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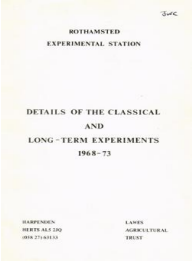
Details of the Classical and Long-term Experiments 1968-73


ROTHAMSTED
EXPERIMENTAL STATION

DETAILS OF THE CLASSICAL
AND
LONG-TERM EXPERIMENTS
1968-73

Full Table of Content

Rothamsted Experimental Station: Details of the Classical and Long-term Experiments 1968-73

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ROTHAMSTED

EXPERIMENTAL STATION

DETAILS OF THE CLASSICAL AND LONG-TERM EXPERIMENTS 1968-73

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(R = Rothamsted W = Woburn S = Saxmundham)

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INTRODUCTION

This booklet brings up to date the *Details of the Classical and Long-Term Experiments up to 1967* (short title *Details 1967)* published in 1970 and should be used in conjunction with it for all experiments which appear in both publications. The original intention was to cover a period of five years 1968–72 but 1973 has been included as this is the last year of a cycle in a number of classical experiments. It is for use with the annual *Yields of the Field Experiments* (up to 1970 this was entitled *Numerical Results of the Field Experiments;* these are referred to as *Yields)*

Corrections to Details 1967

The following amendments and clarifications to the General Notes on the Classical Experiments given in *Details 1967* pp. 9–10 should be noted.

(i) The unit dressing of nitrogen from 1938 has been 43 lb N and not 23 lb as stated.

(ii) Na: is applied as $Na_2SO_4 . 1OH_20$ although the anhydrous salt may have been used in earlier years.

(iii) Mg, Na: the standard rates on Barnfield are 20 lb Mg and 80 lb Na respectively compared with 10 lb and 14 lb respectively in other Classical experiments.

(iv) Rape cake. The standard dressing of 2000 lb contains about 100 lb N, and also about 20 lb P and 20 lb K.

Amendments and corrections relating to individual experiments are given at the start of the appropriate report as necessary.

The period covered is generally the six harvest years 1968 to 1973 except in those cases where an experiment, not included in *Details 1967*, is reported on and then information is given from its commencement. In a few instances a different period has been taken for the presentation of results in order to embrace one or more complete cycles.

(This booklet brings together information on the treatments, the more important aspects of husbandry and, where appropriate, summaries of the yields. Further details, especially on matters of husbandry should be sought in the appropriate *Yields* or in the publications listed.)

Conventions

The following conventions have been used:

Period

(i) All years quoted are harvest years and all operations directly concerned with that crop are linked with it even if carried out during the previous summer or autumn, e.g. a weedkiller applied to the stubble of a crop in 1970 is related to the 1971 crop.

(ii) '1968-73' indicates a treatment or other operation first carried out on the 1968 crop and ending with the one harvested in 1973. '1968–' implies that the treatment has been continued beyond 1973.

(iii) 'Since 1968' or 'from 1968' implies an operation first adopted for the 1968 crop. Similarly 'until 1973' or 'to 1973' implies one ending with the 1973 crop.

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Units

(i) Metric units were introduced in the 1971 issue of *Yields* and have been used thereafter, so in this report it has been necessary to convert all the figures for the years 1968-70. The conversion factors used are those given in the appendix.

(ii) All yields, seed rates, rates of application of fertilisers, sprays etc are per hectare unless otherwise stated and all areas are in hectares. Measurements of length are in metres or centimetres if more appropriate.

(iii) Yields of grain and straw are calculated as at 85% dry matter. Grass, hay, etc are expressed as dry matter. For potatoes yields of total fresh tubers are given.

(iv) Operations in the field have continued to be carried out in Imperial units as the machinery still in use must be set for widths in feet or inches. Consequently it is less confusing to do all the work in the old units as the necessary conversions can be made very easily by the computer. As a result, when certain data are converted, slight discrepancies may appear e.g. treatments which are exact multiples of hundredweights may not appear exactly so in kg.

Degrees of accuracy

(i) Materials for treatments are normally weighed out on a balance for each unit area and so are given to the nearest 1%. Basals or standard treatments are commonly applied by a machine which has been calibrated beforehand and consequently data are usually given to an accuracy of 5%.

(ii) Two systems have been followed in setting out quantities of manurial ingredients applied. In the Classical Experiments dressings are expressed in units of the element involved which has been the practice for many years. In the other experiments the units used in the Fertiliser and Feedingstuffs legislation – P_2O_5, K_2O – have been followed so that they can be more readily linked with farm practice.

Husbandry

Unless stated to the contrary the following practices have been adopted throughout:

(i) All cereal seed has been dressed by commercial methods with organo-mercury and gamma-BHC materials. Where a special material has been used in addition, such as ethirimol or dieldrin, this is stated.

(ii) An ammonium nitrate, calcium carbonate mixture sold under the trade name 'Nitro-Chalk' has been used as the source of N when applied alone. The material used up to 1972 contained 21% N and the 25% grade was introduced in 1973.

(iii) Compound fertilisers are indicated: (20–10–10) implying a compound of 20% N, 10% P_2O_5 and 10% K_2O and in granular form unless otherwise noted.

(iv) Liming. Lime is normally applied in one of three different ways. Routine liming for a field or part of a field is normally done by a contractor using commercial equipment. For small parcels of land or

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if a contractor is not available, lime is applied by the farm staff using a fertiliser drill whose rate of application is checked periodically. For experiments where lime is one of the treatments, weighed quantities of materials of known composition are applied by machine or by hand to individual plots. The Total Neutralisation Value (TNV) is determined and the quantities applied are calculated on this basis. The quality of a sample is checked by determining the calcium carbonate content.

The materials normally used are ground chalk at Rothamsted and ground magnesium limestone (dolomite) or chalk at Woburn.

Soil series

The main soil types, as classified by the Soil Survey of England and Wales, are given for each experimental site. A description of the Rothamsted soils is given in the *Rothamsted Guide 1974,* pp 40-46, and for Great Hill, Road Piece and Butt Close fields at Woburn in *Rothamsted Experimental Station Report for 1974,* Part 2, pp 5-28, and for Saxmundham on pp 143-148 of the *Report for 1971*, Part 2.

Terminology and abbreviations

W = winter wheat, B = spring barley, O = oats, P = potatoes, BE = spring beans, SB = sugar beat, F = fallow.

FYM or D = Farmyard manure

'Minerals' = inorganic manures other than nitrogenous, i.e. P, K, Na, Mg

'Basal', an operation applied to the whole experiment.

'Standard', an operation applied to one section of an experiment but common to two or more treatments.

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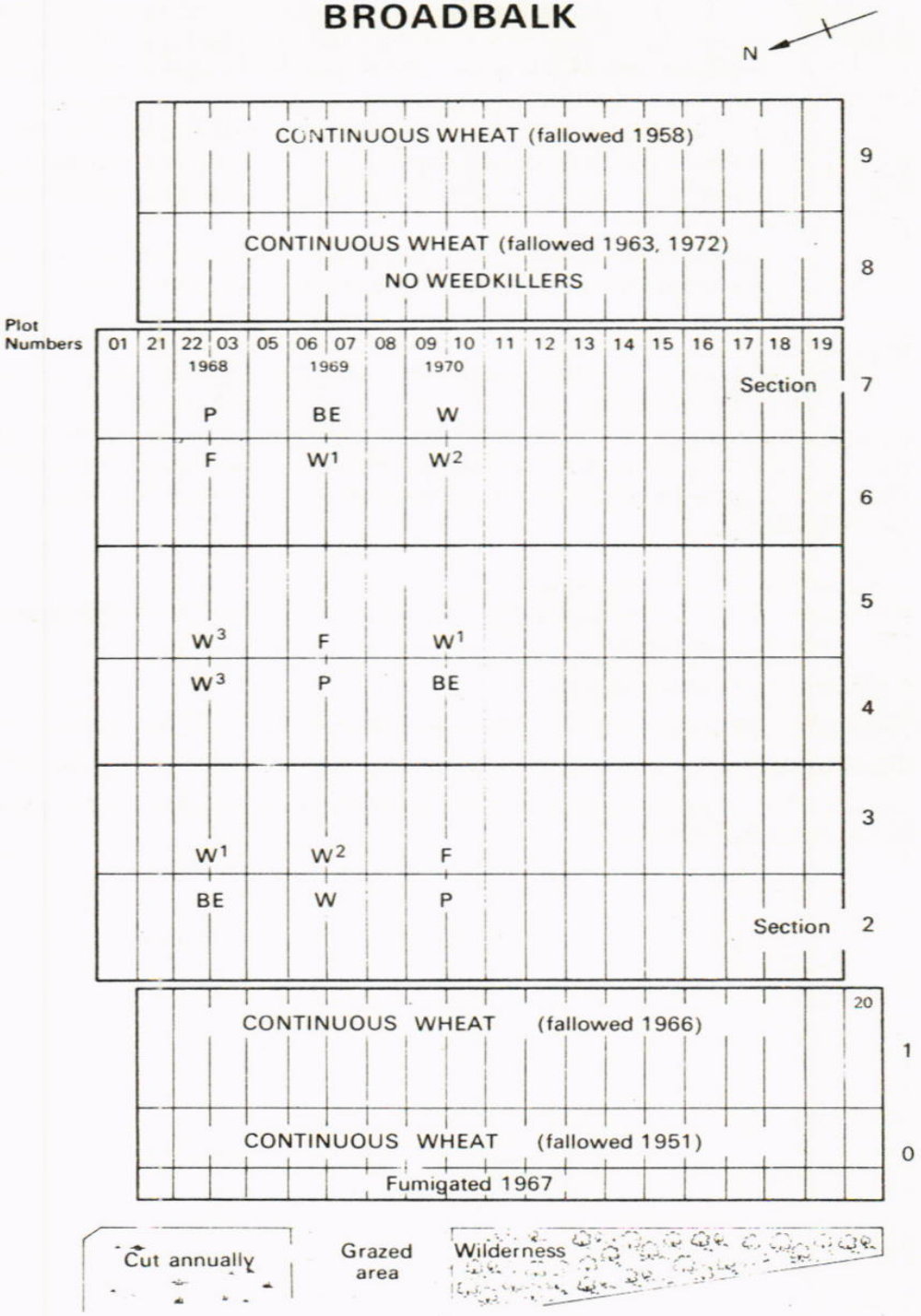
BROADBALK



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BROADBALK

WHEAT AND THREE COURSE ROTATION

(R/BK/1)

The history of the experiment from the first experimental wheat crop in 1844 to that of 1967 is given in *Details 1967*, pp 11-15 and the *Rothamsted Report for 1968* Part 2.

Important changes in cropping were introduced for the 1968 crop, the main object being to grow wheat on part of the field after a two year break. Comparisons can therefore be made of the effects of the long continued manurial treatments on wheat in rotation and on continuous wheat. At the same time some modifications were made to the manurial treatments.

Manuring from 1968

(i) Organic manures and minerals for all crops and for fallow are now applied in autumn before ploughing whereas only farmyard manure was ploughed in previously and no manures or minerals were applied to fallows.

(ii) All inorganic nitrogen is applied as one dressing in spring and 'Nitro-Chalk' has replaced both sulphate of ammonia and nitrate of soda but is not applied to fallows.

NOTE: A new plot (plot 1) previously untreated receives FYM plus N2PK. Plot 21, formerly 2A, now receives N2 in addition to FYM. Plot 9, previously N1PKNaMg, now receives N4PKNaMg. Plot 14, previously N2PMg, now receives N2PKMg. Plot 15, previously N2PKNaMg, now receives N3PKNaMg. Plots 17 and 18, previously N2 alternating with PKNaMg, now receive N2 and half-rate PKNaMg each year.

Symbols, materials and rates of application (annuals from 1968).

N1, N2, N3, N4.	'Nitro-Chalk' to supply 48, 96, 144, 192 kg N
P	Powdered superphosphate (approx 20% P_2O_5) to supply 34 kg P
K	Sulphate of potash (approx 50% K_2O) to supply 90 kg K
Na	Sulphate of soda (approx 14% Na) to supply 16 kg Na (except plot 12, 57 kg Na)
Mg	Sulphate of magnesia (approx 10% Mg) to supply 11 kg Mg (except plot 14, 31 kg Mg)
FYM	35 t farmyard manure
C	Castor meal (approx 5% N) to supply 96 kg N.

Treatments

Plot	Treatments immediately prior to 1968	Treatments from 1968
01	–	DN2PK
21 (formerly 2A)	D	DN2
22 (formerly 2B)	D	D
03	None	None
05	PKNaMg	PKNaMg
06	P1PKNaMg	P1PKNaMg
07	N2PKNaMg	N2PKNaMg

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Plot		Treatments immediately prior to 1968	Treatments from 1968
08		N3PKNaMg	N3PKNaMg
09		N1*PKNaMg	N4PKNaMg
10		N2	N2
11		N2P	N2P
12		N2PNa	N2PNa
13		N2PK	N2PK
14		N2PMg	N2PKMg
15		N2+PKNaMg	N3PKNaMg
16		N2*PKNaMg	N2PKNaMg
17	even years	PKNaMg	N2+½(PKNaMg)
	odd years	N2	
18	even years	N2	N2+½(PKNaMg)
	odd years	PKNaMg	
19		C	C
20		N2KNaMg	N2KNaMg

* Nitrate of soda + Applied in the autumn

NOTES: (i) Plot 01 extends over Sections 2-7 (rotation and fallow, wheat, wheat sequences only).
(ii) Plot 20 extends over Sections 0 and 1 (continuous wheat only).

Liming

The liming scheme adopted in 1954 (*Details 1967*, p 14) continued until the autumn of 1967 but no further regular lime was applied in 1969-73.

In autumn 1967 certain plots were given additional dressings of chalk to counteract acidity shown by soil analyses.

Plot	7	8	11	13	14	15
Section 1	–	2.9	–	–	–	–
6, 7	–	8.7	2.9	2.9	–	–
8	2.9	2.9	–	2.9	2.9	2.9
9	2.9	2.9	–	–	–	–

Cropping, fallowing and weed control

(1) *Crop Sequences.* From 1968 two of the five sections which had already been subdivided (IA and B; VA and B) were allocated to continuous wheat, these sections may be fallowed occasionally to control troublesome weeds but not all in the same season. The remaining three sections (II, III, IV) were divided into halves transversely; three of the smaller sections so formed grow wheat only in a cycle of fallow, wheat, wheat and the other three follow a rotation of potatoes, spring beans and wheat. The ten sections were renumbered:

Cropping and Fallowing Sequences

Old section No.		IA	IB	II		III		IV		VA	VB
New section No.		0	1	2	3	4	5	6	7	8	9
Year	1968	17	2	BE	1	3	3	F	P	5	10
	1969	18	3	W	2	P	F	1	BE	6	11
	1970	19	4	P	F	BE	1	2	W	7	12

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1971	20	5	BE	1	W	2	F	P	8	13
1972	21	6	W	2	P	F	1	BE	F	14
1973	22	7	P	F	BE	1	2	W	1	15

1, 2, 3 . . first, second, third crop of wheat after fallow, F.
BE = Spring beans, P = potatoes, W = wheat.
Section 8 (VA) continues as hitherto to receive no chemical weedkiller.

(2) *Varieties.*

Wheat:	Cappelle: 1969-73 dieldrin dressed (in addition to normal dressing)
Spring beans:	Maris Bead: 1968-70 inoculated with Rhizobium.
Potatoes:	1968 Majestic, Irish A chitted. 1969-73 King Edward, once grown chitted from Rothamsted Farm, paracrinkle virus free.

(3) *Weed Control.*

(a) *Use of Chemicals.* All sections carrying wheat have been sprayed as thought necessary each year to control weeds with the exception of section 8 which never receives any weedkiller. Terbutryne and related triazines ('Prebane') has been applied from 1969 onwards to wheat soon after sowing to control blackgrass *(Alopecurus myosuroides).* For many years before 1969 sowing was usually delayed to allow the initial growth of blackgrass seedlings to be destroyed by cultivations.

Simazine was used on the bean crop in 1968 but discontinued thereafter because it damaged beans on plots without organic manures and did not control weeds on plots with them. No weedkillers have been used on this crop since, except paraquat prior to drilling in 1971 to kill fresh growth since autumn cultivations.

(b) *Weedkillers* (Section 8 not treated throughout):

Wheat	1968	Ioxynil with mecroprop
	1969-71 & 1973	Terbutryne; dicamba with mecoprop and MCPA
	1972	Aminotriazole with ammonium thiocyanate (except section 6) to preceding stubble; terbutryne; dicamba with mecoprop and MCPA
Potatoes	1968	None
	1969-73	Linuron with paraquat
	1972	Aminotriazole with ammonium thiocyanate to preceding stubble.

Paraquat was also used in the autumn preceding;

1969	Wheat, potatoes and fallow
1971	Wheat, potatoes and beans

(c) *Mechanical cultivations.* Potato plots have been grubbed and rotary ridged approximately a month after weedkiller applied. The beans have been hoed several times as necessary.

(d) *Hand weeding.* Field horsetail *(Equisetum arvense)* had been

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recorded on Broadbalk since 1930 but only became troublesome in the potato crop introduced in 1968 necessitating hand pulling in some years from 1969. Wild oats *(Avena ludoviciana)* have been pulled regularly in the wheat plots, continuing the practice started in 1943. Thistles *(Cirsium arvense)* have been pulled in the wheat in 1968-70.

Other chemicals applied

(i) Mancozeb has been applied two or three times each year to the potatoes.

(ii) Demeton-S-methyl has been applied once annually to beans and potatoes to control aphids.

(iii) 1968, 1970, 1972 & 1973. Potato haulm burnt off with sulphuric acid (Brown Oil of Vitriol).

(iv) In autumn 1967 3.05 m of the eastern discards of every plot in section 0 was fumigated with methyl bromide at 975 kg and yields were compared in 1968 and 1969 with those from an equal adjoining length receiving normal treatments only.

Plot size

(i) Wheat: From 1968 a 15-row drill was used and the cropped plot width was reduced from 36 rows (6.40 m) to 30 rows (5.33 m). Plots 21 and 22 originally 20 rows (3.56 m) each now have 22 rows (3.91 m). Rows are 17.8 cm (7 in) apart.

