The Rothamsted field experiment on barley 1852-1937. Part I Emp. J. exp. Agric. 6, 268-314; Part II Ibid. 7, 193-220.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 4 BARLEY - HOOSFIELD 1852-1962

10-Year Means
Grain: cwt per acre

Plot	Treatment	1852-1861	1862-1871	1872-1881	1882-1891	1892-1901	1902-1911	(1) 1912-1921	1922-1931	(2) 1932-1941	(3) 1942-1951	(4) 1952-1961	Means 1852-1962 Grain cwt.per acre	Straw cwt.per acre	No. of years
1.0	O	11.4	8.8	6.8	6.2	5.3	5.2	6.5	3.7	6.9	9.3	7.4	7.0	7.9	107
2.0	P	13.9	11.8	9.0	9.6	7.1	9.3	10.2	6.7	11.6	11.7	10.6	10.1	9.8	107
3.0	KNaMg	12.5	10.2	7.8	6.0	4.8	5.5	7.5	3.8	9.0	11.7	7.6	7.8	9.0	107
4.0	PKNaMg	15.3	12.4	8.8	8.2	6.6	8.4	10.9	6.4	13.5	15.8	10.9	10.6	11.7	107
5.0	PK	12.3(a)	10.9	7.5	7.4	6.2	6.9	7.3	4.8	10.9	15.0	8.9	9.0	10.2	106
1A	N	17.0	15.8	13.2	12.0	8.8	10.7	11.2	5.4	10.4	11.5	10.8	11.6	13.2	107
2A	NP	22.9	24.7	20.4	18.0	15.5	16.1	16.2	11.8	18.8	15.9	16.8	17.9	19.4	107
3A	NKNaMg	17.8	17.8	15.0	12.4	11.8	11.0	11.3	6.0	13.2	14.4	13.4	13.1	15.9	107
4A	NPKNaMg	23.2	23.8	20.9	20.0	18.0	20.1	18.2	13.1	20.9	17.8	18.9	19.6	22.3	107
5A	NPK	21.7	23.1	19.8	15.0	14.1	15.2	16.1	10.9	19.5	14.2	19.8	17.2	21.9	106
1AA	N'		16.0	14.2	14.0	11.6	12.6	12.3	7.1	12.1	13.0	12.9	15.8	15.6	91
2AA	N'P		24.0	21.1	21.0	19.4	20.3	19.7	14.7	22.0	18.5	20.2	24.3	22.5	91
3AA	N'NaMg		16.5(d)	15.1	14.2	12.8	11.6	12.1	6.3	14.4	15.9	13.9	16.5	16.8	91
4AA	N'NaMg		24.0	21.6	20.1	18.5	19.8	18.9	13.3	21.8	21.4	19.9	24.1	22.8	91
1AAS	N'Si		18.7	17.7	17.1	16.0	14.9	14.9	8.6	16.4	16.1	17.0	16.4	18.4	91
2AAS	N'PSi		24.6(d)	22.3	22.2	20.3	19.5	19.7	14.9	21.4	20.4	22.9	21.7	23.4	91
3AAS	N'KNaMgSi		21.5	19.4	17.5	16.7	15.5	14.2	8.4	16.7	17.3	18.3	17.2	19.8	91
4AAS	N'PKNaMgSi		25.5	23.6	22.1	20.2	21.4	17.9	14.1	23.1	22.5	23.3	22.3	24.6	91
1C	R	23.4	22.5	19.8	17.5	16.0	17.5	13.5	11.4	18.4	15.6	17.2	17.6	19.9	107
2C	RP	23.9	23.7	21.2	19.1	17.1	18.3	14.6	14.8	21.3	20.9	19.5	19.5	21.4	107
3C	RKNaMg	22.1	22.4	19.0	16.8	15.1	17.4	12.2	10.0	17.6	21.1	17.0	17.4	20.1	107
4C	RPKNaMg	23.8	24.4	21.3	17.8	16.6	19.9	13.0	14.0	21.6	23.7	20.0	19.7	22.4	107
7-1	D until 1871			17.4	13.0	10.6	9.7	11.0	7.0	13.4	15.1	11.7	12.1	13.7	87
7-2	D	22.7	26.7	25.7	23.7	22.9	23.6	18.6	15.0	26.1	26.7	28.0	23.6	28.6	107
6-1	O	12.6	9.6	6.9	7.7	5.6	5.4	8.2	3.4	8.7	10.3	6.9	7.7	8.8	107
6-2	Ashes until 1932	12.1	10.2	7.7	8.2	6.1	7.1	9.9	4.4	8.9	9.8	8.7	8.4	9.4	107
1N	N'	19.0(b)	18.8	15.6	15.6	14.1	13.5	11.5	6.2	14.1	14.6	12.1	14.1	17.3	106
2N	N'	18.0(c)	20.5	17.9	17.0	16.8	16.8	14.8	9.4	17.5	18.1	15.9	17.7	19.4	101

(1) Omitting 1912 all plots fallowed (a) omitting 1852
(2) " 1933 " " " (b) " "
(3) " 1943 " " " (c) " 1852-1857
(4) " 1953 No yields recorded (d) " 1852-1867 (plots 1AA, 2AA, 3AA, 4AA. 1AAS, 2AAS, 3AAS, 4AAS)
(e) " 1954 No yield recorded.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

ALTERNATE WHEAT AND FALLOW, HOOSFIELD 1856 ONWARDS

Two half-acre strips side by side, one carrying wheat while the other lies fallow these treatments alternating on their respective plots. No manure has been given since 1851. The varieties grown have been the same as those grown on Broadbalk. Squareheads Master since 1900.

In 1932 a modification was made to enable the effect of a 1-year fallow to be compared with that of a 3-year fallow. The strips were divided transversely into four equal sections. When a strip carries wheat only three of the four sections are cropped, the fourth section being left fallow. Each of the eight sections has the triple fallow in turn. The sequence in the 8-year cycle is as follows:-

	Strip A				Strip B			
	A_1	A_2	A_3	A_4	B_1	B_2	B_3	B_4
1956	F	C	C	C	F	F	F	F
1957	F	F	F	F	C	C	F	C
1958	C	F	C	C	F	F	F	F
1959	F	F	F	F	C	C	C	F
1960	C	C	F	C	F	F	F	F
1961	F	F	F	F	F	C	C	C
1962	C	C	C	F	F	F	F	F
1963	F	F	F	F	C	F	C	C

(F = Fallow C = Crop)

In autumn 1956 the strips were divided into halves longitudinally. The centre two halves carried on the 8-year cycle as before on plots of half the former width. The outer two strips were assigned to the Entomology Department for field studies on wheat bulb fly, the factors studied being plant density and various sequences of wheat and fallow. No fertilisers are used. All plots have been combine harvested since 1957.

Plot area for fallow effects 1956 onwards: 0.063 acres approximately.

For an account of the long-period results of the Wheat and Fallow experiment see Rep. Rothamst. exp. Sta. for 1956, 184-187. The yearly yields over the period 1851-1900 are given in Memoranda of the Field Experiments 1901, 32.

Table 5

Wheat after Fallow - Hoosfield
8-year means

	Grain cwt per acre. years of fallow		Straw cwt per acre. years of fallow	
	1	3	1	3
1934-1941	9.7	10.6	14.1	16.8
1942-1949	11.6	12.9	18.4	20.9
1950-1957	9.7	10.6	*14.5	*15.5
1934-1957	10.3	11.4	15.7+	17.4+

*Not recorded in 1957 mean of 7 years
+Mean of 23 years

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

AGDELL,
4-COURSE ROTATIONS, 1848-1951

The experiment compared two 4-course rotations:-
Plots 2, 4, 6: Turnips, barley, red clover (or beans), wheat.
Plots 1, 3, 5: Turnips, barley, bare fallow, wheat.
The manures were applied to the turnips only at the following rates per acre:-

Table 6

1848 to 1948 unless otherwise stated.

Plot Number	Treatment P P_2O_5 lb.	K K_2O lb.	Na lb.	Mg lb.	N N lb.	R lb.
	(1)	(2)	(2)	(2)	(3)	(4)
5; 6	-	-	-	-	-	-
3; 4	85	245	100	200	-	-
1; 2	85	245	100	200	43	2000

Treatments. P: superphosphate. K: sulphate of potash. Na:sulphate of soda. Mg: sulphate of magnesia. N: sulphate of ammonia. R: castor meal.

Notes:
(1) Until 1884 made from 200 lb. bone ash and 150 lb. sulphuric acid supplying about 65 lb. P_2O_5 per acre. 1888-1892 ordinary superphosphate 68 lb. P_2O_5. 1896-1900 basic slag 108 lb. P_2O_5.
(2) Until 1892 the rates were 147 lb. K_2O, 200 lb. sulphate of soda, 100 lb. sulphate of magnesia.
(3) Until 1912 a mixture of ammonium sulphate and ammonium chloride.
(4) Until 1936 rape cake. The rape cake and castor meal each provided about 100 lb. N per acre.

The above arrangement gave 6 main plots each of 0.4 acres, but these were further subdivided to show the effect of carting the roots and leaves of the turnip crop off the land as compared with feeding them off by sheep or ploughing them in. This comparison was discontinued after the root crop of 1900; all roots and leaves have since been carted off.

Clover was grown in 16 seasons, and was replaced by beans in 10 seasons.

Varieties: Swedes: Since 1932 Bruce; previously several varieties had been grown for short periods only. In 1944 14 varieties of turnips and swedes were compared for resistance to club-root.

Barley: Plumage Archer since 1917, previously Chevalier and Archer Stiff Straw.

Wheat: Squarehead's Master since 1903 (Little Joss 1911), previously Red Rostock and Red Club. In 1947 winter wheat failed and was replaced by spring wheat, Atle.

Club-root (Plasmodiophora brassicae) was first mentioned as causing serious damage to the turnip crop in 1920, thereafter the yields declined rapidly and by 1948 the crop was not fit to weigh.

After the end of the 26th rotation in 1951 the experiment ended but cropping continued to measure the residual effects of the phosphate and potash applied to the root crop since 1848. Uniform

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

dressings of nitrogenous fertiliser were given to all plots according to the needs of the crops. The cropping has been:-

1952 Bare fallow.
1953 Barley, Plumage Archer, unmanured.
1954 Barley, Plumage Archer, 1.0 cwt. N, divided dressing.
1955 Spring wheat, Koga II, 0.6 cwt. N.
1956 Winter beans, S.Q. Giant, unmanured.
1957 Potatoes, Ulster Supreme, 1.0 cwt. N.
1958 Italian Ryegrass S22. The original 6 plots were divided; one half of each was sown with ryegrass, the other was bare fallowed. The ryegrass was cut twice and 0.8 cwt. N per acre was applied for each cut.
1959 2nd year Italian Ryegrass; 3.2 cwt. N in four dressings. Fallow plots sown with strips of potatoes, sugar beet, barley, each crop testing 0.0; 0.25; 1.0 cwt. P_2O_5 as superphosphate.
1960 Cocksfoot S37 after Italian Ryegrass; 0.8 cwt. N for each cut. Rotation of potatoes, sugar beet, barley continued testing direct application 0.0; 0.25; 1.0; 1.5 cwt. P_2O_5.
1961 Second year cocksfoot; 0.8 cwt. N for each cut. Plots 1, 3, 5 only: crops in rotation, testing superphosphate as follows:- None; 0.75; 1.50 cwt. P_2O_5 either ploughed in or in seedbed; also 0.75 cwt. ploughed in plus 0.75 cwt. in seedbed.
1962 Third year cocksfoot; 0.8 cwt. N for each cut. Plots 2, 4, 6 only: treatments and cropping as in 1961 on plots 1, 3, 5.

Liming: In 1954 the plots were limed with ground chalk at the following rates in tons calcium carbonate per acre:- Plot 1 3 tons; plot 2 4 tons; plot 3 (part only) 0.5 tons; plot 4 parts at 0.5, 1.0 and 1.5 tons. See Rep. Rothamst. exp. Sta. for 1954, pp. 146-148.

For further details of the early years of the experiment and yearly yields see Memoranda of the Field Experiments 1901, 110-121.

For residual effects of the manures see Warren, R.G. (1957). Rep. Rothamst. exp. Sta. for 1957, 252-260.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 7

CROPS IN ROTATION - AGDELL

1848 - 1919

Manure to turnips until 1948	None since 1848		Mineral manure* No Nitrogen		Mineral* and nitrogenous manure+	
Plot	5	6	3	4	1	2
Rotation	Fallow	Clover	Fallow	Clover	Fallow	Clover
Swedes, roots: tons per acre	1.7	0.6	8.8	9.6	18.0	15.9
Barley, grain: cwt per acre	11.4	10.8	12.0	12.0	16.4	18.4
Beans, grain: cwt per acre	-	7.7	-	10.7	-	13.1
Clover, hay: cwt per acre	-	30.7	-	58.6	-	60.2
Wheat, grain: cwt per acre	13.8	12.8	16.3	17.7	16.9	17.8

1920 - 1953

Manure to turnips until 1948	None since 1848		Mineral manure* No Nitrogen		Mineral* and nitrogenous manure+	
Plot	5	6	3	4	1	2
Rotation	Fallow	Clover	Fallow	Clover	Fallow	Clover
(1) Swedes, roots: tons per acre	1.00	0.35	7.69	10.84	13.88	6.99
(2) Turnips, roots: tons per acre	0.72	0.23	3.27	3.78	5.19	4.03
(3) Barley, grain: cwt per acre	7.7	6.5	11.1	14.5	10.8	10.7
(4) Clover, hay: cwt per acre	-	8.6	-	30.2	-	25.2
(5) Wheat, grain: cwt per acre	13.3	11.6	16.6	17.1	14.0	16.0

*P, K, N_a, Mg.

+Rape dust (or castor meal + sulphate of ammonia)

(1) Mean of 2 years 1920 and 1928
(2) Mean of 4 years 1924, 1932, 1936 and 1940
(3) Mean of 8 years 1921, 1925, 1929, 1933, 1941, 1945, 1949 and 1953
(4) Mean of 4 years 1922, 1926, 1930, 1938
(5) Mean of 7 years 1923, 1927, 1935, 1939, 1943, 1947, 1951

1937 Barley 1931 Wheat excluded crop failed

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

BARNFIELD, MANGOLDS, 1876-1959
(WITH SUGAR BEET ALSO SINCE 1946)

The previous experimental crops on the Barnfield plots were:- white turnips 1843-1848, swedes 1849-1852, barley 1853-1855, swedes 1856-1870, sugar beet 1871-1875. The layout of the field and the manures applied for these crops were similar to those adopted for the mangolds, but there were some important changes. For details of dressings and yields obtained in these early years see Memoranda of the Field Experiments 1901, pp. 56-63. For the complete history of cropping and manuring 1843-1959 see Rep. Rothamst. exp. Sta. for 1961, p. 227.

The field is manured on a cross dressing system: the "mineral" manures P, K, Na, Mg are laid in various combinations on strips running North and South, the various nitrogenous manures are applied across these strips at right angles. The strips are (1) dung, (2) dung + PK, (4) PKNaMg, (5) P, (6) PK, (7) P Na Mg, (8) no minerals. The nitrogen cross dressings are 0: no nitrogen, N: nitrate of soda, A: sulphate of ammonia, AC: sulphate of ammonia and castor meal, C: castor meal. The actual rates of manuring are given in Table 8 below:

Table 8

Strip Manures applied annually since 1876 unless otherwise stated. Dung (D), superphosphate (P), sulphate of potash (K), agricultural salt (Na), sulphate of magnesia (Mg) per acre.

	Treatment					
Strip	D tons	P P_2O_5 lb. (1)	K K_2O lb.	Na lb.	Mg lb.	Notes
1	14	-	-	-	-	
2	14	65	245	-	-	(2)
4	-	65	245	200	200	(4)
5	-	65	-	-	-	
6	-	65	245	-	-	
7	-	65	-	200	200	(3)
8	-	-	-	-	-	

Cross Dressings (nitrogenous) per acre

Series	Nitrate of soda N lb.	Sulphate of ammonia N lb.	Castor meal N lb.	Notes
O	-	-	-	
N	86	-	-	(4)
A	-	86	-	(5)
AC	-	86	86	(6)
C	-	-	86	(6)

Plot 9: There are no cross dressings. The manures given since 1903 are sulphate of potash 245 lb. K_2O; agricultural salt 200 lb.; sulphate of magnesia 200 lb.; nitrate of soda 86 lb. N. See note (7).

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

BARNFIELD

The individual plots are defined by their strip number and their series letter. Thus plot 5N has superphosphate (65 lb. P_2O_5) and nitrate of soda (86 lb. N).

Notes:

(1) Basic slag was used in place of superphosphate from 1896-1902.
(2) Until 1894 dung and superphosphate.
(3) Until 1902 the whole of strip 7 received 65 lb. P_2O_5 245 lb. K_2O and ammonium salts providing 8 lb. N. The present test of Na and Mg begun in 1903.
(4) In 1903 plot 4N was halved. 4Na carried the original manures; 4Nb received superphosphate 392 lb., calcium chloride 190 lb., potassium nitrate 570 lb., calcium nitrate 100 lb. per acre.
(5) Until 1916 equal parts of ammonium sulphate and chloride. (1887 ammonium sulphate only).
(6) Until 1939 rape cake @ 2000 lb. per acre (none 1917-1920); 1940-1954 2000 lb. castor bean meal; since 1955 86 lb. N as castor bean meal.
(7) 1876-1902 14 tons dung, 65 lb. P_2O_5, 86 lb. N as ammonium salts per acre.

Application of manures: Dung is ploughed in in winter; P, K, Mg, salt and castor bean meal and one third of the sulphate of ammonia and nitrate of soda are applied after the first cultivation but before the seed is drilled. The remaining two-thirds of the nitrogenous fertilisers are applied as a top dressing about the time of singling.

Variety of mangolds: Yellow Globe. Leaves apread on their plots and ploughed in. In 1908 and 1927 swedes were grown when mangolds failed. In 1931 a crop of mixed mangolds and swedes was grown. In 1935 the mangolds failed and the field was bare fallowed.

Since 1946 four rows of sugar beet (Kleinwanzleben E) have been drilled on the East side of every strip except strip 8 which has the sugar beet on the West side. Top weights are estimated from one random row per plot and the tops are spread on their plots and ploughed in except on the 0-series (less dung plots).

Since 1954 a space equal to four rows of mangolds has been kept free from crop along the East side of strip 1. This area receives the same manure as the adjacent cropped area.

In 1955 certain plots badly infested with twitch (Agropyron repens) were divided into two parts, one part being sprayed with sodium trichloroacetate (TCA). In 1956 the other half of these plots was similarly treated.

Chalking: In spring 1956 a corrective dressing of 5 tons of ground chalk per acre was applied to the A and AC series. After the crop had been removed a maintenance dressing was applied to balance the sulphate of ammonia and castor meal given over a 5-year period on series A, AC, and C, the rate being 100 lb. calcium carbonate per 14 lb. N as sulphate of ammonia and 50 lb. calcium carbonate per 14 lb. N as castor meal.

Leaf yields: Since 1942 the leaf yields have been estimated from the produce of two random rows per plot. Since 1954 the yields on the 0 series (except the dung plots) have been calculated from the two sample rows chosen for leaf weights. In 1955 it was decided that owing to the small amount of organic matter contained in the leaves of these plots, these leaves should in future be carted off.

The experiment ended in 1959. The land was fallowed in 1960 in preparation for experiments to study the residues of the former treatments.

https://doi.org/10.23637/ERADOC-1-191 *pp 19*

This work is licensed under a Creative Commons Attribution 4.0 International License.

For a summary of Barnfield results up to 1940 see Watson, D. J. & Russell, E. J. (1943-46). The Rothamsted experiments on mangolds 1872-1940.

Part 1. Effect of manures on yield of roots. Emp. J. exp. Agric. 11, 49-64.
Part 2. Effect of manures on the growth of the plant. Ibid. 11, 65-77.
Part 3. Causes of variation of yield. Ibid. 13, 61-79.
Part 4. The composition of the mangold grown on Barnfield (i) The dry matter content of leaves and roots. Ibid. 14, 49-56 (ii) The nitrogen content of leaves and roots. Ibid. 14, 57-70.

See also Kalamkar, R. J. (1933). A statistical examination of the yield of mangolds from Barnfield at Rothamsted. J. agric. Sci. 23, 161-175.

For an account of the yields of mangolds and sugar beet 1941-1959 and analyses of crops and soils from Barnfield see Warren, R. G. and Johnston, A. E. Rep. Rothamst. exp. Sta. for 1961, 227-247.

https://doi.org/10.23637/ERADOC-1-191 *pp 20*

Table 9

MANGOLDS, BARNFIELD 1876-1959

Roots: tons per acre, means over 19, 37 and 9 years

Series	O			A			N			C			AC		
	No nitrogen			Ammonium sulphate			Sodium nitrate			Rape cake			Rape cake + Ammonium sulphate		
Strip	1876-94	1904-40	1941-59	1876-94	1904-40	1941-59	1876-94	1904-40	1941-59	1876-94	1904-40	1941-59	1876-94	1904-40	1941-59
8 No P or K	3.8	3.0	1.5	6.0	5.6	5.8	10.2	10.6	8.1	10.2	8.3	8.4	10.1	7.5	8.1
5 P	5.0	4.0	2.2	8.3	6.8	7.4	15.7	16.1	11.7	12.0	9.4	9.8	11.2	8.8	9.3
6 P K	4.5	3.8	2.1	13.7	14.5	11.7	15.5	16.8	12.3	18.0	17.6	14.4	22.1	22.0	18.9
7 P Na Mg	(5.9)	4.0	2.2	(15.0)	16.1	12.2	(15.9)	18.4	12.4	(18.9)	19.2	15.1	(22.0)	21.5	17.0
4 P K Na Mg	5.3	4.2	2.7	15.5	15.5	12.8	18.3	19.0	14.4	20.7	20.7	15.8	25.0	26.4	19.1
1 D	16.8	17.4	8.9	22.1	22.0	18.1	23.2	28.0	20.0	23.6	23.0	17.9	24.5	23.2	19.9
2 D P K*	(17.0)	19.9	11.3	(21.4)	26.9	19.6	(24.2)	29.4	21.7	(23.3)	27.8	20.7	(23.5)	29.4	23.5

* The figures in brackets are means for the period, but the treatments differed from that given later.

https://doi.org/10.23637/ERADOC-1-191 pp 21

This work is licensed under a Creative Commons Attribution 4.0 International License.

