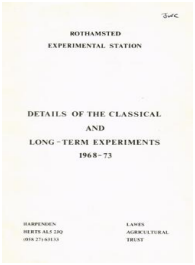
Details of the Classical and Long-term Experiments 1968-73



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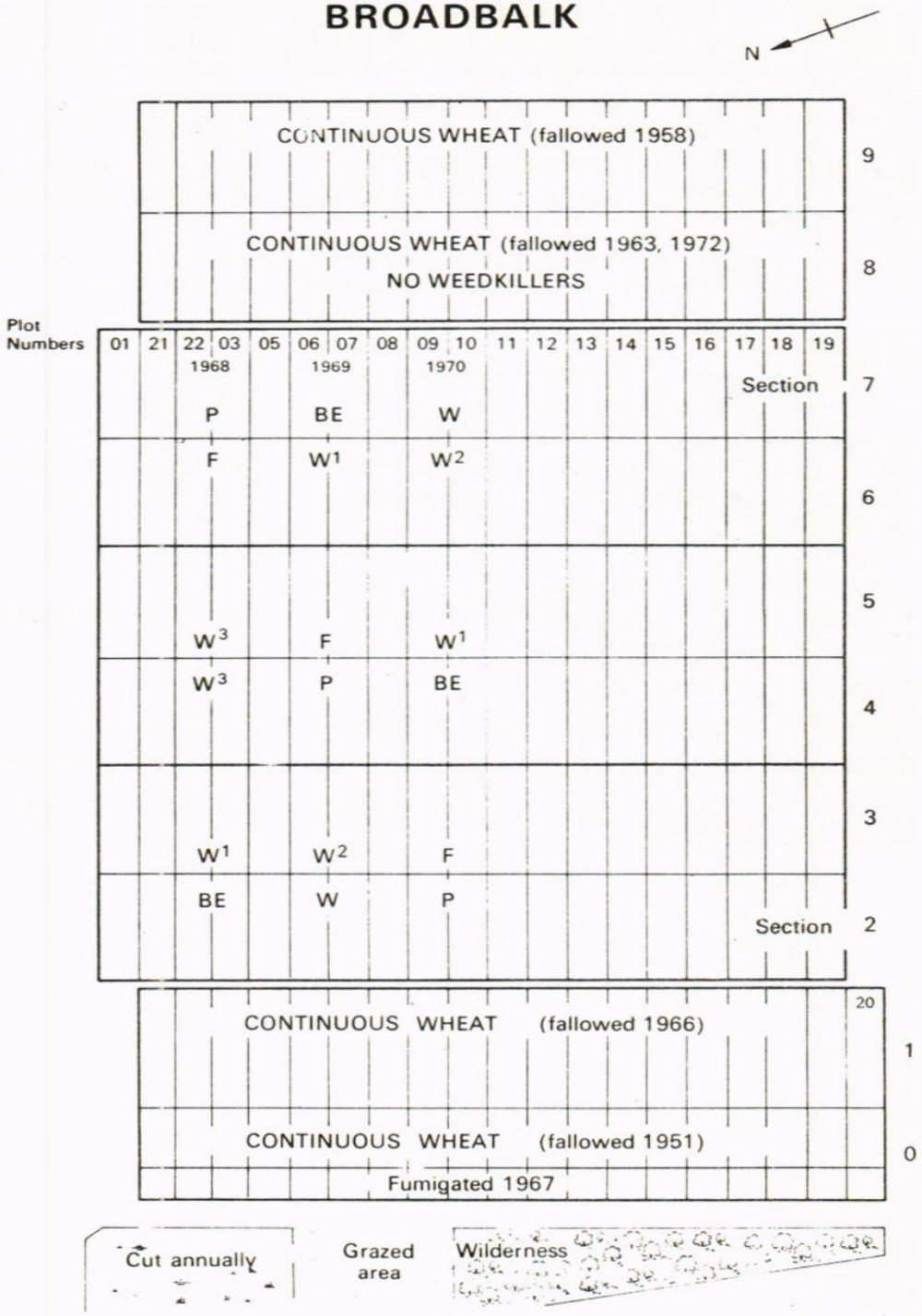
Classical Experiments