(ii) Beans: 12 rows drilled in a plot width of 6.40 m, plots 21 and 22 have 7 rows in a plot width of 3.73 m. Rows are 53.3 cm (21 in) apart.

(iii) Potatoes: 9 rows planted in a plot width of 6.40 m, plots 21 and 22 together have 11 rows in a plot width of 7.82 m. Rows are 71.1 cm (28 in) apart.

Areas manured

Manures, with the exception of 'Nitro-Chalk' continue to be applied to the full, 6.40 m, width for all crops. FYM is applied to plots 21 and 22 as though they were one plot 8.00 m wide. 'Nitro-Chalk' is applied to the drilled area for wheat and to the full width for beans and potatoes except plots 21 and 22 where the treated width is 3.96 m.

Areas harvested

	Wheat (16 rows)	Beans (5 or 6 rows)	Potatoes (4 rows)
Section 0	0.00434		
1	0.00798		
2-7	0.00659	0.00618 (1968, 69, 72)	0.00659
		0.00741 (1970, 71, 73)	
8-9	0.00694		

Soil series Shallow Batcombe series with areas of Batcombe and Hook series.

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Reference

Rothamsted Experimental Station. Report for 1968, Part 2.

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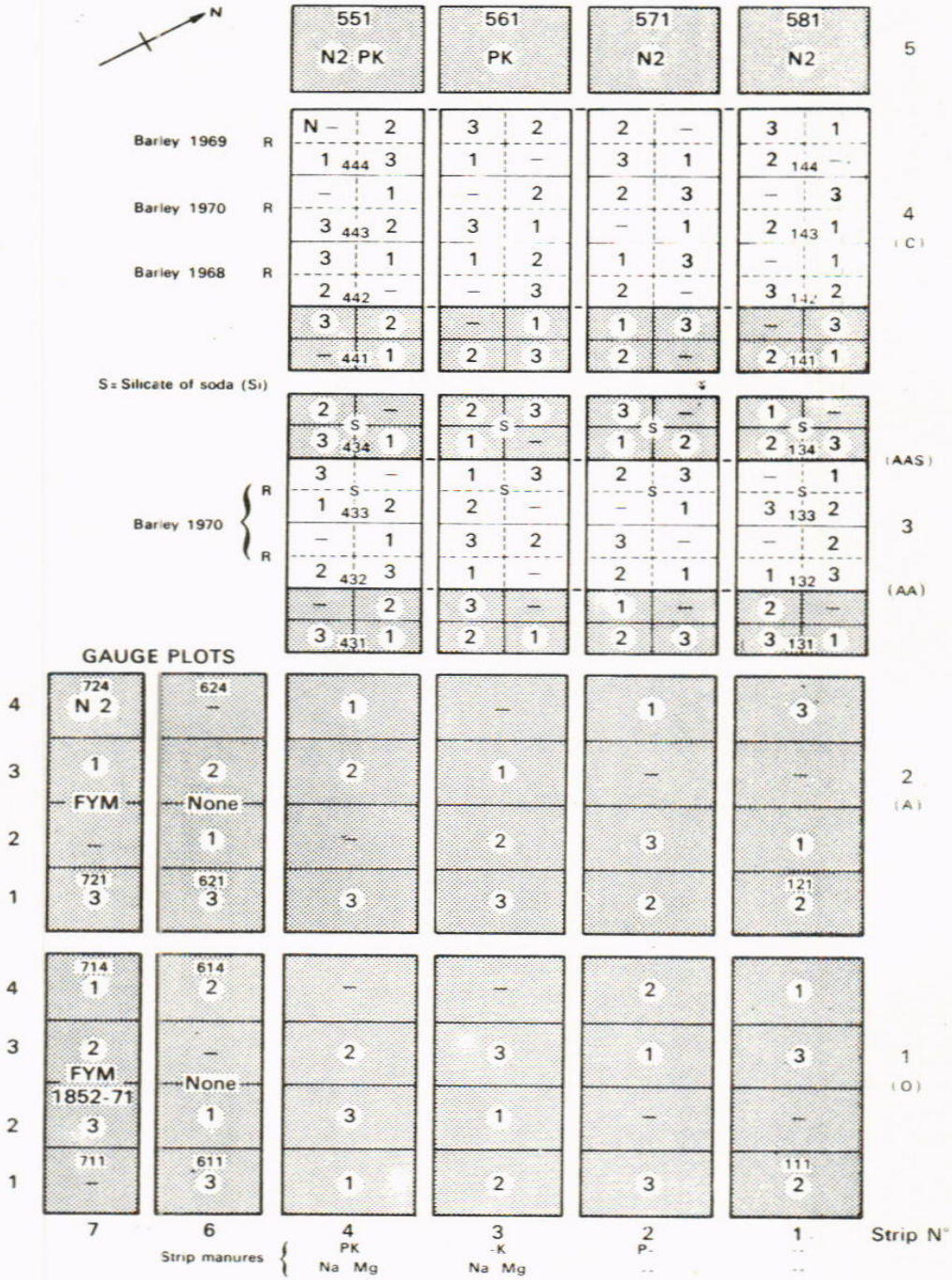
HOOSFIELD

R Rotation of potatoes, beans, barley
Shaded area = Continuous barley



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HOOSFIELD

BARLEY AND THREE COURSE ROTATION

(R/HB/2)

As on Broadbalk changes in the cropping system were made in 1968 to enable comparisons to be made of the effects of the long continued manurial treatments on barley in a rotation of potatoes, beans, barley and on continuous barley. At the same time some changes were made in the manurial treatments.

Manuring from 1968

(i) Castor meal was discontinued after an equalising dressing in 1967 equivalent to 3 years application (144 kg N) to the half plots receiving the lower rate from 1964-66.

(ii) FYM and minerals are now applied in autumn before ploughing.

(iii) Sulphate of ammonia and nitrate of soda are no longer applied, and all N is given as 'Nitro-Chalk' as a top dressing for barley and in the seedbed for potatoes.

(iv) The test of no minerals v. P v. KNaMg v. PKNaMg on the four main strips of plots (started in 1852) and the test of silicate of soda (from 1862) on plots 33-34 of strips 1-4 (formerly Series AAS) were continued.

(v) All plots (except 551, 561, 571, 581) were split into four for a N test on barley.

Symbols, materials and rates of application

Annual dressings 1968-73

NO, N1, N2, N3	'Nitro-chalk' to supply 0, 48, 96 and 144 kg N to barley (0, 96, 192, 288 kg N to potatoes in 1973).
P	Powdered superphosphate (approx. 20% P_2O_5) to supply 34 kg P
K	Sulphate of potash (approx. 50% K_2O) to supply 90 kg K
Na	Sulphate of soda (approx. 14% Na) to supply 16 kg Na
Mg	Sulphate of magnesia (approx. 10% Mg) to supply 11 kg Mg
Si	Silicate of soda at 448 kg
FYM	Farm yard manure at 35 t

The Series treatments discontinued after the 1966 crop (the whole area was fallowed in 1967) were:

O	None
A	48 kg N as Sulphate of Ammonia
AA	48 kg N as Nitrate of Soda
C	48 kg N as Castor bean meal

NOTE: Strip 3 (K, Na, Mg) has received the following additional dressings (kg/ha) because of the limitations of the fertiliser distributor.

1969	7.2 kg K	1.0 kg Na	0.9 kg Mg
1971	9.8 kg K	1.3 kg Na	1.1 kg Mg

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Treatments *(see plan)*

(i) Strip manures (applied annually since 1852)

Strip 1	Nil
2	P
3	KNaMg
4	PKNaMg

(ii) Farm yard manure (applied annually since 1852)
Plots 721 – 724 (formerly 7-2)

(iii) Silicate of soda (applied annually since 1862)
Plots 33-34 of strips 1-4
(formerly Series AAS)

(iv) Nitrogen. N is applied cumulatively
(a) From 1968-72 potatoes received a basal dressing of 144 kg N.
(b) Beans receive no nitrogen
(c) In 1968 plots 721 and 723 received no N and 722 and 724, N1. Thereafter as shown as plan.
(d) In 1968 plots 611-614, 621-624, 711-714 and 721-724 received nitrogen at 63 (N1), 129 (N2), 192 (N3) kg N in error.

(v) Plots 551, 561, 571 and 581. From 1968, N where applied, is at 96 kg, P and K are at the same rates as strips. (From 1970-72 plots 551 and 561 received 18 kg P and 168 kg K in error).

Liming. No lime was applied in the period 1968-73.

Cropping and Weed Control

In 1968 plots formerly receiving castor bean meal (Series C) were divided into four , one quarter in continuous barley and the others in an annual rotation of potatoes, spring beans and barley.

The former nitrate of soda plots (Series AA) and nitrate of soda plus silicate of soda ones (Series AAS) were each divided into two, one in continuous barley and the other in one phase of the rotation each year.

The remaining plots continue to grow spring barley each year giving the following cropping sequences.

(1) *Crop Sequences.*

Old Series	0	A	AA		AAS		C				1N 50	2N 5A
New Plot Nos	111-714	121-724	131-431	132-432	133-433	134-434	141-441	142-442	143-443	144-444	551-	581
Year 1967	FALLOW											
1968	B	B	B	P	P	B	B	B	P	BE		B
1969	B	B	B	BE	BE	B	B	P	BE	B		B
1970	B	B	B	B	B	B	B	BE	B	P		B
1971	B	B	B	P	P	B	B	B	P	BE		B
1972	B	B	B	BE	BE	B	B	P	BE	B		B
1973	B	B	B	B	B	B	B	BE	B	P		B

(2) *Varieties.*

Barley	1968 & 69	Maris Badger
	1970 & 71	Julia
	1972 & 73	Julia dressed with ethirimol

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Beans	1968-70	Maris Bead inoculated with *Rhizobium*
	1971-73	Maris Bead
Potatoes	1968	Majestic. Irish A, chitted.
	1969-73	King Edward. Once grown, chitted from Rothamsted Farm, paracrinkle virus free.

(3) *Weed Control*

(i) *Weedkillers.*

Barley	1968	Dicamba with mecoprop and MCPA
	1969	Non rotational barley only, paraquat in preceding autumn.
	1970	Paraquat in autumn and dicamba with mecoprop and MCPA.
	1971	Paraquat in autumn and ioxynil, bromoxynil and dicamba.
	1972 & 73	Paraquat in autumn and dicamba with mecoprop and MCPA.
Potatoes	1968	None
	1969	Paraquat in autumn and paraquat plus linuron pre-emergence.
	1970 & 71	Paraquat in autumn and linuron pre-emergence.
	1972	Paraquat in autumn and paraquat plus linuron pre-emergence.
	1973	Paraquat plus linuron applied pre-emergence.
Beans	1968	Simazine
	1971	Paraquat applied in preceding autumn.

(ii) *Hand weeding.* Wild oats in barley have been pulled by hand once or twice each year as necessary.

Other chemicals applied

(i) Mancozeb. has been applied annually to the potato crop on two or three occasions.

(ii) Demeton-S-methyl has been applied once annually to the potato crop with the exception of 1971.

(iii) Demeton-S-methyl has been applied once annually to the beans in 1969 to 1971 and in 1973, and phorate once in 1968 and 1972.

(iv) In 1968, 1970, 1972 and 1973: Potato haulm was destroyed by sulphuric acid.

Areas harvested

(i) 1968-71

Plot	Crop	Area harvested
111-424 (Old Series O & A)	Barley	0.0035
611-724 (Old Series 6-1 and 6-2 7-1 and 7-2)	Barley	0.0026
131-444 (Old Series AA, AAS, C)	Barley	0.00096
	Potatoes	0.0019
	Beans	0.0018*

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551-581 (Old Series 1N, 2N, 50, 5A)	Barley	0.0041

* Harvested in pairs 1968 and 1969. 0.0022 in 1971 as 6 rows harvested per sub-plot instead of 5 as in other years.

Barley was harvested by a small combine (1.4 m cut) on plots 131-444 and by a large combine (2.8 m) on the remainder as were the beans. In 1970 plots 111-724 were used for a comparison of these two combines and a 2.1 m one (See *Yields 1970*, p.257).

(ii) In 1972 and 1973 the 2.1 m combine was used on all cereal and bean plots giving the harvested areas:

Plot	Crop	Area harvested
111-424	Barley	0.0026
611-724	Barley	0.0020
131-444	Barley	0.0014
	Potatoes	0.0019
	Beans	0.0014
551-581	Barley	0.0031

Soil series. Batcombe series with small area of Winchester and shallow Batcombe series

WHEAT AND FALLOW, HOOSFIELD

(R/WF/3)

The wheat and fallow sequences started with a preliminary season in 1855 and following the modification in 1932, have continued unchanged providing a one and a three year fallow comparison. *(Details 1967,* pp 23-24).

Manuring. None since 1851

Cropping, fallowing and weed control

(1) *Crop Sequences.*

	Strip A				Strip B			
	A1	A2	A3	A4	B1	B2	B3	B4
New Plot Nos.	1	3	5	7	2	4	6	8
1968	W	W	F	W	F	F	F	F
1969	F	F	F	F	F	W	W	W
1970	W	W	W	F	F	F	F	F
1971	F	F	F	F	W	F	W	W
1972	F	W	W	W	F	F	F	F
1973	F	F	F	F	W	W	F	W

F = Fallow W = Wheat

(2) *Variety.* Cappelle, dressed with dieldrin.

(3) *Weedkillers.* 1968-71 Ioxynil with mecoprop
1972 and 73 Dicamba, with mecoprop and MCPA.

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Area harvested. 0.01483

Soil series. Batcombe series with small area of Hook series.

EXHAUSTION LAND, HOOSFIELD

(R/EX/4)

Barley has been grown continuously since fallowing in 1967 to test the residual value of manures applied 1856-1901 and N only has been applied subsequently. *(Details 1967,* pp 43-44)

Manures
Basal N at 88 kg N has been combine-drilled but no separate plot treatments have been applied.

Cropping and weed control

(1)	*Varieties.*	1968-69	Maris Badger
		1970-73	Julia (dressed with ethirimol 1972 and '73)
		All sown at 155 kg	
(2)	*Weedkillers.*	1968-70, 1972 & '73	Dicamba with mecoprop and MCPA
		1969-70	Paraquat in autumn
		1971	Bromoxynil with ioxynil and dichlorprop
		1972	Aminotriazole with ammonium thiocyanate in autumn.

Area harvested. 0.03000

Soil Series. Batcombe with small area of Hook series.

Reference

Johnston, A.E., Warren, R.G. and Penny A. (1970)
The value to arable crops of residues accumulated from superphosphate and from potassium fertiliser.
Rothamsted Experimental Station. Report for 1969, Part 2, 39-90.

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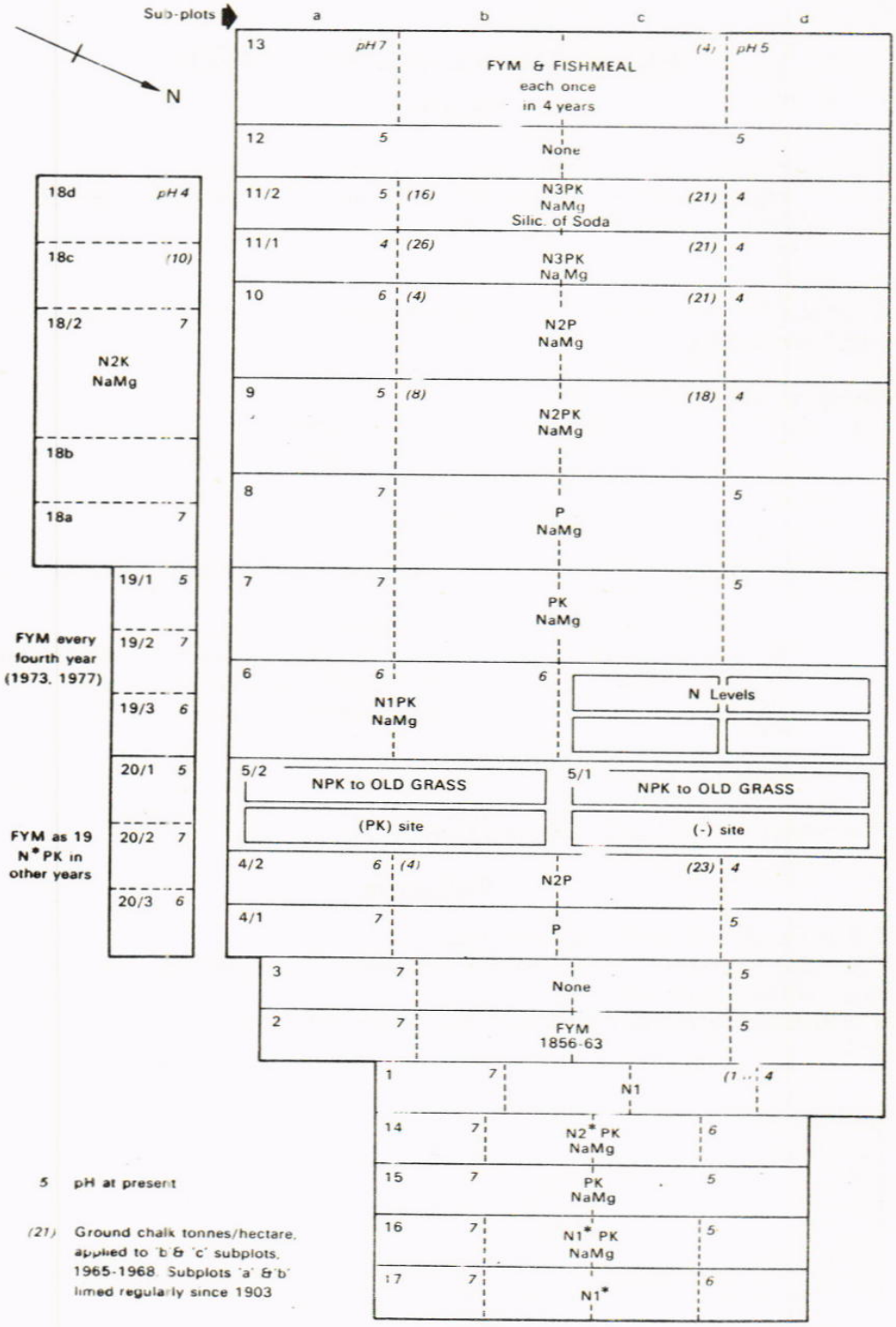
PARK GRASS



5 pH at present

(21) Ground chalk tonnes/hectare, applied to 'b' & 'c' subplots, 1965-1968. Subplots 'a' & 'b' limed regularly since 1903

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PARK GRASS

(R/PG/5)

The manuring, liming and general management of this experiment has continued as set out in *Details 1967*, pp 35-39, but the rates of application are given for convenience in metric terms.