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 10

SUGAR BEET BARNFIELD

Roots and tops: tons per acre, means over 14 years 1946-59

Strip,	Series O		A		N		C		AC	
	No Nitrogen		Ammonium sulphate		Sodium nitrate		Rape cake		Rape cake + ammonium sulphate	
	Tops	Roots	Tops	Roots	Tops	Roots	Tops	Roots	Tops	Roots
8 No P or K	2.0	1.5	4.9	4.2	6.1	5.0	7.5	5.6	9.0	6.4
5 P	2.1	1.9	4.8	5.0	7.4	6.7	6.6	6.9	9.3	7.2
6 PK	1.9	1.6	5.3	6.6	6.6	6.2	6.8	8.2	10.4	9.5
7 P Na Mg	2.1	1.8	6.4	7.2	7.8	7.2	8.4	7.7	11.7	9.0
4 P K Na Mg	2.0	1.8	5.8	7.2	7.5	8.0*	7.5	9.1	10.2	10.3
1 D	5.2	6.2	12.2	11.5	10.6	11.1	10.3	11.4	12.1	11.4
2 D P K	5.5	5.9	9.0	8.6	11.0	9.9	9.8	9.8	11.2	10.3

*Sodium nitrate replaced by a mixture of potassium and calcium nitrates.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

HAY, THE PARK GRASS PLOTS, 1856 ONWARDS

The Park has probably been in grass for some centuries. There is no record of any seed having been sown. The herbage has been cut for hay each year since manurial treatments were first applied in 1856. The management of the aftermath following the first hay cut in each season varied in the early years of the experiment. It was grazed by sheep in the years 1856 to 1872 except for 1866 and 1870. In 1866, 1870, 1873, 1874, 1876, 1884, 1885, 1887 the aftermath was mown but not removed from the plots. In all other years the produce of the second and sometimes third cut has been carted and weighed either as hay or green.

Table 11

Manures applied per acre, 1856 onwards unless otherwise stated.

	Treatment									
Plot	D tons	P P_2O_5 lb. (2)	K K_2O lb. (3)	Na lb. (4)	Mg lb.	Si lb.	N N lb. (1)	N N lb.	F cwt.	Notes
1	-	-	-	-	-	-	43(N_1)	-	-	(5)
2	-	-	-	-	-	-	-	-	-	(6)
3	-	-	-	-	-	-	-	-	-	
4-1	-	65	-	-	-	-	-	-	-	(19)
4-2	-	65	-	-	-	-	86(N_2)	-	-	(19)
5-1	-	-	-	-	-	-	-	-	-	(7)
5-2	-	65	245	-	-	-	-	-	-	(7)
6	-	65	245	100	100	-	-	-	-	(8)(19)
7	-	65	245	100	100	-	-	-	-	
8	-	65	-	100	100	-	-	-	-	(9)(19)
9	-	65	245	100	100	-	86(N_2)	-	-	
10	-	65	-	100	100	-	86(N_2)	-	-	(9)
11-1	-	65	245	100	100	-	129(N_3)	-	-	(10)(19)
11-2	-	65	245	100	100	400	129(N_3)	-	-	(10)(11)
12	-	-	-	-	-	-	-	-	-	
13	14	-	-	-	-	-	-	-	-	(12)
	-	-	-	-	-	-	-	-	6	
14	-	65	245	100	100	-	-	86(N_2)	-	(13)
15	-	65	245	100	100	-	-	-	-	(14)
16	-	65	245	100	100	-	-	43(N_1)	-	(15)
17	-	-	-	-	-	-	-	43(N_1)	-	(15)
18	-	-	245	100	100	-	86(N_2)	-	-	(16)
19	14	-	-	-	-	-	-	-	-	(17)
20	14	-	-	-	-	-	-	-	-	(18)
	-	33	49	-	-	-	-	26(N)	-	

Plot areas: For manuring mostly 0.5 acre and 0.25 acre, a few 0.17 and 0.12 acre. Most plots are divided into halves to test lime.

https://doi.org/10.23637/ERADOC-1-191 *pp 23*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Treatments: D: farmyard manure, P: superphosphate, K: sulphate of potash, Na: sulphate of soda, Mg: sulphate of magnesia, Si: silicate of soda, N: sulphate of ammonia, N': nitrate of soda, F: fish guano.

Notes:

(1) Until 1916 the ammonia nitrogen was supplied as a mixture of equal parts of ammonium sulphate and ammonium chloride. Since 1917 only ammonium sulphate was used.
(2) Until 1888 the phosphate was made from 200 lb. bone ash and 100 lb. sulphuric acid per acre, then superphosphate. 1897-1902 basic slag.
(3) Until 1878 the standard dressing of sulphate of potash was 147 lb. K_2O per acre, it was then raised to 245 lb. K_2O.
(4) Until 1863 plots 7, 9, 11-1, 11-2, 13, 14, 16 had 200 lb. sulphate of soda.
(5) Until 1863 14 tons dung also.
(6) Until 1863 14 tons dung only.
(7) After ammonium salts 86 lb. N until 1897.
(8) After ammonium salts 86 lb. N until 1868.
(9) Since 1862 147 lb. K_2O as sulphate of potash; 200 lb. sulphate of soda; 100 lb. sulphate of magnesia; 65 lb. P_2O_5. From 1864-1904 the dressing of sulphate of soda was 250 lb.. (500 lb. 1862-1863).
(10) Until 1881 the ammonium salts were applied at 172 lb. N except in 1859-1861 when the dose was 86 lb.
(11) The silicate dressing began when plot 11 was divided in 1862 and from 1862-1870 equal parts of calcium and sodium silicate were used.
(12) Until 1897 complete fertiliser as plot 9 with 2000 lb. per acre of cut wheat straw in addition. From 1898-1904 as plot 9, no straw. The dung has been applied once every 4 years starting 1905 and the fish meal once every 4 years starting 1907. Since 1959 the fish meal dressing has been standardised at 0.5cwt. N per acre (approximately 6cwt. meal).
(13) Since 1858.
(14) Since 1876. Nitrate of soda 86 lb. N 1858-1875.
(15) Since 1858.
(16) Since 1905. From 1865-1904 P, K, Na, Mg, Si, and N equal to the amounts contained in 1 ton of hay.
(17) Every 4th year since 1905. From 1872-1904 65 lb. P_2O_5; 142 lb. K_2O; and 43 lb. N as nitrate of soda.
(18) Dung every 4th year since 1905, fertilisers in intervening years. From 1872-1904 superphosphate 65 lb. P_2O_5 and potassium nitrate, supplying approximately 43 lb. N and 142 lb. K_2O.
(19) Sawdust at 18cwt. per acre was applied to plots 6, 8, 10 until 1862, and on plot 4 until 1858.

Liming: The first liming was done in 1881, when a strip 11 yards wide on the North side of plots 1-13 received 27cwt. chalk per acre. In 1883-1884 the plots were halved, one half having 18cwt. burnt lime per acre. In 1887-1888 the other halves of the plots were similarly treated. Plots 11-1 and 11-2 received a double dose on these occasions. In 1903 a regular liming scheme was started on the South halves of plots 1 to 4-2, 7 to 11-2, 13, 16. The dressing was 2000 lb. ground lime per acre every 4 years (missing 1911). In 1920 plots 14, 15, and 17 came into this scheme, all dressings being increased by one quarter to allow for the extra year, and plots 18,

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

PARK GRASS

Table 12

Hay - The Park Grass Plots, 1920 - 1959

Dry matter; cwt per acre

Plot	Treatment Symbols	8-year Means 1920 - 27 Not Limed 1st crop	1920 - 27 Not Limed Total	1920 - 27 Limed 1st crop	1920 - 27 Limed Total	1928 - 35 Not Limed 1st crop	1928 - 35 Not Limed Total	1928 - 35 Limed 1st crop	1928 - 35 Limed Total	1936 - 43 Not Limed 1st crop	1936 - 43 Not Limed Total	1936 - 43 Limed 1st crop	1936 - 43 Limed Total
1	N_1	13.6	20.9	15.7	21.3	11.7	15.7	15.1	18.4	6.1	10.8	12.4	16.2
2	O	10.3	15.7	12.1	16.2	11.3	14.6	11.6	14.3	7.3	10.6	8.4	11.1
3	O	8.8	12.8	9.6	13.2	9.7	12.4	9.6	11.8	6.5	9.2	7.9	10.6
4-1	P	13.0	17.7	11.8	15.8	13.8	17.1	10.9	12.8	9.4	12.7	8.9	11.7
4-2	N_2P	15.5	19.6	24.4	31.9	14.6	17.5	27.3	31.7	10.6	15.7	21.5	26.2
5-1	O	8.6	12.1	-	-	9.4	12.4	-	-	6.3	9.5	-	-
5-2	PK	15.1	20.9	-	-	15.5	19.9	-	-	12.8	18.3	-	-
6	PKNaMg	20.1	28.0	-	-	20.5	26.0	-	-	18.6	25.5	-	-
7	PKNaMg	20.0	28.2	24.3	31.2	21.8	27.7	27.8	34.6	19.3	28.3	24.3	31.8
8	PNaMg	13.4	19.4	11.3	16.2	15.3	19.9	12.1	16.2	12.8	17.9	10.5	14.6
9	N_2PKNaMg	26.2	35.6	38.7	48.6	32.9	39.9	45.0	52.3	26.2	36.2	33.3	41.8
10	N_2PNaMg	19.7	26.6	29.8	38.6	21.2	26.0	32.5	38.6	14.6	21.6	27.1	34.0
11-1	N_3PKNaMg	31.4	45.4	43.4	55.4	35.2	47.6	47.1	55.8	22.9	40.0	38.1	50.6
11-2	N_3PKNaMgSi	38.7	50.8	44.1	57.2	40.0	53.7	47.8	59.7	30.7	48.7	40.3	55.8
12	O	11.5	15.7	-	-	11.2	14.8	-	-	8.4	13.1	-	-
13	D; F	30.6	39.5	27.5	35.8	34.0	41.8	31.4	37.8	25.2	35.9	20.8	28.6
14	N_2'PKNaMg	39.4	49.5	35.9	43.0	42.7	52.1	41.8	47.9	36.6	45.9	34.7	41.7
15	PKNaMg	21.8	29.7	18.5	25.1	21.2	27.1	21.4	25.3	14.1	19.6	19.9	24.8
16	N_1'PKNaMg	27.5	34.9	26.7	33.6	31.1	37.1	26.7	31.4	25.4	32.0	25.6	31.4
17	N_1'	16.4	22.4	18.4	24.1	16.4	20.5	20.0	23.0	12.9	17.3	15.9	18.8
18	N_2KNaMg	16.2	27.2	25.8*	36.6*	17.6	23.8	32.3*	38.7*	7.9	16.3	18.2*	21.3*
				23.0+	31.7+			26.0+	31.3+			16.9+	20.5+
19	D	20.6	28.4	17.9*	23.9*	21.4	28.2	18.7*	23.5*	19.8	27.3	18.6*	24.5*
				18.8+	24.9+			20.5+	25.5+			19.4+	26.0+
20	D; N'PK	26.3	34.9(1)	25.7*	33.0*	31.6	38.0	28.8*	34.2*	26.9	34.4	23.7*	29.8*
				29.7+	37.1+			30.4+	36.0+			25.0+	31.4+

* Heavy Liming + Light Liming (1) Excluding second crop 1925

https://doi.org/10.23637/ERADOC-1-191 *pp 25*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 12 (continued)

Dry matter; cwt per acre

Plot	Treatment Symbols	8-year Means 1944 - 51 Not Limed 1st crop	Not Limed Total	Limed 1st crop	Limed Total	1952 - 59 Not Limed 1st crop	Not Limed Total	Limed 1st crop	Limed Total	40-year Means 1920 - 59 Not Limed 1st crop	Not Limed Total	Limed 1st crop	Limed Total
1	N_1	5.1	9.1	12.5	15.3	5.5	11.5	15.0	23.3	8.4	13.6	14.1	18.9
2	O	8.7	11.8	9.3	12.0	9.5	15.5	12.7	20.5	9.4	13.6	10.8	14.8
3	O	7.8	10.8	9.2	11.3	8.3	13.9	12.2	18.0	8.2	11.8	9.7	13.0
4-1	P	11.5	14.6	11.6	15.4	14.9	23.2	15.3	24.1	12.5	17.1	11.7	15.9
4-2	N2P	8.5	11.3	20.3	24.2	10.2	17.9	24.4	32.9	11.9	16.4	23.6	29.4
5-1	O	4.9	6.5	-	-	6.7	11.9	-	-	7.2	10.5	-	-
5-2	PK	11.0	15.9	-	-	17.5	27.1	-	-	14.4	20.4	-	-
6	PKNaMg	20.3	29.0	-	-	23.5	35.5	-	-	20.6	28.8	-	-
7	PKNaMg	18.7	27.4	29.0	36.9	22.6	34.1	29.5	41.8	20.5	29.2	27.0	35.3
8	PNaMg	15.8	22.3	11.2	15.1	18.1	27.8	15.3	23.9	15.1	21.5	12.1	17.2
9	N_2PKNaMg	26.1	38.0	29.4	35.0	23.7	36.4	36.0	46.6	27.0	37.2	36.5	44.9
10	N_2PNaMg	14.9	22.9	23.4	28.5	13.7	23.8	29.0	37.7	16.8	24.2	28.4	35.5
11-1	N_3PKNaMg	23.9	42.7	40.1	49.5	21.9	45.0	40.8	56.5	27.1	44.2	41.9	53.6
11-2	N_3PKNaMgSi	31.0	48.2	40.9	52.6	29.6	52.3	47.8	69.2	34.0	50.8	44.2	58.9
12	O	9.0	13.2	-	-	10.6	18.3	-	-	10.1	15.0	-	-
13	D;F	21.8	30.0	26.0	33.6	27.3	40.9	25.8	40.1	27.7	37.6	26.3	35.2
14	N_2'PKNaMg	34.2	44.7	32.8	39.7	39.1	55.2	39.2	53.7	38.4	49.5	36.9	45.2
15	PKNaMg	14.7	22.0	18.5	22.6	18.6	27.6	28.8	42.4	18.1	25.2	21.4	28.0
16	$N_1'^1$PKNaMg	22.1	29.3	24.8	30.9	28.5	40.7	33.8	49.7	26.9	34.8	27.5	35.4
17	N_1'	13.4	18.7	15.3	19.9	16.9	26.6	18.8	29.4	15.2	21.1	17.7	23.0
18	N_2KNaMg	7.9	13.2	19.8*	24.0*	8.7	17.4	20.6*	27.8*	11.7	19.6	23.3*	29.7*
				17.7+	22.5+			20.2+	29.1+			20.8+	27.0+
19	D	20.6	28.3	20.5*	26.5*	24.8	36.9	23.5*	35.2*	21.4	29.8	19.9*	26.7*
				22.2+	27.8+			25.8+	38.7+			21.4+	28.6+
20	D; N^1PK	26.8	34.2	28.4*	34.5*	29.3	42.4	30.2*	42.8*	28.2	36.8(1)	27.4*	34.8*
				28.3+	35.7+			28.8+	42.0+			28.4	36.4+

* Heavy Liming + Light Liming (1) Excluding 2nd Crop 1925

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

19, 20 were each divided into three sections one being left unlimed and the other two limed every 4 years:-

Plot 18	61 and 35	cwt.	ground	lime	per	acre.		
19	28 and 5	"	"	"	"	"		
20	25 and 5	"	"	"	"	"		

In 1956 the lime used contained a high proportion of calcium carbonate and it was decided that in future the whole dressing should be applied as calcium carbonate equivalent to 2000 lb.CaO per acre.

Harvesting: For many years all operations were done by hand The mowing machine was first used for the first cut in 1901 though it had been used for the second cut since 1881. The first cut was made into hay and weighed as such until 1959; the second cut is weighed green and yields are calculated from the dry matter figures. In 1959 a flail type forage harvester was compared with the ordinary cutter-bar machine on the first cut on parts of plots 1, 7, 11-1, and 13. The tabulated yields for this crop refer to hay made in the usual way. The second cut on all plots in 1959 was estimated entirely by forage harvester, taking two cuts per plot except plots 5 to 10, 13, 18 which had four cuts. From 1960 yields of both cuts have been estimated from 2 or 4 cuts by the forage harvester; at the first cutting the remainder of each plot is cut by mower and made into hay on the plot but at the second cutting the whole produce is cut by forage harvester and carried green.

Further details of manuring: Memoranda of the Field Experiments, 1901, pp. 20-23.

Yields and botanical composition: Brenchley, W.E. The Park Grass plots at Rothamsted. Revised by K. Warington. Harpenden: Rothamsted Experimental Station. 1958.
Brenchley, W.E.(1924). Manuring for hay. Rothamsted Monographs on Agricultural Science. London: Longmans, Green & Co.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

EXHAUSTION LAND
HOOSFIELD, 1850 ONWARDS

The experiments in progress on this land test the residual effects of manures applied in a classical potato experiment which occupied this site from 1876-1901(1). There were 10 plots of potatoes each of 0.167 acres, manured as follows:-

Table 13

MANURES APPLIED YEARLY PER ACRE 1876-1901

	Treatment							
Plot	D tons	P P_2O_5 lb. (6)	K K_2O lb.	Na lb.	Mg lb.	N_2 N lb. (5)	N'_2 N lb.	Notes
1	-	-	-	-	-	-	-	
2	-	-	-	-	-	-	-	(2)
3	14	-	-	-	-	-	-	(3)
4	14	-	-	-	-	-	-	(4)
5	-	-	-	-	-	86	-	
6	-	-	-	-	-	-	86	
7	-	65	147	100	100	86	-	
8	-	65	147	100	100	-	86	
9	-	65	-	-	-	-	-	
10	-	65	147	100	100	-	-	

Treatments: D: farmyard manure. P: superphosphate. K: sulphate of potash. Mg: sulphate of magnesia. Na: sulphate of soda. N: ammonium salts. N′: nitrate of soda.

Notes:

(1) Some of the treatments date back to a much earlier period:-
1850-1855 Wheat, unmanured.
1856-1874 Five strips of continuous wheat each 0.33 acres. Using the numbers of the potato plots given above the yearly manures to wheat were (with minor changes in the amounts of K, Na, Mg):-
1, 2, 3, 4 No manure.
5, 6 Ammonium salts 86 lb. N
7, 8 Ammonium salts 86 lb. N with complete mineral manure (see below).
9,10 Mineral manure superphosphate 65 lb. P_2O_5, sulphate of potash 98 lb. K_2O sulphate of soda 100 lb., sulphate of magnesia 100 lb.
In 1875 the wheat failed and the land was fallowed.
The yields of wheat for the first 8 seasons are recorded in J. Roy. Agric. Soc. (1864) 25. p.493.

(2) After 14 tons of dung until 1881.

(3) Until 1882, this plot also received superphosphate at 65 lb. P_2O_5 per acre.

(4) Also 65 lb. P_2O_5 until 1882 and also 86 lb. N as nitrate of soda until 1881.

(5) The ammonium salts consisted of equal parts of ammonium sulphate and chloride.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

(6) 1897-1901 Basic slag was used in place of superphosphate made from 200 lb. bone ash and 150 lb. sulphuric acid.

For fuller details yields and crop analyses see Memoranda of the Field Experiments 1901, pp. 86-108.

Residual years: The cropping from 1902 onwards has been:-

1902-1922 Cereals without manure, yields taken. 16 crops of barley, 3 of oats, 1 of wheat and a bare fallow in 1920. (Plots 5-10 red clover from 1905 to 1911). For details see Rep. Rothamst. exp. Sta. for 1921-22, p. 88.

1923-1939 Cereals without manure, no yields recorded except for wheat in 1935.

1940-1948 Cereals with nitrogen only, average dressing 0.6 cwt. N per acre. No yields taken.

1949-1958 Barley (Plumage Archer) with 0.5 cwt. N per acre, yields taken.

1957 The land was cropped in halves, the West half containing Plots 2, 4, 6, 8, 10 and the East half 1, 3, 5, 7, 9.
W. Half Bare fallow, except a narrow strip in barley.
E. Half Strips of spring wheat, barley, sugar beet, potatoes, kale, swedes divided into microplots to test residuals against direct application of P and K.

1958 W. Half Barley.
E. Half As in 1957 but on fresh land (headlands of 1957 experiment).

Since 1959 Both halves in Barley with 0.5 cwt. N per acre.

Liming: In the winter of 1954-55 calcium carbonate at rates varying from 2 to 5 tons per acre was applied as ground chalk to various parts of the experimental area according to their needs (For details see Rep. Rothamst. exp. Sta. for 1954, p. 148).

Part of plot 2 received ground chalk at 2 tons per acre in winter 1959-60.

For general account of Exhaustion Land see Rep. Rothamst. exp. Sta. for 1959, 230-239.

For preliminary results of diversified cropping in 1957 and 1958 see Rep. Rothamst. exp. Sta. for 1958, pp. 55-57.

For residual effects measured in barley see Warren, R. G. (1956) N. P. K. residues from fertilisers and farmyard manure, in long-term experiments at Rothamsted. Proc. Fertil. Soc. 37, 1-33.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 14

EXHAUSTION LAND HOOSFIELD

Wheat Yields: cwt per acre
5-year means

Plot No.	1	2	3	4	5	6	7	8	9	10
Treatment	-		-		N_2		N_2PKNaMg		PKNaMg	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
1856-1860	11.1	16.8	9.0	14.0	15.8	26.6	20.0	36.9	9.9	15.5
1861-1865	8.1	12.3	5.7	8.7	10.2	16.2	20.3	31.6	7.5	10.7
1866-1870	6.3	9.2	6.0	9.0	7.3	11.3	11.5	18.5	7.4	11.2
1873-1874*	9.6	16.0	8.6	16.1	13.1	23.0	13.7	24.7	9.4	17.2

* Means of 2 years, crop failed 1871, fallow 1872 and 1875.

