Report for 1971

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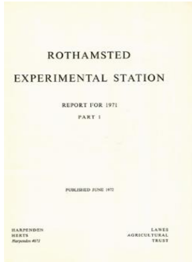

Field Experiments Section

G. V. Dyke

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FIELD EXPERIMENTS SECTION

G. V. DYKE

Field Plots Committee

The field experiments at Rothamsted, Woburn and Saxmundham are controlled by the Field Plots Committee: G. W. Cooke (Chairman), G. V. Dyke (Secretary), J. McEwen (Deputy Secretary), F. C. Bawden, J. M. Hirst, A. E. Johnston, F. G. W. Jones, J. R. Moffatt, R. Moffitt, J. A. Nelder and C. P. Whittingham.

D. J. Watson, who retired on 31 March 1971, had been Chairman since 1968. He was Secretary from 1930 to 1947 and recently served on many Working Parties, often as Chairman.

Table 1 shows the number of plots on the three farms; for the first time the grand total exceeds 10 000. Changes were mainly small; there were more plots in crop-sequence experiments and fewer in rotation experiments than in 1970; there was a large increase in annual experiments with roots (mainly potatoes) at Woburn. Microplots again increased substantially.

Field Experiments Section

Dyke and McEwen continued the secretarial work of the Field Plots Committee and its Working Parties. McEwen, Allen and Barnard prepared sketches, instructions and final

TABLE 1

Number of plots in 1971

	Grain	Roots	Hay	Total
Full scale plots (yields taken):				
Classical experiments:				
Rothamsted	340	183	200	723
Saxmundham	—	—	80	80
Long-period rotation experiments:				
Rothamsted	860	184	92	1136
Woburn	334	328	32	694
Crop-sequence experiments:				
Rothamsted	716	148	146	1010
Woburn	272	299	—	571
Saxmundham	128	—	—	128
Annual experiments:				
Rothamsted	1344	468	—	1812
Woburn	300	144	—	444
Saxmundham	80	—	—	80
Totals:				
Rothamsted	3260	983	438	4681
Woburn	906	771	32	1709
Saxmundham	208	—	80	288
Total	4374	1754	550	6678
Full scale plots (no yields taken):				
Rothamsted				518
Woburn				110
Microplots:				
Rothamsted				1803
Woburn				1069
Saxmundham				280
			Total	10 458

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plans for all the experiments done by farm staff and members of the Section. McEwen, Barnard and Jarvis assembled the summaries of treatments, cultivations etc. which were passed to Dunwoody (Statistics Department) for inclusion in the published results. The possibility of including in this publication non-yield observations (e.g. assessments of disease in an experiment testing curative measures) was discussed, but proved impracticable without considerably enlarging the publication. To emphasise the decision to continue publishing yield results only, the publication will be entitled 'Yields of the Field Experiments'. From this year also Imperial units give way to metric except for a few long-term experiments that are nearly ended. Whether this change (which applies to this Report also) will make our results more or less readily intelligible to readers is uncertain, especially as there seems to be no generally accepted metric unit of yield per unit area for crops such as cereals.

All members of the Section, but especially Scowen and Jarvis, continued to serve visitors to Rothamsted by demonstrating the field experiments, by describing the work of departments, and by arranging appropriate meetings with members of the station staff.

Small-plot experiments

The section undertook all agricultural operations on 26 experiments, involving 810 plots and some operations on 20 others. The small sprayer was used about 70 times on experiments.

In autumn 1970 Long Hoos V was allocated for small-plot experiments and observations and is now managed in the same way as the Garden Plots. There are eight sites of 0·1 ha each but electricity is not available and irrigation can be arranged only with difficulty. In autumn 1970 and again in 1971 175 kg P_2O_5 and 350 kg K_2O/ha were applied before ploughing. These dressings, together with smaller annual ones, should ensure that no crop suffers from a lack of P or K. The annual dressing on the Garden Plots is 125 kg P_2O_5 and 125 kg K_2O/ha.

We used nets supported about 60 cm above the soil to protect peas and brussels sprouts from birds early in the season. These are easier to manipulate than the ones on taller supports used to protect cereals. Protecting cereal experiments in this way is not very satisfactory as special layouts are needed at drilling time so that the supporting pillars can be kept out of the plots; they are usually left in position from brairding to harvest and so interfere with such jobs as spraying. (Wilson, Turnell and Finch)

Annual summary of yields from standard experiments at Rothamsted and Woburn

Winter wheat. Cappelle wheat on Broadbalk without N fertiliser yielded about as much as in 1970, but N increased yields more and best yields without FYM were about 1 tonne/ha more than in 1970 and roughly equal to those of 1969 (Table 2).

The FYM plot yielded about 1 tonne more than fertilisers; this has been consistently so for wheat after the 2-year break in the three seasons since the rotation was established. A yield of 7·5 tonnes/ha (3 tons/acre) still eludes us on Broadbalk.

On the Ley–Arable Joss Cambier, grown as second test-crop after potatoes, gave similar yields in the two fields except that on plots ploughed from 'reseeded' grass in autumn 1963 and cropped as 'arable with hay' since, Highfield gave 0·8 tonne less than Fosters (Table 3). 100 kg N was needed for maximum yield after 'arable with hay' but after leys or 'reseeded' 50 kg N gave very nearly maximum yields. Best yields in 1971 were a little less than in 1970 on Highfield, a little more on Fosters; on both fields 1971 yields were 1–2 tonnes/ha less than in 1969.