Symbols, materials and rates of application

Manures applied annually except where indicated.

N1, N2, N3:	Sulphate of ammonia to supply 48, 96, 144 kg N
$N1^X$, $N2^X$	Nitrate of soda to supply 48, 96 kg N
P	Powdered superphosphate (approx. 20% P_2O_5) to supply 34 kg P (except plot 20)
K	Sulphate of potash (approx. 50% K_2O) to supply 224 kg K (except plot 20)
Na	Sulphate of soda (approx. 14% Na) to supply 16 kg Na
Mg	Sulphate of magnesia (approx. 10% Mg) to supply 11 kg Mg
Si	Silicate of soda at 448 kg water soluble powder
FYM	35 t farmyard manure every fourth year (applied autumn 1968 and 1972)
F	Fish meal (about 6.5% N) to supply 63 kg N every fourth year (applied autumn 1970)
P, K, Na, Mg	applied in winter
N1, N2, $N1^X$	applied in one dressing about March
$N2^X$	Half in March and half in April/May
N3	Two-thirds applied in March and one-third in April/May

NOTES: Plot 20: In the three years between applications of FYM mineral fertilisers are applied: 30 kg N (as nitrate of soda), 17 kg P (as superphosphate) and 45 kg K (as muriate of potash)

Plots 5-1, 5-2, 6-N were used for microplot experiments during the period (see 'NPK to Old Grass' and 'N levels to Old Grass')

Plot 6-S: Excluded during the period 1965-71 and used for microplot experiments 1967-70 (simulated grazing R/CS/23; received PKNaMg 1965-71 as previous to 1965). Received N1 in 1972 and N1PKNaMg in 1973.

Liming.

Ground chalk (t $CaCO_3$)

	Dec. 1967			Nov. 1971
Sub-plots	a	b	c	a
1	2.00	–	3.14	2.00
2, 3, 4/1	2.00	–	–	2.00
4/2	2.00	1.26	5.65	–
7/8	2.00	–	–	2.00
9	2.00	2.51	4.39	2.00
10	2.00	1.26	5.02	–
11/1	4.00	6.28	5.02	–
11/2	4.00	3.77	5.02	–
13	2.00	–	1.26	2.00
14, 16, 17	2.00	–	–	2.00

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	Dec. 1967			Nov. 1971	
	a	b	c	a	
18		1.14	–	2.51	1.14
Whole plots					
5/1		6.15			–
5/2		5.53			–
6		7.53			–
1		–			–
15		–			–
18/2		1.14			1.14
19, 20		1.14			–

Soil series. Batcombe series

References

1. Edwards, C.A., Butler, C.G. & Lofty, J.R. (1976)
The Invertebrate Fauna of the Park Grass Plots II. Surface fauna.
Rothamsted Experimental Station, Report for 1975, Part 2, 63-89.

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The Invertebrate Fauna of the Park Grass plots I. Soil fauna.
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Changes in the soil properties caused by the new liming scheme on Park Grass.
Rothamsted Experimental Station, Report for 1971, Part 2, 177-80.

4. Nutman, P.S. & Ross, G.J.S. (1970)
Rhizobium in the soils of the Rothamsted and Woburn Farms.
Rothamsted Experimental Station. Report for 1969, Part 2, 148-67.

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Changes in yield and botanical composition caused by the new liming scheme on Park Grass.
Rothamsted Experimental Station. Report for 1973, Part 2, 67-73.

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AGDELL
RESIDUAL EFFECTS OF P AND K
(R/AG/6)

The cropping and management in 1968 and 1969 continued the pattern set in 1964 when large fresh dressings of P and K were applied to the sub-plots of both grass and fallow areas (*Details 1967*, pp 26-27. Note that the heading in Table 7 p. 27 should read 1920-51 and not 1920-53).

In 1970 a further scheme was introduced with annual applications of P (1970-72) and K (1973-75) to a three-course rotation of sugar beet, barley, potatoes (two crops present each year).

An outline of the layout of the plots from 1958 onwards is set out in the diagram on pages 22 and 23 to show the changes in plot boundaries and the relationship of the successive treatments. Details of treatments between 1958 and 1967 are given on pages 25-27 of *Details 1967*.

Detailed treatments 1968-73

(1) *P test half plots*

(a) 1968-69 – Half fallow, half Timothy (S 51 sown 1964) 3 dressings of 100 kg N applied each year to the grass. P and K applied each autumn or early winter to replace removals in grass the previous year, except that plots without fresh P in 1964 continued to receive none to measure the release of P residues accumulated during 1848-1951.

(b) 1970-72 – Effects of different amounts of soil P were tested in a three-course rotation – sugar beet, barley, potatoes, starting with sugar beet and barley. Fresh P was tested on the sub-plots cumulatively.

Barley	None v. 27 kg P
Sugar beet	None v. 55 kg P
Potatoes	None v. 82 kg P

Basal manuring. Sugar beet:	190 kg N; 260 kg K as muriate of potash; 60 kg Mg as kieserite.
Barley:	95 kg N, 50 kg K as (25-0-16).
Potatoes:	250 kg N, 210 kg K, 60 kg Mg – materials as for sugar beet.

(c) 1973 – Rotation ended, barley grown testing residues of P applied in 1964 and 1970-72 with a fresh N test applied in strips of sixty-fourth plots.

N1	63 kg N
N2	95 kg N

(2) *K test half plots*

(a) 1968-70 – Half-fallow, half Timothy (S 51 sown 1964). 100 kg N applied three times in 1968 and 1969, twice in 1970 to the grass.

Balancing P and K applied each autumn or winter to replace removals in grass, except that plots without fresh K in 1964 continued to receive none to measure the recovery of K residues accumulated during 1848-1951 and the release of soil K.

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(b) 1971-72 – The whole area was fallowed in 1971 and cropped with oats in 1972.

Standard applications: Oats – 75 kg N, 14 kg P as (30-13-0)

(c) 1973 – The three-course rotation commenced with sugar beet and barley.

K treatments applied in first year of rotation.

Barley	None v. 50 kg K
Sugar beet	None v. 257 kg K

Standard applications: Sugar beet: 190 kg N, 55 kg P as granular superphosphate, 60 kg Mg as kieserite.
Barley: 95 kg N, 18 kg P as (30-13-0).

(3) *Compensatory dressings of P and K*

Dressings of triple superphosphate and muriate of potash were applied to compensate for the removals in the grass during the years 1964-69 from the P plots and 1964-70 from the K plots. Dressings were normally applied annually to compensate for the removals during the previous season but in the period 1965-67 certain adjustments between years were made. (For details see *Results 1965 to 1970).*

No phosphate was applied to the PO plots and No K to the KO plots throughout the period.

The total removed and replaced (except on the PO and KO plots) were:

P (kg/ha)

	Sub-plots testing P				Sub-plots testing K			
	P0	P1	P2	P4	K0	K1	K2	K4
Plot 1	(102)	165	175	186	157	194	200	200
2	(68)	139	158	162	134	188	198	198
3	(67)	147	148	175	148	171	176	175
4	(48)	122	127	151	160	189	177	190
5	(38)	111	128	144	126	163	162	167
6	(22)	117	133	149	125	171	169	169

K (kg/ha)

	Sub-plots testing P				Sub-plots testing K			
	P0	P1	P2	P4	K0	K1	K2	K4
Plot 1	1398	1694	1664	1678	(689)	1453	1601	1787
2	1020	1481	1611	1532	(493)	1378	1631	1798
3	974	1525	1471	1576	(612)	1429	1441	1619
4	736	1387	1313	1451	(707)	1461	1509	1732
5	543	1303	1381	1449	(485)	1291	1423	1647
6	371	1311	1371	1379	(448)	1378	1363	1549

Liming

In the autumn of 1969 plots 1 and 2 and the south halves of plots 3 (P test) and 4 (K test) received ground chalk at 3 t

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Cropping and Weed Control

(1) *Varieties*

Sugar beet:	Klein E
Barley:	Julia (dressed with ethirimol 1973)
Potatoes:	King Edward, once grown Rothamsted paracrinkle-free seed, chitted.
Oats:	Manod

(2) *Weedkillers*

Potatoes:	1971 and 1972: Linuron with paraquat
Oats:	1972: Bromoxynil, ioxynil, dichloroprop and MCPA
Grass:	1968: Ioxynil with mecoprop.

Other Chemicals applied

Sugar Beet:	1970 and 1972:	Menazon, 1972: pyrethrum
Potatoes:	1971 and 1972:	Menazon and mancozeb, 1972: captafol

Areas harvested

Grass:	0.00081 – 0.00186
Barley:	0.00061 – 0.00087
Sugar beet:	0.00077
Potatoes:	0.00069

Soil series Winchester and shallow Batcombe series

References

1. Johnston, A.E., Warren, R.G., and Penny, A. (1970)
The value to arable crops of residues accumulated from superphosphate and from potassium fertiliser.
Rothamsted Experimental Station. Report for 1969, Part 2, 39-90.

2. Johnston, A.E., & Penny, A. (1972)
The Agdell Experiment 1848-1970.
Rothamsted Experimental Station. Report for 1971, Part 2, 38-68.

3. Johnston, A.E., & Mitchell, J.D.D. (1974)
Potassium in soils from the Agdell experiment.
Rothamsted Experimental Station. Report for 1973, Part 2, 74-97.

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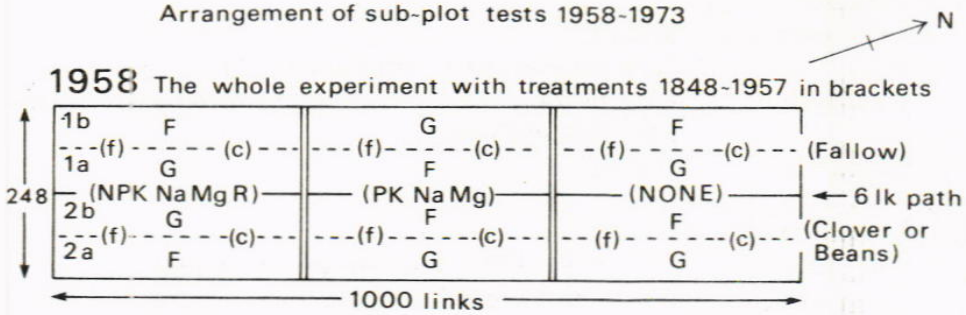
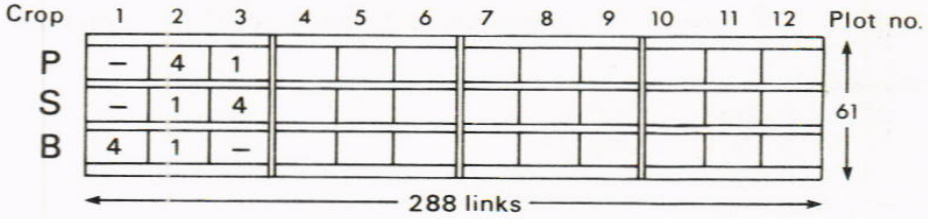
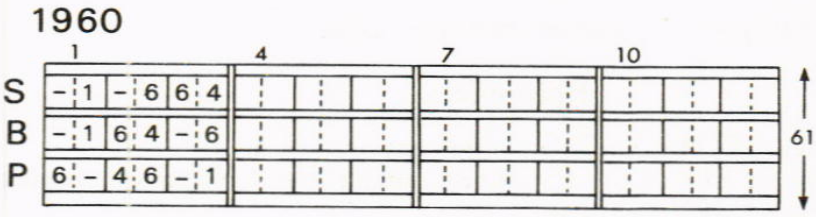
AGDELL

Arrangement of sub-plot tests 1958-1973

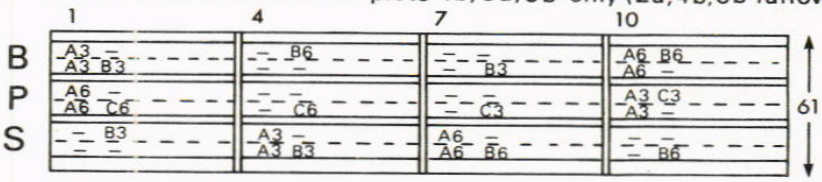


1959-63 Details of sub-plots on plot 1b (one replicate only shown)

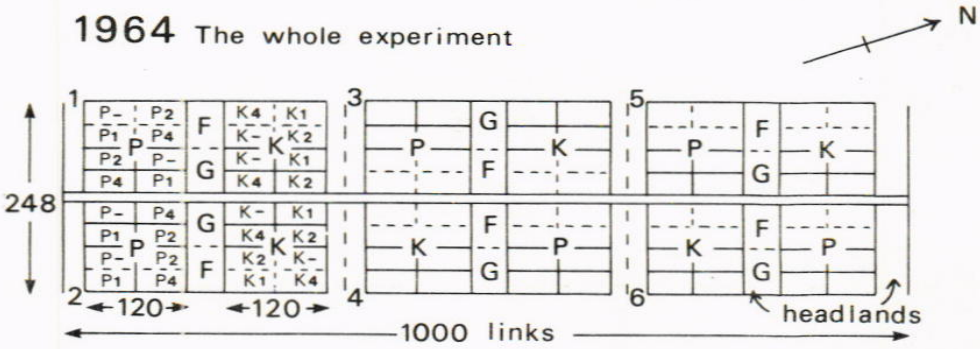




1961 Sub divisions of plots 1b, 3a, 5b only (2a, 4b, 6b fallowed)



1962 Plots 2a, 4b, 6b sub divided as above (1b, 3a, 5b fallowed)
1963 All plots fallowed
(1958-63 G plots remained in grass)



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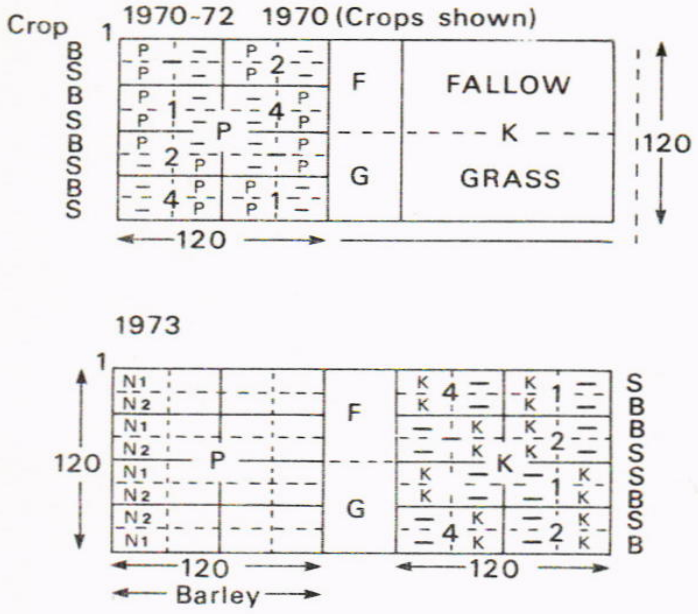
1970-73 Details of sub-plots on plot 1



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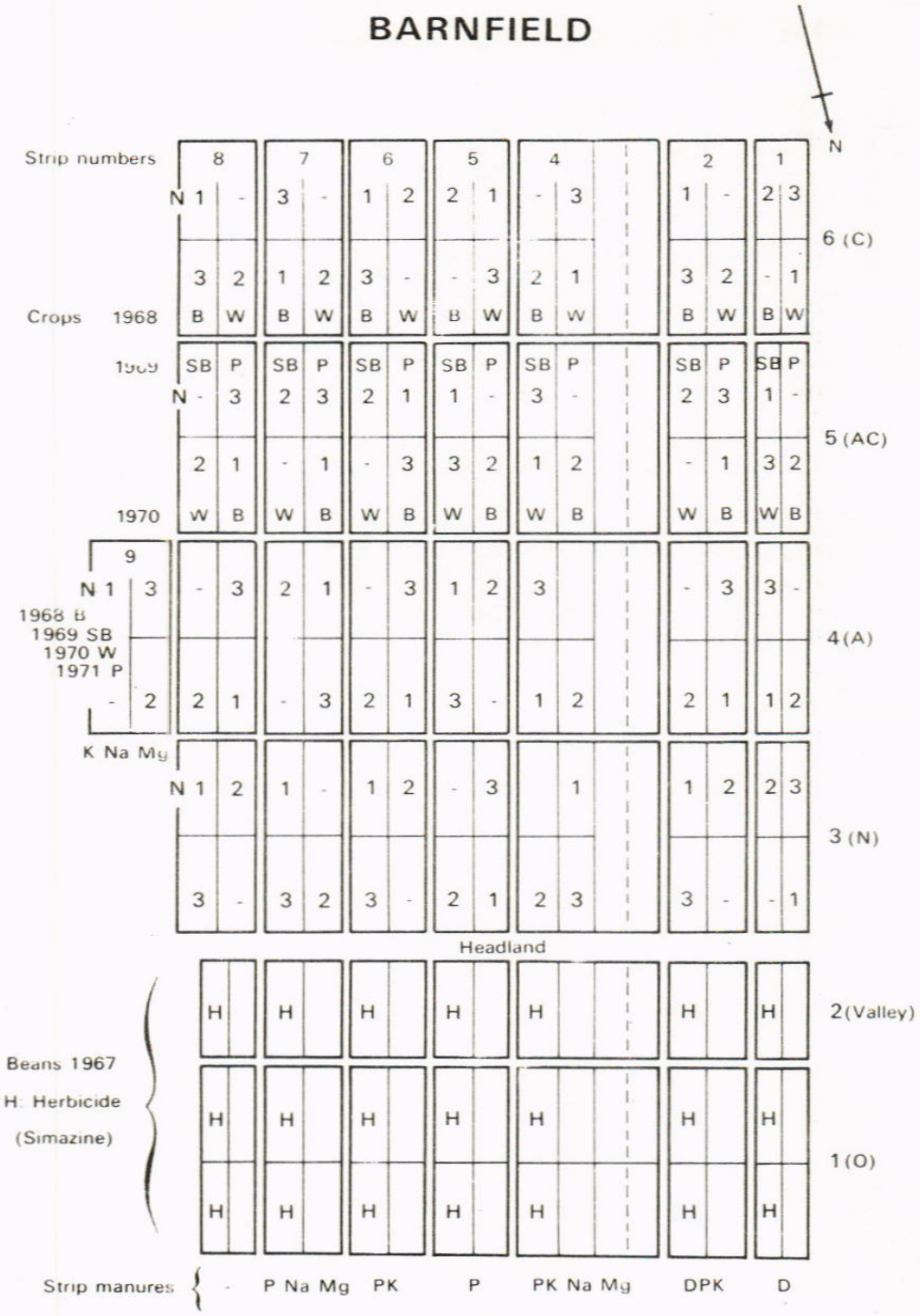
BARNFIELD



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BARNFIELD

(R/BN/7)

Mangolds were grown on all plots from 1876 to 1959; in addition sugar beet was grown on part of each plot from 1946. In the period 1960-67 the field was fallowed or cropped with mangolds and potatoes, and finally with beans in the year before the introduction of a new cropping scheme in 1968 (*Details 1967*, p 31).