Table 15

EXHAUSTION LAND HOOSFIELD

Potatoes Total Tubers: tons per acre
5-year means

Plot No.	1	2	3	4	5	6	7	8	9	10
Treatment	-	-	D	D	N_2	N_2'	N_2PKNaMg	N_2'PKNaMg	P	PK
1876*	3.86	4.26	5.33	6.72	2.89	3.88	8.10	8.79	6.05	6.18
1877-1881	1.96	5.42	5.63	7.19	2.43	3.07	7.40	7.58	3.58	3.74
1882-1886	1.76	3.20	4.27	3.80	2.15	2.04	6.26	5.58	3.61	3.58
1887-1891	0.98	2.02	4.38	4.75	1.44	2.00	4.44	4.86	2.18	2.48
1892-1896	1.09	1.86	6.48	6.71	1.53	2.19	5.35	5.79	2.43	2.90
1897-1901	0.55	0.94	2.92	2.81	0.69	0.98	2.43	2.68	1.17	1.20

* Manures applied October 1874 and not again before 1876 potatoes

https://doi.org/10.23637/ERADOC-1-191 *pp 30*

This work is licensed under a Creative Commons Attribution 4.0 International License.

EXHAUSTION LAND

Table 16

EXHAUSTION LAND HOOSFIELD
Barley

Means over 4 years 1949 - 52

Treatment Symbol	Plot	cwt per acre Grain	Straw
O	1	11.4	13.9
O	2	12.0	14.8
D	3	24.3	25.7
D	4	25.7	27.8
N_2	5	13.2	15.2
N_2'	6	13.0	14.5
N_2PKNaMg	7	22.6	24.2
N_2'PKNaMg	8	24.8	24.2
P	9	22.7	22.5
PK	10	25.4	25.9

Means over 4 years 1953-56

Plot	cwt per acre Grain	Straw
1	12.6	15.6
2	13.7	18.9
3	25.0	26.9
4	24.4	26.8
5	14.8	16.8
6	12.4	16.8
7	24.0	26.0
8	22.8	25.6
9	21.8	24.4
10	24.0	27.3

Means over 3 years 1960 - 62

Treatment Symbol	Plot	cwt per acre Grain	Straw
O	1	17.5	11.4
O	2	15.6	9.9
D	3	24.3	16.0
D	4	24.9	16.1
N_2	5	16.3	10.4
N_2'	6	14.8	9.8
N_2PKNaMg	7	20.8	13.9
N_2'PKNaMg	8	20.8	13.2
P	9	20.7	13.4
PK	10	21.7	14.6

Means over 11 years 1949-56 and 1960-62

Plot	cwt per acre Grain	Straw
1	13.5	13.8
2	13.6	15.0
3	24.6	23.5
4	25.0	24.2
5	14.6	14.5
6	13.3	14.1
7	22.6	22.1
8	23.0	21.7
9	21.8	20.7
10	23.9	23.3

https://doi.org/10.23637/ERADOC-1-191 *pp 31*

This work is licensed under a Creative Commons Attribution 4.0 International License.

ROTHAMSTED GARDEN CLOVER, 1854 ONWARDS

First crop sown in spring 1854 on a plot in the kitchen garden of the Manor House, and resown when necessary ever since. Complete resowing or patching is now almost a yearly operation.

Variety: Red Clover.

In 1956 the plot was divided into two to test an annual dressing of muriate of potash at 2 cwt. per acre (4 cwt. per acre in 1961).

In 1960 the sub-plots were halved to test the effect of a foliage spray of molybdenum.

2 or 3 cuts of greenstuff are taken each season.

Whole plot area: 0.0022 acres.

For an account of the history and yields of this plot see Rep. Rothamst. exp. Sta. for 1956, pp. 187-189.

Table 17

CLOVER - ROTHAMSTED GARDEN

Dry matter: cwt per acre

Means over 6 years
1957-62

Muriate of Potash: cwt per acre

None	2*	Mean
18.1	34.6	26.4

NB For 1960-62 the yields from the plots sprayed with sodium molybdate have been excluded.

Means over 3 years
1960-62

Muriate of Potash: cwt per acre	Spray		Mean
	None	Sodium Molybdate	
None	9.3	3.7	6.5
2*	22.7	15.7	19.2
Mean	16.0	9.7	12.8

* 4 cwt in 1961

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

WOBURN, STACKYARD FIELD
CONTINUOUS WHEAT AND BARLEY, 1877 ONWARDS

The experiments on wheat and barley tested the same set of manurial treatments under the same plot numbers. There were four periods (1) 1877-1906 during which the fertiliser dressings were on much the same scale as for continuous cereals at Rothamsted (2) 1907-1926 when additional treatments were tested and most of the nitrogen dressings were reduced by half (3) 1927-1959 when the manurial treatments were discontinued and only nitrogen was applied while the residuals of the former treatments were being measured (4) 1960 onwards a more detailed study of residual effects involving direct additions of P and K on micro-plots.

Commencing in 1898 certain of the plots were subdivided to test lime applications. These lime dressings are tabulated separately in Table 19.

Plot size: The main plots of the original experiment were $\frac{1}{4}$ acre.

Varieties: Many changes were made, 11 varieties of wheat and 8 of barley were grown during the course of the experiment. Since 1927 the varieties have usually been Squareheads Master wheat and Plumage Archer barley. The table gives the treatments applied from 1877-1926.

Table 18

Manures, lb. per acre. 1877 - 1926 unless otherwise stated.

	Treatments						
Plot (1)	P P_2O_5 lb. (2)	K K_2O lb. (2)	N N lb.	N N lb.	R N lb.	D N lb.	Notes
1	-	-	-	-	-	-	
2	-	-	20.5	-	-	-	(7)
3a	-	-	-	41	-	-	
3b	-	-	-	20.5	-	-	(7)
4	56	27	-	-	-	-	
5	56	27	20.5	-	-	-	(7)
6	56	27	-	20.5	-	-	(7)
7	-	-	-	-	-	-	
8a, 8b	PK and 41 lb. N as sulphate of ammonia alternately						(3)
9a, 9b	PK and 41 lb. N as nitrate of soda alternately						(3)
10a	56	-	-	20.5	-	-	(4)
10b	-	-	-	-	20.5	-	(5)
11a	-	55	-	20.5	-	-	(6)
11b	-	-	-	-	-	82	(7)

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Treatments: P. superphosphate. K: sulphate of potash. N: sulphate of ammonia (until 1906 equal parts of ammonium sulphate and ammonium chloride) N : nitrate of soda. R: rape cake. D: farmyard manure.

Notes

(1) Subdivisions of the plots for liming are ignored in this table. See below.
(2) Until 1906 the "minerals" provided 65 lb. P_2O_5, 98 lb. K_2O, 100 lb. sulphate of soda and 100 lb. sulphate of magnesia.
(3) Until 1881 the plots were undivided and the minerals and nitrogen were applied in the same year.
(4) Dung 53 lb. N until 1881; unmanured 1882-1906.
(5) Dung 53 lb. N until 1887; unmanured 1888; rape cake 82 lb. N 1889-1906.
(6) Dung 105 lb. N until 1881; unmanured 1882-1906.
(7) 105 lb. N until 1906.

Liming: After 16 years of ammonium salts providing 41 lb. N per acre the barley yields on plot 2 began to decline. This plot was first limed for the crop of 1898 as was also its counterpart in wheat which was by then also showing deterioration but to a lesser degree. Thereafter lime has been applied to several of the plots in different amounts and years. The material used was high grade burnt lime, slaked before application. The details are:

Table 19

Lime (CaO) cwt. per acre and years of application

	5	10	20	40
		Wheat		
2aa	'05, '09, '10, '11	-	-	-
2b	-	-	-	'98
2bb	-	-	-	'98, '05
5b	-	-	'05	-
8aa, 8bb	-	'05, '18	-	-
		Barley		
2aa	'05, '09, '10, '11	'23	-	-
2b, 5b, 8aa, 8bb	-	-	-	'98, '12
2bb	-	-	-	'98, '05
4b	-	-	'15	-
5aa	-	-	'05, '16	-
3aa, 3bb	-	-	-	'21

From 1927-1940 the plots were cropped with Red Standard wheat (Million in 1929 and 1930) and Plumage Archer barley usually without manure. The plots were bare fallowed in 1927, 1928, 1934, 1935. In 1931 and 1932 the varieties Plumage and Archer were grown side by side in alternate strips on all the barley plots. Most of the plots were unmanured but plots 8, 9, 10a, 11a received fertilisers as detailed below.

https://doi.org/10.23637/ERADOC-1-191 *pp 34*

This work is licensed under a Creative Commons Attribution 4.0 International License.

WOBURN CLASSICALS

Manures applied to certain plots 1931, 1932

lb. per acre

Plot	Super-phosphate P_2O_5 lb.	Sulphate of potash K_2O lb.	Sulphate of ammonia N lb.	Nitrate of soda N lb.
8	56	82	41	-
9	56	82	-	41
10a	56	-	-	42
11a	-	82	-	42

From 1941 to 1957 cropping was continued as before but nitrogenous fertilisers were given to all plots. In 1941 and 1942 sulphate of ammonia at 47 lb. N per acre was given as a basal dressing for both crops. In 1943 the plots, excluding 2, 5, and 8 which had received sulphate of ammonia, were divided into sets of three and dressings of 35 lb., 70 lb., 105 lb. N per acre as "Nitro-Chalk" were applied to the plots of each set in cyclical order. The sets were:

No PK	Plots 1, 3, 7
PK	Plots 4, 6, 9
Dung	Plot 11b (divided into 3 sections)
Various treatments	Plots 10a, 10b, 11a

The wheat plots were fallowed in 1947, 1948, 1955, 1956, 1957; the barley plots in 1947, 1948, 1949, 1956, 1957. No crop weights were taken on either experiment in 1950. In 1952 and 1953 the barley plots were divided to compare winter and spring sown barley.

Liming: In 1955 dressings of ground chalk ranging from 20-50 cwt. per acre, according to pH of the individual plots, were applied to both experiments in order to bring all plots to about pH 6.0.

In 1956 and again in 1957 further adjustments involving dressings ranging from 7.5-15 cwt. chalk per acre were made to both experiments.

1958 All main plots of both experiments divided into 4 sections carrying winter wheat, winter barley, spring wheat and spring barley respectively. The crops were uneven and were ploughed up in spring 1958.

1959-61. All main plots divided to test Squareheads Master wheat and Plumage Archer barley with a basal dressing of 102 lb N per acre.

1960 On the barley strip crossing plots 7, 8, 9, 11a, 11b on both experiments two sub-strips were put down one in Plumage Archer barley and the other in Majestic potatoes. These were divided into microplots to measure residuals against direct applications of P and K.

1961 As 1960 but microplots included also Klein E Sugar beet.

1962 Spring oats, variety Condor with a basal dressing of 56 lb. N per acre. A further small area was allocated for micro-plots on soil structure, occupying parts of plots 4, 5, 6, 11a and 11b of the Permanent Barley Site.

Summary of yields 1877-1926. Rep. Rothamst. exp. Sta. for 1927-28, pp. 104-107. Early results yearly in the J.R. agric. Soc., since 1921 yearly in the Rep. Rothamst. exp. Sta.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 20

Continuous Wheat and Barley

Wheat Grain: cwt. per acre

Means over 7 years 1944, 45, 49, 51, 52, 53, 54.

Plot Numbers Treatment 1877-1926		1, 3, 7 No P or K	4, 6, 9 PK	10a, 10b, 11a, NP, R, NK	11b D	Mean
Treatment "Nitro-Chalk" 1944-54 cwt. per acre	2	8.3	9.5	8.6	11.1	9.4
	4	9.8	13.9	10.8	13.2	11.9
	6	12.1	14.5	13.3	16.3	14.1
Mean		10.1	12.6	10.9	13.5	11.8

(1943: failed. 1946: rejected (highest yield 6.7 cwt.). 1947, 48: fallow. 1950: failed. 1955: fallow).

Barley Grain: cwt. per acre

Means over 6 years 1943, 44, 45, 46, 52, 53.

Plot Numbers Treatment 1877-1926		1, 3, 7 No P or K	4, 6, 9 PK	10a 10b 11a NP, R, NK	11b D	Mean
Treatment "Nitro-Chalk" 1943-54 cwt. per acre	2	5.6	7.2	5.8	9.0	6.9
	4	7.4	11.2	7.2	9.9	8.9
	6	8.8	10.9	6.5	11.5	9.4
Mean		7.3	9.7	6.5	10.1	8.4

Note: no yield was recorded for plot 10a (N3) in 1952. A value (10.5 cwt.) was estimated and used in making the table.

(1947, 48, 49: fallow. 1950: failed. 1951: rejected - 3 plots not recorded, (highest yield 8.7 cwt.). 1952, 53: yields of spring-sown barley only used. 1954: rejected - 5 plots not recorded. 1955: not included - lime applied).

https://doi.org/10.23637/ERADOC-1-191 *pp 36*

This work is licensed under a Creative Commons Attribution 4.0 International License.

RESIDUAL VALUES EXPERIMENT, LITTLE HOOS, 1904-1926

This experiment tested the direct action and residual effect over the three following years of five nitrogenous and three phosphatic manures. Swedes, barley, mangolds and wheat were grown (one crop each year) mainly in the order given. Clover hay was taken in 1917 and 1923, without direct applications of the manures and in 1925 the experiment lay fallow. One series of five plots was assigned to each manure. Each set had a control plot and the remaining four plots showed the four stages of exhaustion of the manure in question. The manures and the usual dressings per acre were:-

Nitrogenous set:

(i) Farmyard manure made with ordinary feeding 16 tons
(ii) Farmyard manure made by cattle receiving rich cake feeding 16 tons
(iii) Shoddy, 1 ton till 1917, then 8½ cwt.
(iv) Guano 8 cwt
(v) Rape dust 10 cwt.

Phosphatic set:

(vi) Superphosphate 5.3 cwt.
(vii) Bone meal 3.8 cwt.
(viii) Basic slag 5.3 cwt.

For details see Finney(1).

Basal dressings: The nitrogen set (including controls) had basal dressings of superphosphate and sulphate of potash as required; the phosphate set likewise had sulphate of ammonia and sulphate of potash.

Plot arrangement: The eight series were applied to eight strips running side by side across the field. The nitrogen set and the phosphate set each being kept together. The controls ran diagonally across the field but the order of the manurial treatments within the series was systematic. The plots were 0.125 acres.

When two cycles had been completed, Hall (2) made a preliminary assessment of the results, and after the experiment had ended Finney(1) examined the whole data in the light of the various changes that had been made in dressings and sequence of cropping drawing up tables that exhibited the more valid comparisons. The following table is derived from Finney's data. Swedes and mangolds are taken together, the cereals are expressed in bushels (1 bushel wheat = 60 lb. approximately, 1 bushel barley = 52 lb. approximately) the number of years for which a complete set of balanced data is averaged is given after each crop.

(1) Finney, D.J. (1940). The Little Hoos field experiment on the residual values of certain manures. Emp. J. exp. Agric. 8, 111-125.
(2) Hall, A.D. (1913). The duration of the action of manures J.R. agric. Soc. Eng. 74, 119-126.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 21

RESIDUAL VALUES EXPERIMENT LITTLE HOOS 1904-1926

	Nitrogenous manures				Phosphatic manures,			
	Ordinary Dung	Cake-fed Dung	Shoddy	Guano	Rape-dust	Superphosphate	Bone Meal	Basic Slag
Roots, Swedes and mangolds: tons per acre								
Means over 4 seasons								
Control	8.7	8.7	8.7	8.7	8.7	6.5	6.5	6.5
Years since Manured								
0	12.1	13.1	10.3	11.6	10.3	9.9	8.4	8.7
1	10.3	11.5	10.8	9.0	9.1	9.3	9.2	9.3
2	10.3	10.3	9.3	9.1	8.9	8.9	7.7	8.4
3	8.7	8.3	8.1	8.2	8.1	8.3	7.2	7.9
Mean	10.3	10.8	9.9	9.5	9.1	9.1	8.1	8.6
Wheat, Grain bushels per acre								
Means over 4 seasons.								
Control	19.2	19.2	19.2	19.2	19.2	24.2	24.2	24.2
Years since Manured								
0	27.4	31.4	22.7	25.4	24.2	24.2	25.3	27.6
1	24.0	27.2	23.6	18.9	19.6	25.1	26.6	26.9
2	23.6	23.2	22.0	18.5	19.8	25.0	25.6	26.2
3	23.1	23.3	19.6	19.1	19.3	23.3	25.2	28.3
Mean	24.5	26.3	21.9	20.5	20.7	24.4	25.7	27.3
Barley, Grain: bushels per acre								
Means over 3 seasons								
Control	24.5	24.5	24.5	24.5	24.5	27.9	27.9	27.9
Years since Manured								
0	41.4	45.4	36.6	42.2	37.1	38.5	34.7	37.4
1	38.6	40.9	23.7	24.1	28.1	30.7	29.1	33.1
2	35.9	33.5	25.0	21.5	24.6	30.3	29.1	30.5
3	32.7*	35.4*	29.5	23.2	23.4	29.7	31.0	31.8
Mean	37.1	38.8	28.7	27.7	28.3	32.3	31.0	33.2
* Contains one 7 year residual								
Clover, Hay: cwt per acre								
Means over 2 seasons								
Control	49.2	49.2	49.2	49.2	49.2	43.9	43.9	43.9
Years since Manured								
1	69.8	71.2	51.5	49.7	46.4	48.3	46.9	55.3
2	65.7	69.2	45.0	46.6	50.4	49.8	46.0	48.4
3	64.4	68.4	48.6	51.3	48.3	46.7	42.5	51.2
4	61.2*	64.8*	43.8	48.0	48.2	47.9	42.5	51.2
Mean	65.3	68.4	47.2	48.9	48.3	48.2	45.4	51.7
* Contains one 8 year residual								

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

TWO-COURSE ROTATION EXPERIMENT, EFFECT OF AGRICULTURAL SALT, LONG HOOS VII, 1942-1950

The crop rotation was sugar beet, barley. There were 96 plots arranged in randomised blocks of 12. The blocks were grouped in two series one in each crop each year. Treatments were first applied to sugar beet, in 1942 (Series I) and 1943 (Series II).

The treatments were all combinations of the following factors:-

Salt to sugar beet: 0, 2½, 5, 7½ cwt. agricultural salt per acre

Muriate of potash to sugar beet: none, the equivalent of half the single dressing of salt, the equivalent of the single dressing of salt (i.e. 0, 1, 2 cwt. K_2O per acre approximately)

Time of application of salt: in seedbed at sowing time, before ploughing in winter (1942 and 1943; after ploughing, one month before sowing)

Salt to barley: none, at half rates applied to sugar beet.

Basal dressings, applied at sowing

Barley: 0.3 cwt. N per acre as sulphate of ammonia
Sugar beet: 0.8 cwt. N per acre as sulphate of ammonia
0.6 cwt. P_2O_5 per acre as superphosphate.

For a summary of the results to 1949 see Rep. Rothamst. exp. Sta. for 1949, 101-104.

Table 22

Two-Course Rotation.

Sugar beet, Total Sugar: cwt. per acre. Means over 8 years 1942-49.

Salt to sugar beet cwt per acre	Muriate of potash: cwt per acre None	2	4	Mean
None	40.9	43.7	45.9	43.5
2½	50.0	47.8	49.0	48.9
5	50.0	50.2	49.5	49.9
7½	48.0	49.4	50.0	49.1
Mean	47.2	47.8	48.6	47.9

Table 23

Two-Course Rotation Experiment,

Barley, grain: cwt per acre. Means over 8 years 1943-1950.

Salt to barley : cwt per acre	Muriate of potash: cwt per acre None	2	4	Mean
None	27.7	28.4	27.4	27.8
1.25	28.3	28.7	28.3	28.4
2.50	27.5	27.8	27.3	27.5
3.75	27.0	28.7	28.2	27.9
Mean	27.6	28.4	27.8	27.9

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

THREE-COURSE ROTATION EXPERIMENT
EFFECTS OF STRAW AND STRAW COMPOST
LONG HOOS VI, 1933 - 1958

This experiment falls into two periods (i) the original experiment 1933-1951 (ii) modified treatments to test particular points arising from the results of the original experiments 1952-1958. The object of the experiment was to study the long-period effect of raw straw ploughed in and of straw made into compost.

First Period

The rotation was potatoes (Ally till 1941, then Majestic), barley (Plumage Archer), sugar beet (Kuhn till 1941, then Kleinwanzleben E).

There were three series, one for each crop of the rotation. The treatments were:-

(I) No organic manure, fertilisers applied in spring (F)
(II) Straw compost applied in autumn (C)
(III) Raw straw in autumn, fertilisers in spring (Ss)
(IV) Raw straw in autumn, $\frac{1}{2}$ fertilisers in autumn, $\frac{1}{2}$ in spring (Sd)

These treatments were repeated on their respective plots in alternate years to show direct effects plus the cumulative effect of previous dressings and first year residuals. Half the plots received the manures in even years, half in odd years.

Notes 1. From 1933-1937 there was a test of autumn-sown green manuring crops, 0 v. Rye v. Vetches taken factorially with the above, making 24 treatments per series (randomised as one block).

2. From 1943 till 1951 sulphate of magnesia was applied yearly to two of the six plots assigned to each main treatment, the dressings being cumulative.

The rates of dressing per acre were:-

F Fertilisers only 0.4 cwt. N, 0.4 cwt. P_2O_5, 0.5 cwt. K_2O

C Straw compost derived from the rotting of $53\frac{1}{3}$ cwt. straw, the chemical added in the heap providing 0.4 cwt. N and 0.4 cwt. P_2O_5. In addition 0.5 cwt. K_2O was applied with the compost.

Ss $53\frac{1}{3}$ cwt. straw; 0.4 cwt. N, 0.4 cwt. P_2O_5, 0.5 cwt. K_2O.

Sd $53\frac{1}{3}$ cwt. straw; 0.2 cwt. N, 0.2 cwt. P_2O_5, 0.25 cwt. K_2O in autumn and the same amount of fertiliser again in spring.

Basal dressings: Sugar beet; 0.2 cwt. N, 0.2 cwt. P_2O_5, 0.25cwt. K_2O.
Potatoes; 0.4 cwt. N, 0.4 cwt. P_2O_5, 0.5 cwt. K_2O.
Barley; None

Fertilisers used: N: Barley and potatoes and autumn $\frac{1}{2}$ dressing to sugar beet as sulphate of ammonia, sugar beet spring dressing nitrate of soda.

https://doi.org/10.23637/ERADOC-1-191 *pp 40*

This work is licensed under a Creative Commons Attribution 4.0 International License.