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TABLE 2

Broadbalk Wheat; yields of crops from selected treatments

Grain, tonnes/ha

Treatment	1971 (a)	1971 (b)	1971 (c)	1970 (a)	1970 (b)	1970 (c)	1969 (a)	1969 (b)	1969 (c)
None	2·5	3·1	2·1	2·3	3·0	2·1	3·4	3·0	2·1
N2	5·4	4·1	3·3	4·4	4·3	1·9	4·5	2·9	2·8
PKNaMg	2·6	3·8	2·5	2·5	4·0	2·6	4·4	3·5	2·4
N1PKNaMg	4·9	4·7	4·5	4·6	4·5	4·1	5·8	5·1	4·3
N2PKNaMg	6·4	5·1	6·0	5·3	4·6	5·1	6·4	6·4	5·5
N3PKNaMg	6·0	5·3	5·7	4·9	4·8	5·8	5·9	5·8	5·9
N4PKNaMg	6·0	5·4	5·3	5·1	4·6	5·5	5·4	5·8	5·3
N2P	5·1	3·0	4·2	4·5	3·8	3·6	5·0	4·4	4·1
D	6·9	7·3	6·5	5·9	6·3	5·3	7·4	6·0	4·8
DN2	4·9*	6·1	4·9*	5·6	5·8	4·5	6·8	6·2	5·8
R	5·7	5·2	4·6	4·9	4·6	3·6	4·6	5·0	2·9
Mean of all plots	5·5	5·0	4·9	5·0	4·6	4·3	5·5	5·1	4·4

(a) Wheat after potatoes, beans.
(b) First wheat after fallow.
(c) Continuous wheat since 1952.

Symbols: N1, N2, N3, N4 = 'Nitro-Chalk' at 48, 96, 144, 192 kg N/ha
P = Superphosphate annually, at 73 kg P_2O_5/ha
K = Sulphate of potash annually, at 110 kg K_2O/ha
Na = Sulphate of soda annually, at 16 kg Na/ha
Mg = Sulphate of magnesia annually, at 11 kg Mg/ha
D = Farmyard manure annually, at 35 tonnes/ha
R = Castor meal annually, at 96 kg N/ha

* Badly lodged.

Fourth test-crop wheat (the third successive cereal crop) yielded well on all rotations on Fosters (best yields being about 0·3–0·7 tonne less than those of the 2nd test-crop), but on Highfield (except after 'clover-grass ley') the 4th test-crop yielded about 1 tonne less than the 2nd test-crop. This difference, probably caused by take-all, is similar to, but smaller than, that shown in 1969. Yields of the 6th and 7th test-crop wheat were less than or equal to those of the 4th test-crop; differences probably reflect different amounts of take-all (see p. 142).

Joss Cambier grown on plots of the Intensive Spring Barley experiment that have been in wheat since 1961 yielded 2 tonnes/ha more than in 1970, and about as much as Cappelle in 1969 (Table 4).

TABLE 4

Winter Wheat after Intensive Spring Barley experiment

Wheat, grain, tonnes/ha
(Continuous wheat since 1961, spring-sown 1961–68)

1971 (Joss Cambier) 126 kg N/ha	1970 (Joss Cambier) 126 kg N/ha	1969 (Cappelle) 126 kg N/ha
6·0	4·0	6·2

Basal dressing: 35 kg P_2O_5, 70 kg K_2O/ha (1971)
157 kg P_2O_5, 314 kg K_2O/ha (1970)
179 kg P_2O_5, 320 kg K_2O/ha (1969)

On the Woburn Intensive Cereals experiment best yields of Cappelle were 5 tonnes/ha after a 2-year break, 3·8 tonnes after wheat; 126 kg N gave almost maximum yield in both sequences. Best yields were 1·2–1·8 tonnes more than in 1970, a little less than in 1969 (Table 5).

