Report for 1969 - Part 1

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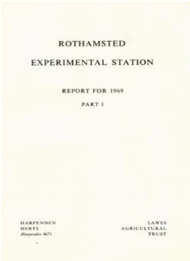
ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1969
PART 1

Field Experiments Section

G. V. Dyke

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FIELD EXPERIMENTS SECTION

G. V. DYKE

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

Dyke and McEwen continued to act as secretaries of the Field Plots Committee, its Working Parties and Sub-Committees and of the Garden Plots Committee which deals mainly with experiments sited on the Garden Plots (where there is electricity and small-scale irrigation equipment). The work of preparing sketches and instructions for the experiments continued much as before. An innovation is the use of the Orion computer to produce randomisations for the experiments. A program (written by Patterson), given simple instructions, now gives us randomisations for almost all the experimental designs (except Latin squares) that are commonly used on the Farms. The treatments are expressed in numerical symbols many of

TABLE 1

Number of full-scale plots harvested in 1969

	Grain	Roots	Hay	Total
Classical experiments:				
Rothamsted	348	151	200	699
Saxmundham	46	10	—	56
Long-period rotation experiments:				
Rothamsted	732	480	76	1288
Woburn	382	344	64	790
Saxmundham	48	—	—	48
Crop sequence experiments:				
Rothamsted	267	96	175	538
Woburn	314	449	—	763
Annual experiments:				
Rothamsted	955	312	78	1345
Woburn	404	278	—	682
Saxmundham	20	—	—	20
Totals:				
Rothamsted	2302	1039	529	3870
Woburn	1100	1071	64	2235
Saxmundham	114	10	—	124
Total	3516	2120	593	6229
Full-scale plots (no yields taken):				
Rothamsted				264
Woburn				118
Saxmundham				4
Microplots:				
Rothamsted				855
Woburn				757
Saxmundham				291
			Total	8518

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which can be transferred directly to the working sketch; this has appreciably eased the burden of producing sketches, especially where restricted randomisation is involved. Barnard now takes responsibility for sketches and instructions for all Woburn experiments and for day-to-day liaison between their sponsors and the Head of Farms. The work of the Section in demonstrating the field experiments to visitors and in making arrangements for some of them to visit departments also continued as in recent years.

Table 1 shows the number of plots on the three farms in 1969. The total is very close to that of 1968. At Rothamsted there were fewer, at Woburn more than in 1968. The increase at Woburn (mainly in roots) reflects the increase in work on soil-borne pathogens of potatoes and sugar beet, much of it involving soil fumigation. For the first time there were more plots of root crops at Woburn than at Rothamsted.

The Classical experiments

Table 2 (p. 284) shows the yields obtained from some of the more important treatments included in the Broadbalk, Hoos Permanent Barley and Barnfield experiments.

Broadbalk. The wheat crop (variety Cappelle) looked well except for a short period during late June when it was disfigured by loose smut (*Ustilago tritici*), which affected at least 5% of the shoots. There was no lodging.

For the first time for many years part of the wheat followed a 2-year break from wheat (fallow, beans). When the rotation is fully established the 2-year break will be potatoes, beans, but the effect may be expected to be similar. Yields of Cappelle after the 2-year break ranged from 27 cwt (unmanured) to 51 cwt with N2PKNaMg (the largest yield without organic manure) and 59 cwt with FYM. These large yields are roughly double those obtained on Broadbalk with the older varieties and without a 2-year break; the yield with FYM nearly equals the best yields of Cappelle on other experiments at Rothamsted in 1969. The first crop of wheat after fallow also yielded well, 51 cwt grain with N2PKNaMg, but only 48 cwt with FYM. (The crop in 1969 was protected against Wheat Bulb fly by a seed dressing.) After the 2-year break and the 1-year break maximum yield with fertilisers was given by 86 lb N (with PKNaMg); more N gave less although there was no lodging. The corresponding maximum yield in the 2nd crop after fallow was 47 cwt, given by 129 lb N and PKNaMg; in this section FYM plus 86 lb N gave 56 cwt.