Rothamsted Research

Rothamsted Research (1977) *Classical Experiments ;* Details Of The Classical And Long-Term Experiments 1968-73, pp 4 - 35 **- DOI: https://doi.org/10.23637/ERADOC-1-193**

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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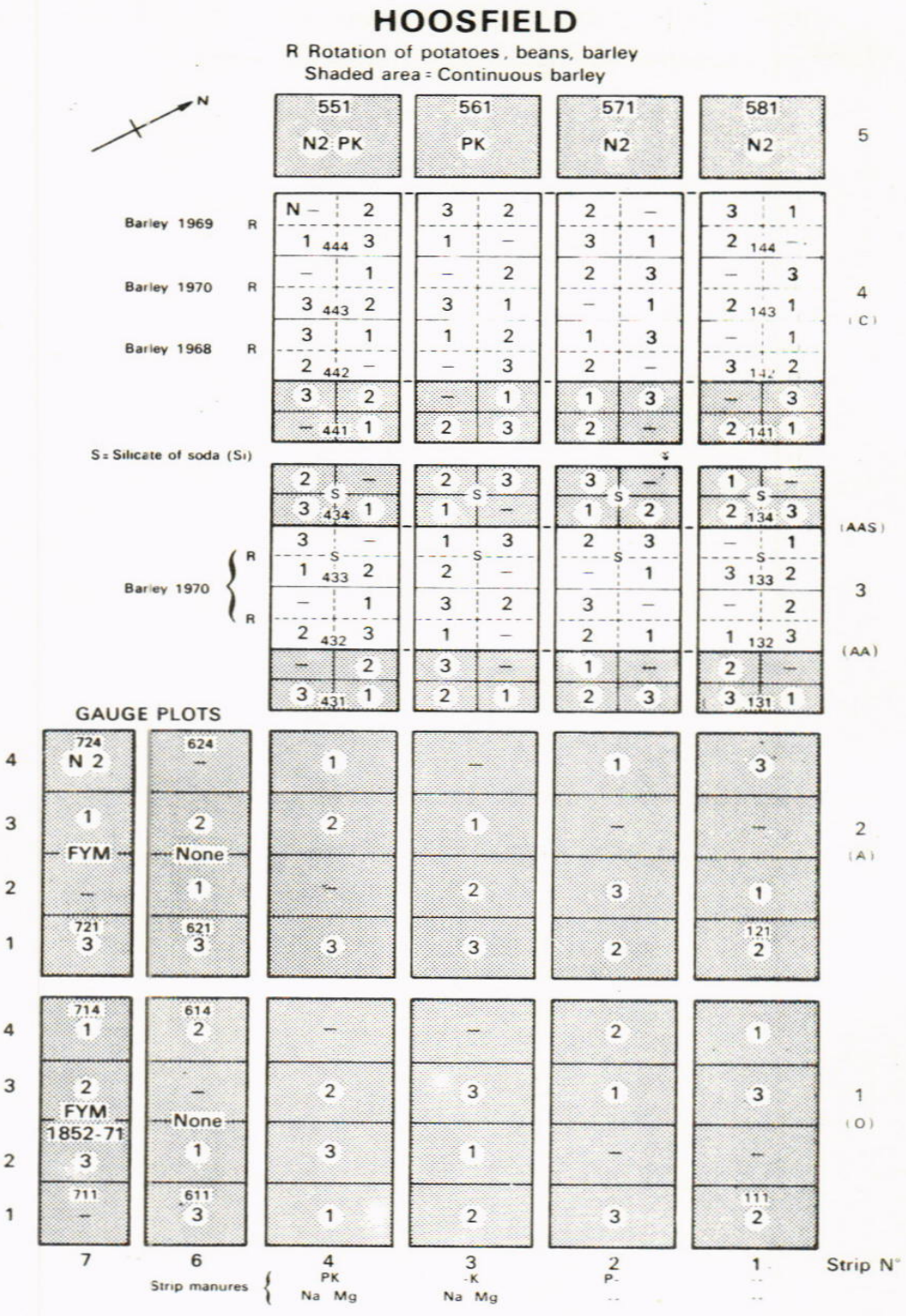
Reference