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TABLE 3

Rothamsted Ley–Arable

Wheat (Joss Cambier), grain, tonnes/ha

	2nd test-crop						4th test-crop					6th test-crop					7th test-crop			
	1971 kg N/ha				1970	1969	1971 kg N/ha				1969	1971 kg N/ha				1970	1971 kg N/ha			
Previous cropping	0	50	100	150	Maximum yield (N)	Maximum yield (N)	75	125	175	225	Maximum yield (N)	75	125	175	225	Maximum yield (N)	75	125	175	225
										Highfield										
Lu	6·2	7·2	7·3	5·9	7·6 (150)	8·1 (100)	4·9	5·2	5·2	5·7	4·5 (125)	4·9	6·0	5·2	5·7	3·8 (225)	5·1	5·6	5·6	5·6
Lc	5·7	6·3	6·6	6·0	8·1 (150)	7·9 (150)	6·5	6·8	6·6	5·8	6·0 (125)	5·3	5·7	5·2	4·5	4·2 (175)	5·2	5·4	6·2	4·9
Ln	5·5	7·4	7·6	7·0	7·6 (100)	8·3 (150)	6·7	6·6	6·8	5·8	5·3 (175)	3·4	4·2	4·4	3·9	4·0 (175)	5·5	6·1	6·0	5·6
Ah	5·4	6·7	7·1	7·2	7·3 (100)	8·3 (150)	6·1	6·3	5·7	6·0	5·0 (225)	4·8	5·6	5·8	5·7	3·9 (225)	5·8	6·6	6·7	6·0
Rc } Rn	5·7[8]	6·1[8]	6·4[8]	6·0[8]	8·1[8](150)	8·6[2] (50)	7·0[4]	6·4[4]	6·6[4]	5·3[4]	6·4[1] (75)	5·5[3]	4·3[3]	4·3[3]	4·3[3]	3·9[6](225)	6·5[7]	6·6[7]	6·1[7]	5·2[7]
Rn						8·5[2] (50)	7·4[4]	7·1[4]	5·7[4]	5·6[4]	6·4[1](125)	5·4[3]	5·7[3]	5·4[3]	4·4[3]					
Gc	—	—	—	—	7·6[2](100)	8·5[2](100)	6·7[4]	5·8[4]	5·9[4]	4·7[4]	5·9[1](225)	5·4[3]	6·4[3]	3·9[3]	5·3[3]	6·5[3](175)	4·1[4]	3·8[4]	4·9[4]	4·9[4]
Gn	—	—	—	—	8·1[2](150)	8·2[2](150)	6·7[4]	7·4[4]	6·0[4]	5·8[4]	6·2[1] (75)	4·2[3]	4·1[3]	4·4[3]	3·9[3]	5·8[3](125)	2·9[4]	4·2[4]	3·6[4]	4·6[4]
										Fosters										
Lu	6·0	7·2	7·3	6·5	7·0 (150)	8·9 (100)	6·2	7·0	6·6	6·0	7·7 (125)	5·4	6·4	6·5	6·1	5·5 (225)	5·2	6·6	6·4	5·8
Lc	6·1	7·1	7·2	6·3	6·7 (150)	8·5 (100)	6·2	6·4	6·5	6·0	7·5 (175)	5·9	6·8	6·6	5·8	5·4 (225)	4·8	6·4	6·2	5·7
Ln	5·8	6·9	7·0	6·1	6·3 (150)	8·8 (100)	6·3	6·9	6·4	5·9	8·1 (175)	5·4	6·5	6·4	6·2	5·8 (225)	5·4	6·6	6·0	5·7
Ah	5·0	6·2	6·9	6·5	6·4 (150)	9·1 (150)	5·7	6·5	6·6	6·4	8·0 (125)	5·6	6·9	6·5	6·4	5·1 (225)	4·7	6·1	6·4	5·8
Rc } Rn	5·3[8]	6·9[8]	7·2[8]	6·8[8]	6·9[8](150)	8·5[2](100)	7·1[4]	6·6[4]	5·8[4]	6·6[4]	7·1[1](225)	6·4[3]	6·8[3]	6·4[3]	5·9[3]	5·6[6](225)	5·5[7]	5·9[7]	6·3[7]	5·8[7]
Rn						9·3[2](100)	7·0[4]	6·3[4]	5·7[4]	5·9[4]	7·3[1](175)	5·8[3]	6·8[3]	6·5[3]	5·6[3]					

Symbols: Lu = lucerne (3 years), arable (3 years), alternating
Lc = clover-grass ley (3 years), arable (3 years), alternating
Ln = all-grass ley (3 years), arable (3 years), alternating
Ah = arable with hay (3 years), arable (3 years), alternating
R = reseeded grass
G = old permanent grass
c = PK but no N applied (as Lc)
n = PK and N applied (as Ln)

[1] 1st crop after grass
[2] 2nd crop after grass; followed potatoes
[3] 3rd crop after grass; followed wheat, wheat
[4] 4th crop after grass; followed potatoes, wheat, barley (4th test-crop 1971); followed wheat, wheat, wheat (7th test-crop 1971)
[6] 6th crop after grass; cropping as 'Ah' meanwhile
[7] 7th crop after grass; cropping as 'Ah' meanwhile
[8] 8th crop after grass; cropping as 'Ah' meanwhile

Basal dressing: 113 kg P_2O_5, 113 kg K_2O/ha

Erratum to Report for 1970, Part I, p. 226, Table 6.
Footnote [2] should read '2nd crop after grass; followed potatoes (2nd test-crop 1969); followed wheat (5th test-crop 1970 and 1969)'
Footnote [3] should read '3rd crop after grass; followed wheat, wheat'

TABLE 5

Woburn Intensive Cereals experiment

Wheat (Cappelle), grain, tonnes/ha

	1971 kg N /ha				1970 Maximum yield (N)	1969 Maximum yield (N)
	63	126	188	251		
(i)	3·2	4·8	5·0	4·6	3·2 (188)	5·5 (188)
(ii)	2·9	3·6	3·8	3·2	2·6 (188)	4·0 (188)

(i) After ley, potatoes.
(ii) Continuous wheat since 1966.

Basal dressing: 126 kg P_2O_5, 251 kg K_2O/ha

To sum up: there are rather few experiments allowing comparisons of yields between 1971, 1970 and 1969 but it seems that wheat yielded 1–2 tonnes/ha more in 1971 than 1970 except on the Rothamsted Ley–Arable experiment; here the differences were small and, on Highfield (old grass till the experiment began) yields were less than those of 1970. Yields were generally about equal to those of 1969, but on the Ley–Arable the exceptionally large yields of 1969 were not equalled.

Barley. Yields of Julia barley on the Hoos Permanent Barley experiment ranged from less than 2 tonnes/ha to nearly 6 tonnes, the largest being some of the best ever recorded on these plots (Table 6).