In the 11th successive wheat crop the best yield was 49 cwt and in the 18th 47 cwt, both given by 129 lb N with PKNaMg; both are remarkable for land that has received no organic manure for 130 years and has grown no crop except wheat for 126 years.

Just before harvest the appearance of plots 11 (NP) and 12 (NPNa) on Section 9 (11th crop after fallow) greatly deteriorated, showing much straggling, especially in the central strips taken for yield. The corresponding areas of Section 8 (6th crop, no weedkiller) were not affected. Stubble samples from these plots examined by Slope showed *less* disease (take-all,

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eyespot, sharp eyespot) on Section 9 and the yields on Section 8 were less than on Section 9. What caused the straggling (which had little or no effect on yield) is not known.

The plant of beans (grown without simazine this year) on some plots on Broadbalk was poor because fewer seeds were drilled than intended, but yields on other plots were satisfactory; the apparent effect of N may reflect the uneven drilling.

Potatoes responded to N up to the maximum applied. The best yield with fertilisers was 17·9 tons (PKNaMg and 172 lb N), more than the yield with FYM alone, but FYM plus 86 lb N as 'Nitro-Chalk' gave 19·2 tons. Plots 17 and 18 (half-rate PKNaMg plus 86 lb N) gave about 1·5 tons less than the nearby plot with full PKNaMg and 86 lb N.

Hoos Permanent Barley. In contrast to 1968, barley (Maris Badger) did respond to N on plots where P, K, Na, Mg, silicate or castor meal have not been applied, N3 (129 lb N) giving an increase of 17 cwt grain; the response where PKNaMg are applied annually was 31 cwt. N3 usually gave more grain than did smaller amounts, except on the FYM plot where N2 (86 lb N) was enough; maximum yields were about 43 cwt where FYM or PKNaMg are given, and a little greater where castor meal has been applied in the past. On the castor meal area barley after beans yielded 2 cwt more grain than barley after barley. Silicate of soda gave an increase of 10 cwt where P has not been applied, but no increase where it has.

As on Broadbalk, the beans were an irregular plant; silicate gave no increase, but P gave an average increase of 2 cwt, and residues of castor meal 8 cwt.

Yields of potatoes which were grown only on the old castor meal plots ranged from 4·4 to 19·1 tons/acre. P without KNaMg halved the yield, but with KNaMg gave an increase of 3·3 tons. N applied to barley in 1968 had no residual effect.

Barnfield. Beans grown for the third successive year on the old Series O yielded less than in 1968. Again, on all strips without FYM, yields were much smaller where weeds were controlled by simazine than when they were controlled by inter-row cultivation. On the FYM strips, simazine and cultivation gave about equal yields. (In 1969 the yield of strip 1 without simazine was estimated from a cut as far as possible from the edge of the field and so avoided the area affected by the turning of the tractor during ploughing—see *Rothamsted Report for 1968*, Part 1, 248).

Potatoes yielded poorly on strip 8 (no P, K, Na, Mg or FYM) whatever amount of Nitro-Chalk was applied. On all other strips (which all receive P or FYM) there was a large response to fertiliser N; the maximum yields were 17·2 tons without FYM, 22·4 tons with.

Potatoes on Barnfield with N and P but no K remained actively growing with green haulm much longer than those on similarly treated plots of Broadbalk and Hoos Barley and the yields differed accordingly (Table 2).