Rothamsted Experimental Station. Report for 1968, Part 2.

https://doi.org/10.23637/ERADOC-1-193



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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.

https://doi.org/10.23637/ERADOC-1-193

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)
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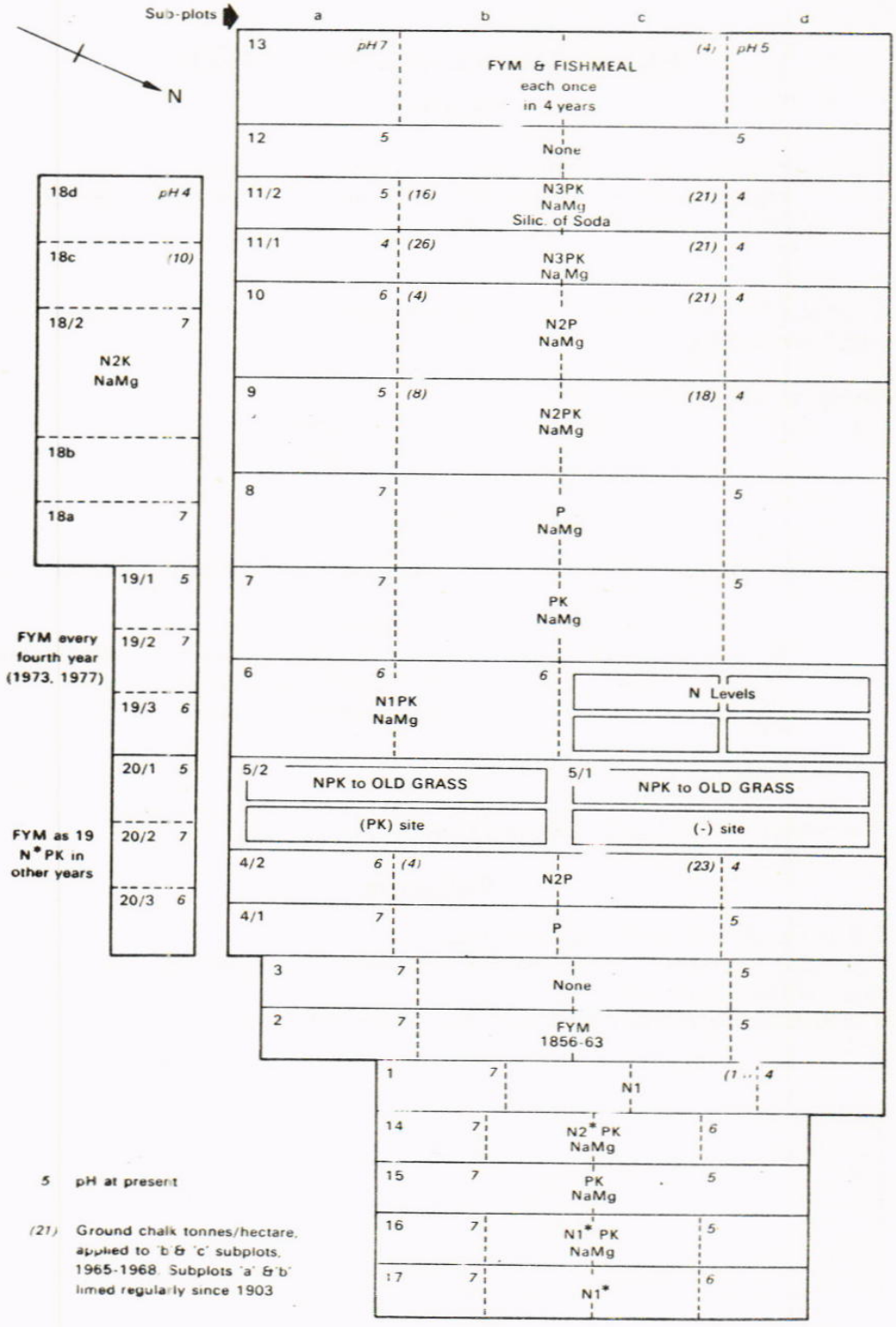
Rothamsted Experimental Station. Report for 1969, Part 2, 39-90.