The area known as The Valley, some 30 m deep between Series 0 and N, had been unmanured until 1967. The following season 18.5 m adjacent to Series 0 were brought into the manured area of each strip and included in the new scheme. The Series were therefore redesignated Sections and numbered as follows:

Section 1 (Series 0), 2 (Valley), 3 (Series N), 4 (Series A)
5 (Series AC), 6 (Series C)

In the period 1968-73 beans were grown continuously on Sections 1 and 2 without fertiliser nitrogen but with the traditional strip manures. On the rest of the field a four-course rotation was followed – potatoes, barley, sugar beet, spring wheat, with only two phases present (on half strips) each year. The rotation and a new test of N at four rates were designed to test cumulative effects of the traditional strip manures and the residual effects of the Series manures, particularly of castor meal, which were discontinued in 1968.

Treatments to Sections

In Sections 1 and 2 plots were split lengthways and in Section 1 also across for a test (unrandomised) of simazine at 0 v. 1.12 kg. Three combinations of treatments have been tested:

	1967	1968	1969	1970	1971	1972	1973
(i)	+	–	–	–	–	+	–
(ii)	+	+	+	–	+	–	+
(iii)	+	+	+	+	–	–	+

On Section 1 treatment (i) was duplicated, Section 2 had treatments (i) and (ii) only. Mechanical cultivation was used to control weeds on sub-plots without simazine.

In Sections 3-6 each plot was split lengthways into two to carry two crops of the four-course rotation, barley and wheat one year, potatoes and sugar beet the following. Each half plot was further split breadthways into two and received two of the four N rates which were applied cumulatively. Each whole plot had the four N rates each year, NO and N2 on one crop, N1 and N3 on the other. In each crop on any one strip Sections 3 and 6 (without and with the castor meal residues respectively) had the same two rates of N, Sections 4 and 5 (without and with castor meal residues) the other two. In each crop on any one section strips 1, 4 and 5 had the same two rates of N, and strips 2, 6, 7 and 8 the other two (see diagram).

Strip 3, which was discarded from the experiment in 1903 as it was very narrow, has carried the same crops as the adjacent half of strip 4 and was manured at the discretion of the Head of Farms. Parts of this strip in Sections 1 and 2 have been used for experiments on the chemical control of soil-borne pathogens of beans (*Yields* 70/R/BE/7, 71/R/BE/1, 72 and 73/R/CS/82).

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Plot 9 carried only one phase of the four-course rotation starting with barley in 1968. It was also divided into quarter plots to which the four rates of N are applied to each crop.

NOTE: From 1974 certain changes were made to the strip manures and most of the field (except Sections 1 and 2) was bare fallowed in preparation for a new long-term scheme.

Manuring up to 1973

The seven strip treatments (1, 2, 4, 5, 6, 7 and 8) which have been basically unchanged since 1876 have been continued:

Annual dressings per hectare

(1) *Minerals*

P	Powdered superphosphate (approx. 20% P_2O_5) to supply 34 kg P.
K	Sulphate of Potash (approx. 50% K_2O) to supply 224 kg K.
Na	Sodium chloride (agricultural salt approx. 39% Na) to supply 90 kg Na.
Mg	Sulphate of magnesia (approx. 10% Mg) to supply 22 kg Mg.

(2) *Organic*

FYM 35 t farmyard manure. Castor meal no longer applied.

(3) *Nitrogen*

N0, N1, N2, N3 'Nitro-Chalk' to supply 0, 48, 96, 144 kg N applied cumulatively to barley and wheat, 0, 72, 144, 216 kg N to potatoes and sugar beet cumulatively. No N is applied to the beans.

(4) *Application*

P, K, Na, Mg and FYM are applied in autumn before ploughing. N applied just before or soon after sowing cereals, before planting potatoes and before sowing sugar beet (except 1969 shortly after sowing).

Treatment to strips

1	D
2	DPK
4	PKNaMg
5	P
6	PK
7	PNaMg
8	None
Plot 9	KNaMg

Liming

None applied in period 1968-73.

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Cropping, varieties and weed control

(1) *Cropping sequences*

Sections 1 and 2	Continuous spring beans	
Sections 3 – 6	Eastern half of each strip and Plot 9	Western half of each strip
1968	B	SW
1969	SB	P
1970	SW	B
1971	P	SB
1972	B	SW
1973	SB	P

B = barley, SB = sugar beet, SW = spring wheat, P = potatoes

(2) *Varieties and treatment of seed*

Spring beans: Maris Bead uninoculated sown at 220 kg (seed was inoculated with Rhizobium in 1967)
Barley: 1968 Maris Badger, 1970 and 1972 Julia (dressed with carboxin 1970, ethirimol 1972) sown at 160 kg.
Spring wheat: Kolibri.
Sugar beet: Klein E. sown at 9.0 kg in 1969, 5.6 kg in 1971.
Potatoes: King Edward, once grown chitted paracrinkle free.

(3) *Weedkillers*

Weedkillers were applied in autumn as follows:

Beans 1969:	Diquat	in previous autumn
Beans 1970:	Strips 1 and 2 only) Paraquat	in previous autumn
Beans 1971, 1972:	Paraquat	in previous autumn
Potatoes 1969, 1971:	Paraquat and linuron	
Spring wheat and Barley 1972:	Dicamba with mecoprop and MCPA	
Sugar beet 1969:	(Strips 1 and 2 only) Phenmedipham	

Other chemicals applied

Beans:	1969-71 and 1973	Demeton-S-methyl
	1968 and 1972	Phorate
Potatoes:	1969, 1971 and 1973	Mancozeb
	1969 and 1973	Demeton-S-methyl
Sugar beet:	1969, 1971	Demeton-S-methyl

Plot size

The original classical plots as used till 1959 ranged from 0.060 to 0.081 ha. The areas harvested from 1968 were:

Wheat and barley (quarter plots):		0.00781
Beans (half plots): Section 1:	1968, 1969:	0.00147
	1970-73:	0.00878
Potatoes (quarter plots):		0.00390
Sugar beet (quarter plots)	1969, 1971:	0.00130
	1973:	0.00098

Soil series

Winchester & shallow Batcombe series with small area of Charity Complex (Valley)

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2. Nutman, P.S. & Ross, G.J.B. (1970)
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GARDEN CLOVER

MANOR GARDEN

(R/GC/8)

In 1968, after a number of tests in the period 1854-1967 *(Details 1967)*, the area was divided into four to test all combinations of:

Nitrogen	0 v. 126 kg N per cut
Magnesium	0 v. 112 kg Mg per annum

N as 'Nitro-Chalk 21', Mg as Epsom Salts ($MgSO_4 . 7H_2O$), half in winter, half in summer.

In 1973, these tests being completed, a corrective dressing of Mg was applied to plots which had not previously received any and the whole area received basal N, P, K, Mg.

Basal manuring

1968-73	33 kg P, 125 kg K as (0-14-28) in winter, 62 kg K as muriate of potash, after each cut except the last.
and in 1973 only	130 kg N per cut, 110 kg Mg as Epsom Salts (half in winter after digging, half after first cut) in addition to corrective Mg.

Corrective Magnesium 1973

500 kg Mg as Epsom salts: 335 kg before digging in winter, 110 kg in winter after digging, 55 kg after first cut.

Liming 1973

Plots 2 and 4 (those receiving N1 1968-72) 2.5 t calcium carbonate as ground chalk, half before and half after digging.
Plots 1 and 3 (N0) 1.7 t calcium carbonate applied as above.

Cropping

The S 123 red clover sown in 1967 was retained in 1968, each year thereafter a fresh seeding of English Broad Red Clover was made in April. Two cuts were taken in 1968 and three each year subsequently.

Area harvested

0.00007 – 0.00010

Soil series. Disturbed soil

Rothamsted Garden Clover

Yield of dry matter (t) 1968-72

	- -	N -	- Mg	NMg	Mean
1968	–	–	4.35	3.95	–
1969	3.14	3.16	2.38	3.00	2.92
1970	3.99	3.56	4.87	5.47	4.47
1971	4.74	6.36	7.11	6.81	6.25
1972	3.14	3.58	4.62	5.47	4.20
Mean	3.75	4.17	4.75	5.19	4.46

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SAXMUNDHAM

ROTATION I

(S/RN/1)

The four-course rotation of wheat, sugar beet, barley and beans was continued until the 1969 harvest. In 1970 the northern half of each plot was sown to lucerne and the southern (including the small plots of 5.5 m at the extreme southern end carrying the old treatments) to a timothy, meadow fescue mixture. The treatments first applied in 1966 (*Details 1967*, p.54) and the old treatments as modified in 1966 have been continued over the period 1968–73 with the exception of the rates of nitrogen.

NOTE: The following amendments should be made to the information given in *Details 1967*, p. 54. The P and K dressings should be regarded as an average of the period 1899-1965 rather than the original rates and the amount of P_2O_5 as 0.32 cwt rather than 0.3 cwt.

The second period started with the 1966 harvest and not 1965 as stated and the phosphate dressings were applied as triple superphosphate from that date.

Symbols, materials and rates of application

The treatments up to 1965 were based on a fixed weight of the fertiliser and did not allow for changes in composition over the years. (See reference 1 for an estimate of the average composition.) In 1966 in introducing the new treatments certain new fertilisers were substituted for those used previously and all applications were based on stated amounts of nutrients except for bone meal which was applied at the old rate.

Symbol	Material	Treatments to 1965	Old Treatments 1966 onwards	New Treatments 1966 onwards
D	Farmyard Manure	15 t	30 t	30 t
B	Bone meal	500 kg	500 kg	500 kg
N	Nitrate of soda	250 kg		
	'Nitro-Chalk'		38 kg N	
N1, N2	'Nitro-Chalk'			126 kg N 189 kg N*
P	Superphosphate	250 kg		
	Triplesuperphosphate		22 kg P	
P1:P2	Triplesuperphosphate			22 kg P 44 kg P
K	Muriate of potash	125 kg	63 kg K	
K+	Muriate of potash			104 kg K

* 1968 and 1969

For full details see Reference 2 Table 6

Treatments 1966 onwards

Plot	Old Treatments	New Treatments
1	D	D+N
2	B	B
3	N	N2P2

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4	P	N1P1
5	K	N1P2K$^+$
6	None	N1P2
7	PK	N1P1K$^+$
8	NK	N2P2K$^+$
9	NP	N2P1
10	NPK	N2P1K$^+$

NOTES :

(i) Crops other than beans in FYM plots also received 63 kg N from 1967 onwards.

(ii) Under the new treatments beans in plots 3, 8, 9 and 10 only received nitrogen and at N½ (63 kg).

(iii) In 1969 the sugar beet previously receiving N2P2 and N2P1K$^+$ (Plots 3 and 10) received a further top dressing of 63 kg N.

(iv) In 1970 FYM was applied at 60 t and no more will be applied until the grass or lucerne is ploughed up.

(v) Arable crops. As a result of the marked response by crops to nitrogen in 1967 the N1 rate (except beans and plots receiving FYM) was raised to 126 kg N in 1968 and 1969 and the N2 plots were given a top dressing of 63 kg N in addition to the N1 rate at a time decided on by periodical tissue analyses. Therefore the rates of N1 v. N2 became 1 v. 1½.

(vi) Grass and lucerne. No N has been applied to lucerne. In 1970-73 nitrogen was applied for each cut of grass; 100 kg N to all large plots and 38 kg to N-treated small plots except in 1970 when all small plots received a dressing of 38 kg N in the autumn to aid establishment. One cut of lucerne but none of the grass were taken in 1970. Subsequently there were three cuts in 1971 and two in 1972 and 1973 of both grass and lucerne.

Varieties

	1968	1969
Winter wheat	Cappelle	Cappelle
Barley	Zephyr	Sultan
Beans	Maris Bead	Maris Bead
Sugar beet	Klein E	Klein E
Grass	Timothy S 352 and Meadow Fescue S 215 sown in equal proportions by weight in 1970.	
Lucerne	Europe	

Weedkillers

1968 & 1969	Sugar beet	Pyrazone
	Barley	Mecoprop with 2,4-D
	Winter wheat	Mecoprop with 2,4-D
	Beans	Simazine
1970	Grass	2,4-D

Insecticides

Sugar beet	1968	DDT
	1969	Demeton-S-methyl
Beans	1969	Demeton-S-methyl

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Areas harvested

	Old Treatments	New Treatments
Wheat, barley, beans 1968-69	0.00057	0.00931 – 0.0104
Sugar beet 1968-69	0.00068	0.00291 – 0.00388
Lucerne 1970-73	–	0.00106 – 0.00139
Grass 1971-73	0.00050	0.000028–0.00145

Soil series. Beccles series (slope phase).

References

1. Cooke, G.W. and Williams, R.J.B. (1972)
Problems with soil structure at Saxmundham.
Rothamsted Experimental Station. Report for 1971, Part 2, 122-142.

2. Williams, R.J.B. and Cooke, G.W. (1971)
Results of the Rotation I experiment at Saxmundham 1964-69.
Rothamsted Experimental Station. Report for 1970, Part 2, 68-97.

3. Williams, R.J.B. (1971)
The chemical composition of water from land drains at Saxmundham and Woburn and the influence of rainfall upon nutrient loss.
Rothamsted Experimental Station. Report for 1970, Part 2, 36-76.

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ROTATION II

(S/RN/2)

Third period, 1969 onwards

The study of the residues of superphosphate and FYM applied from 1899 to 1964 which commenced in 1965 was completed with the barley crop of 1968 (*Details 1967*, pp 56-57). Between 1969 and 1973 the effects of these residues and those of dressings of phosphate and FYM applied in the years 1965-67 were measured (no dressings were applied in 1968). Each treatment strip was divided into five plots and cropped in a rotation of potatoes, barley, sugar beet, barley, as shown below.

In 1973 a fresh experiment testing annual and triennial dressings of P fertiliser was started on plots growing sugar beet and potatoes, to be followed by two crops of barley; the same sequence on the other two plots commenced in 1974.

The cropping sequence was therefore:

		1968	1969	1970	1971	1972	1973
North block:	North	B	P	B	SB	B	P
	South	B	SB	B	P	B	SB
South block:	North	B	B	P	B	SB	B
	South	B	B	SB	B	P	B

B = barley, P = potatoes, SB = Sugar beet

Treatments

(a)	Barley	1968-73	No P
(b)	Sugar beet and potatoes	1969-72	Each plot was divided into five sub-plots in 1969 and P0, P1, P2, P3 was applied cumulatively (P0 to two sub-plots per plot)
		1973	P0, P1, P3 (P3 duplicated in each plot). P1 will be applied to the P1 sub-plot in each of the next two barley crops to equal the P3 dressing.

The plots were paired according to the P content of the soil in 1973 and the P treatments were allocated so as to balance the treatments up to 1967 and in the period 1969-72. (In 1974 the treatments were reversed as between crops.)

Potatoes 1973

Plot No.	1	2	3	8	4	6	5	7
Treatments 1899-1964	0	D	DP	DP52	DP	DP	DP	DP
Treatments 1965-67	0	D	0	0	D2	P1	D2P1	P2

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P to potatoes and beet 1969 and 1971

	'A'		'B'			
P0	0	0	0	0		
P0	P1	P3	P3	P1		
P1	P3	P1	P1	P3	'A'	'B'
P2	P1	P3	P3	P1		
P3	P3	P1	P1	P3		
Sugar beet 1973	'B'		'A'		'B'	'A'

Symbols

1899-1964	D =	25 t FYM, 630 kg superphosphate (to 1920), 940 kg since 1921 applied every 4 years.
	DP52 =	25 t FYM, 1260 kg superphosphate (to 1920), 1880 kg superphosphate since 1921 applied every 4 years to 1951 when manuring stopped.
1965-67	D2 =	50 t FYM in 1966 and 1967; P1 = 82 kg P, P2 = 164 kg P annually.
1969-72	P1 =	27.4 kg P, P2 = 54.8 kg P, P3 = 82.2 kg P as superphosphate to potatoes and sugar beet.