Yields of sugar beet on Barnfield ranged from 3 tons of roots (14 cwt sugar) to 17 tons of roots (70 cwt sugar) with fertilisers only. Residues of castor meal gave a maximum yield of 18 tons (71 cwt sugar). With FYM

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TABLE 2

Rothamsted Classical Experiments 1969; yields of crops from selected treatments

Grain, cwt/acre, total tubers, tons/acre and total sugar, cwt/acre

	Treatment											
	—				PKNaMg					FYM		P
Experiment	—	N1	N2	N3	—	N1	N2	N3	N4	—	N2	N2
BROADBALK												
Wheat												
(i) after 2 year break (fallow, beans)	27	—	36	—	35	46	51	47	43	59	54	40
	—	—	37†	—	—	—	—	—	—	—	—	—
(ii) 1st after fallow	24	—	23	—	28	41	51	46	46	48	49	35
	—	—	40†	—	—	—	—	—	—	—	—	—
(iii) 18th after fallow	17	—	22	—	19	34	44	47	42	38	46	33
	—	—	23†	—	—	—	—	—	—	—	—	—
Beans (no simazine)	8*	—	16	—	18	23	26	26	29	17*	12*	11
	—	—	21†	—	—	—	—	—	—	—	—	—
Potatoes	5·2	—	3·0	—	7·8	11·9	14·6	16·2	17·9	16·0	19·2	2·4
	—	—	8·3†	—	—	—	—	—	—	—	—	—
HOOS BARLEY												
Barley‡	11	19	23	28	12	25	38	43	—	18	43	32
	(15)	(33)	(43)	(46)	(22)	(33)	(43)	(43)	—	—	—	(41)
Beans (no (simazine)	8	—	—	—	24	—	—	—	—	—	—	—
	(15)	—	—	—	(30)	—	—	—	—	—	—	—
Potatoes	—	—	—	(10·2)	—	—	—	(19·1)	—	—	—	(5·5)§
BARNFIELD												
Potatoes	3·6	5·7	6·6	6·6	4·2	10·4	14·7	16·4	—	10·7	22·4	13·1
	(4·4)	(6·2)	(8·0)	(8·2)	(4·0)	(8·9)	(14·0)	(17·2)	—	(9·7)	(17·7)	(13·3)
Sugar beet	11	26	36	41	19	39	56	70	—	30	74	51
	(20)	(38)	(52)	(46)	(24)	(49)	(65)	(71)	—	(26)	(70)	(53)
Beans												
(i) Cultivated	19	—	—	—	24	—	—	—	—	18	—	24‖
(ii) Simazine	6	—	—	—	13	—	—	—	—	17	—	12‖

* Germination poor because of defective drilling.
† 86 lb N as castor meal annually including 1969.
‡ Means of old Series O (No N) and Series A (sulphate of ammonia).
§ N3P.
‖ P alone.

Symbols:

- N1, N2, N3, N4 — 'Nitro-Chalk' at 43, 86, 129, 172 lb N/acre—i.e. about 0·4, 0·8, 1·2, 1·6 cwt N/acre (Broadbalk, Hoos Barley). On Barnfield N1, N2, N3 are 64, 129, 193 lb N/acre, i.e. about 0·6, 1·2, 1·7 cwt N/acre.
- P = Superphosphate annually, at 0·6 cwt P_2O_5/acre.
- K = Sulphate of potash annually, at 0·9 cwt K_2O/acre (Barnfield 2·2 cwt K_2O/acre).
- Na = Sulphate of soda annually, at 14 lb Na/acre (Barnfield, agricultural salt at 80 lb Na/acre).
- Mg = Sulphate of magnesia annually, at 10 lb Mg/acre (Barnfield 20 lb Mg/acre).
- FYM = Farmyard manure annually, at 14 tons/acre.
- () = Indicates yield with residues of castor meal last applied 1967 (Hoos Barley), 1961 (Barnfield).

the best yield was 19 tons (74 cwt sugar); the small difference between the best yields with and without FYM contrasts sharply with the potato crop.

Annual summary of yields from standard experiments at Rothamsted and Woburn

Wheat. Cappelle wheat on well-manured plots of Broadbalk yielded 15–20 cwt more than in 1968; on plots without applied N the difference was rather smaller.