https://doi.org/10.23637/ERADOC-1-193

PARK GRASS



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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

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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.

2. Edwards, C.A. & Lofty, J.R. (1976)
The Invertebrate Fauna of the Park Grass plots I. Soil fauna.
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3. Johnston, A.E. (1972)
Changes in the soil properties caused by the new liming scheme on Park Grass.
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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.

5. Williams, E.D. (1974)
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.

https://doi.org/10.23637/ERADOC-1-193 *pp 16*

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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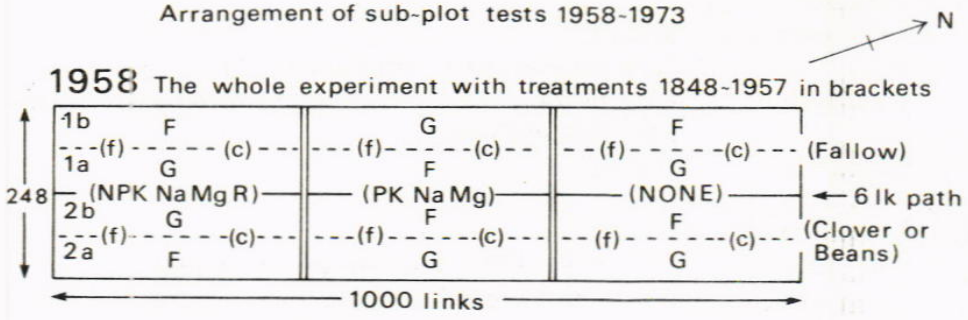
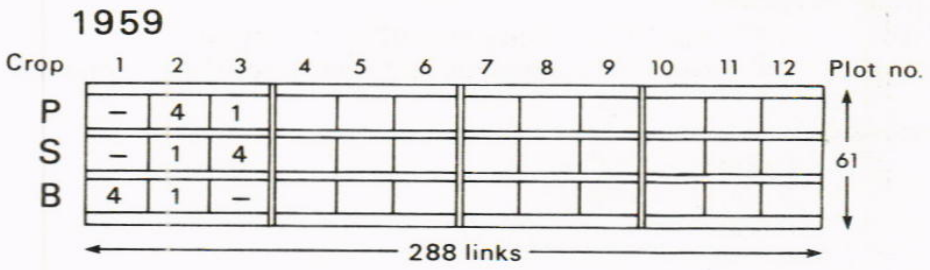
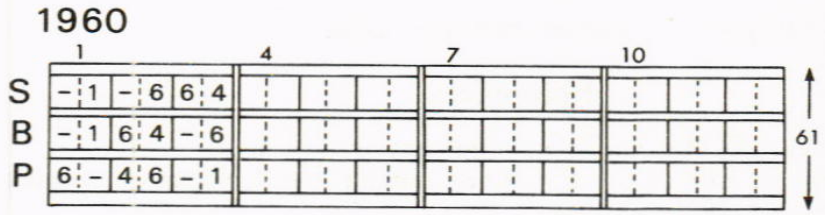
AGDELL