TABLE 6

Hoos Barley experiment

Yields of selected treatments (and effects of Si)
Barley, grain, tonnes/ha

Treatment	1971 (Julia)	1970 (Julia)	1969 (Maris Badger)
None	1·6	1·0	1·4
N1	2·3	2·0	2·4
N2	2·7	2·1	2·9
N3	2·4	2·3	3·5
PKNaMg	2·0	1·5	1·5
N1PKNaMg	3·8	3·0	3·1
N2PKNaMg	5·9	4·4	4·8
N3PKNaMg	5·9	5·2	5·4
D	5·0	4·4	2·3
DN2	4·8*	5·7	5·4
Effect of Si:			
Without P	+1·7	+1·2	+1·2
With P	+0·9	+0·2	+0·3

Symbols: N1, N2, N3 = 'Nitro-Chalk' at 48, 96, 144 kg N/ha
P = Superphosphate annually, at 73 kg P_2O_5/ha
K = Sulphate of potash annually, at 110 kg K_2O/ha
Na = Sulphate of soda annually, at 16 kg Na/ha
Mg = Sulphate of magnesia annually, at 11 kg Mg/ha
Si = Silicate of soda annually, at 448 kg/ha
D = Farmyard manure annually, at 35 tonnes/ha

* Badly lodged.

Where minerals have been applied annually since 1852, N trebled the yield; without minerals the response to N was much smaller. 96 kg N was enough for maximum yield. Yields with minerals and N were better than 1970 by about 1 tonne. Most yields in 1969 (when Maris Badger was grown) were intermediate between those of 1971 and 1970, except that plots with N alone yielded exceptionally well in 1969.

On the Ley–Arable, Julia barley (Table 7) gave generally better maximum yields than in 1970, by 1·3–2·3 tonnes/ha, on Fosters (old arable), by much less on Highfield (old

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TABLE 7

Rothamsted Ley–Arable

Barley, grain, tonnes/ha

Previous cropping	1971 (Julia) kg N/ha 0	50	88	126	1970 (Julia) Maximum yield (N)	1969 (Maris Badger) Maximum yield (N)
Highfield						
Lu	5·3	6·3	5·9	5·6	6·1 (126)	6·1 (25)
Lc	5·8	6·3	6·0	6·4	6·0 (50)	5·9 (38)
Ln	5·2	6·8	5·9	6·2	5·9 (88)	5·6 (25)
Ah	4·9	6·4	6·2	6·1	6·0 (126)	5·6 (38)
Rc } Rn }	6·1[9]	6·6[9]	6·2[9]	6·2[9]	6·7[3] (88)	—
					6·6[3] (88)	—
Gc	6·3[3]	6·6[3]	5·5[3]	6·0[3]	6·5[3] (88)	—
Gn	6·3[3]	6·0[3]	5·9[3]	5·6[3]	6·4[3] (88)	—
Fosters						
Lu	5·2	6·2	7·3	6·5	5·1 (88)	6·4 (75)
Lc	5·8	6·2	6·8	6·1	4·8 (88)	6·2 (75)
Ln	5·4	6·4	6·4	6·6	4·7 (88)	6·2[3](50)
Ah	4·6	6·1	6·3	6·6	4·8 (126)	6·2[3](75)
Rc } Rn }	5·3[9]	6·5[9]	6·7[9]	6·8[9]	4·8 (50)	—
					5·0 (126)	—

Symbols: Lu = lucerne; Lc = clover–grass ley; Ln = all-grass ley; Ah = arable with hay

R = reseeded grass; G = old permanent grass; c = PK but no N applied (as Lc); n = PK and N applied (as Ln)

[3] 3rd crop after grass: followed potatoes, wheat

[9] 9th crop after grass; cropping as Ah meanwhile

Basal dressing: 38 kg P_2O_5, 76 kg K_2O/ha

grass until the experiment began). On Highfield 50 kg of N were about enough for maximum yield on all sequences (more N caused much lodging) but on Fosters 88 or 126 kg N were needed. (Second test-crop wheat, by contrast, suffered little lodging and rates of N for maximum yield were about the same on both fields—see Table 3). Yields of barley were rather better on Fosters than on Highfield, in contrast to 1970 when yields on Fosters were at least 1 tonne less than on Highfield. Second test-crop wheat yields showed a similar pattern.

On the Residual Phosphate Rotation experiments yields of Julia barley (Table 8) were less than on the Ley–Arable but followed the same pattern as on the Ley–Arable; the old arable site (Sawyers I) gave better yields than the old grass (Great Field IV) in 1971 and 1969 but relatively poor yields in 1970.

On the Cultivation–Weedkiller Rotation experiment yields of Julia barley were greater than in 1970, by 1·0–1·2 tonnes/ha; 1969 yields were intermediate (Table 9).

At Woburn, on the Intensive Cereals experiment (Table 10), best yields were a little greater than in 1970 or in 1969; in 1971 and 1970 the crop was resown after a failure.