Basal applications (kg)

		N	K	Material
Barley:	1968	94	50	(25-0-16)
	1969 & 1970	125	67	(25-0-16)
	1971-73	100	53	(25-0-16)
Potatoes:	1969	250	210	(25-0-16) + muriate of potash
	1970	250	417	(25-0-16) + muriate of potash
	1971-73	250	448	(25-0-16) + muriate of potash
Sugar beet:	1969	190	314	(25-0-16) + muriate of potash
	1970	190	468	(25-0-16) + muriate of potash
	1971-73	190	415	(25-0-16) + muriate of potash

Varieties

Barley:	1968	Zephyr,
	1969	Sultan,
	1970-73	Julia (1973 dressed with ethirimol).
Potatoes:	1969-73	King Edward, once grown Rothamsted para-crinkle free seed, chitted.
Sugar beet:	1969-1973	Klein E

Weedkillers

Barley:	1968-71	Mecoprop with 2,4-D
	1972-73	Dichlorprop with MCPA
Potatoes:	1969	Linuron with paraquat
	1970	Linuron
	1971-73	Linuron with paraquat
Sugar beet:	1969-70	Pyrazone

Other chemicals applied

Fungicides	Barley	1972-73	Tridemorph
	Potatoes	1969	Fentin hydroxide

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		1970	Captafol
		1971-73	Mancozeb
Insecticides	Potatoes	1969	Dimethoate
		1970-73	Menazon
	Sugar beet	1969	Dimeton-S-methyl and dimethoate
		1970	Menazon
		1971-72	DDT and menazon
		1973	Menazon

Area harvested

Barley:	0.00050 to 0.0060
Potatoes:	0.00078
Sugar beet:	0.00100

Soil series. Beccles series (slope phase) and Beccles series (deeper phase).

Reference

1. Mattingley, G.E.G., Johnston, A.E. and Chater, Margaret (1970) The residual value of farmyard manure and superphosphate in the Saxmundham Rotation II Experiment 1899-1968. *Rothamsted Experimental Station. Report for 1969,* Part 2, 91-112.

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LEY-ARABLE ROTATION

ROTHAMSTED, HIGHFIELD AND FOSTERS FIELD

(R/RN/1 & R/RN/2)

Full details of this experiment from its initiation in 1949 are set out in *Details 1967*, pp 78-87 but certain alterations and amplifications should be noted:

(a) Table 36. First and second periods 1949-60; R and G plots. The entry '0.15 v. 0.3+' applies to all hay years. These were:

1951-54	Blocks in 3rd treatment and 3rd test.
1955	Blocks in 3rd treatment only.
1956-57	Blocks in 1st treatment only.

From 1958 hay cutting of 'R' and 'G' plots was discontinued. Of the two plots of each type of grass in each phase, one was grazed as soon as it was fit, the other was grazed after an early silage cut. All these plots received N at 0.075 v. 0.15 cwt in spring and again in summer (after cutting on silage plots).

(b) The dates of ploughing certain reseeded 'R', and permanent, 'G' grass (*Details 1967*, p.80) and their subsequent cropping from 1963 are shown in Table 1. The statement that 'R' and 'G' plots were split for fertiliser treatment in 1962 and 1963 respectively should have the years reversed (p 81). The 'R' plots which were not split continued under the earlier management until they were ploughed.

(c) Table 37. Although covered by the footnote on p 83 it should be noted that the amounts of potash shown as applied in the treatment years to the Cg plots from 1958 do not include the 0.22 cwt K_2O per cut applied as a NK (16-0-16) dressing.

(d) Replace the first paragraph on p 83 with the following:

The new leys Ln and Lc introduced from 1962 onwards received standard 0.6 cwt P_2O_5 and 1.2 cwt K_2O in the seedbed for the first year and as a top dressing in winter for the second and third years. In addition they received 0.6 cwt K_2O for each cut except:

the first cut of 1Lc, 1Ln in 1962-67
the first cut of 2Lc and 3Lc in 1962-65
the first cut of 2Ln and 3Ln in 1962-64

(e) The footnote++ to table 37 on page 83 is more clearly stated:

Standard manuring to potatoes as second test crop was increased for the years 1965-67. Sub-plots without FYM received additional P and K 1961-67.

	1961-64		1965		1966-67	
	P_2O_5	K_2O	P_2O_5	K_2O	P_2O_5	K_2O
Standard	0.9	0.9	1.2	1.2	1.8	1.8 (cwt)
Additional to no FYM plots	0.6	0.9	0.5	1.0	0.7	0.7 (cwt)

(f) The yields of herbage crops other than lucerne were estimated from a single central cut of a forage harvester from 1961 instead of two (*Results*

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1967, p.87). The samples of lucerne have been cut by mower throughout but the discards have been cut by forage harvester from 1969.

Fourth period 1968–

In 1968 the fourth period of this experiment started and the cropping sequences are set out in table 1. Two phases (A and B) in each field are being maintained to study the effects of treatments on changes in soil organic matter. In one of these, Phase B, the 'reseeded' plots ploughed up in 1964 were sown down again in 1973 in order to restore the original pattern.

In the remaining four phases (C-F) the normal test crop sequence is being followed by continuous wheat cropping to study soil-borne cereal diseases.

Notes and Symbols

Symbols:

Lu	Lucerne
Lc	Grass/clover ley receiving no N
Ln	All grass ley receiving fertiliser N
G	Old grass (Highfield only) (Gn receives N; Gc receives no N)
R	Reseeded grass sown 1949, 1950, 1951 except Phase B resown in 1973 also (Rn receives N; Rc receives no N)
W	Wheat
P	Potatoes
B	Barley
H	1-year hay
SB	Sugar beet
O	Oats

Treatment crop sequences:

Lu	Lu	Lc	Ln	A
(Tr1) First year	Lucerne	Clover-grass	All grass	Hay
(Tr2) Second year	Lucerne	Clover-grass	All grass	Sugar beet
(Tr3) Third year	Lucerne	Clover-grass	All grass	Oats

Test crop sequences:

	To 1968	1968 –
First year	W	P
Second year	P	W
Third year	B	B

The original sequence, if started before 1968, was completed. At the same time varieties of crops were changed to King Edward, Joss Cambier and Julia respectively (see below).

NOTES. 1. In 1970-72 in Phase A the normal arable treatment sequence of crops was replaced by barley, hay, sugar beet, as a four-year sequence was planned in order to provide a comparison with Saxmundham in 1974 but this was abandoned and the test crop sequence was started normally in 1973.

2. The permanent grass in one whole plot of Phase B was ploughed by mistake in 1963 and was reseeded under wheat in 1964 but the results have been excluded subsequently.

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Manuring

(1) *Treatment crops*

Standard N dressings (kg N)

	Lu	Lc,Rc,Gc	Ln,Rn,Gn	A
First	0	0	75 for each cut	75 for each cut (hay)
Second	0	0	75 for each cut	188 (sugar beet)
Third	0	0	75 for each cut	25 (oats)

Standard P and K dressings (kg P_2O_5 and K_2O)

	Lu		L,R,G		A	
	P_2O_5	K_2O	P_2O_5	K_2O	P_2O_5	K_2O)
First	75	75	75	150	75	75 + 75 after each cut except the last. (Note 2).
Second	115	230	75	150 (see Note 1)	125	300
Third	115	230	75	150 (see Note 1)	38	75

Note 1: The supplementary potash dressings (in addition to the PK one given in autumn or in the seedbed in the case of L1) for the leys and grass were altered during the period:–

1968-69	R,G,L	75 kg K_2O	for each cut
1970–	R,G,2L,3L	48 kg K_2O	for each cut
1970 & 1973	1L	48 kg K_2O	after each cut except the last and resown in 1973.

Note 2: Applied as (15-15-15). When this fertiliser was discontinued, (25-0-16) was substituted in 1971 keeping N rate unchanged so K_2O became 48.

Note 3: Because of the change in the treatment crops in phase A the manuring in the arable sequence was according to the crop grown in the following years:

1970 – Barley (first treatment) 50 kg N, 38 kg P_2O_5, 75 kg K_2O
1971 – Seeds hay (second treatment) as for first normal treatment
1972 – Sugar beet (third treatment) as for second normal treatment

(2) *Test crops*

(i) *Potatoes as first crop:*
(for manuring of potatoes as second test crop see *Details 1967*, pp 81-83).

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Table 1 Ley-Arable Experiment Rothamsted Cropping, 1962-73

PHASE	A			B			C			D			E			F		
Rotation	Lu,Lc Ln,A	R	G	Lu,Lc Ln,A	R	G	Lu,Lc Ln,A	R	G	Lu,Lc Ln,A	R	G	Lu,Lc Ln,A	R	G	Lu,Lc Ln,A	R	G
1962	P	R	G	Tr2	R	G	W	R	G	Tr1	R	G	Tr3	R	G	B	R	G
			c-n			c-n			c-n			c-n			c-n			c-n
1963	B	R	G	Tr3	R	*G	P	R	G	Tr2	R	G	W	W	G	Tr1	R	G
		c-n	c-n			c-n		c-n	c-n			c-n			c-n		c-n	c-n
1964	Tr1	R	G	W	W	*G	B	R	G	Tr3	R	G	P	P	G	Tr2	R	G
		c-n	c-n			c-n		c-n	c-n			c-n			c-n		c-n	c-n
1965	Tr2	R	G	P	P	G	Tr1	R	G	W	W	G	B	B	G	Tr3	R	G
		c-n	c-n			c-n		c-n	c-n			c-n			c-n		c-n	c-n
1966	Tr3	R	G	B	B	G	Tr2	R	G	P	P	G	Tr1	H	G	W	R	G
		c-n	c-n			c-n		c-n	c-n			c-n			c-n		c-n	c-n
1967	W	R	G	Tr1	H	G	Tr3	R	G	B	B	G	Tr2	S	G	P	R	G
		c-n	c-n			c-n		c-n	c-n			c-n			c-n		c-n	c-n
1968	P	R	G	Tr2	S	G	P	P		WHEAT			Tr3	0	G	B	R	G
		c-n	c-n			c-n									c-n		c-n	c-n
1969	B	R	G	Tr3	O	G	W	W		WHEAT			P			WHEAT		
		c-n	c-n			c-n												
1970	Tr1+B†	R	G	P	P	G	B	B		WHEAT			W			WHEAT		
		c-n	c-n			c-n												
1971	Tr2+H	R	G	W	W	G	WHEAT			WHEAT			B			WHEAT		
		c-n	c-n			c-n												
1972	Tr3+SB	R	G	B	B	G	WHEAT			WHEAT			WHEAT			WHEAT		
		c-n	c-n			c-n												
1973	P	R	G	Tr1	R	G	WHEAT			WHEAT			WHEAT			WHEAT		
		c-n	c-n		c-n	c-n												

† See Note 1. * See Note 2.

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(a) Supplementary K dressings (kg K_2O) calculated to bring the K levels on both fields up to that of the Fosters Lc plots were ploughed in during the autumn for the 1968-70 crops. These supplementary K dressings were only given for the first test crop potatoes in these years and have not been applied subsequently.

Rotation	Fosters			Highfield		
	1968	1969	1970	1968	1969	1970
A	690	590	550	840	930	670
Lu	480	580	360	600	540	460
Lc	0	0	0	75	25	25
Ln	365	615	188	550	680	450
Rc	0	–	–	0	–	–
Rn	440	–	–	440	–	–
R+	–	770	490	–	880	550
Gc	–	–	–	–	not corrected	–
Gn	–	–	–	440	430	–

+ These had carried the 'arable' rotation for 6 years after ploughing up.

(b) Standard and test dressings (kg)
1968-70
FYM. Tested at 0 v. 30 t on ¼ plots cumulatively with applications to previous test crop potatoes. In 1968 and 1969 no FYM was applied to the R and G plots (phases C and E) coming with potatoes and these plots were treated as F plots.

Nutrient	Test	Standard	FYM Equiv. (to plots without FYM)	Total
N (1/8 plots)	0 v. 75 v. 150 v. 225	–		0 v. 75 v.150 v. 225
P_2O_5 (1/16 plots)	0.v. 115	190+	55	No FYM 245 v. 360
K_2O (1/16 plots)	0 v. 115	115	115	No FYM 230 v. 345 FYM 115 v. 230

+In 1968 300 on both fields: because of an excess application to Fosters Field the dressing on Highfield was equalised. Applications were:

	300	55	No FYM 355 v. 470 FYM 300 v. 415

1971 and 1972 no potatoes
1973 Test N 0 v. 80 v. 160 v. 240 kg N

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No P and K test, standard only at 300 kg P_2O_5 and 300 kg K_2O
No fresh FYM test

(ii) *Wheat as second test crop* (only present in 1969, 1970 and 1971):
N test on 1/8 plots 0 v. 50 v. 100 v. 150 kg N
Standard dressings 50 kg P_2O_5 plus 50 kg K_2O ploughed down
63 kg P_2O_5 plus 63 kg K_2O combine drilled

(iii) *Wheat as fourth and subsequent test crop:*

1968	N test (Highfield)	38v. 75 v. 115 v. 150 kg N
	on ¼ plots (Fosters)	50 v. 100 v. 150 v. 200 kg N
	Standard dressings	115 kg P_2O_5 and 115 K_2O half combine drilled and half after drilling
1969-70	N test (both fields) on ¼ plots	75 v. 125 v. 175 v. 225 kg N
	Standard dressings	50 kg P_2O_5, 50 kg K_2O ploughed down 63 kg P_2O_5, 63 kg K_2O combine drilled
1971-73	N as 1969-70	
	Standard dressings	75 kg P_2O_5, 75 kg K_2O combine drilled

(iv) *Barley as third test crop*
N test on 1/8 plots
1968-69 Highfield - all rotations 0 v. 12.5 v. 25 v. 37.5 kg N
Fosters Lu, Lc, Ln rotations 0 v. 25 v. 50 v. 75 kg N
Fosters A rotation 0 v. 50 v. 75 v. 100 kg N
1970-72 Both fields all rotations 0 v. 50 v. 90 v. 125 kg N

Standard P and K
1968-72 38 kg P_2O_5 and 75 K_2O
There was no test barley in 1973

Liming
Highfield only. 5.8 t of ground chalk were applied to the two blocks for the third test crop barley (and grass where present in the same blocks) 1968-72. None since.

Materials
Compound fertilisers were used wherever practicable; they included (0-14-28); (0-20-20); (25-0-16); (16-0-16 up to 1968). 'Nitro-Chalk', superphosphate or muriate of potash were used where a single nutrient was required or no suitable compound was available or in a small number of cases to supplement a compound.

Methods of application:
Supplementary muriate of potash: broadcast and ploughed in during preceding autumn.

Potatoes: N,P,K and FYM broadcast before working down seedbed for 1st test crop 1968-70.

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NOTE:	To 1961	FYM was applied in spring over the ridges.
	1962-68	FYM was ploughed down in the autumn for 2nd test crop. (In 1968 potatoes were taken as both 1st and 2nd test crops)

Cereals:	P and K combine drilled. N top-dressed
Sugar beet:	N, P, K broadcast before working down seedbed.
First year leys:	Standard dressings broadcast and harrowed into seedbed, top-dressed by hand after cutting.
Other leys:	PK applied by drill in autumn, top-dressed by hand in spring and after cutting.

Varieties of arable crops

(a)	Potatoes	1968	Second test: Majestic, Irish A chitted
		1968	First test: King Edward, Irish A chitted
		1969-70 & 1973	King Edward paracrinkle free, once grown, chitted.
(b)	Winter wheat	1968	Cappelle
		1969-72	Joss Cambier
		1973	Cappelle
(c)	Barley	1968-69	Maris Badger
		1970	Julia, dressed with carboxin
		1971	Julia
		1972	Julia, dressed with ethirimol
(d)	Sugar beet	1968 & 1972	Klein E
(e)	Oats	1968 & 1969	Manod

Seeds mixtures for leys

(a) H, undersown in barley 1970, sown without a cover crop autumn 1972:
Perennial ryegrass S.24: 64% Red Clover S.123: 29%
Canadian Alsike: 7% Mixture sown at 31 kg

(b) Ln, sown without a cover crop spring 1970 and 1973:
Timothy S.51: 45% Meadow Fescue S.215: 55%
sown at 37 kg in 1970, 33 kg in 1973.

(c) Lc, 1970 and 1973; Rn, Rc 1973, sown without a cover crop in spring:
Timothy S.51: 42% Meadow Fescue S.215: 50%,
White clover S.100: 8%. Sown at 38 kg.

(d) Lucerne, sown spring 1970 and 1973:
1970 Du Puits sown at 28 kg. 1973 Europe sown at 28 kg.

Management of grass and leys

As for the third period 1961-67 (*Details 1967*, p. 87) except for the one year ley (H) which was cut four times in 1971 while in 1973 it was cut twice. All leys, also R and G where applicable, were ploughed in the autumn before the first test crop in the following year, except the Lucerne in 1969 which was ploughed in July for a short fallow.

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Weedkillers

Wheat and Barley	1968 & 1969	2, 4-D with mecoprop
Wheat	1970/71	2, 4-D with dichlorprop
Barley	1970	2, 4-D with dichlorprop
Barley undersown	1970	MCPA with MCPB
Barley	1971	Ioxynil with mecoprop
Wheat	1972/73	Dicamba, with mecoprop and MCPA
Barley	1972	Bromoxynil, ioxynil, dichlorprop and MCPA
Oats	1969	Ioxynil with mecoprop
Potatoes	1968-70 & 1973	Paraquat with linuron
First year leys	1970	MCPA with MCPB
First year leys	1973	Benazolin, 2, 4-DB and MCPA
Lucerne	1973	2, 4-DB and MCPA

Soil series

Highfield:	Batcombe series
Fosters:	Batcombe series with small areas of sandier soil.

Reference

1. Johnston, A.E. (1973)
The effect of ley and arable cropping systems on the amount of soil organic matter in the Rothamsted and Woburn ley-arable experiments. *Rothamsted Experimental Station. Report for 1972,* Part 2, 131-159.

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LEY-ARABLE ROTATION
WOBURN, STACKYARD FIELD
(W/RN/3)

This experiment, which was started in 1938, was designed to test the effects on soil fertility of a three-year grazed ley, three years of lucerne and a three course arable rotation including one year hay in comparison with a rotation without leys measured by the yields of two successive test crops. *(Details 1967,* pp. 105-114).

Large differences in the yields of potatoes grown in contrasting conditions in 1966 led to the introduction of a number of studies in soil pathogens. Initially the tests were applied to the treatment crops of potatoes but in 1971 potatoes were re-introduced as the first test crop. A number of other changes were made including the substitution of S123 red clover for sainfoin which had often failed to survive three years. These are summarised below and set out in detail in table 2.