The Ley-Arable Experiment carried wheat on three of the six phases; the variety Joss Cambier replaced Cappelle. The '2nd test-crop' wheat followed potatoes in the new sequence of test-crops. The '4th test-crop' followed barley (the 3rd test-crop under the old scheme) and the '5th test-

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TABLE 3

Rothamsted Ley-Arable

Wheat, grain, cwt/acre
(1968, Cappelle; 1969 Joss Cambier)

Previous cropping	2nd test-crop 1969, cwt N/acre				4th test-crop 1969, cwt N/acre				4th test-crop 1968		5th test-crop 1969, cwt N/acre			
	0·0	*0·4*	*0·8*	*1·2*	*0·6*	*1·0*	*1·4*	*1·8*	Maximum yield	(N)	*0·6*	*1·0*	*1·4*	*1·8*
Highfield														
Lu	48	60	64	62	22	36	33	34	26	(0·9)	42	41	43	40
Lc	51	58	63	63	44	48	45	44	37	(0·3)	46	46	47	44
Ln	48	58	65	66	38	40	42	40	35	(0·3)	42	44	41	45
Ah	42	54	63	66	37	40	39	40	31	(1·2)	44	48	48	46
Rc	56[2]	68[2]	68[2]	66[2]	51[1]	36[1]	45[1]	42[1]	37[4] (Rc, Rn)	(0·3)	52[5]	51[5]	52[5]	50[5]
Rn	57[2]	68[2]	67[2]	65[2]	42[1]	51[1]	49[1]	49[1]						
Gc	53[2]	65[2]	68[2]	64[2]	45[1]	47[1]	30[1]	47[1]	27[1]	(0·3)	57[2]	49[2]	47[2]	44[2]
Gn	58[2]	63[2]	62[2]	66[2]	50[1]	41[1]	47[1]	33[1]	28[1]	(0·3)	55[2]	56[2]	49[2]	52[2]
Fosters														
Lu	58	71	71	70	58	61	61	59	42	(0·8)	65	64	66	64
Lc	54	67	68	67	57	58	60	59	42	(0·4)	64	67	63	62
Ln	52	62	70	69	58	64	64	63	43	(0·8)	61	68	65	64
Ah	43	58	68	72	55	64	63	63	40	(0·8)	59	62	64	65
Rc	58[2]	64[2]	68[2]	68[2]	54[1]	54[1]	53[1]	57[1]	43[4] (Rc, Rn)	(0·4)	60[5]	63[5]	62[5]	60[5]
Rn	60[2]	72[2]	74[2]	69[2]	57[1]	54[1]	58[1]	50[1]						

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)

[1] 1st crop after grass.
[2] 2nd crop after grass; followed potatoes.
[4] 4th crop after grass; followed wheat, potatoes, barley.
[5] 5th crop after grass; followed wheat, potatoes, barley, wheat.
N.B. Highfield 1969: all 4th test-crop and one of two blocks of 5th test-crop resown (see text).
Basal dressing: 0·9 cwt P_2O_5, 0·9 cwt K_2O.

crop' followed wheat after barley. In 1968 there was '4th test-crop' wheat only (Table 3).

The October-sown wheat in Highfield was severely damaged by rats on some blocks and much was resown in November. Malformed ears on the resown areas were probably caused by weedkiller applied a little too early (at the right time for the earlier sowing). The resown wheat seems to have yielded about 5 cwt less than the original sowing on undamaged blocks.

In both years on Highfield, take-all severely affected the 4th test-crop wheat after 'lucerne' and 'arable' and moderately affected the one after the two ley treatments. In 1968 wheat on plots newly ploughed from old permanent grass suffered from insect attack. So (and because of the resowing in 1969) Highfield gives no useful comparison between seasons. On Fosters, however, take-all was not severe in either year and the comparison is valid. Maximum yields of Joss Cambier (4th test-crop) were about 20 cwt more than the corresponding Cappelle in 1968 on Fosters. The change to Joss Cambier might be expected to give 'a quarter of a ton more' (as claimed by its introducer) but we are left with perhaps 15 cwt to be ascribed to seasons.

Yields of the 2nd test-crop (following potatoes) were very good on Highfield, outstandingly good (even for this experiment) on Fosters where (except after arable) no treatment gave less than 50 cwt and maxima of 70 cwt or more were recorded on four of the six sequences. The yields of the 5th test-crop (wheat after wheat after barley) on Fosters were surprisingly good, 19 of the 20 treatments giving 3 tons or more of grain.