TABLE 8

Residual Phosphate Rotation experiments

Barley, grain, tonnes/ha
(1971, 1970: Julia. 1969: Maris Badger)

P_2O_5(kg/ha) as superphosphate	Sawyers I 1971	1970	1969	Great Field IV 1971	1970	1969
0	4·9	3·0	4·9	3·6	3·0	3·8
376 in 1960	5·2	3·5	4·9	3·1	4·0	4·0
63 annually	5·8	4·0	5·6	4·6	4·8	3·9

Basal dressing: 100 kg N, 63 kg K_2O/ha (1971, 1970)
100 kg N, 126 kg K_2O/ha (Sawyers I, 1969)
50 kg N, 126 kg K_2O/ha (Great Field IV, 1969)

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TABLE 9

Cultivation-Weedkiller Rotation experiment

Barley, grain, tonnes/ha

	1971 (Julia)	1970 (Julia)	1969 (Maris Badger)
Ploughed	6·0	5·0	5·5
Rotary cultivated	5·8	4·6	5·5
Tine cultivated	5·8	4·6	5·5

Basal dressing: 94 kg N, 38 kg P_2O_5, 38 kg K_2O/ha

TABLE 10

Woburn Intensive Cereals experiment

Barley, grain, tonnes/ha

	1971 (Julia) kg N/ha				1970 (Julia) Maximum yield (N)	1969 (Maris Badger) Maximum yield (N)
	50	100	150	200		
(i)	3·6	4·6	4·4	4·8	4·7 (150)	4·5 (100)
(ii)	3·1	3·6	4·3	4·6	4·1 (200)	3·9 (150)

(i) After ley, potatoes.
(ii) Continuous barley since 1966.
Basal dressing: 126 kg P_2O_5, 251 kg K_2O/ha

TABLE 11

Yields of beans (Maris Bead) from selected treatments of the Classical experiments

Grain, tonnes/ha

Experiment	Treatment	1971	1970	1969
Broadbalk (i)	None	2·0	0·5	1·0
	N2	1·5	0·2	2·0
	N2P	0·5	0·8	1·4
	PKNaMg	2·7	0·8	2·2
	D	2·6	1·8	2·1
Hoos Barley* (i)	None	1·8	1·1	1·9
	P	1·4	0·7	1·6
	KNaMg	1·7	0·9	2·5
	PKNaMg	2·4	1·4	3·7
Barnfield (i)	None	1·3	0·4	2·4
	P	1·8	0·5	3·0
	PNaMg	1·6	0·5	2·7
	PKNaMg	1·6	0·4	3·0
	D	1·2	0·7	2·3
	DPK	1·3	1·2	2·8
(ii)	None	0·3	0·1	0·8
	P	0·4	0·2	1·6
	PNaMg	0·3	0·2	1·4
	PKNaMg	0·4	0·3	1·6
	D	1·6	1·0	2·1
	DPK	0·7	0·7	2·6

(i) No simazine. (ii) With simazine

* All with residues of castor meal last applied 1967.

Symbols: N2 = 'Nitro-Chalk' at 96 kg N/ha
P = Superphosphate annually, at 73 kg P_2O_5/ha
K = Sulphate of potash annually, at 110 kg K_2O/ha (Broadbalk and Hoos Barley), 275 kg K_2O/ha (Barnfield)
Na = Sulphate of soda annually, at 16 kg Na/ha (Broadbalk and Hoos Barley); agricultural salt annually, at 88 kg Na/ha (Barnfield)
Mg = Sulphate of magnesia annually, at 11 kg Mg/ha
D = Farmyard manure annually, at 35 tonnes/ha

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To sum up: yields of barley at both farms were better than in 1970. Old arable fields at Rothamsted gave 1–2 tonnes/ha more, but at Woburn, and after grass at Rothamsted, the difference was small. Most yields were a little better than in 1969.

Beans. Spring beans again yielded poorly on the Classical experiments (Table 11). Best yields were about 2·5 tonnes/ha, double those of 1970 but much less than those of 1969, which were not particularly good by comparison with 1968 and earlier years. Yields on Barnfield (5th successive crop of beans) were about two thirds of those grown in rotation on Broadbalk and Hoos Barley. Yields on the Cultivation–Weedkiller rotation varied in much the same way as on the Classicals (Table 12).

TABLE 12

Cultivation-Weedkiller Rotation experiment

Beans (Maris Bead) grain, tonnes/ha

	1971	1970	1969
Ploughed	2·2	1·0	3·1
Rotary cultivated	2·0	0·5	3·1
Tine cultivated	1·9	0·6	3·1

Basal dressing: 56 kg P_2O_5, 113 kg K_2O/ha

Potatoes. On plots of Broadbalk and Barnfield that receive no mineral fertiliser yields of potatoes were much less than in 1970 or 1969 (Table 13). On the Hoos Barley experiment

TABLE 13

Yields of potatoes (King Edward) from selected treatments on the Classical experiments

Total tubers, tonnes/ha

Experiment	Treatment	1971	1970	1969
Broadbalk	None	7·8	12·6	13·0
	N4	9·2	10·5	7·5
	PKNaMg	9·6	19·1	19·6
	N8PKNaMg	45·6	41·8	45·0
	D	36·2	43·8	40·2
	DN4	49·4	49·1	48·2
Date of planting		3 April	30 April	10 April
Hoos Barley*	N6	18·8	19·1	25·6
	N6PKNaMg	36·6	33·6	47·8
Date of planting		2 April	30 April	10 April
Barnfield†	None	5·8		9·0
	N9	17·7		16·5
	PKNaMg	11·9		10·5
	N9PKNaMg	32·7		41·2
	D	22·8		26·8
	DN9	31·6		50·8
Date of planting		2 April		9 April

Symbols: N4, N6, N8, N9 = 'Nitro-Chalk' at 96, 144, 192, 216 kg N/ha
P = Superphosphate annually, at 73 kg P_2O_5/ha
K = Sulphate of potash annually, at 110 kg K_2O/ha (Broadbalk and Hoos Barley), at 275 kg K_2O/ha (Barnfield)
Na = Sulphate of soda annually, at 16 kg Na/ha (Broadbalk and Hoos Barley); agricultural salt annually, at 88 kg Na/ha (Barnfield)
Mg = Sulphate of magnesia annually, at 11 kg Mg/ha
D = Farmyard manure at 35 tonnes/ha

* All with residues of castor meal, last applied 1967.
† No potatoes in 1970.