Treatment crops

	1st year	2nd year	3rd year
Ley (L)	Grazed to 1968 Cut from 1969	Grazed to 1968 Cut from 1969	Grazed to 1969 Cut from 1970
Sainfoin (cut) (S)	Till 1971	Till 1971	Till 1971
S123 Clover (cut (C1))	1972–	Sown July 1971	Sown July 1971
Arable (roots) (A)	Potatoes (P)	1968-71 Rye (R) 1972 – Barley (B)	1968-71 Carrots (C) 1972 – Barley
Arable (hay) (AH)	Potatoes	1968-71 Rye 1972 – Barley	Hay* (H)

*the seeds were undersown in the preceding cereals in some seasons.

Test crops

	1st	2nd
1968-70	Barley	Barley
1971	Potatoes	Barley
1972 & 1973	Potatoes	Wheat

Treatments

(i) *Potatoes*

(a) *Treatment crops*

1968 None v. thiram (approx. 8 kg a.i.) applied to tuber

NOTE: Thiram-dressed seed was chitted, untreated seed was not chitted (on 1/24 plots)

1968-70 (a) None v. 448 kg chloropicrin (on ¼ plots)
(b) 125 v. 188 v. 251 kg N (on 1/12 plots)

1969 & 1970 None v. 11 kg aldicarb (on 1/24 plots)

1972 None v. 448 kg chloropicrin plus 5.6 kg aldicarb (on 1/4 plots)

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1973 None v. 448 kg chloropicrin plus 6.7 kg aldicarb (applied also in error to the 1/4 plots of the 1st year ley and 1st year clover on 'alternating' rotations.

(b) *Test crops* (Note: FYM no longer applied to test crop)

1971 None v. 448 kg chloropicrin plus 11.2 kg aldicarb
Varieties: Maris Piper v. Pentland Crown
On 1/2 plots after ley and sainfoin and 1/4 plots after arable and arable with ley (1971 only; other years Maris Piper only).

1972 & 1973 None v. 448 chloropicrin plus:
1972 5.6 kg aldicarb,
1973 6.7 kg aldicarb.

(ii) *Other test crops*

(a) Barley as first test crop 1968-70 (on 1/8 plots) after A and AH rotations: 50 v. 100 v. 150 v. 200 kg N. After L and S rotations: 0 v. 50 v. 100 v. 150 kg N.

(b) Wheat as second test crop 1972 and 73. (on 1/8 plots) 0 v. 63 v. 126 v. 188 kg N.

Residual effects of the farmyard manure applied prior to 1968 and of fumigants from 1968 have been tested in a number of crops as shown in Table 2.

Table 2
Cropping Sequences and Residuals Tested

Phase 1

	Continuous				Alternating rotations			
1967	L1	S1	P	P	P	P	L1	S1
1968	L2	S2+	R+	R+	R+	R+	L2	S2+
1969	L3	S3	H	C	H	C	L3	S3
1970				BARLEY+				
1971				BARLEY				
1972	L1	Cl1	P*+	P*+	Cl1	L1	P*+	P*+
1973	L2	Cl2	B+F	B+F	Cl2	L2	B+F	B+F

NOTES: (1) FYM at 38 t last applied to 1st test crop (Sugar beet) 1965
Residual effect measured in crops marked (+)
(2) Fumigant test applied to potato crops (*)
Residual effect measured in crops marked (F)

Phase 2

	Continuous				Alternating rotations			
1967	L2	S2	R	R	R	R	S2	L2
1968	L3	S3+	H+	C+	C+	H+	S3+	L3
1969				BARLEY+				
1970				BARLEY				
1971	L1	S/C1	P+	P+	S/C1	L1	P+	P+
1972	L2	C12	B	B	C12	L2	B	B
1973	L3	C13	H	B+	C13	L3	B+	H

NOTES: (1) FYM at 38 t last applied to 1st test crop (Sugar beet) 1964
Residual effect measured in crops marked (+)

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Phase 3

		Continuous				Alternating rotations		
1967				BARLEY				
1968	L1	S1+	P*	P*	S1+	L1	P*	P*
1969	L2	S2	R+F	R+F	S2	L2	R+F	R+F
1970	L3	S3	H	C+F	S3	L3	H	C+F
1971				POTATOES+*				
1972				WHEAT+F				
1973	L1	C11	P*+	P*+	P*+	P*+	C11	L1

NOTES: (1) FYM at 38 t last applied to 1st test crop (Sugar beet) 1966
Residual effect measured in crops marked (+)
(2) Fumigants applied to potatoes (*)
Residual effect measured in crops marked (F)

Phase 4

		Continuous				Alternating rotations		
1967	L3	S3	H	C	H	C	L3	S3
1968				BARLEY+				
1969				BARLEY				
1970	L1	S1	P*+	P*+	S1	L1	P*+	P*+
1971	L2	S2/Cl	R+F	R+F	S2/Cl	L2	R+F	R+F
1972	L3	Cl3	H	B	Cl3	L3	B	H
1973				POTATOES*+				

NOTES: (1) FYM at 38 t last applied to 1st test crop (Sugar beet) 1963
Residual effect measured in crops marked (+)
(2) Fumigants applied to potatoes (*)
Residual effect measured in crops marked (F)

Phase 5

		Continuous				Alternating rotations		
1967				SUGAR BEET				
1968				BARLEY+				
1969	L1	Sl	P*+	P*+	S1	L1	P*+	P*+
1970	L2	S2	R+F	R+F	S2	L2	R+F	R+F
1971	L3	S3	H	C+F	S3	L3	C+F	H
1972				POTATOES*+				
1973				WHEAT+F				

NOTES: (1) FYM at 38 t last applied to 1st crop (Sugar beet) 1967
Residual effect measured in crops marked (+)
(2) Fumigant test applied to potato crops (*)
Residual effect measured in crops marked (F)

Standard manurial dressings (kg)

Treatment crops

	N	P_2O_5	K_2O	Material	Application
Potatoes					
1968-70	–	115	225	(0-14-28)	On the flat
1971–	251	251	387	(13-13-20)	On the flat

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Rye					
1968	75	40	75	'N-Chalk, & (0-14-28)	Top-dressed combine drilled
1969–	40	40	75	'N-Chalk' & (0-14-28)	Top-dressed combine drilled
Barley					
1972–	63	63	63	(15-15-15)	Combine drilled
Carrots					
1968-71	75	75	225	'N-Chalk', Super & Muriate	Seedbed
One year ley (hay)					
1968	125	75	150	'N-Chalk' & (0-14-28)	In spring
	75	–	75	(16-0-16)	After 1st cut
1969-73	Spring dressing as 1968				
	75	–	50	(25-0-16)	After 1st cut
Ley–first year					
1968-73	50	188	125	'N-Chalk', Super & Muriate	Seedbed
1968 (grazed)	75	–	75	(16-0-16)	1 top dressing
1969, 1970, 1972 & 1973 (cut)	100	–	63	(25-0-16)	2 dressings
1971 (cut)	50	–	32	(25-0-16)	1 dressing
	N	P_2O_5	K_2O	Material	Application
Ley-second & third years					
1968 (cut) 2nd year	100	–	100	(16-0-16)	2 dressings
1969 (cut) 3rd year	100	--	63	(25-0-16)	2 dressings
1969 (grazed) 2nd & 3rd year	150	–	93	(25-0-16)	3 dressings
1970-73 (cut)	150	–	93	(25-0-16)	3 dressings
Sainfoin 1st year					
1968-71	63	188	126	'N-Chalk', Super & Muriate	Seedbed
2nd & 3rd year					
1968-71	63	–	188	'N-Chalk' & Muriate	1 dressing
Clover					
1st year 1972	63	188	126	'N-Chalk,' Super & Muriate	To Seedbed
2nd & 3rd years					
1972–	63	–	188	'N-Chalk' & Muriate	1 dressing

Magnesium sulphate (as Epsom salts) was applied to first treatment crops in the seedbed:–

1968 and 1969	620 kg (62 kg Mg)
1970	375 kg (37 kg Mg) – the smaller quantity applied in error.

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Test crops	N	P_2O_5	K_2O	Material	Application
Barley – 1st test					
1968-70	–	63	63	(0-20-20)	Seedbed
Barley – 2nd test					
1968	75	40	0	'N-Chalk' & Super	Seedbed
1969-71	63	63	63	(15-15-15)	Seedbed
Potatoes – 1st test					
1971-73	250	250	385	(13-13-20)	Seedbed
Wheat – 2nd test					
1972-73		60	60	(0-20-20)	Seedbed

Table 3

Corrective K dressings (kg K_2O) applied to first test crop as muriate of potash, half before ploughing and half after

Continuous rotations	1968		1969		1970		1971		1972		1973	
	O	D	O	D	O	D	O	D	O	D	O	D
Leys (L)	0	126	188	0	200	0	126	126	251	251	502	502
Sainfoin (S) (Clover from 1972 (C1))	377	377	439	314	439	377	126	126	0	0	126	126
Arable with hay (AH)	628	502	502	439	628	628	188	188	314	251	314	376
Arable (A)	251	251	377	377	377	251	0	0	314	314	439	439

Alternating rotations (Last two rotations in order)

	1968			1969			1970	
	O	D		O	D		O	D
AH/L	0	63	A/L	251	251	AH/L	251	63
A/S	628	377	AH/S	377	251	A/S	439	314
L/AH	628	377	LU/AH	502	502	L/AH	502	502
LU/A	628	377	L/A	377	377	LU/A	439	439

	1971			1972			1973	
	O	D		O	D		O	D
A/L	188	439	A/L	439	376	L/A	439	439
AH/S	126	126	H/C1	126	126	S/AH	439	502
L/AH	63	63	L/AH	251	251	A/L	502	502
S/A	188	314	C/A	376	376	AH/C	251	0

O = No FYM half plots D = FYM half plots

Liming

Lime was applied in the autumn to the plots intended for the second test crop.

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1968	Ground Magnesium limestone at 5.6 t
1969	Ground Magnesium limestone at 5.0 t
1970	Ground Chalk at 5.0 t
1971-73	Ground Magnesium limestone at 5.0 t

Varieties

1968-70	Common Sainfoin	Maris Badger Barley	Maris Piper Potatoes	King II Rye	Autumn King Carrots
1971	S.123 Red Clover	Julia Barley	Maris Piper* Potatoes	King II Rye	Autumn King Carrots
1972 & 1973	S.123 Red Clover	Julia Barley	Maris Piper Potatoes	Capelle Wheat	

* Pentland Crown was also grown in the test crop plots.

Seeds mixtures

Hay 21 kg S.24 Perennial ryegrass,
10 kg Late flowering Red clover, 2 kg Alsike clover

Ley 22 kg S.23 Perennial ryegrass, 12 kg S.143 Cocksfoot,
7 kg Late flowering Red clover, 3 kg S.100 White clover.

Soil series Cottenham and Flitwick.

Reference

Johnston, A.E. (1973)
The effects of ley and arable cropping systems on the amounts of soil organic matter in the Rothamsted and Woburn ley arable experiments.
Rothamsted Experimental Station. Report for 1972, Part 2, 131-159.

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MARKET GARDEN
WOBURN LANSOME I
(W/RN/4)

The study of the effects of bulky organic materials, mainly on Market Garden crops over the period 1942-1967 are described in *Details 1967*, pp. 115-122. Tick beans were grown in 1968 and 1969 without further treatment and since then farm crops have been grown for a study of direct and residual effects of phosphate on the same site.

Corrections and additions to the 1967 report are:

(a) p.118 Table 58. Symbols and treatments 1964 should read: N1 = 0.45, N2 = 0.9 cwt for carrots; N1 = 0.90, N2 = 1.8 cwt for red beet and leeks as 'Nitro-Chalk'.

(b) Same Table 1965: Add Series A carrots 0.45 N v. 0.90 cwt N as 'Nitro-Chalk'.

(c) Same Table 1967: Series B should read Quarter in place of Eighth plots.

(d) The following additional note should be added at the foot of the table:

(6) $N' = N_3 + N_2 - N_1 - N_0$
$N'' = N_3 - N_2 - N_1 + N_0$
$N''' = N_3 - N_2 + N_1 - N_0$

(e) substitute the following for the paragraph on Liming on p 120:

Liming

From 1943 to 1945 ground chalk at 29 cwt/acre was applied before planting cabbages. From 1948 to 1951 attempts were made to correct the acidity developed due to the application of sulphate of ammonia. A uniform dressing of chalk was given to all plots: Series A: 11 cwt in 1948 and 22 cwt in 1950. Series B: 22 cwt in 1949 and a few plots received further small dressings in 1951. From 1952 to 1967 20 cwt of ground chalk was given before every crop of red beet with the following exceptions:

(i) In 1955 this was applied to spring cabbages also.
(ii) From 1958 the quantity was increased to 23 cwt except 1963 when 20 cwt was applied.
(iii) No chalk was applied in 1965.
(iv) In 1967 40 cwt of ground chalk was applied to 16 only of the 40 plots in Series B used for fertiliser and continuous FYM experiment.

Cropping

	Series A	Series B
1968 and 1969	Beans	Beans
1970	Sugar beet	Barley
1971	Barley	Potatoes
1972	Potatoes	Sugar beet
1973	Barley	Barley

No yields were taken in 1973 because of bird damage.

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Treatments

No fresh treatments were applied in 1968, 1969 and 1973.

Barley 1970 and 1971	0 v. 63 kg P_2O_5
Sugar beet 1970 and 1972	0 v. 126 kg P_2O_5
Potatoes 1971 and 1972	0 v. 188 kg P_2O_5

Applied to whole plots with confounding of certain two and three factor interactions.

Basal manuring (kg/ha)

Beans 1968 and 1969	None		
Sugar beet 1970	190 N	320 K_2O	100 MgO
1972	190 N	500 K_2O	95 MgO

Boron was applied as a spray in June 1972 – 6.7 B_2O_3

Barley 1970 and 1971	63 N	63 K_2O	
1973	70 N		
Potatoes 1971	250 N	250 K_2O	100 MgO
1972	250 N	250 K_2O	100 MgO

Materials: Superphosphate, muriate of potash, Epsom Salts and 'Solubor'.

Liming

1969	Series A:	2.8 t ground magnesian limestone
	Series B:	5.6 t ground magnesian limestone
1970-72	2.5 t ground chalk	

Weedkillers

Beans 1968	Simazine
1969	Paraquat and simazine
Barley	Ioxynil with mecoprop
Sugar beet	Phenmedipham
Potatoes 1971	Linuron
1972	Linuron with paraquat

Other sprays

Beans	Demeton-S-methyl
Sugar beet	Demeton-S-methyl
Potatoes	Mancozeb and demeton-S-methyl

Varieties

Beans	Tarvin
Barley	Julia (dressed with ethirimol 1973)
Sugar beet	Klein E
Potatoes	Pentland Crown

Areas harvested

1968 and 1969	Beans 0.00166
1970	Sugar beet 0.00162 – Barley 0.00073
1971	Barley and potatoes – 0.00074
1972	Potatoes 0.00147 – Sugar beet 0.00127

Soil series Cottenham

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Rothamsted Experimental Station. Report for 1975, Part 2, 5-35.

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RESIDUAL PHOSPHATE

ROTHAMSTED, GREAT FIELD IV AND SAWYERS I

(R/RN/7)

The crop rotation and phosphate manuring programmes for the second period 1967-72 (*Details 1967*, p.89) have been followed. In 1973 the rotation was continued for one more year before changes in 1974, and the treatments were slightly altered on metrication in 1973.

NOTE: The potash applied as a basal manure is the sulphate, not the muriate as stated on p. 90 (*Details 1967*).

Treatments (all as granular superphosphate kg P_2O_5/ha)

Symbol	Frequency	Total 1967-72	1973
0	None	–	0
A1	Annual	188*	29*
A2	Annual	377*	57*
A3	Annual	753*	115*
A4	Annual	1130*	172*
T1	1969, 1972	188*	–
T2	1969, 1972	377*	–
R2	1967	377°	344+
R3	1967	753°	688+
R4	1967	1130°	1032+
G1	None since		
S1	1960		

For details of manuring during the first period 1960-65 and the fallow of 1966 see *Details 1967*, pp 88-89.

* applied in seedbed
\+ half applied in autumn before ploughing and half in spring before cultivation
o half applied in June and half in September 1966 and worked into fallow

Basal dressings (kg/ha)
Broadcast in spring before sowing or planting as 'Nitro-Chalk' and sulphate of potash; except for barley since 1970 as (25-0-16) combine drilled.

		N	K_2O
Barley:	1968-69	50 Great Field	126
		100 Sawyers	126
	1970–	100	63
Potatoes:	1968-69	150	188
	1970–	251	251
Swedes:	1968-73	63	126

Liming
Ground chalk applied before ploughing in autumn to land to be cropped with barley t/ha

1968	None
1969	2.9

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	1970-71	3.1
	1972	2.9
	1973	None

Varieties

Barley:	1968-69	Maris Badger
	1970-73	Julia (dressed with ethirimol 1972 and 1973.)
Potatoes:	Majestic, chitted seed:	
	1968	Irish A
	1969-71	Once grown
	1972	Scotch
	1973	Foundation Stock
Swedes:	1968-73	Wilhelms dressed with Gamma-BHC with captan (1970 Green Globe turnips were sown in place of swedes which failed)

Weedkillers

Barley:	1969-70	2,4-D with dichloroprop
	1971-72	Ioxynil, bromoxynil with dichloroprop
	1973	Dicamba, mecoprop with MCPA
Potatoes:	1968	Paraquat with linuron
Swedes:	1972	Paraquat to previous barley stubble

Other chemicals applied

Potatoes:	1968	Mancozeb and demeton-S-methyl
	1968–	Sulphuric acid (BOV) to burn off tops

Areas harvested

	Great Field IV	Sawyers I
Barley and potatoes:	0.00520	0.00572
Swedes:	0.00390	0.00429

Soil series

Great Field	Batcombe series
Sawyers I	Batcombe series with sandier variants.

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CULTIVATION – WEEDKILLER

ROTHAMSTED GREAT HARPENDEN I

(R/RN/8)

The Rothamsted experiment has been continued, up to 1972 as set out in *'Details 1967,* pp. 91-94. Winter wheat was grown each year except 1971 when this crop was spring-sown and spring beans were grown throughout. From 1973 only one phase of the rotation is maintained each year, starting with winter wheat to be followed by potatoes, barley, spring beans.