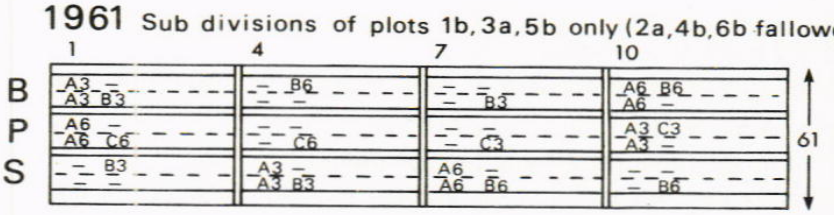
Arrangement of sub-plot tests 1958-1973



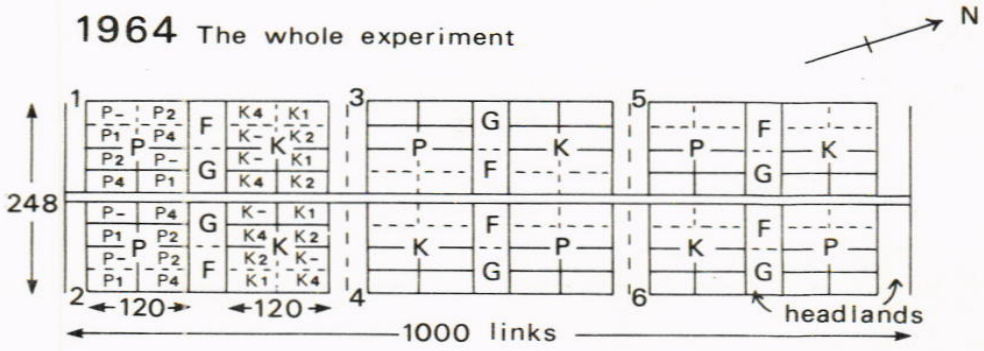
1959-63 Details of sub-plots on plot 1b (one replicate only shown)







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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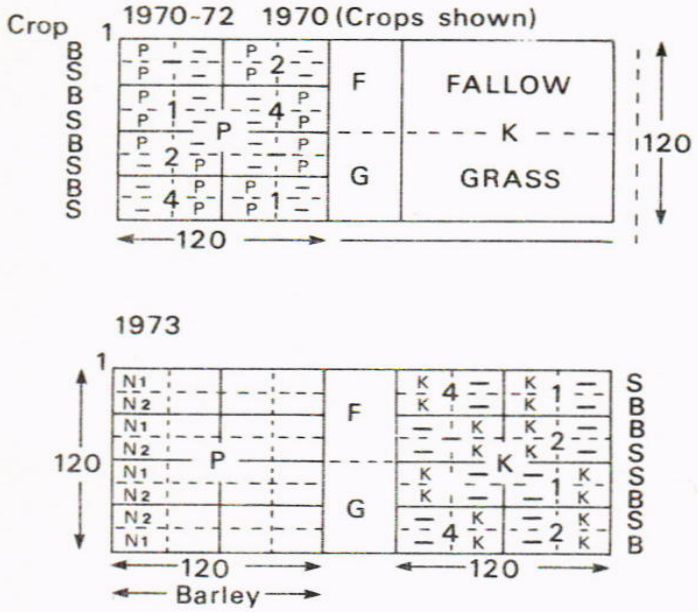
1970~73 Details of sub-plots on plot 1