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(Please note that, although exactly comparable with earlier yields on the Ley-Arable, all the yields given are increased by edge-effects inherent in small plots; to allow for these for comparison with field yields a deduction of about 15% is needed.)

Wheat on the Cultivation-Weedkiller experiment yielded 20 cwt/acre more than in 1968 (Table 4).

TABLE 4

Cultivation-Weedkiller Rotation Experiment

Wheat (Cappelle), grain, cwt/acre

	1969	1968
P	57	35
R	56	38
T	57	38

(1967: spring wheat)

Symbols: P = ploughed
R = rotary cultivated
T = tine cultivated

Basal dressing: 0·15 cwt N, 0·38 cwt P_2O_5, 0·38 cwt K_2O at sowing, plus 0·63 cwt N in spring.

On the Woburn Intensive Cereals experiment wheat gave a maximum yield 10 cwt more than in 1968, but 9 cwt less than in 1967 (Table 5).

TABLE 5

Woburn Intensive Cereals Experiment

Wheat (Cappelle) after 2-year break
(1967: after 3-year break)
Grain, cwt/acre

1969				1968		1967	
cwt N/acre				Maximum yield	(N)	Maximum yield	(N)
0·5	*1·0*	*1·5*	*2·0*				
33	42	44	40	34	(1·0)	53	(2·0)

Basal dressing: 1 cwt P_2O_5, 2 cwt K_2O

1969 was a good season for wheat at Rothamsted; everywhere that conditions of soil, etc. were the same in the two years the yields of 1969 exceeded those of 1968 by 15–20 cwt. Plot yields of 65–70 cwt grain were common and suggest that potential yields from large areas were about 60 cwt; at least one field at Rothamsted gave this yield.

Barley. On the Classical Barley Experiment best yields were about 7 cwt more than in 1968. Although the comparison is not strictly fair, because the 1968 crop followed a fallow, the comparison between barley in a rotation of crops and in continuous cultivation (possible in 1969 for the first time) suggests that the effects of different preceding cropping are small.

On the Ley-Arable experiment barley in 1969, 1968 and 1967 was grown as the third test-crop, following wheat, potatoes. Maximum yields exceeded those in 1968, on Highfield by 3–6 cwt, on Fosters by 9–10 cwt (Table 6).

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Highfield yields about equalled those of 1967, Fosters yields were less than in 1967.

TABLE 6

Rothamsted Ley-Arable

Barley (Maris Badger), grain, cwt/acre

Previous cropping	1969 cwt N/acre					1968 Maximum yield	(N)	1967 Maximum yield	(N)
				Highfield					
	0·0	*0·1*	*0·2*	*0·3*					
Lu	44	46	48	48		42	(0·2)	47	(0·3)
Lc	41	46	44	47		43	(0·2)	46	(0·3)
Ln	40	42	45	43		42	(0·3)	47	(0·3)
Ah	35	36	43	45		42	(0·3)	47	(0·3)
R	—	—	—	—		—	—	55	(0·1)
				Fosters					
	0·0	*0·2*	*0·4*	*0·6*	*0·8*				
Lu	42	48	50	51	—	41	(0·4)	55	(0·4)
Lc	41	45	49	49	—	40	(0·4)	52	(0·4)
Ln	37	45	49	48	—	40	(0·6)	53	(0·4)
Ah	36	—	49	49	48	39	(0·6)	56	(0·6)
R	—	—	—	—	—	—	—	56	(0·2)

Symbols: Lu = lucerne (3 years).
Lc = clover-grass ley (3 years).
Ln = all-grass ley (3 years).
Ah = arable (hay, sugar beet, oats).
R = reseeded grass ploughed autumn 1964.
(all followed by wheat, potatoes).
Basal dressing: 0·3 cwt P_2O_5, 0·6 cwt K_2O.