Treatments (from 1961 unless stated otherwise)

(1) *Whole plots.* All combinations of:

(i) Primary cultivation for each crop by: mouldboard plough (P), rotary cultivator (R), deep-tine cultivator (T).

(ii) Post planting weed-control in beans and potatoes: mechanical (no weedkiller) (M), persistent weedkiller with little or no cultivation (SX), persistent weedkiller (SY) (differing from SX in material, time of application or subsequent cultivation).

(2) *'Reserve plots'* have been used in addition:

(a) (Since 1964) for spring sown crops, no culivation in autumn or winter, rotary cultivated before sowing; for autumn sown crops: as treatment P. These crops are sprayed as X.

(b) (Since 1966) all crops receive the minimum cultivations necessary to produce a seedbed. Details vary according to conditions and paraquat may be used at any stage in the rotation (see below). These crops are sprayed as X and cereals treated as H sub-plots. Since 1969 the cereal straw has been burnt and bean straw raked off as there has been insufficient to burn.

(c) (Since 1969). 'Standard cultivations' applied where primary cultivations considered best for the crop are used:

Potatoes:	plough in autumn, rotary cultivate in spring, weedkiller and rotary ridging as SY plots.
Barley:	deep time cultivate, treat with same weed-killer as H plots.
Beans:	plough, weedkiller as SX plots.
Wheat:	plough or deep-tine cultivate, treat with same weedkiller as H sub-plots.

NOTE: Herbicide treatments on wheat and barley were omitted in 1969 on C plots.

(3) *Half-plots.*

Weed control in wheat and barley: no spray (0) v. post emergence herbicide (H).

(Since 1968) 0 v. paraquat (G) applied to stubbles after beans, wheat and barley applied cumulatively on half plots.

Rates: 1968-71 0 v. 0.84 kg ion
1972 & 73 0 v. 0.56 kg ion

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NOTE: (i) Paraquat at 1.68 kg ion applied to all bean stubbles in September 1970 instead of to half plots.
(ii) the interaction (0 v. H) x (0 v. G) is confounded with the block difference in each series.

Treatments from 1973

One series only is retained, and the treatments are continued except for reserve plots A, B and C which are now:

Whole plots	A	Spike rotary cultivated direct on stubble
	B	Shallow ploughed
	C	Standard farm practice
Half plots	A and C test (0 v. H) (0 v. G)	
	B tests (0 v. H) with basal G.	

Weedkillers used 1968-73

(a) Persistent weedkillers for beans and potatoes (a.i./ha)

	Beans		Potatoes
1968 & 1969	Simazine 1.1 kg		Linuron 0.84 kg with paraquat 0.42 kg ion.
1970	Simazine 1.1 kg		Linuron 1.68 kg
	SX,A,B,C, plots	SY plots	
1971	Simazine 1.1 kg	Dinoseb acetate 2.8 kg	Linuron 0.84 kg with paraquat 0.84 kg ion
1972	Simazine 1.1 kg	Dinoseb acetate 2.8 kg	Linuron 0.84 kg with paraquat 0.42 kg ion

(b) Non-persistent weedkiller to wheat and barley (H sub-plots, B and C reserve plots)

	Wheat	Barley
1968 & 1969	Mecoprop with 2,4-D. (9.8 l 'Methoxone Extra')	Mecoprop with 2,4-D (8.4 l 'Methoxone Extra')
1970	Mecoprop with 2,4-D (6.3 l 'Methoxone 4X')	Mecoprop with 2,4-D (5.6 l 'Methoxone 4X')
1971	Ioxynil at 0.84 kg with 2.52 kg mecoprop	Ioxynil at 0.84 kg with 2.52 kg mecoprop
1972 & 1973	Ioxynil at 0.63 kg with 1.90 kg mecoprop	Ioxynil at 0.53 kg with 1.60 kg mecoprop

(c) Weedkillers applied in autumn and winter:

1967-69	Sodium trichloroacetate (40 kg split dressing) before barley.
1969-70	Paraquat (0.84 kg) before wheat, beans, potatoes on B plots.
1970-71	Paraquat (0.84 kg) before beans and potatoes on B plots. (See above re treatment of bean stubble before wheat)
1971-72	Sodium trichloroacetate (40 kg split dressing) before barley. Paraquat (0.56 kg) before wheat, beans, potatoes on B plots.

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NOTE: The rates for certain weedkillers given above differ from those given in the reference and should be taken as the correct ones.

Standard manuring kg/ha

Beans	1968-72	(0-14-28) at 410
Potatoes	1968-72	(13-13-20) at 1250
Barley	1968-72	(25-10-10) at 377
Wheat	1968 & 1969	(6-15-15) at 314 plus 75 N
	1970	(8-20-) at 235 plus 75 N
	1971	(25-10-10) at 377
	1972	(10-24-24) at 251 plus 75 N
	1973	(10-24-24) at 251 plus 95 N

Liming

Ground chalk t/ha applied autumn 1967

Beans 2.9 Wheat and potatoes 5.8 Barley 11.6

Varieties

Beans	1968 & 1969	Maris Bead
	1970	Maris Bead
	1971	Maris Bead
	1972	Maris Bead
	1973	—
Wheat	1968 & 1969	Capelle
	1970	Capelle
	1971	Kolibri
	1972	Cappelle
	1973	Bouquet
Potatoes	1968 & 1969	Pentland Dell Irish A.
	1970	Pentland Dell Once grown
	1971	Pentland Crown Irish A
	1972	Pentland Crown Once grown
	1973	—
Barley	1968 & 1969	Maris Badger
	1970	Julia
	1971	Julia
	1972	Julia (dressed with ethirimol)
	1973	—

Other Chemicals to beans and potatoes

	Beans	Potatoes
1968	—	Mancozeb and Demeton-S-methyl Tops burnt off with B.O.V.
1969-71	Demeton-S-methyl	Mancozeb and Demeton-S-methyl, B.O.V.
1972	Phorate	Mancozeb and Demeton-S-methyl, B.O.V.

Areas harvested

Beans 0.00405 – 0.00488 Wheat & Barley 0.00434
Potatoes 0.00217 – 0.00434

Soil series

Shallow Batcombe and Batcombe series with small area of Charity complex.

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Reference

1. Moffatt, J.R. (1975)
Cultivation weedkiller Experiment, Rothamsted, 1961-72.
Rothamsted Experimental Station. Report for 1974, Part 2, 155-170

Cultivation Weedkiller Experiment

Two statements regarding treatments applied included in the article in the *Report for 1974,* Part 2, appear to conflict with the records in the White Book.

1. Page 157
'in all years from 1965, except 1969 and 1970, the ground after potatoes for barley was sprayed with TCA at 20 lb/acre . . . . . In 1966 the bean stubble was sprayed with aminotriazole at 2 gal/acre in 40 gal.'

The rates recorded were 'Tecane at 20 lbs per acre on two occasions each year. Tecane is reported to contain 90% acid equivalent i.e. approx. twice amount mentioned in the article was applied. The material applied to the bean stubble was 'Weedazol T-L' at 2 gal/acre. 2 gal contains 4 lb aminotriazole and 3.7 lb ammonium thiocyanate *'Results 1967'* and *'Details 1967'* Table 43. So the statement should refer to the material used or the rate should be altered.

2. Page 161
'The herbicides used were:

1964-65	linuron (2 lb/acre) plus paraquat (0.75 lb/acre)
1966-68	linuron (1 lb/acre) plus paraquat (0.37 lb/acre)
1969-72	linuron (1 lb/acre) plus paraquat (0.75 lb/acre)'

The statement for 1964-65 agrees with the records for the SY plots but does not mention the SX plots which received 2 lb prometryne plus 0.75 lb paraquat. *(Details 1967,* Table 41).

The applications recorded in the White Book are:

Year	Product	Active materials
1966 & 1967	3 pints Gramoxone W	0.75 lb paraquat
	+ 2 lb linuron 50	1 lb linuron
1968 & 1969	1½ pints Gramoxone W	0.37 lb paraquat
	+ 1½ lb linuron 50	0.75 lb linuron
1970	3 lb linuron 50	1.5 lb linuron
1971	3 pt. Gramoxone W	0.75 lb paraquat
	1½ lb linuron 50	0.75 lb linuron
1972	1½ pt Gramoxone W	0.37 lb paraquat
	1½ pt linuron 50	0.75 lb linuron

There are therefore some differences from the amounts in the article in all these years.

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ORGANIC MANURING

WOBURN STACKYARD B

(W/RN/12)

The experiment was designed to test the effects of several different forms of organic matter applied to the light poorly-structured soils at Woburn. An initial period (1965 to 1971 or 1972) in which organic matter was added by leys, green manures or organic materials applied to arable crops, is being followed by an arable rotation in which effects are tested without further additions. (For further details see Ref 1)

Treatments

(a) *Organic*

(Lc)	Grass-clover ley, N to seedbed only
(Ln)	All grass ley, N for each cut
(St)	Barley straw, chopped except in 1970, at 7.5 t dry matter annually
(Pt)	Sedge peat at 7.5 t dry matter annually
(Gm)	Green manures as practicable depending on arable crop grown
(Fs)	No organic matter
(Dg)	Farmyard manure at about 50 t fresh weight per annum (25 t in 1967 and 1970)
(Fd)	No organic matter but P, K and Mg equivalent to that in FYM applied

NOTES: 1. Treatments other than Dg and Fd received the same total amounts of PKMg either as fertilisers alone (Fs) or as fertiliser additions to the organic manures. The amounts were equal to the PK and Mg in the barley straw plus an amount of superphosphate to bring the total phosphate to 63 kg P_2O_5 per ha.

2. Annual balancing dressings of PKMg were applied retrospectively to allow for differential removals by crops.

3. Full details of the PKMg applied in accordance with 1. and 2. are given in Appendix I of reference I.

4. An outline of the treatments and of the cropping programme are set out in Table 4.

(b) *Nitrogen*

(i) Tests in the initial period. N was applied at four equally spaced levels to the first four crops, the dressings being rotated to avoid differential effects:–

Year	Crops	N rates (kg/ha)			
1966	Barley	0	25	50	75
1967	Potatoes				
1968	Winter wheat	25	75	125	175
1969	Sugar beet				

(ii) 1972 & 1973 Potatoes (Blocks I and III 1972: II and IV 1973)
0, 50, 100, 150, 200, 250, 300, 350 kg N

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(iii) 1973 Wheat (Blocks I and III)
0, 25, 50, 75, 100, 125, 150, 175 kg N

(c) *Green manuring* – Details of cropping

1964	Hybrid Italian ryegrass sown in spring but rotavated in July owing to weed infestation
1965	Hybrid Italian ryegrass sown in spring and ploughed in September
1966	Trefoil was undersown in wheat in November and again in the barley, which replaced the wheat in April. This was ploughed up at the end of November
1968	Late flowering red clover undersown in winter wheat in March and ploughed in at the end of November
1971	Late flowering red clover undersown in winter rye in April and ploughed in at the end of October
1972	Blocks II and IV: Late flowering red clover undersown in winter rye at end of April and ploughed in at the end of November

Basal applications

1964	Lc and Ln	25 kg N	63 kg P_2O_5	63 kg K_2O in seedbed
	Gm	63 kg N	63 kg P_2O_5	63 kg K_2O in seedbed
1965	Lc and Ln	63 kg N	63 kg P_2O_5	63 kg K_2O in seedbed
	Ln	63 kg N after first cut		

N applications to Ln during the season

1966	190 kg N in 3 dressings: in spring and after first two cuts
1967-69	125 kg N in 2 dressings: in spring and after first cut
1970-71	250 kg N in 2 dressings: in spring and after first cut
1972	Blocks II and IV 250 kg N in 2 dressings: in spring and after first cut.

1970	Beans	63 kg P_2O_5 125 kg K_2O as (0-14-28)
1971	Rye	31 kg N in spring
1972	Rye (Blocks II and IV)	40 kg N in spring 63 kg P_2O_5 125 kg K_2O as (0-14-28) 40 kg MgO as Epsom Salts
	Potatoes (Blocks I and III)	460 kg P_2O_5 and 480 kg K_2O, half in autumn and half in spring. 100 kg MgO as Epsom Salts in spring.
1973	Potatoes as in 1972	

Fertiliser used except where stated:
P: superphosphate, K: muriate of potash

Liming

1969 Ground chalk at 5.0 t/ha to whole area

Weedkillers

Barley:	1966	Paraquat
Winter wheat:	1968 & 1973	Ioxynil and mecoprop
Potatoes:	1973	Linuron with paraquat
Beans:	1970	Simazine

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Other chemicals applied

Potatoes:	1967, 1972 & 1973	Mancozeb and undiluted B.O.V.
Sugar beet:	1969	Demeton-S-methyl
Beans:	1970	Demeton-S-methyl

Varieties

Winter wheat:	1968 & 1973	Cappelle
Potatoes:	1967	Majestic
	1972 & 1973	Pentland Crown
Barley:	1966	Maris Badger
Sugar beet:	1969	Klein E
Rye:	1971 & 1972	King II
Beans:	1970	Maris Bead

Seeds mixtures

	Lc	Ln
S48 Timothy	25%	31%
S215 Meadow Fescue	42%	46%
Smooth stalked meadow grass	17%	23%
Kersey Red Clover	13%	
S184 Wild White Clover	4%	
Total seeding:	27 kg/ha	29 kg/ha

Areas harvested

Potatoes:	0.00087 – 0.00413
Winter wheat:	0.00173 – 0.00421
Rye & barley:	0.00421
Beans:	0.00393
Sugar beet:	0.00138

Soil series. Cottenham

References

1. Mattingly, G.E.G. (1974)
The Woburn Organic Manure Experiment. I, Design, crop yields and nutrient balances 1964-72.
Rothamsted Experimental Station. Report for 1973, Part 2, 98-133.

2. Mattingly, G.E.G., Chater, M and Poulton, D.R. (1974)
The Woburn Organic Manure Experiment. II, Soil analyses 1964-72, with special reference to changes in carbon and nitrogen.
Rothamsted Experimental Station. Report for 1973, Part 2, 134-151.

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Table 4

Organic Manuring, Woburn Stackyard B

Cropping and Treatments

Treatment	1964		1965		1966		1967		1968		1969		1970		1971		1972		1973	
	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
Lc Ln	Sown	Pl	Resown				Leys left growing up to: 1971 & 1972								I,III	Pl	II,IV	Pl		
St				+		+		+		+		+		+						
Pt				+		+	+	+		+		+		+						
Gm	IR	Pl	IR	Pl	Tref U/S	Pl		–	LFR U/S	Pl		–		–	LFR U/S	Pl	LFR U/S II,IV	Pl		
Fs				+		+		+		+		+		+						
Dg				50t		50t		25t		50t		50t		25t						
Fd				+		+		+		+		+		+						
Crops	Fallow		Fallow		Barley		Potatoes		Wheat		S.Beet		Beans		W.Rye		W.Rye II,IV Potatoes I,III		Potatoes II,IV Wheat I,III	

Symbols: +Treatment applied. Pl: Ploughed up. IR: Italian ryegrass. LFR: Late Flowering Red Clover.
Tref: Trefoil. U/S: Undersown. S: Spring A: Autumn. t: Tonnes. I, II, III, IV, Blocks.

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INTENSIVE CEREALS

WOBURN STACKYARD I

(W/RN/13)

This experiment, started in 1966, deals with the effects of intensive cropping with wheat or barley on yield, incidence of soil-borne diseases and organic matter in the soil. The wheat blocks are situated on part of the site of the Classical Wheat experiment and the barley on the Barley experiment (see Continuous Wheat and Barley, 1877 onwards *Details 1967,* pp 49-52). There are small errors in note (4) p. 49 and Table 19 p.50 and a correct statement is contained in papers I and II of the reference.

Design

For each crop: 2 blocks of 6 whole plots each split into 4 sub-plots (8 in certain seasons)

Treatments

Mustard was sown in the bare fallow in June 1965 and ploughed in during October.

Whole plots:	Continuous wheat or barley and each phase of a five-course rotation of 1-year ley (1966 spring sown, 1967-70 autumn sown, 1971-73 spring sown), potatoes and three years of either wheat or barley.
Quarter plots:	Nitrogen to the cereal:
	Wheat 63 v. 126 v. 188 v. 251 kg N
	Barley 50 v. 100 v. 150 v. 200 kg N
Eighth plots:	0 v. 182 kg Mg0 as Epsom salts on wheat blocks only, applied cumulatively 1968 and 1969.
	0 v. 182 kg Mg0 as Epsom salts on barley block 1969. Residuals compared with equivalent fresh dressings applied to previously untreated eighth plots on both wheat and barley blocks 1970. (Residuals v. 364 kg for wheat and 182 for barley).

NOTE: Eighth plots were not separately harvested after 1970.

Standard manuring

P and K	For all crops including ley: 126 kg P_2O_5 and 251 kg K_2O half ploughed in and half on plough furrow as (0-14-28)		
N	For potatoes:		151 kg N applied to seedbed.
	For leys:	1966	50 kg N applied to seedbed in spring.
		1967-69	50 kg N top dressed in spring.
		1970	126 kg N top dressed in spring and 95 kg N after each of first two cuts.
		1971-73	63 kg N in seedbed and 63 kg N eight weeks after sowing: with additional 75 kg N in 1971 and 60 kg N in 1973 after the first cut (1972 only 1 cut taken in September).

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Liming

1971 5 t magnesium limestone, three quarters ploughed in and one quarter on plough furrow in autumn 1970.

Varieties

Wheat:	1966-73	Cappelle
Barley:	1966-69	Maris Badger
	1970-73	Julia (dressed with ethirimol 1972 and 1973)
Potatoes:	1966	Pentland Dell
	1967-73	Majestic
Seeds mixtures:	1966-69	(Parts by weight) English Italian-ryegrass – 20%; Danish Italian-ryegrass – 40%; English Broad Red Clover – 30%; Canadian Alsike – 10%; sown at 32 kg.
	1970-72	S 22 Italian-ryegrass sown at 32 kg
	1973	S 22 Italian-ryegrass sown at 38 kg.