THREE COURSE

P_2O_5: All crops as superphosphate

K_2O: Barley, sugar beet and autumn ½ dressing to potatoes as muriate of potash (until 1946 the spring dressing to potatoes was applied as sulphate of potash, afterwards as muriate).

Sulphate of magnesia: All crops 2.5 cwt. per acre.

Application of manures:- Straw and compost with their accompanying fertilisers ploughed in in autumn. Fertilisers for sugar beet and barley harrowed into the seedbed in spring before sowing seed. Fertilisers for potatoes broadcast down the ridges before planting (except in 1951 when they were broadcast before ridging).

Plot area: 0.02 acres.

Second Period: 1952-1958 when the experiment ended.

The experiment was redesigned to ascertain whether the effect of straw could be explained mainly in terms of its power to immobilise nitrogen and to supply potash. The rotation was unchanged and continued on the three blocks, the compost and magnesium sulphate treatments being stopped. The plots formerly receiving only inorganic fertilisers now tested ammonium sulphate (N_2) applied in alternate years. One third of the plots originally receiving straw or compost continued to receive straw (S) in alternate years. The remainder tested in presence and absence of sulphate of ammonia the effect of muriate of potash (K_s) equivalent to the potash contained in the straw application.

In the original experiment the straw received nitrogen in the form of sulphate of ammonia at the conventional rate (N = 0.7% of the dry straw) but in the new experiment nitrogen was tested at 0.2 and 0.6 cwt. per acre, roughly 0.4% of the dry straw (N_1) and 1.2% of the dry straw (N_3). The straw plots having the lower rate of nitrogen received 0.4 cwt. N (N_2) in the following year. No further nitrogen was given in the second year to the straw plots receiving high level of nitrogen, except the appropriate basal dressing.

All plots were split to test additional muriate of potash (K) supplying 0.5 cwt. K_2O per acre. These potash dressings were not cumulative but alternated on the half plots. The half plots were weighed in the potato crop only.

For each of the three crops there were available

(a) 6 main plots of the former F treatments, 3 in each phase, i.e. 3 where the fertilisers had been applied in even years and the remaining 3 where the fertilisers had been given in odd years.

(b) 12 main plots of the former Ss and Sd treatments, 6 in each phase.

(c) 6 main plots of the former C treatment, 3 in each phase.

Using the symbols given above the treatments were as follows:-

Old system 1933-51

		F in even years			Ss and Sd in even years						C in even years		
New	Even years	N_2	0	N_2	SN_1	SN_3	N_2	0	K_sN_2	K_s	SN_3	N_2	K_sN_2
System	Odd years	0	N_2	0	N_2	0	0	N_2	0	N_2	0	0	0

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

For plots which received treatment manures in odd years of the old system the two rows of symbols are interchanged, odd for even and vice versa.

The basal dressings were:

	cwt per acre N	P_2O_5	K_2O
Barley	-	0.2	-
Sugar Beet	0.2	0.4	0.25
Potatoes	0.4	0.6	0.5

The fertilisers used were sulphate of ammonia, superphosphate and muriate of potash. Straw was applied in the winter and ploughed in. All fertilisers were applied in spring including the potash equivalent of the straw. Potato fertilisers were broadcast on the flat and the potatoes planted by machine. Ground chalk providing approximately 10 cwt. CaO per acre was applied for the barley in 1952 and 1955-57.

For further information see:-

Rep. Rothamst. exp. Sta. for 1933, 118-119, Original design, procedure and treatments.
Rep. Rothamst. exp. Sta. for 1951, 135-140, Summary of 18 years results.
Results of Field Experiments, 1952, p. Ba/1.1, Details of the revised scheme.
Rep. Rothamst. exp. Sta. for 1958, 167-171, Summary of 6 years results under the revised scheme.
Patterson, H.D. An experiment on the effects of straw ploughed in or composted on a three-course rotation of crops. J. agric. Sci. (1960) 54, 222-230. Summary of the whole experiment.

Table 24
Three-Course Rotation Experiment Long Hoos VI
means over 18 years 1934-51.

Treatment: Applied to test crop F	Ss	Sd	C	Applied to previous crop F	Ss	Sd	C	S.E.
Potatoes, total tubers: tons per acre								
9.12	9.64	9.25	8.00	6.99	8.02	8.11	7.58	±0.137
Barley, grain: cwt per acre								
32.3	30.8	30.8	27.5	27.4	27.3	28.0	26.3	±0.55
Sugar beet, total sugar: cwt per acre								
43.3	41.0	40.9	36.9	37.3	37.4	38.6	36.1	±0.68

https://doi.org/10.23637/ERADOC-1-191 *pp 42*

This work is licensed under a Creative Commons Attribution 4.0 International License.

THREE-COURSE ROTATION EXPERIMENT, LONG HOOS VI
means over 6 years 1953-58

Table 25

Potatoes, total tubers: tons per acre
Original treatment (1933-51)

Treatments to Potatoes	Preceding sugar beet	Straw		Compost		Fertilizers only	
		N to potatoes: cwt per acre					
		0.4	0.8	0.4	0.8	0.4	0.8
S+0.2 cwt. N/acre	-	8.20	9.68	-	8.85	-	-
-	S+0.2 cwt. N/acre	8.37	9.53	8.15	-	-	-
K_8	-	8.01	9.66	-	9.64	-	-
-	K_8	8.28	9.43	8.18	-	-	-
-	-	7.67	8.87	7.54	8.79	7.24	8.50
Mean		8.03	9.34	7.96	9.09	7.24	8.50

Table 26

Barley, grain: cwt per acre
Original treatment (1933-51)

Treatments to Barley	Preceding potatoes	Straw		Compost		Fertilizers only	
		N to barley: cwt per acre					
		0.0	0.4	0.0	0.4	0.0	0.4
S+0.2 cwt. N/acre	-	26.3	31.2	-	31.2	-	-
-	S+0.2 cwt. N/acre	28.2	31.0	29.0	-	-	-
K_8	-	27.7	31.9	-	30.6	-	-
-	K_8	27.4	32.0	27.4	-	-	-
-	-	27.2	30.8	29.4	31.7	27.8	31.1
Mean		27.3	31.3	28.6	31.2	27.8	31.1

Table 27

Sugar beet, total sugar: cwt per acre
Original treatment (1933-51)

Treatments to Sugar beet	Preceding barley	Straw		Compost		Fertilizers only	
		N to sugar beet : cwt per acre					
		0.2	0.6	0.2	0.6	0.2	0.6
S+0.2 cwt. N/acre	-	35.7	42.2	-	41.2	-	-
-	S+0.2 cwt. N/acre	37.0	44.0	34.6	-	-	-
K_8	-	37.6	43.4	-	41.0	-	-
-	K_8	36.9	41.6	37.8	-	-	-
-	-	35.9	42.5	34.4	43.0	34.4	41.7
Mean		36.5	42.7	35.6	41.7	34.4	41.7

https://doi.org/10.23637/ERADOC-1-191 *pp 43*

This work is licensed under a Creative Commons Attribution 4.0 International License.

FOUR-COURSE ROTATION EXPERIMENT
RESIDUAL VALUES OF ORGANIC MANURES AND PHOSPHATIC FERTILISERS, HOOSFIELD, 1930-1956.

This experiment falls into two periods: 1930-1954 the original scheme which attained full cycle in the crops of 1934; and 1955-1956 when a modified scheme was in operation.

1. The Original Experiment. 1930-1954.

The five treatments were farmyard manure, straw compost, straw, superphosphate and rock phosphate (Gafsa); the cropping followed a 4-course rotation (potatoes, barley, ryegrass, wheat). There were four series, one for each crop of the rotation. Each series had twenty-five plots.

Farmyard manure and straw compost were each applied at a rate to supply 50 cwt. of organic matter per acre. The quantity of raw straw per acre for ploughing in was such that if rotted in the heap it would produce compost containing 50 cwt. of organic matter. The nutrient content of the three organic treatments was equalised by adding sulphate of ammonia, muriate of potash and superphosphate, to raise the totals to 1.8 cwt. N, 1.2 cwt. P_2O_5 and 3.0 cwts. K_2O per acre. The phosphatic fertilisers were applied at the rate of 1.2 cwt. P_2O_5 per acre, together with sulphate of ammonia and muriate of potash at the above rates.

Any given plot always received the same treatment, but the treatment was applied to the plot only once in five years, except that the sulphate of ammonia and muriate of potash on the phosphatic plots were applied annually at one fifth of the full rates. Thus in each of the 4 crops every manurial treatment had a set of 5 plots showing respectively its 5 stages of exhaustion. The full cycle was therefore 20 years.

Plot area: 0.0244 acre (Series IV 0.0233).

The fertilisers were applied as follows:-

Bulky organic manures ploughed in before sowing wheat and autumn-sown ryegrass, and later in the winter for the barley and potatoes. Supplementary fertilisers for farmyard manure and compost applied and ploughed down with these organics, the supplementary nitrogen for the straw was applied in three successive dressings. The straw was chaffed to enable it to be ploughed in properly. Superphosphate and rock phosphate with their accompanying potash and half their nitrogen were applied in the seedbed for autumn-sown crops leaving the remaining half of their nitrogen for a spring top dressing. For barley and potatoes the superphosphate and rock phosphate with their supplementary potash and nitrogen were given in the seedbed and ridges respectively.

The following changes have been made:-

1930-31 Turnips were grown but these gave place to potatoes in 1932 and subsequently.

1935 Undersown clover-ryegrass ley replaced by Western Wolths ryegrass sown in autumn.

https://doi.org/10.23637/ERADOC-1-191 *pp 44*

This work is licensed under a Creative Commons Attribution 4.0 International License.

FOUR COURSE

1942 Variety of potatoes changed from Ally to Majestic and potato plots split to test an extra 0.4 cwt. N as ammonium sulphate.

1946 Variety of wheat changed from Yeoman to Squareheads Master.

2. The Revised Experiment, 1955-1956.

The rotation was modified by introducing beans (autumn sown when possible) instead of ryegrass ley, the present rotation being: potatoes, barley, beans, wheat.

The application of farmyard manure, straw, straw-compost and rock phosphate were discontinued. The plots originally testing dung, straw and superphosphate respectively received an annual dressing of 0.24 cwt. P_2O_5 per acre applied as superphosphate, while the old compost plots received 0.12 cwt. P_2O_5 annually as superphosphate. The rock phosphate plots received no phosphate. All plots had a basal dressing of 0.6 cwt. K_2O annually as muriate of potash (but see below for the beans of 1955 and the wheat of 1956)

Each plot of wheat, barley and potatoes was split for nitrogen:-

wheat and barley: none; 0.4 cwt. N per acre applied as sulphate of ammonia.

potatoes: 0.2; 0.6 cwt. N per acre applied as sulphate of ammonia.

The arrangement of the levels of nitrogen was randomised afresh each season. The beans did not receive nitrogen.

The phosphate and potash fertilisers were applied in autumn for beans and wheat, half-plots of wheat receiving a single top dressing of nitrogen in spring. All fertilisers for barley were applied to the seedbed. All fertilisers for potatoes were broadcast on the flat before planting by machine.

In 1955 the plots of beans were split into 3 for a test of potash:- none; 0.8; 1.6 cwt. K_2O per acre applied as muriate of potash. The wheat following these beans received equalising amounts of potash:-

1.6 cwt. K_2O following none; 0.8 following 0.8 and none following 1.6.

Subsequent cropping.

1957 After the harvest of 1956 the second scheme was terminated and the four series were each sown with 5 strips of cereals.

The cereal plots coincided with the blocks of the old rotation.

The crops were:-

Wheats: Yeoman, Squareheads Master, Cappelle; Barley: Proctor; Oats: Sun II.

Studies were made of the incidence of take-all (*Ophiobolus graminis*) and eyespot (*Cercosporella herpotrichoides*) in relation to the previous cropping.

1958 In autumn 1957 the whole area was sown with winter beans.

1959 Yeoman wheat, 0.6 cwt. N as "Nitra-Shell" 20.5% N per acre.

For the design of the original experiment see Rep. Rothamst. exp. Sta. for 1930, 125-126.

For summaries of the original experiment see Rep. Rothamst. exp. Sta. for 1946, 82-84, and for 1954, 153-156.

https://doi.org/10.23637/ERADOC-1-191 *pp 45*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 28

FOUR-COURSE ROTATION, HOOSFIELD

means over 21 years 1934-54.

Years after application	Farmyard manure	Straw compost	Straw	Super-phosphate	Rock phosphate	S.E.
POTATOES, tons per acre (no additional N)						
0	6.41	6.18	6.89	6.90	4.49	±0.18*
1	5.35	4.92	5.01	5.76	4.49	±0.16†
2	5.17	4.47	5.22	5.86	4.69	
3	4.79	4.51	5.10	5.74	4.54	
4	4.58	4.33	4.95	5.60	4.58	
Mean	5.26	4.88	5.43	5.97	4.56	±0.11
Response to 0.4 cwt. additional N per acre, 1942-54						
0	1.49	0.82	1.19	0.78	0.12	
1	1.82	1.47	1.59	1.00	0.81	
2	1.15	1.46	1.53	0.68	0.21	±0.28
3	1.64	0.90	1.08	0.57	0.41	
4	1.54	0.78	1.38	0.75	-0.18	
Mean	1.53	1.09	1.35	0.76	0.27	±0.12
BARLEY, grain: cwt per acre						
0	28.0	27.5	29.3	27.6	23.4	±0.41*
1	22.8	22.0	22.0	25.8	24.0	±0.48†
2	20.7	19.9	21.2	26.4	25.0	
3	19.0	19.6	20.9	26.4	24.3	
4	18.9	18.6	20.5	25.8	25.6	
Mean	21.9	21.5	22.8	26.4	24.5	±0.31
RYEGRASS, dry matter: cwt per acre, means over 18 years - 1935-40, 1942-48, 1950-54.						
0	19.2	19.5	30.9	19.5	17.6	
1	12.5	13.1	11.6	19.3	16.7	
2	11.2	10.3	12.6	18.8	17.0	
3	9.6	9.7	10.7	18.0	16.8	
4	9.6	9.8	9.6	18.0	16.6	
Mean	12.4	12.5	15.1	18.7	16.9	
WHEAT, grain: cwt per acre						
0	20.9	22.2	23.6	18.7	18.7	±0.31*
1	17.0	17.0	15.9	17.8	18.3	±0.32†
2	15.3	15.0	16.8	18.4	18.2	
3	15.1	15.2	15.7	18.1	18.3	
4	15.2	14.8	14.9	18.6	18.0	
Mean	16.7	16.8	17.4	18.3	18.3	±0.17

† S.Es. for horizontal comparisons.
* S.Es. for vertical comparisons and interactions.

Note: All yields except those of ryegrass have been adjusted for block differences. The adjustment of the ryegrass yields is complicated, and has not been carried out; these adjustments are, however, almost certainly small, as they were in the case of the other crops, as each block has in some year carried nearly all of the treatment-phase combinations.

https://doi.org/10.23637/ERADOC-1-191 pp 46

This work is licensed under a Creative Commons Attribution 4.0 International License.

SIX-COURSE ROTATION EXPERIMENTS
ROTHAMSTED, LONG HOOS IV AND WOBURN, STACKYARD, SERIES B, 1930-1960

These experiments were begun in 1930 on both farms but were not fully established on their present sites till 1931.

The purpose was to measure the responses of six crops to several levels of each of the main nutrients N, P, K over a period of years, and to obtain information on the response to fertilisers in different seasons.

The crops of the rotation and the varieties are as follows:-

	Rothamsted	Woburn
Sugar Beet	Kuhn P till 1941, then Klein E	Kuhn P till 1942, then Klein E
Barley	Plumage Archer	Plumage Archer till 1955, then Herta
Clover	Red till 1936, then Montgomery Red	Red till 1945, Montgomery Red till 1955, then Crimson Clover
Wheat	Yeoman	Yeoman till 1945, Squareheads Master till 1955, then Yeoman
Potatoes	Ally till 1941, then Majestic	Ally till 1941, then Majestic
Rye*	Not specified till 1948, then King II	Not specified till 1948, then King II

*Till 1933 an autumn sown forage mixture of rye, vetches, and beans was grown and cut green, but rye for grain was substituted in 1934.

In the early years of the experiments catch crop green manures were grown as follows (dates are those of the succeeding root crops):-

Rothamsted 1932-1940, Woburn 1932-1942, mustard for sugar beet

Rothamsted 1932, 1934-1937, Woburn 1932-1942, 1944 and 1945, rye for potatoes.

There are 15 plots in each block divided into three sets of five as follows:-

Level	0	1	2	3	4	
Nitrogen series	0.0	0.15	0.3	0.45	0.6	cwt. N per acre as sulphate of ammonia
Phosphate series	0.0	0.15	0.3	0.45	0.6	cwt. P_2O_5 per acre as superphosphate
Potash series	0.0	0.25	0.5	0.75	1.0	cwt. K_2O per acre as muriate of potash

The N series has a basal dressing of P and K at their middle levels, and similarly for the other nutrients. All crops receive the same scale of fertiliser dressing. For spring-sown crops all fertilisers are applied in the seedbed. For autumn-sown crops, P and K are given in the seedbed, N as a spring top dressing. Clover has its P and K in the seedbed or as autumn top dressing and the N in spring.

https://doi.org/10.23637/ERADOC-1-191 *pp 47*

This work is licensed under a Creative Commons Attribution 4.0 International License.

The manurial treatments rotate on the plots in such a way that in the course of 15 years every plot has received each of the 15 treatments. Since 1935 ground chalk providing 10 cwt. CaO per acre (23 cwt. ground chalk from 1958 onwards) has been applied before barley and rye. At Woburn no chalk dressing was applied before the barley crops of 1956-1958. In 1956 the rates of nitrogen dressings at Woburn were doubled, except for Crimson clover which remained unchanged at the rate previously used for Late Flowering Red Clover.

In 1959 and 1960 the potato plots at Woburn were split to test 2.6 cwt. magnesium sulphate per acre.

In 1959 the yields of the cereals were measured by one combine cut per plot.

Plot size (acres): Rothamsted, 0.0250; Woburn, 0.0266.

For a description of the design of the experiment see Rep. Rothamst. exp. Sta. for 1932, p. 131.
For a summary of results to 1948, see Rep. Rothamst. exp. Sta. for 1948, p. 90.
For a summary of results 1931-1955, see Yates, F. and Patterson, H.D. A note on the Six-Course Rotation experiments at Rothamsted and Woburn. J. agric. Sci. (1958) 50, 102-109.
See also:

Glynne, M.D. Eyespot (Cercosporella herpotrichoides) and other factors influencing yield of wheat in the sic-course rotation experiment at Rothamsted (1930-60). Ann. appl. Biol. (1963), 51, 189-214.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 29

SIX-COURSE ROTATION EXPERIMENT

ROTHAMSTED LONG HOOS IV

Means over 30 years 1931-1960

	Level [x] 0	1	2	3	4
	Barley, grain: cwt per acre				
N	24.5	27.8	30.1	31.5	31.8
P	29.3	29.2	29.6	30.0	29.2
K	29.4	29.9	29.8	29.0	29.6
	*Clover, hay, dry matter : cwt per acre				
N	27.5	28.9	29.2	29.9	30.3
P	28.5	30.1	31.1	28.9	29.1
K	29.9	29.8	29.9	29.5	30.8
	Wheat, grain: cwt per acre				
N	25.5	28.0	27.9	29.2	29.7
P	29.1	29.3	28.4	28.8	28.7
K	28.4	28.7	28.3	28.5	29.0
	Potatoes, total tubers: tons per acre				
N	6.73	7.29	8.10	8.29	8.69
P	7.64	7.87	8.09	8.25	8.27
K	6.79	7.95	8.19	8.56	8.68
	**Rye, grain: cwt per acre				
N	20.8	24.6	28.0	29.9	29.8
P	26.8	26.6	27.2	26.4	26.5
K	27.3	25.9	25.9	26.9	26.0
	Sugar beet, total sugar: cwt per acre				
N	31.1	33.3	34.6	35.5	36.5
P	34.8	34.6	34.6	34.8	33.6
K	34.2	34.8	34.6	35.2	35.1

*Clover crop failed in 1933, 1935, 1954. Means over 27 years only
**Rye no yields for 1931, 1932, 1933. Means over 27 years only

[x] See text for details

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 30

SIX-COURSE ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Means over 25 years 1931-1955

	Level [x] 0	1	2	3	4
	Barley, grain: cwt per acre				
N	15.0	20.3	23.5	25.1	26.4
P	22.4	24.1	24.0	24.1	23.0
K	22.6	22.6	23.8	23.5	23.0
	Clover, hay, dry matter: cwt per acre				
N	32.8	31.7	30.3	28.0	30.8
P	31.2	30.2	30.6	30.2	32.4
K	29.1	32.0	33.3	31.7	32.4
	Wheat, grain: cwt per acre				
N	10.2	11.3	14.4	16.7	17.7
P	13.8	14.4	13.5	13.3	13.8
K	14.1	13.8	14.1	13.9	13.9
	Potatoes, total tubers: tons per acre				
N	6.24	6.94	7.78	8.45	9.02
P	7.27	7.46	7.88	7.74	7.69
K	7.79	7.57	8.07	7.91	7.78
	Rye, grain: cwt per acre				
N	14.3	17.1	19.6	22.6	24.5
P	20.5	19.5	19.7	19.6	19.6
K	19.7	19.5	19.4	19.8	19.7
	Sugar beet, total sugar: cwt per acre				
N	24.1	27.3	29.3	31.0	32.3
P	30.2	29.8	30.1	30.5	29.3
K	28.1	29.5	30.4	31.2	30.1

[x] See text for details

https://doi.org/10.23637/ERADOC-1-191 *pp 50*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 31

SIX-COURSE ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Means over 5 years 1956-60

	Level[x] 0	1	2	3	4
Barley, grain: cwt per acre					
N	17.3	27.6	28.6	30.6	34.5
P	30.7	32.3	30.8	31.3	32.0
K	30.3	27.6	31.4	30.3	27.1
+Clover, hay, dry matter: cwt per acre					
N	11.0	14.5	12.9	13.5	16.5
P	14.2	17.4	17.4	18.0	18.8
K	9.7	14.1	12.1	12.2	12.6
Wheat, grain: cwt per acre					
N	6.7	12.8	17.7	23.2	24.9
P	20.3	21.2	20.4	19.4	18.7
K	18.8	17.8	18.6	20.6	20.1
Potatoes, total tubers: tons per acre					
N	5.73	8.33	8.82	10.49	11.17
P	9.75	9.58	9.30	9.81	8.89
K	8.96	9.37	11.13	10.40	9.34
Rye, grain: cwt per acre					
N	14.6	19.8	29.7	33.9	33.0
P	27.9	27.0	27.0	28.2	28.4
K	29.0	28.7	28.2	28.3	27.1
Sugar beet, total sugar: cwt per acre					
N	27.6	36.6	39.5	41.2	41.4
P	38.6	37.7	38.1	40.1	42.9
K	42.0	37.9	36.2	44.3	44.5

[x] See text for details

+Clover. Mean over 3 years only. Crop discarded in 1959 and 1960

Table 32

SIX-COURSE ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Potatoes, total tubers: tons per acre

Mean over 2 years 1959-1960

	Level[x] 0	1	2	3	4
Plots not receiving Mg					
N	4.74	7.81	8.68	11.06	10.46
P	9.65	9.06	7.98	9.62	7.70
K	7.96	9.22	10.03	9.20	8.13
Plots receiving Mg					
N	4.36	8.49	10.39	10.74	10.93
P	9.58	9.44	8.14	8.96	8.54
K	9.38	9.60	9.31	10.00	10.56

[x] See text for details

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

DEEP-CULTIVATION ROTATION EXPERIMENT, LONG HOOS I AND II, 1944-1957

The objects of the experiment were: (1) to compare deep ploughing with shallow ploughing (2) to test dung ploughed in at the two depths (3) to test superphosphate and muriate of potash broadcast on the seedbed or ploughed in before preparing the seedbed. These treatments were tested factorially on a rotation of crops sugar beet, barley, one year seeds mixture, wheat, potatoes, spring oats. There were six series, one for each crop of the rotation. Each series had 16 main plots for the combinations of the ploughing, farmyard manure, phosphate and potash treatments. The main plots were split to test the method of application of the phosphate and potash fertilisers. The treatments were repeated on their plots.