Yields of barley on the Cultivation-Weedkiller Rotation were all rather less than on Fosters, but the differences between seasons were very similar to those on Fosters (Table 7).

TABLE 7

Cultivation-Weedkiller Rotation Experiment

Barley (Maris Badger), grain, cwt/acre

	1969	1968	1967
P	44	36	47
R	44	35	46
T	44	36	47

P = ploughed
R = rotary cultivated
T = tine cultivated

Basal dressing: 0·75 cwt N, 0·3 cwt P_2O_5, 0·3 cwt K_2O.

On the Residual Phosphate Rotations plots treated with P (annually or in 1960 only) gave about 10 cwt more than in 1968 (Sawyers I—old arable), or about 6 cwt more (Great Field IV—formerly old grass); the differences correspond closely with those in the Ley-Arable, but comparison with 1967 does not follow the pattern of the Ley-Arable. P-responses were much the same as in 1968 and much less than in 1967 (Table 8).

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TABLE 8

Residual Phosphate Rotations

Barley (Maris Badger), grain, cwt/acre

P_2O_5 (cwt/acre) as superphosphate	Sawyers I 1969	Sawyers I 1968	Sawyers I 1967*	Great Field IV 1969	Great Field IV 1968	Great Field IV 1967*
0	39	28	26	30	25	17
3·0 in 1960	39	30	37	32	25	38
0·5 annually	45	34	39	31	26	33

* after fallow (others after potatoes)

Basal dressing: 0·8 cwt N, 1·0 cwt K_2O (Sawyers I)
0·4 cwt N, 1·0 cwt K_2O (Great Field IV).

On the Woburn Intensive Cereals experiment the first sowing of barley failed and the resown crop yielded about the same as in 1968, much less than in 1967 (Table 9).

TABLE 9

Woburn Intensive Cereals Experiment

Barley (Maris Badger) after 2-year break (1967, after 3-year break), grain, cwt/acre

1969				1968		1967	
cwt N/acre				Maximum		Maximum	
0·4	*0·8*	*1·2*	*1·6*	yield	(N)	yield	(N)
29	36	35	31	34	(0·8)	46	(1·2)

Note: In 1969 the original sowing failed and barley was resown on 16 April.
Basal dressing: 1 cwt P_2O_5, 2 cwt K_2O.

Yields of first test-crop barley on the Woburn Ley-Arable were larger than in 1968 (Table 10). Maxima were given by 0·4 cwt N (after 'ley' and 'sainfoin' treatments) and 0·8 cwt N ('arable with hay' and 'arable with roots') whereas in 1968 every increase in amount of N decreased yields. In 1969, but not in 1968, 'arable with hay' gave a maximum yield distinctly less than the other treatments.

TABLE 10

Woburn Ley-Arable

Barley (1st test-crop, Maris Badger), grain, cwt/acre

	1969					1968	
	cwt N/acre					Maximum	
	0·0	*0·4*	*0·8*	*1·2*	*1·6*	yield	(N)
L	35	39	37	34	—	33	(0·0)
S	23	40	39	37	—	32	(0·0)
AH	—	32	34	34	32	32	(0·4)
AR	—	36	41	36	37	33	(0·4)

Symbols: L = grazed ley (3 years).
S = sainfoin (3 years).
AH = arable with hay (potatoes, rye, hay).
AR = arable with roots (potatoes, rye, carrots).

PK dressings: 0·5 cwt P_2O_5, 0·5 cwt K_2O, plus 'corrective' K varying with rotation.

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In general barley yields at Rothamsted were about 10 cwt more than in 1968 on old arable sites, and about 5 cwt better on sites after old grass. 1969 yields about equalled those of 1967.

Beans. Yields on the Classical Experiments are of little value in comparing 1969 with 1968; the drilling on Broadbalk and Hoos Barley was imperfect (also simazine was applied in 1968 but not in 1969), and on Barnfield disease from soil-borne pathogens may be increasing under the recent continuous growing of beans. On the whole, yields were less than in 1968 by 5–15 cwt. The exceptionally good yields in 1968 on the well-manured plots of the Classicals were not repeated (see *Rothamsted Report for 1968*, Part 1, 247–248).