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TABLE 14

Residual Phosphate Rotation experiments

Potatoes (Majestic), total tubers, tonnes/ha

P_2O_5 (kg/ha) as superphosphate	Sawyers I			Great Field IV		
	1971	1970	1969	1971	1970	1969
0	24	23	23	28	29	32
376 in 1960	23	28	27	28	34	34
188 annually	42	34	32	46	43	40
Date of planting	7 April	6 May	16 April	7 April	6 May	16 April

Basal dressing: 215 kg N, 251 kg K_2O/ha (1971, 1970)
151 kg N, 188 kg K_2O/ha (1969)

potatoes are grown annually only on land that received castor meal for many years and here yields without minerals were much greater and differed less between years. With minerals and ample 'Nitro-Chalk', yields on Broadbalk were 40–46 tonnes/ha in the three seasons; on Hoos and Barnfield this treatment gave 10–20 tonnes more in 1969 than in the later years. Farmyard manure plus 'Nitro-Chalk' gave 4 tonnes more than fertiliser only on Broadbalk but on Barnfield slightly less; the reason for this is not known.

On the Residual Phosphate Rotation experiments basal dressings were increased in 1971 (Table 14). This seems to have increased yields markedly where 188 kg of P_2O_5 is given annually but elsewhere yields were rather less than in 1970 or 1969.

On the Cultivation–Weedkiller Rotation, yields given by mould-board ploughing were 8 tonnes/ha better than 1970 but with rotary cultivation and tine cultivation yields were about equal in the two years (Table 15). All treatments gave less in 1969 than in 1970.

On the Woburn Ley–Arable potatoes were grown as first test-crop for the first time since 1955 when potato cyst-nematode was recognised as a serious pest on certain plots. In 1971 we compared two varieties, Maris Piper with some resistance to nematodes and Pentland Crown with none. Chloropicrin in autumn plus aldicarb in spring were also tested. The resulting sub-plots were very small and the yields recorded should be read with caution (Table 16). It is clear, nevertheless, that with some combinations we have produced exceptionally good yields ranging to 85 tonnes/ha (34 tons/acre). Chloropicrin plus aldicarb increased yields substantially on most plots; the increase was (surprisingly) greater and more consistent with Maris Piper than with Pentland Crown.

Table 16 shows also the yields of treatment-crop potatoes (all Maris Piper). Although in 1971 these were planted on the same day as the test-crop, they yielded about 20 tonnes/ha less than the corresponding (unfumigated) test potatoes. If this difference is put down to differences in soil between the blocks of the experiment it suggests that comparison of yields in successive years (necessarily in different blocks) is almost valueless.

Majestic potatoes on the Woburn Intensive Cereals experiment yielded on average about 8 tonnes/ha more than in 1970, 2 tonnes more than in 1969 (Table 17). Yields on

TABLE 15

Cultivation-Weedkiller Rotation experiment

Potatoes, total tubers, tonnes/ha

	1971 (Pentland Crown)	1970 (Pentland Dell)	1969 (Pentland Dell)
Ploughed	41	33	29
Rotary cultivated	34	33	30
Tine cultivated	37	37	31
Date of planting	8 April	1 May	15 April

Basal dressing: 163 kg N, 163 kg P_2O_5, 251 kg K_2O/ha

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TABLE 16

Woburn Ley–Arable

Potatoes, total tubers, tonnes/ha

Previous cropping	1971 Test-crop Pentland Crown O	F	Maris Piper O	F	1971 Treatment-crop Maris Piper O	1970 Treatment-crop Maris Piper O	F	1969 Treatment-crop Maris Piper O	F
L (P)	64	65	60	73	—	—	—	—	—
L (A)	54	68	63	76	41	35	48	45	56
S (P)	58	65	72	85	—	—	—	—	—
S (A)	57	58	65	75	33	29	43	47	59
AH (P)	42	55	50	67	29	24	42	35	55
AH (A)	50	70	56	85	—	—	—	—	—
AR (P)	43	58	46	58	28	26	40	34	47
AR (A)	56	69	64	79	—	—	—	—	—
Date of planting	30 March				30 March	22 April		17 April	

Note: yields of test-crop 1971 on AH, AR are from sub-plots not given chloropicrin and aldicarb in 1969.

Symbols:
- O = no fumigant
- F = chloropicrin plus aldicarb in current year.
- L = 3-year ley (1971 potatoes; ley grazed first year, then cut for hay. 1970, 1969 potatoes: ley grazed)
- S = 3-year sainfoin
- AH = potatoes, rye, hay
- AR = potatoes, rye, carrots
- (P) = rotation permanent
- (A) = rotations in rotation; symbol indicates last rotation

Note: plots of treatments AH, AR have carried potatoes more frequently than those of L, S since 1938.

Basal dressing: 1971: 225 kg N, 255 kg P_2O_5, 393 kg K_2O/ha (with additional K_2O to certain plots of test-crops).
1970, 1969: 113 kg P_2O_5, 226 kg K_2O/ha (yields given are means of 126, 188, 251 kg N/ha).

the old barley experiment site were 11 tonnes greater than on the wheat site. Why this difference, which had diminished in recent years, is so great again, is not known.