Weedkillers

Potatoes	1969-73	Linuron with paraquat (1971 linuron only)
Wheat and barley	1966-71 & 1973	Ioxynil with mecoprop
	1972	2,4-D with dichlorprop
	1970 and 1972	Paraquat applied previous autumn.

Other chemicals

Potatoes	1966-73	Mancozeb
	1968-73	Demeton-s-methyl
	1967, 1968, 1970 & 1973	B.O.V. (haulm mechanically destroyed other years)

Area harvested

Potatoes:	0.00138 – 0.00343
Wheat & Barley:	0.00134 – 0.00277
Ley:	0.00089 (Yields of leys not taken 1971 and 1972)

Soil series. Stackyard series.

References

1. Johnston, A.E. (1975)
Experiments made on Stackyard Field, Woburn. 1876–1974
I. History of the field, details of the cropping and manuring and the yields in the Continuous Wheat and Barley experiments.

2. Johnston, A.E., Chater, M. (1975)
II. Effects of treatments on soil pH, P and K in the Continuous Wheat and Barley experiments.

3. Mattingly, G.E.G., Chater, M., and Johnston, A.E. (1975)
III. Effects of NPK fertilisers and farmyard manure on soil carbon, nitrogen and organic phosphorous.
Rothamsted Experimental Station. Report for 1974, Part 2, 29-77.

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ROTATION AND FUMIGATION
WOBURN BUTT CLOSE
(W/RN/15)

This experiment, started in 1969, is designed to study different ways of using nematicides in a three-course rotation and to determine the effects on crop yield and incidence of pathogenic nematodes.

Design
3 series each of 2 blocks of 3 plots split into 7. One phase of a 3-course rotation, potatoes, barley and sugar beet is present in each series.

Treatments
Each crop tests all combinations of:–
Whole plots: N fertiliser (kg N)

Potatoes and Sugar beet	Barley
75	38
150	75
225	113

Sub-plots: Fumigants
(a) None
(b) Dichloropropane/dichloropropene ('D-D' at 448 kg): before potatoes
before sugar beet
before barley
before all crops

Plus 2 reserve sub-plots: one no fumigant:
one allocated in 1970 to dazomet at 224 kg before all crops after no treatment in 1969.

NOTE: 'D-D' has been injected into ploughed or cultivated soil in autumn or early winter. Dazomet has been applied and rotary cultivated in before the 'D-D' injection except in December 1971 when it was worked in the following day. In 1971 and 1972 all sub-plots were rotary cultivated, in 1970 and 1973 only dazomet-treated sub-plots were cultivated following application.

Standard manuring

Barley:	310 kg (0-20-20)
Potatoes:	1050 kg (0-14-28)
Sugar beet:	1050 kg (0-14-28)
1971:	13 kg B_2O_3 as 'Solubor'
1972 & '73:	7 kg B_2O_3 as 'Solubor'

Liming
1971-73: 2.5 t magnesian limestone in autumn before sugar beet.

Varieties

Barley:	1969	Zephyr
	1970-73	Julia (dressed with ethirimol 1972 and 73)

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Potatoes:	1969	King Edward
	1970-73	Pentland Crown
Sugar beet	1969-73	Klein E

Weedkillers

Barley:	1969-72	Ioxynil with mecoprop
Potatoes:	1969-73	Linuron: alone 1971 and 1973 and with paraquat in 1969, 70 and 72.
Sugar beet:	1969-70 and 1972-73	Phenmedipham; and paraquat in 1972

Other chemicals applied

Fungicides	Potatoes	1969-73	Mancozeb
Insecticides	Potatoes and Sugar beet	1969-73	Demeton-s-methyl

Plot area harvested

Barley	0.00052
Potatoes	0.00052 – 0.00104
Sugar beet	0.00057 – 0.00156

Soil series Cottenham series

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INTENSIVE BARLEY FOLLOWED BY WHEAT AFTER INTENSIVE BARLEY

ROTHAMSTED LITTLE KNOTT I

(R/C5/6)

This experiment, started in 1961, was designed to provide a comparison each year between barley immediately following a two-year break from cereals and barley 2, 3 . . . years after the break. Barley in a four-course rotation (one phase only), continuous barley, continuous winter wheat and continuous spring wheat were also included.

From 1969 winter wheat was the only cereal grown and the experiment was used to study the effects of different sequences of pre-cropping with barley on yields and incidence of take-all *(Gaeumannomyces graminis)* in wheat; break-crops (fallow and beans) were introduced in certain sequences.

Since 1973 only one quarter of the experiment has been continued, primarily for studies on the phenomenon of take-all decline.

Design

Two replicates of 40 treatments in four blocks of 20 (with certain interactions confounded). Later the experiment was analysed as two blocks of 40.

In 1971 each strip of 40 plots was divided across the plots for a test of lime.

In 1973 only two replicates of 10 plots were retained.

Treatments

(1) *Crop sequences*

Treatment	1961	62	63	64	65	66	67	68	69	70	71	72	73
1	0	BE	B	B	B	B	B	B	WW	F	WW	WW	WW
2	WS	0	BE	B	B	B	B	B	WW	WW	WW	F	WW
3	0	WS	0	BE	B	B	B	B	WW	WW	WW	F	BE
4	BE	0	WS	0	BE	B	B	B	WW	WW	WW	WW	F
5	WS	BE	0	WS	0	BE	B	B	WW	WW	WW	WW	WW
6	WS	WS	BE	0	WS	0	BE	B	WW	WW	WW	WW	WW
7	B	B	B	B	B	B	B	B	WW	WW	WW	WW	WW
8	WS	WS	WS	WS	WS	WS	WS	WS	WW	WW	WW	WW	WW
9	WS	WW	WW	WW	WW	WW	WW	F	WW	WW	WW	WW	WW
10	BE	WW	P	B	BE	WW	P	B	F	WW	WW	WW	WW

0 = Oats, BE = Spring beans, B = Barley, WW = Winter wheat, WS = Spring wheat, F = Fallow

(2) *Nitrogen* (kg N as 'Nitro-Chalk')

1961-68	1969 & 70
None (NO)	75 (N3) to former N0 plots
38 (N1)	126 (N5) to former N1 plots
76 (N2)	176 (N7) to former N2 plots
114 (N3)	226 (N9) to former N3 plots

Applied to continuous cereals and to winter wheat and barley in treatment sequence 10.

Nitrogen treatments were discontinued in 1971.

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(3) *Lime*

1971 Each strip of 40 plots was split across all plots for a test of none (U) v. ground chalk at 12.6 t (L).

Standard applications

Cereals and beans	
1961-68	37.5 kg P_2O_5, 75 kg K_2O as (0-14-28) cereals combine drilled, beans placement drilled. Oats and non-continuous spring wheat: 56 kg N as 'Nitro-Chalk'.
Potatoes	
1963	125 kg N, 125 kg P_2O_5, 225 kg K_2O as (10-10-18).
1967	145 kg N, 145 kg P_2O_5, 225 kg K_2O as (13-13-20).
Winter wheat	
1969	140 kg P_2O_5, 280 kg K_2O as (0-14-28) ploughed in. 40 kg P_2O_5, 40 kg K_2O as (0-20-20) combine drilled.
1970	120 kg P_2O_5, 240 kg K_2O as (0-14-28) ploughed in. 35 kg P_2O_5, 70 kg K_2O as (0-14-28) combine drilled
1971-73	35 kg P_2O_5, 70 kg K_2O as (0-14-28) combine drilled 125 kg N as 'Nitro-Chalk' top dressed.
Spring beans	
1973	55 kg P_2O_5, 110 kg K_2O as (0-14-28)

Liming

1961	3.0 t ground chalk
1966	3.1 t ground chalk
1971	See treatment above
1973	10.0 t on half plots not limed in 1971 and 2.5 t overall.

Weedkillers

Oats, barley, winter and spring wheat:	1961-63	MCPA with TBA
Oats, barley, spring wheat:	1964	MCPA with dichloroprop
Winter wheat:	1964 & 1965	Mecoprop with 2,4-D
Oats:	1965	MCPA with dicamba
Barley:	1965	Mecoprop with 2,4-D
Barley, winter and spring wheat & Oats:	1966-68 1966	Ioxynil with mecoprop
All plots:	1968	Aminotriazole with ammonium thiocyanate in autumn 1967.
Winter wheat:	1969-73	Paraquat in preceding autumn
	1969	Ioxynil, bromoxynil with dichlorprop
	1970-73	Terbutryne and related triazines
	1970	Dichloroprop
	1972 & 1973	Dicamba, / mecoprop with MCPA

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Other chemicals applied

Beans:	1961, 1963, 1966, 1967	Demeton-S-methyl
	1965	Menazon
	1973	Phorate
Potatoes:	1963	Tops burnt off with B.O.V.
	1967	Mancozeb

Varieties

Barley:	1961-68	Proctor
Winter wheat:	1962-67, 1969, 1973.	Cappelle
	1970-72	Joss Cambier
Spring wheat:	1961-68	Jufy I
Spring beans:	1961-66	Tick
	1967	Tarvin
	1973	Minor
Oats:	1961-66	Condor
Potatoes:	1963 & 1967	Majestic

Areas harvested

Yields were taken for barley, winter and spring wheat only

1961-70 & 1973		0.00563 – 0.005 (1968 S. wheat: 0.00761)
1971 & 1972	Sub-plot area harvested	0.00266 – 0.00269

Soil series Batcombe and Hook series.

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LONG-TERM LIMING
ROTHAMSTED (R) SAWYERS I
WOBURN (W) STACKYARD SERIES C
(R & W/CS/10)

These experiments have continued on the lines set out in *Details 1967*, pp. 95-96.

The cropping has been:

1968	Potatoes	Majestic
1969	Fallow	
1970-73	Barley	Julia (dressed with ethirimol 1972 & 1973)

Treatments

(a) No lime was applied 1968-73.

Ground chalk: total applied 1962 and 1963 (tonnes $CaCO_3$)

Rothamsted	Woburn
None	None
5	5
10	12
20	19

(b)	Phosphate:	1968	0 v. 126 kg P_2O_5 as superphosphate
		1970-73	0 v. 63 kg P_2O_5 as superphosphate
(c)	Potash:	1968	0 v. 188 kg K_2O as muriate of potash
		1970-73	0 v. 126 kg K_2O as muriate of potash

P and K were applied cumulatively from 1962

No treatments were applied to the fallow in 1969

Basal applications

Nitrogen

1968	Rothamsted	188 kg N	broadcast before planting
	Woburn	251 kg N	
1970-73	Rothamsted	95 kg N	combine drilled
	Woburn	126 kg N	broadcast before planting

Weedkillers

Potatoes:	1968 (R) & (W)	Paraquat with linuron
Barley:	1970 (R)	2,4-D with dichlorprop
	(W)	Ioxynil with mecoprop
	1971 (R)	Ioxynil, bromoxynil with dichlorprop
	(W)	Paraquat. Ioxynil with mecoprop
	1972 (R)	Paraquat. Ioxynil, bromoxynil, dichlorprop and MCPA
	(W)	Paraquat
	1973 (R)	Dicamba with mecoprop and MCPA
	(W)	Ioxynil with mecoprop

Other chemicals applied

Potatoes:	1968 (R) & (W)	Mancozeb and demeton-S-methyl. Haulm burnt off with sulphuric acid.

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Areas harvested

1968	(R)	0.00384
	(W)	0.00510
1970-73	(R)	0.00512 – 0.00518
	(W)	0.00516 – 0.00520

Soil series. (R) Batcombe series with sandier variants.
(W) Cottenham series.

References

1. Bolton, J. (1971)
Long term liming experiments at Rothamsted and Woburn.
Rothamsted Experimental Station. Report for 1970, Part 2, 98-112.

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NITROGEN LEVELS TO OLD GRASS

ROTHAMSTED PARK GRASS

(R/CS/13)

This experiment, started in 1965, studies the effects of a range of nitrogen rates on yield and botanical composition of very old permanent pasture given a single dressing of P and K annually. The contribution of legumes to the productivity of the sward is studied by spraying half of the N0 plots with weedkillers. The effects of treatments on nutrients available in the soil are also studied. From 1965-69 the effects of 3 and 6 applications of N and grass cuts were measured. From 1970 the N was applied in four equal dressings, one for each cut. The effect of Mg on Mg content of the herbage was also studied for 1970 and 1971. The experiment is located on plot 6/1 of the Park Grass Experiment which received P, K, Na, Mg annually 1869-1964 after N only (96 kg N) 1856-68.

Design

4 randomised blocks of 10 plots. The magnesium treatments 1970 and 1971 and the extra N treatments from 1972 were arranged on the original treatments:–

Treatments 1965-69

Cuts			3					6		
Total N	0	0[x]	1	2	3	0	0[x]	1	2	3

Treatments 1970-71

Cuts			4					4		
Total N	0	0[x]	1	2	3	0	0[x]	1	2	3
Mg level										
Blocks I & II	1	1	2	1	2	2	2	1	2	1
Blocks III & IV	2	2	1	2	1	1	1	2	1	2

Treatments 1972–

Cuts			4					4		
Total N	0	0[x]	1	3	5	0	0[x]	2	4	6

[x] Plots treated with mecoprop to eliminate clovers.

Treatments

(1) *Nitrogen* (kg N per annum as 'Nitro-Chalk')

	1965-71		1972–	
No. of cuts	None	(N0)	None	(N0)
(A)	145	(N1)	75	(N1)
(A)	290	(N2)	225	(N3)
(A)	435	(N3)	375	(N5)
(B)	145	(N1)	150	(N2)
(B)	290	(N2)	300	(N4)
(B)	435	(N3)	450	(N6)

(A) 1965 & 1966 3 cuts/annum, N applied equally for each.
1967 3 cuts/annum, N applied in 6 equal dressings.

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	1968 & 1969	6 cuts/annum, N applied in 3 equal dressings for first, third and fifth cuts.
(B)	1965-69	6 cuts/annum, N applied equally for each.
(A) and (B)		
	From 1970	4 cuts/annum, N applied equally for each.

(2) *Control of legumes*
Two plots per block receiving no N are sprayed with mecoprop, once annually 1965, 1967 and 1969 and twice 1966, 1968 and 1970-73.

(3) *Magnesium*

1970 and 1971	28 kg Mg v. 56 kg Mg each year as magnesium sulphate.

Basal applications

1965–	34 kp P as superphosphate, 224 kg K as potassium sulphate.
1965-69	16 kg Na as sodium sulphate.
1965-69, 1972 & 1973	11 kg Mg as magnesium sulphate.

Liming (as ground chalk)

1965	8.7 t
1968	7.5 t
1970	2.9 t

Plot areas harvested 0.00086 – 0.00090

Soil series Batcombe series.

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NPK TO OLD GRASS

ROTHAMSTED PARK GRASS

(R/CS/14)

This experiment, started in 1965, studies the effects of a range of P and K levels on yields of permanent pasture and is located on Park Grass plots 5/1 and 5/2 which provide sites with little and much P and K respectively.

Design

On each site a single replicate of 2 x 4 x 4 in 2 blocks of 16 plots each, with 2 x 2 additional plots in each block.

Treatments

(1) The sites differ in previous history:

Plot 5/1:	1856-97	96 kg N annually
	1898-1964	Unmanured
Plots 5/2:	1856-97	96 kg N annually
	1898-1964	Superphosphate and sulphate of potash to supply 34 kg P and 224 kg K annually.

(2) On each site all combinations of:

(a) Nitrogen fertiliser (kg N for each cut)

	N1	N2
1965	37.5	75
1966	56.0	112
1967-73	33.6	67.2

(b) Phosphate (Kg P) annually as superphosphate

P0	None
P1	16.8
P2	33.6
P4	67.2

(c) Potassium (kg K) annually as potassium chloride

K0	None
K2	112
K4	224
K8	448

(3) Together with extra treatments on each site: all combinations of:

(a) nitrogen fertiliser as 2(a)

(b) residues of PK fertiliser applied 1965 only

33.6 kg P + 56.1 kg K
33.6 kg P + 336 kg K

Number of nitrogen applications have been:

1965	4
1966	3
1967	5/1 – 3; 5/2 – 4
1968 & 1969	3

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1970 & 1971	2
1972	3
1973	3

Liming

Ground chalk applied (t/ha)

1965:	Plot 5/1 – 12.8	plot 5/2 – 11.5
1968:	Plot 5/1 – 6.2	plot 5/2 – 5.5
1970:	Both plots – 8.8	

Area harvested 0.00085 – 0.00090

Soil series Batcombe series

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PK AND TAKE-ALL

ROTHAMSTED WEST BARNFIELD II

(R/CS/24)

This experiment, started in 1968, is designed to study the effects of different amounts of phosphate and potash on the yield and incidence of soil-borne diseases, particulary take-all (*Gaeumannomyces graminis)* in continuous cereals (barley until 1973).

Design

1968-69:	5 x 2, in 4 randomised blocks of 10 plots
1970–	5 x 2 x 4 in 4 blocks of 10 plots split into two for N.

Treatments

All combinations of:

Whole plots	(a)	Phosphate (kg P_2O_5) as superphosphate
None		
38 150		annually to seedbed
226 904		Six-yearly, last applied autumn 1967, half before ploughing, half after
	(b)	Potash (kg K_2O) as muriate of potash
37.5 150		annually to seedbed

NOTE: Rates of P and K have been slightly changed from 1974

From 1970.

Sub-plots	(c)	Nitrogen (kg N) applied cumulatively in successive years
38		
75		
113		
150		

Basal applications

Nitrogen:	1968 & 1969	100 kg N

Liming

1969	2.9 t ground chalk
1972	5.0 t ground chalk

Weedkillers

1968 & 1969, 1971-73	Paraquat applied to stubble in previous autumn
1968	Aminotriazole with ammonium thiocyanate in previous autumn
1969 & 1970	2,4-D with dichlorprop
1971	Ioxynil, bromoxynil with dichlorprop
1972	Ioxynil, bromoxynil, dichlorprop with MCPA
1973	Dicamba, mecoprop with MCPA

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Varieties	
1968 & 1969	Maris Badger
1970-73	Julia
Areas harvested	
1968 & 1969	0.00567
1970	0.00264 – 0.00273
Soil series	Hook series

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