The Cultivation-Weedkiller Rotation gives a good comparison (Table 11), and here beans yielded 4 cwt more than in 1968, but 6 cwt less than in 1967, the last good season for beans at Rothamsted.

TABLE 11

Cultivation-Weedkiller Rotation Experiment

Spring beans (Maris Bead), grain, cwt/acre

	1969			1968	1967
	M	S	Mean	Mean	Mean
P	25	24	25	22	32
R	25	25	25	21	30
T	27	23	24	20	30

Symbols: P = ploughed
R = rotary cultivated
T = tine cultivated

M = mechanical weed control
S = simazine weedkiller

Basal dressing: 0·45 cwt P_2O_5, 0·9 cwt K_2O.

Potatoes. The Classical Experiments give no valid comparison between potato yields of 1969 and 1968 because a good stock of King Edward was used in 1969, an indifferent stock of Majestic in 1968. Also the 1969 crops received weedkiller sprays, the 1968 ones cultivations only.

King Edward potatoes were grown on the Rothamsted Ley-Arable experiment for the second time, using once-grown home-produced chitted seed in both years. (In 1968 Majestic were grown on other parts of the experiment and these only were considered in the 1968 Report.)

Yields of total tubers were good in both years, up to about 21–22 tons/acre on Highfield in both years and on Fosters in 1968, but only to 19 tons on Fosters in 1969 (Table 12). The smaller yield on Fosters was probably caused by the drought from July onwards, in contrast to 1968 which was abnormally wet at that time; the Highfield soils with more organic matter than Fosters allowed growth to continue a little longer. The differences between maximum yields (1968 minus 1969) on the four rotations were:

	Highfield	Fosters
Lu	+0·1	+2·1
Lc	−1·6	+2·5
Ln	+0·5	+3·3
Ah	+2·2	+3·1

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TABLE 12

Rothamsted Ley-Arable

Potatoes (King Edward), total tubers, tons/acre

Previous cropping	1969 cwt N/acre *0·0*	*0·6*	*1·2*	*1·8*	1968 Maximum yield	(N)
			Highfield			
Lu	17·5	19·5	19·8	20·1	20·2	(0·6)
Lc	16·9	19·2	21·2	19·6	19·6	(0·0)
Ln	14·9	17·2	19·0	19·2	19·7	(0·0)
Ah	12·0	16·6	17·2	19·1	21·3	(1·8)
Rc } Rn }	16·9*	18·5*	20·9*	20·5*	21·9† 22·2†	(0·0) (0·0)
Gc	12·4†	17·4†	18·2†	20·8†	21·5†	(0·6)
Gn	15·6†	18·3†	18·7†	20·9†	22·7†	(0·0)
Date of planting		30 April			17 April	
			Fosters			
Lu	14·2	16·9	17·4	17·8	19·9	(0·6)
Lc	14·4	16·4	17·8	17·0	20·3	(1·2)
Ln	13·8	16·0	17·2	17·5	20·8	(0·6)
Ah	10·4	14·3	16·2	17·0	20·1	(1·8)
Rc } Rn }	13·4*	16·2*	17·3*	18·6*	21·0† 22·1†	(0·0) (0·0)
Date of planting		30 April			16, 17 April	

* reseeded grass sown 1951, ploughed autumn 1962; since then cropped as Ah.
† ploughed for potatoes 1969 or 1968.

Treatment crops (since 1951)

Lu = Lucerne (3 years), arable (3 years) alternating.
Lc = Grass-clover ley (formerly grazed ley) (3 years), arable (3 years) alternating.
Ln = All-grass ley (formerly cut ley) (3 years), arable (3 years) alternating.
Ah = Arable with hay (3 years), arable (3 years) alternating.
R = Reseeded grass sown 1951.
G = Old permanent grass.
c = PK but no N applied (as Lc) since 1962 (G), 1963 (R).
n = PK and N applied (as Ln) since 1962 (G), 1963 (R).