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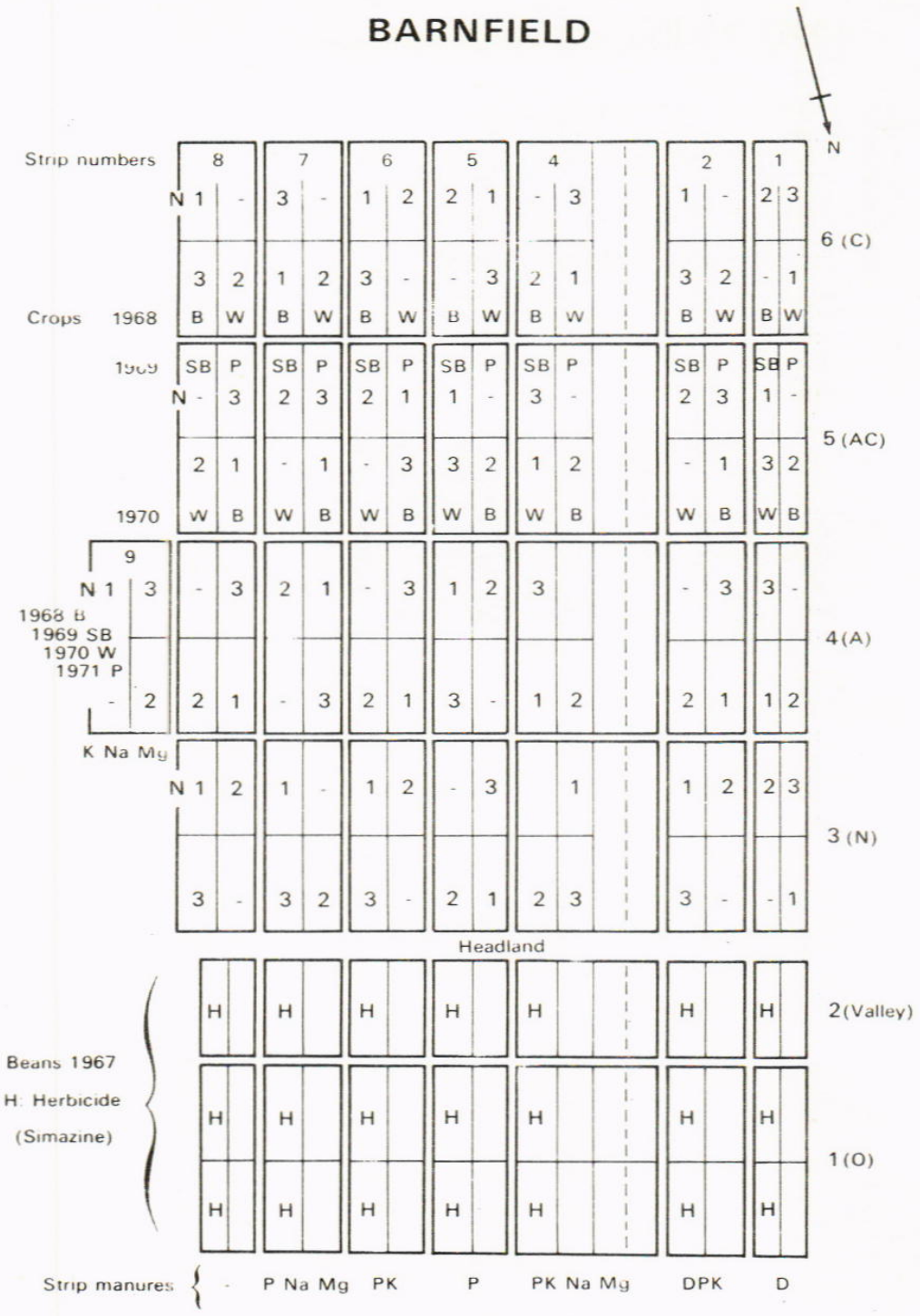

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BARNFIELD

(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)

https://doi.org/10.23637/ERADOC-1-193

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Rothamsted Experimental Station. Report for 1971, Part 2, 5-37.

2. Nutman, P.S. & Ross, G.J.B. (1970)
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Rothamsted Experimental Station. Report for 1969, Part 2, 148-167.

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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.
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2. Williams, R.J.B. and Cooke, G.W. (1971)
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Rothamsted Experimental Station. Report for 1970, Part 2, 68-97.

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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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SAXMUNDHAM

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

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