System of replication: 2 blocks of 8 plots each in each series, the four-factor interaction of main plot treatments being confounded with block differences.

Area of each whole plot: 0.0132 acre.

Whole plots: All combinations of:-

(1) Shallow (6") v. deep (12") ploughing. Ploughing done on stubbles in autumn for sugar beet and potatoes, and on the hay stubble in summer for wheat.

	Sugar Beet	Potatoes
(2) No FYM v. FYM ploughed in	10 tons	20 tons
(3) No phosphate v. superphosphate	0.6 cwt. P_2O_5	0.8 cwt. P_2O_5
(4) No potash v. muriate of potash	0.6 cwt. P_2O_5	1.0 cwt. K_2O

all amounts per acre

Half plots, sugar beet and potatoes only:-

P or K or PK ploughed in v. P or K or PK in seedbed for sugar beet and in ridges for potatoes.

Basal manuring: Applied in the ridges for potatoes, as a top dressing to wheat and in the seedbed for other crops:-

	Sugar Beet (Klein Wanzleben E)	Barley (Plumage Archer)	Ley*	Wheat (Yeoman)	Potatoes (Majestic)	Oats (Star)
Sulphate of ammonia (cwt. N per acre)	0.8	0.3	-	0.5	0.6	0.2
Basic slag (cwt. P_2O_5 per acre)	-	0.6	-	-	-	-

* Seeds mixture: Varied slightly but usually 18 lb. Perennial ryegrass, 8 lb. Late Flowering Red clover, 2 lb. Alsike clover per acre.

Since 1952 ground chalk providing 10 cwt. CaO per acre was applied for barley.

Non-experimental Cultivations: These were carried out over the whole of any series, with the proviso that they must not be deeper than 6 inches except that deep ploughed plots might be worked to a depth of below 6 inches for the root crops.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

DEEP CULTIVATION

Ploughing: The plough used for deep cultivations was a Ransome Solotrac giving a depth of 12 inches at least. In 1944 a Massey Harris Grub Breaker was used which did not always reach 12 inches, the actual depth in that year being 9-12 inches. Until 1947 the whole of the seeds area was ploughed 6" deep after the hay was carted, the deep ploughing being carried out subsequently at the same time as the stubbles were deep ploughed for roots. In autumn 1946 the second ploughing of the seeds could not be carried out owing to wet conditions, so there was no test of deep ploughing on wheat in 1947. In summer 1947 and subsequently the deep and shallow ploughing treatments were carried out directly on the hay stubble.

For summary of the results from 1944-49 see Rep. Rothamst. exp. Sta. for 1949, p. 140.

For summary of results 1944-56 see Rep. Rothamst. exp. Sta. for 1957, p. 193.

Table 33

DEEP-CULTIVATION ROTATION EXPERIMENT

Direct effects and interactions, means over 12 years 1944-55

Response to	Mean	Ploughing		Dung		Phosphate		Potash	
		Shallow	Deep	Absent	Present	Absent	Present	Absent	Present
		Sugar beet, total sugar: cwt. per acre: mean yield 45.2							
Ploughing, deep-shallow	2.9	-	-	3.7	2.1	2.5	3.3	3.3	2.5
FYM	6.8	7.6	6.0	-	-	7.8	5.8	8.3	5.3
Phosphate	1.1	0.7	1.5	2.1	0.1	-	-	1.2	1.1
Potash	2.2	2.6	1.8	3.7	0.7	2.2	2.1	-	-
		Potatoes, ware tubers: tons per acre: mean yield 8.88							
Ploughing, deep-shallow	0.00	-	-	0.14	-0.13	0.23	-0.22	-0.11	0.12
FYM	2.66	2.80	2.52	-	-	2.55	2.76	3.60	1.72
Phosphate	0.62	0.85	0.40	0.52	0.73	-	-	0.46	0.79
Potash	1.53	1.41	1.64	2.47	0.59	1.37	1.69	-	-

Table 34

DEEP-CULTIVATION ROTATION EXPERIMENT

RESIDUAL EFFECTS

Mean yields, cwt. per acre, and increases for deep ploughing, dung, P and K

Means over 12 years, Barley and oats, 1945-56, hay 1946-57

	Barley	Oats	Hay	Wheat
Mean yield	32.1	32.2	59.8	33.4
Residuals	1st year	1st year	2nd year	3rd year
Deep ploughing	+0.2	-1.2	-0.2	-0.5*
FYM	+1.8	+1.2	+4.0	+1.4†
Phosphate	+0.6	+0.9	+0.9	+0.2†
Potash	+0.6	+0.1	+1.9	+0.5†

*Direct effect of deep ploughing 1946 and 1948-57
†1947-57

https://doi.org/10.23637/ERADOC-1-191 *pp 53*

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE ROTATION EXPERIMENT, ROTHAMSTED

HIGHFIELD AND FOSTERS FIELD, 1949 ONWARDS

The purpose of the experiment is to study the effect of various three-year leys on the fertility of the soil as measured by a sequence of three arable test crops. The experiment also includes plots of old permanent grass (Highfield only) and plots of reseeded permanent grass on both fields. It is part of the experiment to measure the output of herbage crops of different duration and management.

The four 6-course rotations being compared are:-

Treatment crops			Lucerne	Ley	Cut grass	Arable with hay
Treatment crops		1st year	Lucerne	Grazed ley	Cut grass	1 year hay
"	"	2nd "	"	" "	" "	Sugar beet
"	"	3rd "	"	" "	" "	Oats
Test	"	4th "	Wheat	Wheat	Wheat	Wheat
"	"	5th "	Potatoes	Potatoes	Potatoes	Potatoes
"	"	6th "	Barley	Barley	Barley	Barley *

*undersown

The Highfield site had been under old permanent grass for many years and has no record of arable cultivation. Fosters was a very old arable field with no long leys in recent years.

Six blocks, one for each of the six phases of the rotation, were put down in duplicate making 12 blocks in each field. On Highfield in addition to the ley arable sequences every block included one plot of the old pasture undisturbed and another plot that had been broken up and resown to long-term grass in the spring of 1949, 1950 or 1951 by phases. On Fosters only the reseeded grass could be tested.

The above crops were grown on main plots of 0.091 acres on both fields, but these were harvested in halves, quarters, and occasionally by eighths to test manurial treatments.

The seed mixtures, which have been unchanged till 1961 are:-

1 year hay: 18 lb. Perennial Ryegrass S.24
8 lb. Late Flowering Red Clover.
2 lb. Alsike Clover
28 lb.

Sown at 28 lb. per acre (40 lb. till 1954). Undersown in barley.

Lucerne: Du Puits (Provence in 1949) sown at 21 lb. per acre (34 lb. until 1952, 28 lb. 1953-1960).
Sown in rows 18 in. apart (12 in. until 1954).

https://doi.org/10.23637/ERADOC-1-191 *pp 54*

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE (R)

3 year grazed ley and reseeded grass:

5 lb.	Italian Ryegrass
8 lb.	Perennial Ryegrass S. 23
8 lb.	Perennial Ryegrass Kent Indigenous
4 lb.	Cocksfoot S. 26
4 lb.	Cocksfoot S. 143
2 lb.	Timothy S. 48
2 lb.	Timothy S. 50
6 lb.	Late Flowering Red Clover
½ lb.	New Zealand White Clover
½ lb.	Kent Indigenous White Clover
40 lb.	

Sown at 44 lb. per acre (56 lb. till 1954). Sown in the open.

Cut grass: 6 lb.	Italian Ryegrass
16 lb.	Cocksfoot S. 26
4 lb.	White Clover S. 100
2 lb.	Alsike Clover
28 lb.	

Sown at 33 lb. per acre (40 lb. till 1954). Sown in the open.

The experiment has been modified from time to time as improvements suggested themselves and it may be regarded as falling into three periods.

First Period: 1949-1954. The cropping for this first cycle was as previously stated except that in the purely arable rotation the second treatment crop was potatoes (Majestic) and the third treatment crop was barley (Plumage Archer till 1953, then Proctor).

All plots had a basal dressing of phosphate and potash given as compound 0:13:13, for the individual crops the applications were according to good practice but all plots received the same total amount of P_2O_5 and K_2O (2.4 cwt.) during a complete rotation.

All treatment crops (except lucerne which received no nitrogen) were grown yearly at low nitrogen level (N_1) and at high nitrogen level (N_2) and the following test crops were similarly treated. These treatments were factorial on quarter plots (N_1 v. N_2 on treatment crops) x (N_1 v. N_2 on test crops) all dressings being cumulative.

Dung (D) at 12 tons per acre was tested on all potato crops, the test crop on all four rotations and the treatment crops of the arable rotation. The residual effect of dung appears in the following cereal crops and leys, so the quarter plots gave the following arrangement:-

Rotation	Applied to treatment crops	Applied to test crops	Replication on each field in each phase
Lucerne	Nil	x (N_1 v. N_2)(0 v. D)	2
Ley, cut grass	(N_1 v. N_2)	x (N_1 v. N_2)(0 v. D)	1
Arable	(N_1 v. N_2)(0 v. D)	x (N_1 v. N_2)(0 v. D)	½

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

The permanent and reseeded grass was managed in a three year cycle, two years sheep grazing and one year hay with aftermath grazing. The 3 year ley was grazed by sheep and never cut.

The following six grass treatments each had its own team of grazing sheep which moved round the replicates for as many cycles as the season would permit. The number of grazing days and the live weight gains were recorded:-

(1) 3 year ley, all ages, low N level 6 plots per field
(2) 3 year ley, all ages, high N level 6 " " "
(3) Reseeded grass, low N level 8 " " " (12 after hay cutting)
(4) Reseeded grass, high N level 8 " " " " " " "
(5) Old permanent grass, low N level (Highfield only) 8 plots (12 after hay cutting
(6) Old permanent grass, high N level (Highfield only) 8 plots (12 after hay cutting

Grazing was by quarter plots of 0.022 acre which gave food for one day only. When a fold was ready for grazing a single transverse cut located at random was made with a "Roto-scythe" to give an estimate of yield and provide material for analysis. The aim was to graze down to the level of the sample cut in one day. The stocking varied between 4 and 7 sheep per fold. No leaving cut was made. Sheep were weighed at the beginning of a grazing cycle but were not weighed again till there was no more keep for them on any of the replicates of their appropriate treatment.

The fertiliser dressings during this first period were:-

Table 35

LEY-ARABLE ROTATION EXPERIMENT, ROTHAMSTED

Nutrients cwt. per acre

N on ¼ plots unless otherwise stated

	'Nitro Chalk'		Basal Dressing compound 0:13:13	
	N_1	N_2	P_2O_5	K_2O
Grazed ley, 1st year	0.075[a]	0.15	0.6	0.6
2nd and 3rd year	0.075[a]	0.15	0.3	0.3
Cut grass, 1st year	0.15 [b]	0.3	0.6	0.6
2nd and 3rd year	0.15 [b]	0.3	0.3	0.3
Lucerne 1st year	-	-	0.6	0.6
2nd and 3rd year.	-	-	0.3	0.3
Reseeded and Old Grass				
Grazing years	0.075[a]	0.15	0.3	0.3
Hay years	0.15 [c]	0.30	0.6	0.6
Wheat	0.3	0.6	0.15[d]	0.15 [d]
Barley	0.2	0.4	0.15[d]	0.15 [d]
1 year hay	0.3	0.6	0.15	0.15
Potatoes[e]	0.5	1.0	0.9	0.9

[a] in spring and same amount again in summer, N on half plots.
[b] for every cut.
[c] in spring and again for aftermath grazing.
[d] combine drilled.
[e] also tested 0 v. 12 tons dung, all manures in the ridges.
Nitrogen as Sulphate of ammonia.

https://doi.org/10.23637/ERADOC-1-191 *pp 56*

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE (R)

Second Period: 1955-1960. The most far-reaching change made at the beginning of this period arose out of an examination of potash withdrawals in the various treatment crops.

Soil and plant analysis had shown that very different amounts of K_2O were being removed from the soil by the various grass crops. Plots growing hay, cut grass and lucerne lost much more K_2O than the grazed plots. This difference was believed to be big enough to affect the yields of the test crops so in 1955 it was decided to give supplementary dressings of muriate of potash to plots that were cut, the amount of the dressings being based on estimates of the K_2O taken away in the crops. The amounts actually given year by year are:-

Table 36

LEY-ARABLE ROTATION EXPERIMENT, ROTHAMSTED

Supplementary potash dressings, K_2O cwt. per acre (as muriate except 1961)

The amounts were used on both Highfield and Fosters unless otherwise stated

(Figures in brackets refer to Fosters only)

Year	Phase of rotation		Lucerne	Cut grass	Old and re-seeded grass	To test crops after lucerne	To test crops after cut grass
1955	1st	treatment	2.4	2.4	2.4	-	-
	2nd	"	0.6	1.2	1.2	-	-
1956	1st	"	3.0	3.0	1.2	-	-
	2nd and 3rd	"	1.0	1.5	-	-	-
1957	1st	"	3.0	3.0	1.0	-	-
	2nd	"	1.0	1.5	1.0	-	-
	3rd	"	1.0	1.5	-	-	-
	1st	test	-	-	-	1.0	1.5
1958	1st	treatment	3.0	3.0	2.4	-	-
	2nd	"	1.2	2.4	1.2	-	-
	3rd	"	1.2	3.6 (3.0)	-	-	-
	1st	test	-	-	-	1.2	1.2
	2nd	"	-	-	-	2.7(3.0)	2.7
1959	1st	treatment	3.0 (4.0)	3.5 (4.0)	2.5[1]	-	-
	2nd	test	-	-	-	0.6(1.2)	2.4(1.8)

[1] Highfield old grass. Reseeded grass on both fields 3.0 cwt.

1960 None

1961 All phases of "Arable" rotation, 3.0 cwt K_2O per acre as sulphate of potash.

1962 None

https://doi.org/10.23637/ERADOC-1-191 *pp 57*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Arising out of the above potash situation a beginning was made to measure differential potash (and phosphate) responses in test crop potatoes following the different leys. The original quarter plots were split to test an extra 0.9 cwt. K_2O, and also an extra 0.9 cwt. P_2O_5 above the basal dressing, i.e. (0.9 v. 1.8 cwt. K_2O) x (0.9 v. 1.8 cwt. P_2O_5). From 1955-1957 these tests were made on plots that had not yet received supplementary K_2O to the previous grass crop; from 1958 onwards they were made on plots that had received three or more adjustments. In the following barley crops the eighths which received high P or K to the potatoes received low P or K and vice versa to equalise the plots.

Other modifications introduced during this 2nd cycle were:

1955 (i) The third treatment crop of the "Arable" rotation was changed from barley to oats to reduce damage from foot rot diseases.

(ii) Nitrogen dressings on Highfield test crop barley reduced to 0 v. 0.2 cwt. N.

(iii) Hay from permanent and reseeded grass taken one in 6 years instead of once in 3. From 1956 the 1st year blocks were chosen for the hay crops.

1958 Grazing days only recorded on all grazed plots, no further sheep weights were taken. Cutting hay from the old and reseeded grass plots was discontinued. On the 2 plots of each type of grass in each phase, one was grazed as soon as it was fit, the other was shut up for an early silage crop. These treatments were applied in alternate years.

1960 Yields of arable hay, cut grass, and silage were estimated from two cuts 40" wide taken through each sub-plot with a flail type forage harvester.

NK compound 16:0:16 used in place of "Nitro-Chalk" for 2nd and 3rd year cut grass.

In 1958 also the PK compound 0:10:20 was used for certain basal dressings to raise the potash level. The scheme, in cwt. nutrients per acre, was:-

	P_2O_5	K_2O	Fertiliser
All cereals	0.15	0.3	(0:10:20)
2nd and 3rd year leys, grazed	0.3	0.6	(0:10:20)
Old and reseeded grass, grazed	0.3	0.6	(0:10:20)
Old and reseeded grass, silage	0.6	1.2	(0:10:20)
2nd and 3rd year cut grass	1.2	1.2	(0:16:16)
and for every cut	-	0.15 v. 0.3	(16:0:16)
Treatment crop potatoes and 2nd and 3rd year lucerne	0.9	1.8	(0:10:20)
1 year hay	0.6	0.6	(0:16:16)

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE (R)

Interim system 1961: The following changes were made (for details see table 37):-

The treatment crops now had basal dressings of nitrogen instead of the former nitrogen tests.

1 year hay was cut twice, "Nitro-Chalk" being applied for each cut.

Sugar beet replaced potatoes as the second treatment crop and the test of 0 v. 12 tons of dung was stopped.

Grazed ley received "Nitro-Chalk" at 0.22 cwt. N in two equal dressings, the P_2O_5 and K_2O for the 2nd and 3rd years were doubled.

Cut grass received 0.22 cwt. N for every cut, in the 2nd and 3rd years potash equal to the nitrogen was also given for every cut using 16:0:16.

Test crops: Wheat tested four nitrogen levels on $\frac{1}{8}$ plots.

Potatoes: All plots had extra basal nitrogen and those without dung had extra basal P_2O_5 and K_2O. These additional basals were broadcast before ridging, the remaining basals and test manures were put in the ridges. Tests of P and K now on $\frac{1}{16}$ plots.

Permanent and reseeded grass: In the silage years the nitrogen level for silage and for the subsequent grazing was raised to 0.3 cwt. N in each case. In the grazing years the nitrogen level was raised to 0.22 cwt. N applied in two equal dressings.

Liming: On Highfield in 1949-1951 each set of 4 blocks received a corrective chalking in autumn as they came into experiment. In autumn 1952 a scheme of maintenance dressings was started, ground chalk being applied at the rate of 20 cwt. CaO per acre once every 6 years before barley. Commencing in 1958 the dressing was raised to 46 cwt. of ground chalk per acre.

On Fosters only blocks 10, 11, 12 needed a corrective dressing. This was applied at the rate of 2 tons ground chalk per acre in spring 1951.

Third Period: 1962 onwards. New seeds mixtures and new systems of management have been introduced in 1962 as follows:-

Plots formerly in "Cut Grass": Cocksfoot S37 at 30 lb. per acre.

Manuring: in seedbed 0.6 cwt. P_2O_5 and 1.2 cwt. K_2O per acre (as 0:14:28) and 0.6 cwt. N as "Nitro-Chalk" followed by 0.6 cwt. N and 0.6 cwt. K_2O (as 16:0:16) after each cut except the last.

These plots to be cut for silage.