On the Woburn Rotation and Fumigation experiment Pentland Crown potatoes yielded 5–20 tonnes/ha less than in 1970 except on fumigated plots with the heaviest dressing of N (Table 18). On this site 225 kg N was needed for maximum yield (as in 1969 also) whereas in 1970 150 kg N gave the best yields.

Although potatoes were planted earlier than usual and there was no prolonged drought, in general they failed to give outstandingly good yields; indeed, where conditions were bad (e.g. on plots very poor in P and K) yields were less than in 1970 or 1969. Where nutrients were plentiful and pathogens few, by contrast, yields were at least as good as in 1970 or 1969. The Woburn Ley–Arable test-crop (but not the treatment-crop) showed us that yields 25% greater than our usual best are attainable.

TABLE 17

Woburn Intensive Cereals experiment

Potatoes (Majestic), total tubers, tonnes/ha

After Classical experiment on:	1971	1970	1969
Wheat	35	32	35
Barley	46	34	41
Date of planting	30 March	22 April	18 April

Basic dressing: 151 kg N, 126 kg P_2O_5, 251 kg K_2O/ha

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TABLE 18

Woburn Rotation and Fumigation experiment

Potatoes, total tubers, tonnes/ha

	1971 Pentland Crown kg N/ha			1970 Pentland Crown kg N/ha			1969 King Edward kg N/ha		
	75	150	225	75	150	225	75	150	225
O	22	24	33	37	45	42	28	37	47
F	30	45	51	38	50	49	36	43	51
Date of planting	31 March			22 April			18 April		

O = no fumigant.
F = 'D–D' at 448 kg/ha for potatoes only.

Basal dressing: 148 kg P_2O_5, 295 kg K_2O/ha

Growth regulators for spring beans

A microplot experiment tested all combinations of:

(i) no growth regulator, aminozide (previously known as B-Nine) at 4·5 kg/ha applied once at 5-leaf stage, aminozide at 4·5 kg/ha applied on each of three occasions from 5-leaf stage to flowering, and 'PP412' (the potassium salt of 2(3-chlorophenyl-carbamoyloxy) propionic acid) at 4·5 kg/ha applied once at flowering;
(ii) 224 and 448 kg/ha of seed;
(iii) 12·7 cm (5 in.) and 50·8 cm (20 in.) spacing between rows.

The mean height of untreated stems was 117 cm. A single spray of aminozide shortened stems to 107 cm, three sprays to 84 cm. 'PP412' shortened them to 100 cm but did some damage to the plants. The mean yield of beans not treated with growth regulator was 3·3 tonnes grain/ha. This was increased to 3·6 tonnes by one spray with aminozide and to 4·2 by three. 'PP412' lessened yield to 3·1 tonnes. Close row spacing was not better than wide and the small increase of 0·3 tonnes obtained by doubling the seed rate was only slightly more than the quantity of extra seed used. (McEwen)

Effects of defoliation on spring beans

The experiment done in 1970 to determine which of four zones of the bean plant made the largest contribution to photosynthetic products in the grain was repeated. Results resembled those obtained last year and again showed that leaves on the nodes bearing pods made the largest contribution but other zones could make considerable contributions if the leaves in the pod bearing zone were removed (grain, tonnes/ha):

Effects of removing zone	Other zones untouched	Both other zones removed
(A) Leaves on nodes below first flowers	−0·3	−0·9
(B) Leaves on first nine flowering nodes	−0·9	−2·5
(C) Leaves and stem above ninth flowering node	−0·1	−1·6

The yield of untouched beans was 3·2 tonnes and that of naked stems + pods 0·4 tonnes. (McEwen)

Soil fumigation and nitrogen for spring beans at Woburn

The experiment, started in 1969, testing all combinations of:

(i) no fumigant, dazomet at 448 kg/ha;
(ii) none, 126 and 252 kg N as 'Nitro-Chalk' was again sown to spring beans with all treatments repeated on the same plots.

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Yields were greater than in either of the previous years. Untreated plots gave 1·8 tonnes grain/ha, dazomet increased this to 2·4 tonnes where nitrogen was not applied and to 2·8 tonnes with the double dressing of nitrogen. Without dazomet, yields were diminished by nitrogen and with the double dressing yield was only 1·2 tonnes. (McEwen with Hornby and Salt, Plant Pathology Department)

Rothamsted Garden Clover. Yields were the largest for seven years. Untreated plots gave a total yield of 4·7 tonnes dry matter/ha (three cuts), increased by magnesium to 7·1 tonnes. (McEwen)

Maize for grain at Woburn

Maize was grown with some success by H. H. Mann at Woburn about 15 years ago (*Rothamsted Report for 1956*, 209) but this work ended with his retirement. The current increase in interest in maize for grain suggests we should try some recent varieties. Two experiments were done in 1971. One, testing several varieties sown at different dates, was badly damaged by pheasants soon after sowing and was abandoned. The other, involving a soil fumigant and nitrogen fertiliser, was also damaged but two of the four blocks were patched by transplanting and taken through to harvest.

This experiment, which we intend to continue for several years, includes all combinations of:

(i) none, dazomet at 450 kg/ha applied in autumn 1970

(ii) 'Nitro-Chalk' at 50, 100, 150 kg N/ha in the seedbed and at 100 kg in the seedbed plus 50 kg att asselling (emergence of male flowers).

Frit-fly (*Oscinella frit*) damaged many seedlings and caused some abnormal male inflorescences. The average yield of grain (at 85% dry matter) was 5·5 tonnes/ha, similar to yields obtained by Mann in favourable seasons. Because two blocks were lost the results must be read with caution; there was little response to more than 50 kg N but yield was increased by dazomet.