Plots formerly in "Grazed Ley":

mixture composed of:-

5 lb.	Timothy S51
6 lb.	Meadow Fescue S215
1 lb.	White Clover S100
12 lb	

sown at 33 lb. per acre.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 37

LEY-ARABLE ROTATION EXPERIMENT, ROTHAMSTED

Fertilizer Application (cwt. per acre)

Crop	N	P_2O_5		K_2O		Materials
Test crops						
Wheat						
Highfield	0.0, 0.3, 0.6, 0.9 (spring)	0.3	(combine drilled)	0.6	(combine drilled)	N/C and (0:14:28)
Fosters	0.0, 0.4, 0.8, 1.2 (spring)	0.3	(combine drilled)	0.6	(combine drilled)	
Potatoes						
Highfield	Basal 0.75 (in ridges)	0.6*	(before ridging)	0.9*	(before ridging)	S/A, super and M/K
	Plus 0 v. 0.5 (broadcast before ridging)	0.9 v. 1.8	(in ridges)	0.9 v. 1.8	(in ridges)	
Fosters	Basal 1.00 (in ridges)					
	Plus 0 v. 0.5 (broadcast before ridging)					
			*only on sub-plots without dung			
Barley						
Highfield	0.0 v. 0.2 (all rotations) (seedbed)	0.3	(combine drilled)	0.6	(combine drilled)	N/C and (0:14:28)
Fosters	0.2 v. 0.4 (except "arable")(seedbed)	0.9 v. 0.0	(in winter)	0.9 v. 0.0	(in winter)	N/C, super and M/K
	0.3 v. 0.6 ("arable" only) (seedbed)			as super and M/K to balance dressings to potatoes		
Treatment crops						
Hay (cut twice)	0.6 (February)	0.6	(February)	0.6	(February)	(8:8:8)
	0.6 (after first cut)	-		0.6	(after first cut)	(16:0:16)
Sugar beet	-			1.4	(plough furrow)	M/K
	1.0 (seedbed)	1.0	(seedbed)	1.0	(seedbed)	(8:8:8)

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE (R)

Oats								
Highfield	0.2	(seedbed)	0.3	(combine drilled)	0.6	(combine drilled)	N/C and (0:14:28)
Fosters	0.4	(seedbed)	0.3	(combine drilled)	0.6	(combine drilled)	
Grazed Ley							
1st year	-		0.6	(seedbed)	0.6	(seedbed)	(0:20:20)
	0.1125	(seedbed)	-		-		N/C
	0.1125	(mid-season)	-		-		N/C
2nd and 3rd years	-		0.6	(winter)	1.2	(winter)	(0:14:28)
	0.1125	(spring)	-		-		N/C
	0.1125	(mid-season)	-		-		N/C
Cut Grass							
1st year	0.225	(seedbed)	0.5625	(seedbed)	0.5625	(seedbed)	(6:15:15)
	0.225	(after each cut except last)	-		-		N/C
2nd and 3rd years	-		1.2	(winter)	1.2	(winter)	(0:20:20)
	0.225	(for each cut)	-		0.225	(for each cut)	(16:0:16)
Lucerne							
1st year	nil		0.6	(seedbed)	0.6	(seedbed)	(0:20:20)
2nd and 3rd years	nil		0.9	(winter)	1.8	(winter)	(0:14:28)
Reseeded and Permanent Grass							
"Silage" years	-		0.6	(winter)	1.2	(winter)	(0:14:28)
	0.3	(spring)	-		-		N/C
	0.3	(after silage out)	-		-		N/C
All grazing years	-		0.3	(winter)	0.6	(winter)	(0:14:28)
	0.1125	(spring)	-		-		N/C
	0.1125	(mid-season)	-		-		N/C

Key to materials

N/C:	"Nitro-Chalk" 21
S/A:	Sulphate of ammonia
M/K	Muriate of potash
(8:8:8) etc.:	granular compound (percentage of N : P_2O_5 : K_2O)

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Manuring: 0.6 cwt. P_2O_5 and 1.2 cwt. K_2O per acre (as 0:14:28) in seedbed.
0.6 cwt. K_2O (as muriate) after each cut except the last.
No N.

These plots to be cut at early silage stage (4"-6").

Old Grass (Highfield):- each plot split lengthwise and the two halves allocated to manuring and management as for the two types of ley above. Grazing discontinued.

Reseeded Grass:

Manuring and management (grazing and silage cuts) as since 1958, pending the ploughing up for test cropping of certain plots. Manuring and management of "Cut Grass" and "Grazed Ley" plots sown in 1960 and 1961 to continue as previously specified (including grazing).

Barley:

4 levels of N are tested on ¼ plots:-

Highfield: 0.0, 0.1, 0.2, 0.3 cwt. N per acre as "Nitro-Chalk".

Fosters, "arable" rotation: 0.0, 0.4, 0.6, 0.8 cwt. N per acre as "Nitro-Chalk"

remainder: 0.0, 0.2, 0.4, 0.6 cwt. N per acre as "Nitro-Chalk".

For a summary of the results to 1960, see Rep. Rothamst. exp. Sta. for 1961, 173-180.

LEY-ARABLE ROTATION EXPERIMENT, ROTHAMSTED

Table 38

Wheat (1st test crop)

Grain at 85% dry matter: cwt per acre

Mean Yields and responses to N over 4 years 1957-60

		Mean yield		Response to N*	
		Highfield	Fosters	Highfield	Fosters
(1)	Grazed ley	39.6	40.1	0.6	2.7
(2)	Conserved ley	39.6	40.0	2.3	4.0
(3)	Lucerne	42.7	46.2	2.2	2.9
(4)	Arable	42.2	39.4	2.8	6.5
	Mean	41.0	41.4	2.0	4.0

* 0.3 v. 0.6 cwt. N/acre.

Table 39

Potatoes (2nd test crop)

Total Tubers: tons per acre

Means over 3 years 1958-60

		Highfield	Fosters
(1)	Grazed ley	16.4	15.8
(2)	Conserved ley	16.4	15.8
(3)	Lucerne	16.2	16.0
(4)	Arable	14.9	14.7
	Mean	16.0	15.6

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 40

Potatoes (2nd test crop)

Total Tubers: tons per acre

Mean responses to FYM, N, P and K over 3 years 1958-60

	Grazed ley	Conserved ley	Lucerne	Arable	Mean
Response to FYM (15 tons FYM per acre)					
Highfield	0.6	0.1	0.8	2.6	1.0
Fosters	2.2	1.4	2.0	2.1	1.9
Response to N (1.0-0.5 cwt. N per acre)					
Highfield	0.4	0.3	0.7	0.6	0.5
Fosters	0.7	0.7	1.0	1.4	1.0
Response to P (1.8-0.9 cwt. P_2O_5 per acre)					
Highfield	0.4	0.5	0.0	-0.5	0.1
Fosters	0.6	0.4	0.2	0.7	0.5
Response to K (1.8-0.9 cwt. K_2O per acre)					
Highfield	0.4	-0.2	0.0	0.9	0.3
Fosters	0.1	0.4	0.3	0.0	0.2

Table 41

Barley (3rd test crop)

Grain at 85% dry matter: cwt per acre

Mean yields and response to N over 3 years 1959-61

	Mean yield		Response to N	
	Highfield	Fosters	Highfield	Fosters
(1) Grazed ley	44.6	46.9	0.0	4.4
(2) Conserved ley	46.0	46.0	1.8	2.5
(3) Lucerne	45.2	48.2	-0.6	4.9
(4) Arable	47.0	43.9	4.2	5.6
Mean	45.7	46.2	1.4	4.4

Note: The rates of N were 0.0 v 0.2 cwt per acre for Highfield and 0.2 v 0.4 cwt per acre for Fosters.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 42

Dry matter: cwt per acre

Means over 10 years 1951-60

		Highfield			Fosters		
		Low N	High N	Mean	Low N	High N	Mean
Reseeded grazed		37.8	40.9	39.4	34.8	35.3	35.0
Old grazed		33.6	37.7	35.6	-	-	-
Reseeded hay or silage		47.9	50.9	49.4	39.1	41.6	40.4
aftermath grazed		20.5	24.4	22.5	21.0	22.1	21.5
Total		68.4	75.3	71.9	60.1	63.7	61.9
Old grass: hay or silage		41.8	47.0	44.4	-	-	-
aftermath grazed		22.7	24.3	23.5	-	-	-
Total		64.5	71.3	67.9			
Grazed ley	1st year	32.2	33.9	33.1	21.4	22.4	21.9
	2nd year	41.2	46.1	43.6	37.9	38.8	38.4
	3rd year	40.3	45.0	42.6	34.2	36.7	35.5
	Mean	37.9	41.7	39.8	31.2	32.6	31.9
Cut ley	1st year	53.0	58.6	55.8	34.1	40.0	37.1
	2nd year	61.5	77.8	69.6	59.0	69.8	64.4
	3rd year	54.6	70.7	62.6	54.8	65.4	60.1
	Mean	56.3	69.0	62.7	49.3	58.4	53.9
Lucerne	1st year			41.8			35.4
	2nd year			92.6			97.3
	3rd year			75.6			97.9
	Mean			70.0			76.9
Seeds hay (Arable rotation)		50.1	52.6	51.3	43.7	50.5	47.1

Note: Yields of grazed herbage are based on sample cuts.

https://doi.org/10.23637/ERADOC-1-191 pp 64

This work is licensed under a Creative Commons Attribution 4.0 International License.

GREEN-MANURING ROTATION EXPERIMENT, 1936 ONWARDS

WOBURN, STACKYARD FIELD, SERIES A.

OLD SCHEME 1936-1953.

The experiment was begun in 1936 to measure the effects of the following green manuring crops:-

(1) Ryegrass undersown in barley for ploughing in in the following July (R)
(2) Red Clover undersown in barley, ploughed in in July (C)
(3) Mustard sown in spring and ploughed in in July (M)
(4) Tares sown in spring and ploughed in in July (T)
(5) No green manures, i.e. spring and early summer fallow (F).

The test crops were kale (Thousand Head) drilled in July, followed by barley (Plumage Archer) as the second test crop. The undersown green manures were sown in the barley crop, thus continuing the rotation. The tares and mustard were grown as cumulative treatments on their respective plots, the clover and ryegrass were grown alternately, i.e. they returned to their respective plots in every other cycle. The yields of the green manures were estimated by sampling. Until 1942 the undersown crops were cut for hay which was removed before ploughing in the remainder.

Manurial treatments tested on kale were 0 v. 10 tons of dung (D); 0 v. $1\frac{1}{2}$ tons straw (S); 2 cwt. v. 4 cwt. sulphate of ammonia (N). These treatments were cumulative.

Basal manuring for kale: 3 cwt. superphosphate, 1 cwt. muriate of potash per acre.

The arrangement was thus 5×2^3 put down on two blocks of 40 plots each; one for each phase of the rotation. Plot size: 0.0395 acres.

From 1944 onwards a top dressing of sulphate of ammonia at 0.3 cwt. N per acre (0.4 cwt. in 1944) was applied to half the barley plots; the experiment then became a half-replicate with identity $I \equiv (R + C - M - F - T)DSNA$, where A denotes the dressing of sulphate of ammonia to barley.

In 1946 several further changes were made

(1) Cabbages (January King) transplanted in July replaced drilled kale which had frequently failed.
(2) Tares were replaced by lupins, and mustard by rape.
(3) Those plots receiving extra nitrogen to barley also received 0.3 cwt. N as sulphate of ammonia when they carried any of the green manuring crops, including bare fallow.

From 1949 the nitrogen dressings to the rape and ryegrass plots were increased from 0.3 to 0.6 cwt. N, the remaining rape and ryegrass plots, hitherto undressed, received 0.3 cwt. N as sulphate of ammonia.

From 1950 the cabbages following undersown green manures and bare fallow were planted on two occasions (1) early, i.e. as soon as the undersown crops were ploughed in (2) late, i.e. when

https://doi.org/10.23637/ERADOC-1-191 *pp 65*

This work is licensed under a Creative Commons Attribution 4.0 International License.

the rape and lupins were ploughed in. These treatments were carried out on half plots. In 1953 owing to the weather all cabbages were planted on the same date.

Liming.

Liming at approximately 5 cwt. CaO per acre applied as ground chalk before barley was given in 1937, 1942, 1943, and 1947-50.

In 1951 clubroot appeared and in 1951 and 1952 calcium carbonate was applied at 40 cwt. per acre for cabbages.

1953 30 cwt. calcium carbonate per acre was applied before barley.

For original design see Rep. Rothamst. exp. Sta. for 1936, p.203.

For results and discussion see Mann, H. H. Field studies in green manuring. II. Emp. J. exp. Agric. 27, (107) p.243-251.

https://doi.org/10.23637/ERADOC-1-191 *pp 66*

This work is licensed under a Creative Commons Attribution 4.0 International License.

GREEN MANURING (W)

NEW SCHEME 1954

The former scheme ended after the harvest of 1953 mainly owing to club-root damage to test crop cabbages, and the need to have a rotation in which the test crops could utilise the growing season more fully.

From 1954 onwards the rotation was: early potatoes, barley. As before each crop was grown every year on one of the two blocks of 40 plots. The green manuring crops were grown according to the following scheme which was repeated every two years:-

1st main crop	Early Potatoes	Early Potatoes	Early Potatoes	Early Potatoes	Early Potatoes
Summer sown Green manure	-	Ryegrass	Ryegrass	Trefoil	Trefoil
2nd main crop	Barley	Barley	Barley	Barley	Barley
Undersown Green manure	-	Ryegrass	-	Trefoil	-

8 plots of each block were allocated to each of these sequences. Half the plots of each group carrying ryegrass or trefoil after early potatoes were ploughed in autumn and the remainder were ploughed in the spring before the barley seedbed was prepared. The undersown green manures were ploughed in after February 1st for early potatoes.

In addition chaffed barley straw at the rate of 30 cwt. per acre was applied after harvesting the barley to the 20 plots receiving straw in the original scheme. Two levels of nitrogen were tested on each of the two main crops.

0.23 v. 0.46 cwt. N per acre as "Nitro-Chalk" to barley

0.6 v. 1.2 cwt. N per acre as "Nitro-Chalk" to potatoes.

the higher level in each case being applied to the same plots.

The fallow plots of the original scheme remained fallow between each main crop in the revised scheme. The new green manuring treatments were superimposed on the plots carrying the original treatments in such a way that one comparison of the latter (lupins and rape v. clover and ryegrass) could be examined for possible residual effects. Residual effects of the original dung treatment, now discontinued, could also be determined, but any residual effects of the nitrogen treatments applied before 1954 were eliminated by randomisation. The green manuring and subsidiary treatments were arranged on the 32 non-fallow plots of each block in a quarter replicate with identities:

I ≡ (D) SPUGN ≡ (D) (X)UN ≡ S(X)PG

where (D) = (residual) dung.
(X) = (residual) rape and lupins v. clover and ryegrass.
S = straw
P = time of ploughing green manures after early potatoes
U = green manures undersown (in addition to those sown after early potatoes)
G = trefoil v. ryegrass
N = nitrogen levels to both crops.

https://doi.org/10.23637/ERADOC-1-191 *pp 67*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Basal dressing: Early potatoes, 0.75 cwt. P_2O_5, 1.5 cwt. K_2O per acre as granular compound fertiliser 0:10:20 till 1959 then 0:12:24 broadcast on the flat before machine planting. Barley and green manures, nil.

Varieties:

Early potatoes:	Ulster Chieftain
Barley:	Herta
Trefoil:	English
Ryegrass:	English Leafy Italian

Liming: 1953-1957 Ground chalk at 10 cwt. CaO per acre was applied before each barley crop, from 1958 onwards the carbonate dressing was raised to 23 cwt. ground chalk per acre.

Yields: Until 1958 the crop was harvested by binder, then a single combine cut was taken per plot.

Yield of Green Manures: The yield of dry matter and nitrogen in all green crops was estimated by sampling.

Transition Period: The barley of 1954 received two levels of nitrogen and was undersown according to the new scheme.

The early potatoes of 1954 received two levels of nitrogen according to the new scheme.

For a summary of the results 1955-1962 see Rep. Rothamst. exp. Sta. for 1962, 193-197.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

GREEN MANURING (W)

GREEN-MANURING ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Table 43

Kale, total produce: tons per acre.
Mean over 3 years 1939, 40 and 42*

	Green Manures					
	None	Tares	Clover	Mustard	Rye-grass	Mean
Mean	7.31	7.45	8.84	7.12	5.47	7.24
No dung	6.48	6.42	7.70	6.08	4.31	6.20
Dung	8.14	8.48	9.97	8.17	6.64	8.28
No straw	7.32	7.33	8.78	7.18	5.85	7.29
Straw	7.30	7.56	8.90	7.06	5.09	7.18
N: cwt per acre						
0.4	6.34	6.52	8.73	6.13	4.08	6.36
0.8	8.27	8.37	8.95	8.12	6.86	8.11

*Crop failed in 1941 and 1943

Table 44

Barley, Grain: cwt per acre. Mean over 6 years 1938-43

Mean	13.5	14.1	15.0	13.2	13.4	13.8
No dung	11.9	12.9	13.8	12.0	11.6	12.4
Dung	15.1	15.3	16.2	14.5	15.3	15.2
No straw	12.6	13.6	14.8	13.4	13.2	13.5
Straw	14.4	14.6	15.2	13.0	13.8	14.2
N: cwt per acre						
0.4	12.8	13.8	15.0	12.7	12.9	13.4
0.8	14.2	14.4	15.0	13.7	14.0	14.3

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

GREEN-MANURING ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Table 45

Cabbages, total produce: tons per acre.
Mean over 4 years 1946-49

	Green Manures					
	None	Lupins	Clover	Rape	Ryegrass	Mean
Mean	5.18	5.04	4.81	3.91	3.98	4.58
No dung	4,57	4.54	4.30	3.24	3.38	4.01
Dung	5.80	5.54	5.33	4.58	4.57	5.16
No straw	5.02	5.23	4.90	4.14	4.14	4.69
Straw	5.34	4.85	4.73	3.68	3.82	4.48
N to cabbages: cwt per acre						
0.4	4.87	4.26	4.42	3.31	3.64	4.10
0.8	5.49	5.82	5.20	4.50	4.32	5.07
N to green manures: cwt per acre						
None	4.73	5.18	5.12	3.56	4.00	4.52
0.4	5.63	4.91	4.50	4.26	3.95	4.65

Table 46

Barley, Grain: cwt per acre. Mean over 6 years 1944-49

Mean	15.6	16.1	14.8	15.0	14.3	15.2
No dung	15.0	15.3	13.7	13.8	13.0	14.1
Dung	16.2	16.9	16.0	16.1	15.7	16.2
No straw	16.0	15.6	14.8	14.8	13.7	15.0
Straw	15.2	16.5	14.9	15.1	15.0	15.3
N to cabbages: cwt per acre						
0.4	16.0	15.8	14.1	15.5	13.4	15.0
0.8	15.2	16.4	15.6	14.5	15.3	15.4
N to barley: cwt per acre:						
None	12.3	13.1	11.8	11.7	11.4	12.1
0.4	18.9	19.0	17.9	18.3	17.3	18.3

https://doi.org/10.23637/ERADOC-1-191 *pp 70*

This work is licensed under a Creative Commons Attribution 4.0 International License.

GREEN MANURING (W)

GREEN-MANURING ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Table 47

Cabbages, total produce: tons per acre
Mean over 4 years 1950-53

	Green Manures					
	None	Lupins	Clover	Rape	Rye-grass	Mean
Mean	6.32	6.74	8.23	5.22	5.55	6.41
No dung	5.54	6.04	7.46	4.75	4.80	5.72
Dung	7.10	7.45	9.00	5.69	6.30	7.11
No straw	6.23	6.86	8.31	5.58	5.78	6.55
Straw	6.42	6.61	8.14	4.86	5.32	6.27
N to cabbages: cwt per acre						
0.4	5.82	6.40	7.66	4.90	4.93	5.94
0.8	6.82	7.08	8.80	5.54	6.16	6.88
N to green manures:						
Low	6.09	6.65	8.10	5.02	5.30	6.24
High	6.55	6.83	8.36	5.41	5.80	6.59

Table 48

Barley, Grain: cwt per acre. Mean over 4 years 1950-53

Mean	17.9	19.6	18.0	18.6	17.7	18.3
No dung	16.8	19.1	17.2	17.4	16.5	17.4
Dung	18.9	20.1	18.8	19.8	19.0	19.3
No straw	17.4	19.2	17.6	18.5	17.1	17.9
Straw	18.4	20.0	18.3	18.8	18.4	18.8
N to cabbages: cwt per acre						
0.4	18.0	19.1	17.4	18.2	16.4	17.8
0.8	17.7	20.1	18.5	18.9	19.0	18.9
N to barley: cwt per acre						
None	15.6	17.6	17.7	16.5	16.0	16.7
0.3	20.1	21.6	18.2	20.6	19.6	20.0

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

GREEN-MANURING ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Table 49

Barley, Grain: cwt per acre. Mean over 8 years

Green manure	Time of ploughing	Nitrogen (cwt per acre) to barley 0.23 (±0.86)	0.46	Mean (±0.61)	Difference (±1.22)
Trefoil	Autumn	25.8	28.0	26.9	2.2
Ryegrass	Autumn	21.8	25.8	23.8	4.0
Trefoil	Spring	28.7	30.4	29.5	1.7
Ryegrass	Spring	25.6	30.4	28.0	4.8
Fallow		18.8	23.5	21.2	4.7
		(±0.54)		(±0.38)	(±0.76)
FYM (tons per acre)	0	23.3	26.9	25.1	3.6
applied before 1955	10	24.9	28.3	26.6	3.4
Mean (±0.38)		24.1	27.6	25.8	3.5

Table 50

Early Potatoes: tons per acre: Mean over 8 years

		F	T_u	R_u (±0.188)	T	R	Mean (±0.084)
Straw (cwt per acre)	0	5.12	5.95	5.54	5.33	5.35	5.46
	30	5.30	5.56	5.72	5.64	5.30	5.50
FYM (tons per acre)	0	4.81	5.34	5.16	4.98	5.11	5.08
	10	5.60	6.14	6.10	5.99	5.54	5.87
N (cwt per acre) to potatoes	0.6	4.96	5.63	5.51	5.45	5.18	5.35
	1.2	5.46	5.88	5.75	5.52	5.46	5.62
Mean (±0.134)		5.21	5.76	5.63	5.48	5.32	5.48

T: trefoil grown as a green manure after early potatoes, in preparation for barley.
R: ryegrass grown after early potatoes, in preparation for barley.
T_u: as T, but with trefoil undersown in the barley in preparation for the coming potato crop.
R_u: as R, but with ryegrass undersown in the barley in preparation for the potato crop.

https://doi.org/10.23637/ERADOC-1-191 *pp 72*

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE ROTATION EXPERIMENT

WOBURN, STACKYARD FIELD, SERIES D. 1938 ONWARDS

The purpose of the experiment is to test the value of a three year ley, three years of lucerne and an arable rotation with a one year ley, as means of building up soil fertility, in comparison with a rotation without leys. The effects of these crop sequences are measured by the yields of two successive test crops, sugar beet and barley. Each rotation therefore has five courses.

There are five series, one for each course of the five year rotation, all the crops of every rotation being represented every year. Each series has eight main plots, on four of them the same rotation continues throughout the experiment. On the other four plots, ley and arable rotations alternate, two according to the sequence ley, arable with 1-year hay, lucerne, arable without hay, and the other two in the sequence ley, arable without hay, lucerne, arable with hay.

Each main plot is divided into two sub-plots of 0.0413 acres, one of which receives dung at the rate of 15 tons per acre applied to the test crop of sugar beet only. The same sub-plots receive dung throughout the experiment.