Free-living nematodes in samples of soil 0–20 cm deep were counted by Corbett and Fraser (Nematology Department): by harvest *Pratylenchus* had increased on unfumigated plots to four times the number found the previous autumn. (Barnard with Hornby, Plant Pathology Department)

Suppression of couch grass by ryegrass or clover undersown in barley or beans

A small-scale experiment compared all combinations of:

(i) barley, beans;

(ii) nothing, Italian ryegrass, red clover undersown.

As in 1970 (*Rothamsted Report for 1970*, Part 1, 237) we planted widely-spaced pieces of rhizome of *Agropyron repens* about the time of sowing the nurse crops and small seeds.

All crops and most of the couch grew well. When 'harvested' in December yields of couch (whole plant) were:

	(air-dry, g per station)	
	Barley	Beans
Undersown		
None	4·0	18·0
Ryegrass	1·9	5·7
Clover	0·5	3·4

(about 0·7 g dry couch planted per station)

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This confirms the results at the Weed Research Organisation (G. W. Cussans (1968, 1970) *Proceedings of the 9th and 10th British Weed Control Conferences*, 131–136 and 337–343 respectively), that beans compete much less effectively than barley with couch. Undersown ryegrass or clover greatly suppress the development of couch. Possibly some farmers troubled by couch might delay its increase in successive crops of cereals or beans by undersowing. (Barnard and Dyke)

The choice of a break crop before wheat

The experiment reported last year (*Rothamsted Report for 1970*, Part 1, 236–237) was continued with spring barley following winter wheat. Yields of barley were little affected by the range of different crops grown in 1969 but there was a slight indication that less 'Nitro-Chalk' was needed for a full yield after clover than on the other sequences.

A similar experiment was started in 1970 with beans, oats and red clover again tested as 'break crops' in comparison with barley before wheat; again trefoil was undersown in half the plots of barley and of oats. In the second experiment, however, we introduced grain maize as an extra break crop, grown with two dressings of N. The preliminary crops all grew well in 1970, though the oats were damaged by frit-fly and birds and yielded poorly.

Undersown trefoil (which grew well and was not badly smothered) lessened the yield of barley by 0·15 tonnes/ha. The amount of N in trefoil sampled just before ploughing in early November differed little between treatments, 35–52 kg N/ha. Clover contained 64 kg N and weeds and self-sown cereals on other plots 9–19 kg N.

Table 19 shows the yields of wheat in 1971; the variety was Joss Cambier and it was badly infected with powdery mildew where much N was applied. Wheat after barley yielded less than wheat with the same amount of 'Nitro-Chalk' after oats, beans, maize

TABLE 19

Wheat after break crops (omitting undersown plots)

Grain, tonnes/ha

Preceding crop	'Nitro-Chalk' to wheat (kg N/ha) 0	50	100	150	Mean
Barley	2·60	3·92	4·28	4·40	3·80
Oats	3·78	5·26	5·56	5·30	4·98
Beans	4·39	5·64	5·72	5·43	5·30
Clover	4·54	5·60	5·56	5·22	5·23
Maize	4·94	5·67	5·71	5·06	5·34

TABLE 20

Wheat after break crops; increases in yield of wheat for trefoil ploughed in

Grain, tonnes/ha

Preceding crop	'Nitro-Chalk' to wheat (kg/N ha) 0	50	100	150	Mean
Barley with 50 kg N	+0·75	−0·09	+0·22	+0·09	+0·24
Barley with 100 kg N	+1·10	+0·45	+0·10	−0·20	+0·36
Mean	+0·92	+0·18	+0·16	−0·05	+0·30
Oats with 50 kg N	+0·32	+0·38	+0·18	−0·06	+0·20
Oats with 100 kg N	+0·49	−0·24	+0·04	+0·14	+0·10
Mean	+0·40	+0·07	+0·11	+0·04	+0·15
Mean of all	+0·66	+0·12	+0·14	0·00	+0·22

Note: All yields in Tables 19 and 20 have been adjusted for a linear trend.

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or clover; indeed the best yield after barley was less than those given by every other combination except no N after oats or beans. Maximum yields of wheat after oats, beans, clover and maize were all 5·6–5·7 tonnes/ha; after oats 100 kg N were needed but after beans, clover and maize 50 kg N was enough for maximum (or very nearly maximum) yield.

Effects of trefoil were rather more erratic than previously (Table 20), but the mean increase was very similar, 0·22 tonnes/ha (0·20 in the previous experiment). (Dyke and Prew, Plant Pathology Department)

Improvement of heathland in the New Forest

A simple experiment was started in 1962 on an area of uncultivated heath (mainly *Erica* and *Calluna* spp.). In 1971 small areas were protected from grazing by cages and samples of herbage were cut on two successive occasions. The treatments so compared were:

(i) untreated heath
(ii) lime and basic slag applied 1962 (calcium hydroxide at 7·5 tonnes/ha and basic slag at 175 kg P_2O_5)
(iii) lime alone applied 1968.

All yields of dry matter were small. Lime alone (1968) showed no increase, but lime plus slag (1962) doubled the yield. The increase was mainly in the legumes that had established with this treatment. These contained much sodium, which was almost absent from the untreated herbage. Sodium may be important to the grazing animals, which are now being excluded from the verges of main roads, one of the few situations in which legumes grow in the Forest. (Scowen, with Williams, Chemistry Department)

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