The output of the 3-year ley is measured yearly in terms of sheep grazing days. Sampling cuts are also made when grazing begins and (since 1946) when the animals are removed.

The details of the rotations are as follows:-

	Treatment crops			Test crops	
Rotation Year:	1st	2nd	3rd	4th	5th
Ley	Ley, grazed	Ley, grazed	Ley, grazed	Sugar beet	Barley
Lucerne	Lucerne, cut	Lucerne, cut	Lucerne, cut	"	"
Arable (hay)	Potatoes	Rye*	1 year Hay	"	"
Arable (roots)	Potatoes	Rye	Carrots	"	"

*undersown

Varieties: Lucerne Du Puits; Sugar beet Kleinwansleben E; Barley Herta; Potatoes Majestic; Rye King II, Carrots James Scarlet Intermediate.

Hay: 19 lb. Perennial Ryegrass S.24
9 lb. Late Flowering Red Clover
2 lb. American Alsike Clover per acre.

Ley: 20 lb. Perennial Ryegrass S.24
11 lb. Cocksfoot S.143
6 lb. Late Flowering Red Clover
3 lb. White Clover S.100 per acre

The above cropping is that in operation in 1960, the changes introduced in the earlier years are detailed in a later section.

https://doi.org/10.23637/ERADOC-1-191 *pp 73*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 51

Fertilisers and methods of application
cwt. nutrients per acre.

	N	P_2O_5	K_2O	Material	How Applied
Potatoes	1.0	1.0	1.5	12:12:18	on flat
Rye	0.6	-	-	"Nitro-Chalk"	top dressed
Carrots	0.6	-	0.6	16:0:16	in seedbed
1 Year Hay	0.6	-	0.6	16:0:16	in spring
	0.22	-	-	"Nitro-Chalk"	for aftermath
Ley 1st Year	0.2	1.0	1.0	"Nitro-Chalk" and 0:16:16	in seedbed
	0.2	-	-	"Nitro-Chalk"	mid season
	0.2	-	-	"Nitro-Chalk"	late season
2nd and 3rd Years	0.18	-	0.18	16:0:16	in three dressings spread over the growing season
	0.18	-	0.18	16:0:16	
	0.18	-	0.18	16:0:16	
Lucerne 1st Year	-	1.0	1.0	0:16:16	in seedbed
2nd and 3rd Years	-	-	0.55	muriate of potash	top dressed
Sugar Beet*	0.72	0.72	0.9	$13\frac{1}{2}$:$13\frac{1}{2}$:$13\frac{1}{2}$: and 12:12:18	in seedbed
Barley+	0.6	-	-	"Nitro-Chalk"	in seedbed.

* Sugar beet also tests 0 v. 15 tons of dung on main plots and (0 v. 0.72 cwt. N) x (0 v. 0.9 cwt. K_2O) on quarter plots in addition to the basal dressing.

\+ Barley has 0.9 cwt. K_2O on those quarter plots which did not receive test potash for the sugar beet.

Table 51 gives the scheme of manuring followed in 1960. The fertilisers used have changed during the course of the experiment owing to the introduction of granular compound fertilisers and higher grade materials.

"Nitro-Chalk" 15.5%N was replaced by a 20.5% grade in 1959 and by 21% in 1960. Potassium sulphate was seldom obtainable after 1943 and was replaced by the chloride. The PK fertiliser 0:13:13 was replaced by 0:16:16 in 1959 and the $7:7:10\frac{1}{2}$ mixture for potatoes by 12:12:18 in 1960. The sugar beet compound 12:12:15 was no longer obtainable in 1959 and a mixture of $13\frac{1}{2}$:$13\frac{1}{2}$:$13\frac{1}{2}$ and 12:12:18 was used instead.

The following are the chief changes in cropping and manuring that have been made since the beginning of the experiment. All plots were originally manured with inorganic fertilisers according to the following scale in cwt. per acre:-

	Sulphate of ammonia	Super-phosphate	Sulphate of potash
Potatoes(1) (Majestic)	3	3	$1\frac{1}{2}$
1st Year of 3 year Ley(2)	1	3	$1\frac{1}{2}$
1st Year Lucerne(3)	-	3	$1\frac{1}{2}$
Wheat (Red Standard)(4)	1	-	-
1 Year Ley(5)	1	-	-
Kale(6) (Thousand Head)	3	-	-
Barley(7) (Plumage Archer)	1	-	-

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE (W)

All rotations had equal total amounts of phosphate (1.16 cwt. P_2O_5-1.00 until 1949) and potash (1.44 cwt. K_2O) per acre, but nitrogen was given according to the needs of the crops.

(1) Both treatment and test crop potatoes received the same fertiliser treatment but only test crop potatoes received dung. The dung was ploughed in until 1947. From 1948 to 1955 it was placed in the ridges. In 1956 sugar beet replaced test crop potatoes and the dung was once more ploughed in.

(2) The seeds mixtures used in the earlier years were in lb. per acre.

	1938-40	1941-47
Italian Ryegrass	-	10
Perennial Ryegrass S.23	14	14
Cocksfoot S.143	8	8
Late-flowering Red Clover S.123	4	4
White Clover S.100	-	2
Wild White Clover	2	-

(3) Until 1949 Provence (Grimm 1945 ; 1946 Argentine)

(4) Spring sown Atle 1948. Since 1949 Rye.

(5) The seeds mixtures used in the earlier years were in lb. per acre.

	1940-44	1945	1946-47	1949-55
Italian Ryegrass	16	24	24	-
Perennial Ryegrass	-	-	-	27
Broad Red Clover	10	12	-	-
Montgomery Red Clover	-	-	12	12
Alsike	-	-	-	3

In 1948 the undersown seeds failed and were replaced by a spring sowing of 22 lb. Italian Ryegrass and 27 lb. Trifolium.

(6) Sugar beet 1945-1955, with 4 cwt. sodium nitrate in place of 3 cwt. ammonium sulphate since 1947. Since 1956 carrots. Tops of sugar beet and carrots carted off.

(7) Herta since 1956.

In 1949 sulphate of ammonia was replaced by "Nitro - Chalk" 15.5%N) and the level of nitrogen was raised. The new dressing in terms of cwt. "Nitro-Chalk" per acre were Barley 1½, Rye 3, Ley 2nd and 3rd years 1, Hay 1st cut 2, 2nd cut 1.

In 1950 the basal for the block carrying the first crops of all rotations was supplied as compound granular fertiliser 13% P_2O_5 13% K_2O to give 0.6 cwt. each of P_2O_5 and K_2O; and the block with

https://doi.org/10.23637/ERADOC-1-191 *pp 75*

This work is licensed under a Creative Commons Attribution 4.0 International License.

test crop potatoes had a basal dressing of granular compound fertiliser 7%N, 7% P_2O_5, 10½% K_2O to give 0.56 cwt. N, 0.56 cwt. P_2O_5, 0.84 cwt. K_2O per acre.

From 1951 the first year of the three year ley received 1.3 cwt. "Nitro-Chalk" in place of 1.0 cwt. sulphate of ammonia per acre. From 1954 the "Nitro-Chalk" dressings applied to first, second and third year leys in the spring were repeated at the same rates in mid season, thus doubling the total amount of N given.

In 1954 and 1955 the plots in the second cut of the one-year hay were split, one half receiving the standard dressing of "Nitro-Chalk" and the other double the amount. It was suspected that potash shortage on the lucerne plots might be disturbing the results of the experiment and that the nitrogen levels were too low; consequently from 1955 the plots of the test crop potatoes were split into quarters to test sulphate of ammonia and muriate of potash additional to the basal dressing namely

(0 v. 0.56 cwt. N) x (0 v. 0.84 cwt. K_2O)

these amounts being equal to the N and K applied as basal dressing of 7:7:10½ fertiliser. The second test crop, barley, received an equalising dressing of 0.84 cwt. K_2O per acre on those quarters that did not receive extra potash to the potatoes. The sub - plots were not harvested separately in the barley.

In 1956 the system of manuring was again revised on the grounds that levels of nitrogen and potassium were too low. The rotations were still balanced in total phosphate (1.72 cwt. P_2O_5) and potash (3.0 cwt. K_2O) but nitrogen was still given according to the needs of the crops.

This scheme was very similar to the final one. Only the points of difference are listed here.

Manuring scheme for Spring 1956

Crops not mentioned were manured as in Table 51

	cwt. per acre N	P_2O_5	K_2O	Materials
Carrots	0.48	-	0.6	Sulphate of ammonia, muriate of potash
1 year Hay	0.48	-	0.6	ditto
Ley 1st year	0.6*	1.0	1.0	"Nitro-Chalk" and 0:16:16
Ley 2nd and 3rd year	0.6*	-	0.55	"Nitro-Chalk" and muriate of potash

*Total. In 1956 in two dressings; 1957 three dressings.

This year also, owing to the build up of potato root eelworm, test crop potatoes were replaced by sugar beet and treatment crop sugar beet by carrots. Test crop carrots failed in 1957 and were replaced by turnips.

Owing to an attack of lucerne stem eelworm plots 27, 28 were ploughed up and fallowed in 1958 at the end of their second year, and in 1959 plots 3, 4, 9, 10 were similarly treated.

Cereals were combine harvested for the first time in 1959.

https://doi.org/10.23637/ERADOC-1-191 *pp 76*

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE (W)

Liming: Commencing in 1947 an application of ground chalk was applied before every barley crop. The rate of dressing was approximately 15 cwt. carbonate per acre. In 1953 the dose was raised to 10 cwt. calcium oxide, i.e. about 19 cwt. ground chalk per acre. In 1958 the dressing was further raised to the maximum amount of ground chalk delivered by one passage of the manure drill. This was about 23 cwt. per acre. In spite of rotational liming before the barley crop, blocks 2 and 3 were still found to be slightly acid in 1957 and corrective dressings of ground chalk were applied in 1958 at the rate of 10 cwt. on block 2 and 23 cwt. on block 3.

For design and cropping see Rep. Rothamst. exp. Sta. for 1938, 135-136.

For a summary of the first eight years' results see Rep. Rothamst. exp. Sta. for 1948, 94-97.

For a full discussion of the results to 1956 see Mann, H.H. and Boyd, D.A. Some results of an experiment to compare ley and arable rotations at Woburn. J. agric. Sci. (1958) 50, 297-306.

LEY-ARABLE ROTATION WOBURN STACKYARD FIELD

Table 52

Means over 5 years 1956-60

Sugar beet, Total Sugar: cwt per acre

	Previous Rotation				
	Ley	Lucerne	Arable (Hay)	Arable (Roots)	Mean
Mean	56.4	52.0	48.0	52.6	52.2
Dung: tons per acre					
None	53.1	47.7	42.4	45.9	47.3
15	59.7	56.3	53.5	59.4	57.2
Diff.	+6.6	+8.6	+11.1	+13.5	+9.9
N: cwt per acre					
0.72	57.8	53.3	49.2	52.3	53.1
1.44	55.0	50.7	46.7	53.0	51.4
Diff.	-2.8	-2.6	-2.5	+0.7	-1.7
K_2O: cwt per acre					
0.90	54.7	50.7	47.0	52.6	51.3
1.80	58.1	53.3	48.9	52.6	53.2
Diff.	+3.4	+2.6	+1.9	0.0	+1.9

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

LEY-ARABLE ROTATION WOBURN STACKYARD FIELD

Table 52 continued

Sugar beet, Tops: tons per acre

	Previous Rotation				
	Ley	Lucerne	Arable (Hay)	Arable (Roots)	Mean
Mean	16.55	14.65	14.41	12.62	14.56
Dung: tons per acre					
None	15.89	13.86	13.26	11.70	13.68
15	17.22	15.43	15.56	13.54	15.44
Diff.	+1.33	+1.57	+2.30	+1.84	+1.76
N: cwt per acre					
0.72	15.25	13.50	13.15	11.03	13.23
1.44	17.86	15.80	15.67	14.20	15.88
Diff.	+2.61	+2.30	+2.52	+3.17	+2.65
K_2O: cwt per acre					
0.90	15.97	14.46	14.55	12.80	14.44
1.80	17.13	14.84	14.27	12.43	14.67
Diff.	+1.16	+0.38	-0.28	-0.37	+0.23

Table 53

Barley, Grain (at 85% dry matter): cwt per acre.

Means over 6 years 1957-62

Dung tons per acre	Ley	Lucerne	Arable with Hay	Arable with Roots	Mean
None	34.0	32.4	31.0	31.4	32.2
15	33.6	33.8	33.8	34.5	33.9
Mean	33.8	33.1	32.4	32.9	33.1
Diff.	- 0.4	+ 1.4	+ 2.8	+ 3.1	+ 1.7

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

MARKET GARDEN EXPERIMENT
WOBURN, LANSOME FIELD, 1942 ONWARDS

The purpose of the experiment is to study the effects of certain bulky organic manures, dung, sewage sludge, and two types of compost, in building up an agricultural soil for the growth of market garden crops. Certain plots are treated with fertilisers alone to provide controls for the organic treatments.

The crops are grown in a **2-year rotation.** The experiment falls into two periods 1942-1950 when 4 crops were grown in the 2 years; 1951 onwards when 3 crops were grown in 2 years. The organic manuring and the basal fertilisers remained practically the same until 1960. The rates of "Nitro-Chalk" on test were raised in the second period. A new scheme of manuring was introduced in 1961.

First Period 1942-1950

The cropping was as follows:-

1st Year Globe Beetroot (sown April, lifted July)
Winter Cabbage (transplanted August, cut December -March)

2nd Year Peas (sown March-April, pulled June-July)
Leeks (transplanted July, lifted January-March).

The **2-year** rotation occupied two series of plots, one carrying beet followed by cabbage, while the other carried peas followed by leeks. Each series has 40 plots divided into 4 blocks of 10 plots, certain interactions being partially confounded with block differences.

Area of each plot:- 0.0125 acres.

Treatments per acre:

(i) Organics at 15 and 30 tons:-
Dung
Sewage sludge (West Middlesex)
Sewage sludge and farm waste compost[1] (Cs)
Vegetable compost (farm waste activated by farmyard manure). (Cd)

(ii) Sulphate of ammonia (total to two crops)
(a) In presence of organics 0 v. 0.6 cwt. N
(b) Without organics 0, 0.6, 1.2, 1.8 cwt. N.

(1) Composted town refuse in 1942 and 1943.

Basal dressings: 0.4 cwt. P_2O_5 as superphosphate.
0.5 cwt. K_2O as muriate of potash.

Application of manures:

(i) Organics ploughed in in winter and basal dressing broadcast in early spring before globe beet and again before peas. No organics nor basal dressings were applied to cabbages or leeks.

(ii) The sulphate of ammonia was divided as follows:-

https://doi.org/10.23637/ERADOC-1-191 *pp 79*

This work is licensed under a Creative Commons Attribution 4.0 International License.

	With organics	No organics
Peas and globe beet	0, 0.2	0, 0.2, 0.4, 0.6
Cabbages and leeks	0, 0.4	0, 0.4, 0.8, 1.2

The higher dressings of sulphate of ammonia were applied in divided dressings according to the requirements of the crop.

In the first year, which was preliminary, winter cabbages were grown on both series. They tested dung, sewage sludge, and composted town refuse (vegetable compost and sewage sludge compost were not available). Sulphate of ammonia at 0.6 cwt. N was also tested. In 1943 composted town refuse was again used in place of sludge compost.

Second Period 1951-1960 (including leeks 1960-61).

The experiment was recast as follows:-

Sequence of crops:

1st Year Red Beet, sown April-May, lifted July-August followed by Spring Cabbage, planted September-October, cut April-May.

2nd Year Leeks, planted June-July, lifted March-April.

Organic manures: The same four organics were applied to each of the three crops of the rotation at 10 and 20 tons per acre, i.e. 30 and 60 tons every two years as before.

Basal fertiliser: 0.3 cwt. P_2O_5 and 0.3 cwt. K_2O as 0:13:13 fertiliser applied to every crop.

Nitrogenous dressings: These were applied to every crop on the following scale:-

In presence of organics 0, 0.3, N as "Nitro-Chalk" (N_1).

In absence of organics 0, 0.3, 0.6, 0.9 cwt. N as "Nitro-Chalk" (N_1, N_2, N_3). The heavier dressings were divided; leeks and red beet had N_1 and half N_2 and half N_3 before planting or sowing, the remaining halves later. Spring cabbage had N_1, half N_2, half N_3 as a spring application and the remainder later. Leeks 1960 - 61 received vegetable compost at half rate.

1961 (including leeks 1961-62)

Organics applied as before.

Fertiliser treatments per acre:

(a) Plots without organics: All combinations of:

Nitrogen: 0.9, 1.8 cwt. N as "Nitro-Chalk" (N_1, N_2)

Phosphate and potash: 1.5 cwt. P_2O_5 with 1.5 or 3.0 cwt. K_2O as compound fertiliser 0:20:20 or 0:14:28 (P_1K_1, P_1K_2).

Methods of application:

(i) All fertiliser before planting or sowing.

https://doi.org/10.23637/ERADOC-1-191 *pp 80*

This work is licensed under a Creative Commons Attribution 4.0 International License.

(ii) Half PK (for potatoes) or half NPK (for red beet and leeks) ploughed in at time of applying organics, remainder before planting or sowing.

Note: "Before planting" fertiliser for potatoes applied on the flat.

(b) Plots receiving organics:

No fertiliser; $N_1P_1K_1$ (rates as above) applied before planting or sowing. In addition, all plots were split for a test of 0 v. 500 lb. sulphate of magnesia applied before planting or sowing. All treatments cumulative.

1962

Applications of sewage sludge and sewage sludge compost discontinued. Dung at 10, 20 tons per acre replaced vegetable compost at 10, 20 tons per acre except for potatoes.

Plots previously treated with sludge and sludge compost were split for a test of P_1K_1 v. $N_1P_1K_1$ (rates as 1961) all applied before planting or sowing. Leeks on these plots harvested at one time only, other plots two dates of harvest.

For red beet only, the split is across the direction of the rows, no sulphate of magnesia being applied to this crop.

A comparison of sowing depths ($\frac{3}{4}$, $1\frac{1}{2}$ inches) was made on red beet, each strip of 4 plots being split for this test. The crop was lifted early, because of excessive bolting, and resown at uniform depth without further manures.

Cabbages, leeks, and red beet are graded and the numbers and weights in each grade are recorded. Since 1950 leeks have been harvested two rows per plot at a time at several intervals during the season; in 1953 the same procedure was adopted for red beet. Since 1961 red beet has been harvested on two dates only. In 1958 winter cabbages failed. Spring cabbage 1952-53 failed and was replaced by peas, in 1953 also red beet failed and was replaced by white turnips. Spring cabbage 1955-56 failed and early potatoes (Arran Pilot) were grown instead on the same manure. It was decided to continue this change, the organic manures being ploughed in in winter, the fertilisers broadcast on the flat in spring, and the potatoes planted by machine.

Liming: From 1943-45 ground chalk at 29 cwt. per acre was applied before planting cabbages. In 1948 and 1949 an amount of ground chalk was applied for the red beet equal in weight to all the ammonium sulphate previously applied up to date. In 1950 chalk was applied to red beet equal to the amount of ammonium sulphate used on the previous four crops on this block. In 1951 certain plots which were still acid were corrected individually. From 1952 onwards 10 cwt. CaO as 18-20 cwt. of ground chalk was given before every crop of red beet. In 1955 this dressing was applied to spring cabbages also. In 1958 the quantity of ground chalk was raised to 23 cwt. per acre.

https://doi.org/10.23637/ERADOC-1-191 *pp 81*

This work is licensed under a Creative Commons Attribution 4.0 International License.

For soil organic matter data see Mann, H.H. and Barnes, T. W. (1956). The permanence of organic matter added to soil. J. agric. Sci., 48, No. 2, 160-163.

For weed growth see Mann, H.H. (1957). Weed herbage of slightly acid arable soils as affected by manuring. J. Ecol., 45, 1949-156.

For bolting of red beet see Mann, H.H. (1951). The effect of manures on the bolting of the beet plant. Ann. appl. Biol. 38, No. 2, 435-443.

For a summary of the results see Rep. Rothamst. exp. Sta. for 1962, 186-193.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

MARKET GARDEN (W)

MARKET GARDEN EXPERIMENT WOBURN, LANSOME FIELD

Table 54

Total produce, tons per acre - Means 1944-1950

First crops after organic manures

Treatment	Rate of manuring (tons per acre)	Globe beet (1944-45, 1947-50) (6) (excluding unmarketable produce) cwt. N per acre 0	0.2	Mean	Diff.	Green peas (1944-50) (7) cwt. N per acre 0	0.2	Mean	Diff.
		(±0.404)		(±0.286)	(±0.571)	(±0.166)		(±0.118)	(±0.235)
No organics		2.03	2.75	2.39	0.72	1.81	1.84	1.82	0.03
		3.02*	3.16†	3.09	0.14	1.86*	1.82†	1.84	-0.04
FYM	15	4.84	4.90	4.87	0.06	2.38	2.23	2.31	-0.15
	30	6.52	6.64	6.58	0.12	2.27	2.04	2.16	-0.23
Mean		5.68	5.77	5.72	0.09	2.32	2.14	2.24	-0.18
		(±0.286)		(±0.202)	(±0.404)	(±0.118)		(±0.083)	(±0.166)
Sewage sludge	15	4.21	4.64	4.43	0.43	1.84	2.04	1.94	0.20
	30	5.31	4.94	5.13	-0.37	1.68	1.84	1.76	0.16
Mean		4.76	4.79	4.78	0.03	1.76	1.94	1.85	0.18
Compost Cd	15	3.87	4.57	4.22	0.70	2.36	2.22	2.29	-0.14
	30	5.74	5.98	5.86	0.24	2.06	2.20	2.13	0.14
Mean		4.80	5.27	5.04	0.47	2.20	2.21	2.21	0.01
Compost Cs	15	3.76	3.73	3.74	-0.03	2.24	2.10	2.17	-0.14
	30	4.61	5.24	4.92	0.63	2.27	2.12	2.20	-0.15
Mean		4.18	4.48	4.33	0.30	2.26	2.11	2.18	-0.15

* 0.4 cwt. N per acre. † 0.6 cwt. N per acre.

Second crops after organic manures

Treatment	Rate of manuring (tons per acre)	Winter cabbages (1944-46, 1948-50)* (6) cwt. N per acre 0	0.4	Mean	Diff.	Leeks (1944-50)* (7) cwt. N per acre 0	0.4	Mean	Diff.
		(±0.246)		(± 0.174)	(±0.348)	(±0.160)		(±0.113)	(±0.226)
No organics		2.63	4.32	3.48	1.69	2.20	2.67	2.44	0.47
		5.24†	5.67‡	5.46	0.43	2.71†	2.90‡	2.80	0.19
FYM	15	4.17	5.41	4.79	1.24	3.16	3.07	3.11	-0.09
	30	5.12	6.17	5.64	1.05	3.84	3.89	3.86	0.05
Mean		4.64	5.79	5.22	1.15	3.50	3.48	3.49	-0.02
		(±0.174)		(±0.123)	(±0.246)	(±0.113)		(±0.080)	(±0.160)
Sewage sludge	15	5.21	6.56	5.88	1.35	3.11	3.06	3.08	-0.05
	30	6.97	7.11	7.04	0.14	3.47	3.66	3.56	0.19
Mean		6.09	6.84	6.46	0.75	3.29	3.36	3.32	0.07
Compost Cd	15	3.87	5.04	4.46	1.17	2.89	3.25	3.07	0.36
	30	4.85	5.91	5.38	1.06	3.52	3.50	3.51	-0.02
Mean		4.36	5.48	4.92	1.12	3.20	3.37	3.29	0.17
Compost Cs	15	3.87	4.97	4.42	1.10	2.89	3.33	3.11	0.44
	30	4.40	6.17	5.28	1.77	3.15	3.18	3.16	0.03
Mean		4.14	5.57	4.85	1.43	3.02	3.25	3.14	0.23

* Years of sowing and transplanting. † 0.8 cwt. N per acre. ‡ 1.2 cwt N per acre.

Number of years given in brackets.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

MARKET GARDEN EXPERIMENT WOBURN, LANSOME FIELD

Table 55

Total produce: tons per acre - Means 1951-60

Treatment	Rate of manuring (tons per acre)	Globe beet (1951-52, 1954-60) (9) cwt N per acre 0	0.3	Mean	Diff.	Leeks (saleable produce) (1951-60)* (10) cwt N per acre 0	0.3	Mean	Diff.
		(±0.784)		(±0.554)	(±1.109)	(±0.190)		(±0.134)	(±0.269)
No organics		4.21	6.19	5.20	1.98	2.56	3.77	3.16	1.21
		8.52†	7.43‡	7.98	-1.09	4.39†	4.07‡	4.23	-0.32
FYM	10	9.25	12.24	10.74	2.99	4.47	5.16	4.81	0.69
	20	15.74	16.89	16.31	1.15	5.77	6.01	5.89	0.24
Mean		12.49	14.56	13.52	2.07	5.12	5.58	5.35	0.46
		(±0.554)		(±0.392)	(±0.784)	(±0.134)		(±0.095)	(±0.190)
Sewage sludge	10	10.99	11.45	11.22	0.46	5.08	5.02	5.05	-0.06
	20	12.61	14.18	13.39	1.57	5.10	5.39	5.25	0.29
Mean		11.81	12.82	12.30	1.02	5.09	5.20	5.15	0.11
Compost Cd	10	10.18	12.38	11.28	2.20	4.71	5.21	4.96	0.50
	20	12.35	16.07	14.21	3.72	5.49	5.81	5.65	0.32
Mean		11.27	14.22	12.74	2.95	5.10	5.51	5.31	0.41
Compost Cs	10	10.00	11.95	10.98	1.95	4.87	5.23	5.05	0.36
	20	13.78	15.29	14.53	1.51	5.20	5.60	5.40	0.40
Mean		11.89	13.62	12.75	1.73	5.03	5.42	5.22	0.39

Treatment	Rate of manuring (tons per acre)	Spring cabbages (1951, 1953-54)* (3) cwt. N per acre 0	0.3	Mean	Diff.	Potatoes (tubers) (1956-60) (6) cwt. N per acre 0	0.3	Mean	Diff.
		(±0.696)		(±0.492)	(±0.984)	(±0.260)		(±0.184)	(±0.367)
No organics		2.20	4.68	3.44	2.48	4.03	5.38	4.70	1.35
		6.28†	6.31‡	6.30	0.03	6.43†	6.35‡	6.39	-0.08
FYM	10	5.48	6.47	5.98	0.99	6.72	7.54	7.13	0.82
	20	7.44	8.65	8.05	1.21	7.79	8.26	8.03	0.47
Mean		6.46	7.56	7.02	1.10	7.25	7.90	7.58	0.65
		(±0.492)		(±0.348)	(±0.696)	(±0.184)		(±0.130)	(±0.260)
Sewage sludge	10	7.07	8.19	7.63	1.12	6.44	6.75	6.59	0.31
	20	9.02	10.05	9.54	1.03	7.06	7.37	7.21	0.31
Mean		8.04	9.12	8.58	1.08	6.75	7.06	6.90	0.31
Compost Cd	10	5.19	6.92	6.05	1.73	6.43	7.45	6.94	1.02
	20	6.32	7.90	7.11	1.58	7.39	7.80	7.59	0.41
Mean		5.75	7.41	6.58	1.66	6.91	7.62	7.27	0.71
Compost Cs	10	5.73	7.21	6.47	1.48	6.59	6.95	6.77	0.36
	20	7.16	8.37	7.77	1.21	7.55	7.86	7.70	0.31
Mean		6.44	7.79	7.12	1.35	7.07	7.40	7.24	0.33

* Years of sowing and transplanting. †0.6 cwt. N per acre. ‡0.9 cwt. N per acre

Number of years given in brackets.

https://doi.org/10.23637/ERADOC-1-191 *pp 84*

This work is licensed under a Creative Commons Attribution 4.0 International License.

IRRIGATION EXPERIMENT
WOBURN, BUTT CLOSE, 1951 ONWARDS

The experiment tests the timing and intensity of irrigation treatments on (i) an arable rotation and (ii) a long-period grass ley. The treatments which are applied by overhead spray-lines, are decided by the Physics Department on the basis of meteorological data. The details of the irrigation treatments are published yearly in "Results of the Field Experiments".

The experiment consists of four series each divided into 12 main plots providing three randomised blocks of four irrigation treatments each. Three of these series carry in turn the crops of a three-course rotation, the fourth is laid down in long-period ley. For all crops except beans the main plots are split to test two levels of nitrogenous manuring. These dressings alternate on their half-plots in the arable crops, but cumulate on the grass plots.

Main plot size: Arable crops 0.0556 acre; grass 0.0528 acre.

First Period 1951-53.

Rotation: 1st Year Early potatoes (Ulster Chieftain) followed by winter cabbages (January King)
2nd Year Sugar beet (Kleinwanzleben E)
3rd Year Barley (Plumage Archer)
Grass ley: Italian Ryegrass 6 lb., Cocksfoot (S. 26) 16 lb., White Clover (S100) 4 lb., Alsike Clover 2 lb. per acre.

Main plot treatments: Four irrigation treatments as specified by the Physics Department. These treatments rotate on the arable plots, but on the grass plots they are cumulative.

Basal manuring:

	cwt. per acre N	P_2O_5	K_2O	Supplied as compound fertiliser
Early potatoes	0.5	0.5	0.75	7:7:10½
Cabbages[1]	-	-	-	
Sugar beet[2]	0.4	0.4	0.6	7:7:10½
Barley	0.2	0.2	0.3	7:7:10½
Grass Ley	-	0.6	0.6	0:13:13

(1) Commencing in 1952 cabbages received 18 cwt. ground chalk per acre.

(2) Commencing in 1952 the sugar beet received 5 cwt. of agricultural salt per acre. The tops were carted off.

Sub-plot treatments in addition to any nitrogen in basal dressings:

Early potatoes 0 v. 0.5 cwt. N as sulphate of ammonia.

https://doi.org/10.23637/ERADOC-1-191 *pp 85*

This work is licensed under a Creative Commons Attribution 4.0 International License.

Winter cabbage	0.5 v. 1.0 cwt. N as "Nitro-Chalk"
Sugar beet	0 v. 0.4 cwt. N as "Nitro-Chalk"
Barley	0 v. 0.2 cwt. N as sulphate of ammonia
Grass ley	0.15 v. 0.3 cwt. N as "Nitro-Chalk after each cut except the last.

In 1952 the winter cabbages failed owing to bird damage.

Second Period 1954-56.

The original scheme was modified as follows:-

The early potatoes followed by winter cabbage were replaced by maincrop potatoes (Majestic) which received a basal dressing of 15 tons of dung in addition to fertilisers as before. The fertilisers were applied on the flat and the potatoes were planted by machine. The variety of barley was changed from Plumage Archer to Herta. The original grass-clover mixture was ploughed up and the plots resown with Cocksfoot (S.27) 28 lb. per acre in spring 1954. The basal manuring for the grass was changed to 0.6 cwt. P_2O_5, 1.2 cwt. K_2O using compound fertiliser 0:10:20. The grass was cut when it reached a definite height, the nitrogen dressings being given independently according to the number of cuts taken from individual treatments. The nitrogen treatments, which now alternated on their half plots, were applied for every cut including the first instead of after every cut except the last.

The lime dressing was fixed at 10 cwt. CaO per acre given as ground chalk for sugar beet.

Third Period 1957-59.

A detailed survey for potato root eelworm made in 1956 had shown a serious build up of this pest on some blocks. Potatoes were consequently replaced by sugar beet.

The new rotation was 1st Year Sugar beet (Kleinwanzleben E)
2nd Year Spring wheat (Peko)
3rd Year Spring beans (Garton's Tick).

The existing Cocksfoot ley (S.37) sown in 1954 was retained. The N splits were changed from alternating to cumulative.

The basal manuring of the main plots was:

	cwt. per acre			
	N	P_2O_5	K_2O	Fertiliser
Sugar beet[1]	0.6	0.6	0.9	7: 7:10½
Spring wheat	0.4	0.4	0.6	7: 7:10½
Spring beans	-	0.3	0.6	0:10:20 (placed)
Grass ley	-	0.6	1.2	0:10:20

[1] Also received 5 cwt. salt per acre.

The half plot tests of nitrogen treatments in addition to any nitrogen in the basal dressing were:

Sugar beet	0 v. 0.6 cwt. N as "Nitro-Chalk"
Spring wheat	0 v. 0.4 cwt. N as "Nitro-Chalk"
Spring beans	0 v. 12 tons dung[1]

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

IRRIGATION (W)

Grass ley 0.3 v. 0.6 cwt. N as "Nitro-Chalk" for every cut.
(1) Half plots for dung taken at right angles to the original nitrogen splits.

Since 1957 the spring beans have been used to test demeton methyl as a spray against aphids. The treatments have been (0 v. irrigation) x (0 v. spray). No spraying was done in 1958. In 1957 the outside rows of certain plots were used to test the effect of hormone sprays for setting the flowers. Spring beans and wheat have been combine harvested since 1957.

Commencing in 1958 a test of extra muriate of potash has been made on whole plots of the grass ley, to find out whether the high level of nitrogen on some plots requires a high level of potassium. The treatments which are cumulative are (0 v. irrigation) x (0 v. 0.6 cwt. K_2O). The potash dressing is repeated on several occasions according to the season.

Liming: Ground chalk at the rate of 10 cwt. CaO was applied to sugar beet in 1957. From 1958 to 1960 the dressing was raised to 46 cwt. ground chalk.

Fourth Period Commencing 1960.

The rotation is 1st Year Early potatoes (Arran Pilot) followed by trefoil green manure
2nd Year Barley
3rd Year Winter beans

The Cocksfoot ley was ploughed up and the plots sown down with Italian Ryegrass S.22 in autumn 1959.

The basal manures on whole plots are as follows:-

	cwt. per acre N	P_2O_5	K_2O	Material
Early potatoes	-	0.75	1.5	0:14:28 on flat
Barley	0.2	0.2	0.3	12:12:18 in seedbed
Winter beans	-	0.4	0.8	0:14:28 placed
Grass ley	-	0.6	1.2	0:14:28 spring top dressed

The nitrogen splits on half plots are:

	cwt. N per acre	
Early potatoes	0.6 v. 1.2	Sulphate of ammonia on flat
Barley	0 v. 0.2	"Nitro-Chalk 21" in seedbed
Beans	None	
Grass ley	0.3 v. 0.6	"Nitro-Chalk 21"

The early potatoes carry an additional test on main plots (0 v. irrigation) x (pre-emergence spray, no cultivations v. ordinary inter-row cultivations). After the potatoes are lifted certain plots are immediately sown with trefoil to test trefoil green manure for the following barley crop. The treatments for trefoil are no irrigation v. irrigation before sowing and again before ploughing in.

See Penman, H. L. Woburn Irrigation, 1951-59. I. Purpose, design and weather. J. Agric. Sci., 1962) 58, 343-348. II Results for grass. Ibid. (1962) 58, 349-364. III Results for rotation crops. Ibid (1962) 58, 365-382.

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.

Table 56

IRRIGATION EXPERIMENT WOBURN, BUTT CLOSE

3-year means

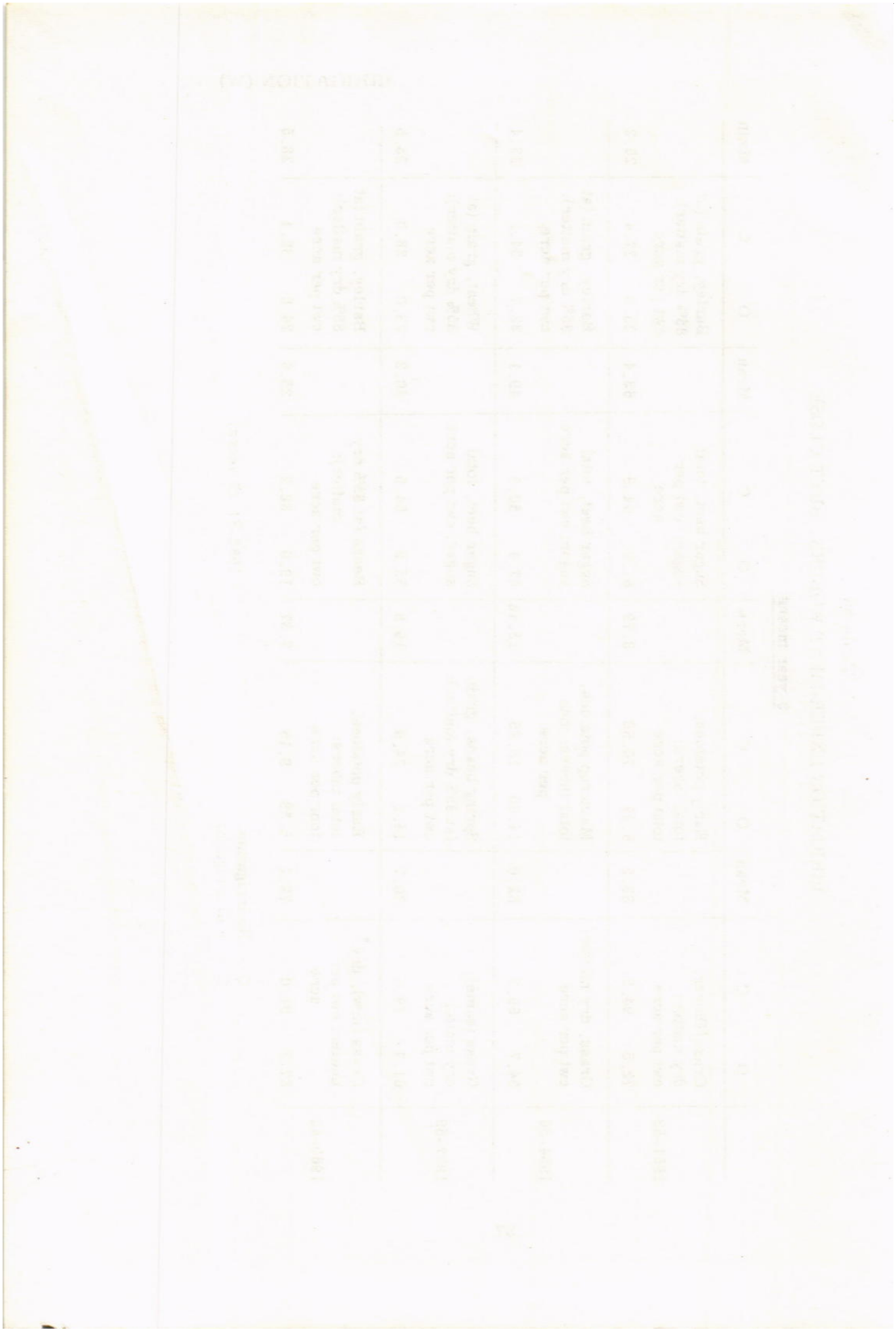
	O	C	Mean	O	C	Mean	O	C	Mean	O	C	Mean
1951-53	Grass/Clover, dry matter: cwt per acre			Early potatoes, total tubers: tons per acre			Sugar beet, total sugar: cwt per acre			Barley, grain (at 85% dry matter): cwt per acre		
	72.5	94.5	83.5	6.99	10.58	8.79	61.9	64.9	63.4	25.0	27.4	26.2
1954-56	Grass, dry matter: cwt per acre			Maincrop potatoes, total tubers: tons per acre			Sugar beet, total sugar: cwt per acre			Barley, grain (at 85% dry matter): cwt per acre		
	54.7	69.3	62.0	14.00	16.95	15.48	47.4	50.8	49.1	32.7	34.2	33.4
1957-59	Grass (same), dry matter: cwt per acre			Spring beans, grain (at 85% dry matter): cwt per acre			Sugar beet, total sugar: cwt per acre			Wheat, grain (at 85% dry matter): cwt per acre		
	61.9	79.5	70.7	14.1	24.9	19.5	55.9	64.5	60.2	23.0	28.0	25.5
1960-62	Grass (new), dry* matter: cwt per acre			Early potatoes, total tubers: tons per acre			Beans (at 85% dry matter): cwt per acre			Barley, grain (at 85% dry matter): cwt per acre		
	67.2	91.0	79.1	5.58	9.16	7.37	19.0	32.2	25.6	24.6	32.4	28.5

O = No irrigation
C = Full irrigation.

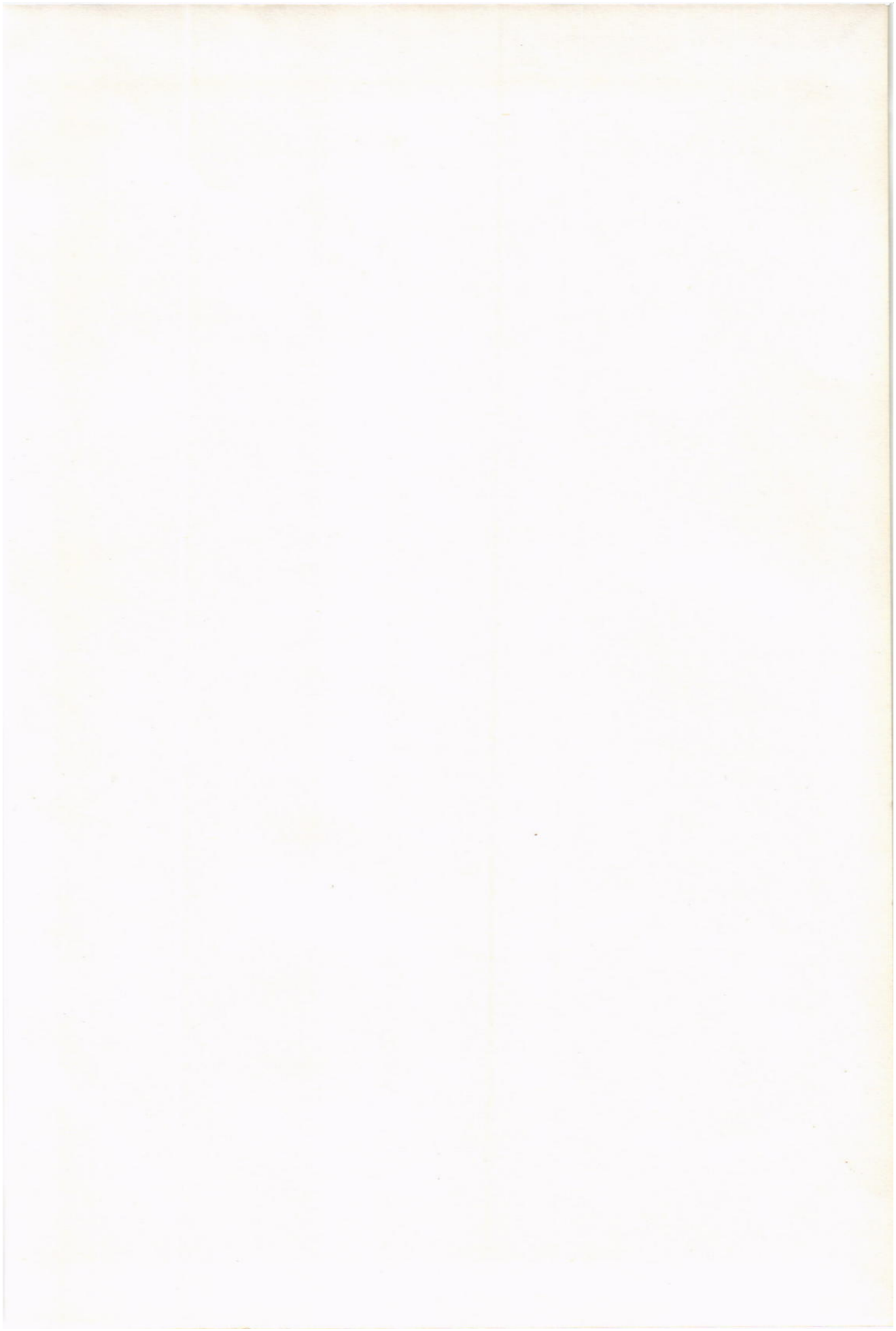
* 1960-61 (2 years)

https://doi.org/10.23637/ERADOC-1-191

This work is licensed under a Creative Commons Attribution 4.0 International License.



This work is licensed under a Creative Commons Attribution 4.0 International License.



This work is licensed under a Creative Commons Attribution 4.0 International License.