PK dressings: with FYM, 1·5 cwt P_2O_5, 0·9 cwt K_2O: without FYM, 1·95 cwt P_2O_5, 1·8 cwt K_2O.
plus 'corrective' K varying with rotation
plus sub-plot tests of 0 v 0·9 cwt P_2O_5, 0 v 0·9 cwt K_2O.

In addition to the difference between the fields, the rotations 'lucerne' and 'clover-grass' ley seem to have lessened the effect of differences between season.

In general more N was needed for maximum yield than in 1968; indeed after 'arable with hay' probably more was needed than the most given (1·8 cwt N/acre). The 'reseeded' plots ploughed in autumn 1962, which have since carried one 6-year cycle of 'arable with hay' crops, yielded 3–4 tons more than the permanent 'arable with hay' plots where no N was applied, about 1·5 tons more with 1·8 cwt N. The great response to applied N on plots ploughed from old grass on Highfield (Gc and Gn) in autumn 1968 is surprising. The maximum yield on these plots was less

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than 10% greater than on plots that have been in 'arable with hay' since 1951. On both fields yields after 'arable with hay' were very small without N, but with 1·8 cwt N differences between the four rotations were small.

Yields of potatoes (Pentland Dell) on the Cultivation Weedkiller Rotation were less in 1969 than in 1968 or 1967 (Table 13). Allowing for the

TABLE 13

Cultivation-Weedkiller Rotation Experiment

Potatoes (Pentland Dell), total tubers, tons/acre

	1969	1968	1967
P	11·4	18·2	14·8
R	12·0	15·7	13·4
T	12·4	16·6	13·1
Mean	11·9	16·8	13·7
Date of planting	15/4	29/3	4/4

P = ploughed
R = rotary cultivated
T = tine cultivated

Basal dressing: 1·3 cwt N, 1·3 cwt P_2O_5, 2·0 cwt K_2O.

effect of delayed planting, yields were roughly 4 tons less than in 1968, a difference corresponding to the one in Fosters, another old arable field. Ploughing which gave better yields than rotary or tine cultivation in 1967 and 1968, gave less in 1969.

On the Residual Phosphate Rotations (Table 14) yields in Sawyers I (old arable) were less than those of 1968 and 1967 but in Great Field IV (old grass up to 1956) yields were larger than in 1968 though less than in 1967.

TABLE 14

Residual Phosphate Rotations

Potatoes (Majestic), total tubers, tons/acre

cwt	Sawyers I			Great Field IV		
P_2O_5	1969	1968	1967*	1969	1968	1967*
0	9·3	12·3	14·0	12·8	11·9	15·7
3·0 in 1960	10·8	11·8	14·5	13·7	12·4	16·5
0·5 annually	12·0	13·5	14·3	15·1	12·3	17·8
Mean	10·7	12·5	14·3	13·9	12·2	16·7
Date of planting	16/4	29/3	17/4	16/4	28/3	17/4

* after fallow; remainder after swedes.

Basal dressing: 1·2 cwt N, 1·5 cwt K_2O.

Potatoes grown without Mg on the Woburn Intensive Cereals experiment yielded about 2–3 tons more than in 1968 (in spite of later planting) and 5–8 tons more than in 1967 (Table 15). The reason for these differences is not known.

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To sum up: it seems that for potatoes at Rothamsted there is no simple 'seasonal effect'. On soils of long arable history potatoes yielded 2–4 tons less than in 1968, but on soils with much grass or lucerne in their recent or distant past, yields were equal to or better than in 1968.

TABLE 15

Woburn Intensive Cereals Experiment

Potatoes (Majestic), total tubers, tons/acre

After Classical Experiment on:	1969 0	1969 Mg	1968 0	1967 0
Wheat	13·6	14·2	10·5	5·2
Barley	15·8	17·2	13·7	10·6
Date of planting	18/4		27/3	22/3

Basal dressing: 1·2 cwt N, 1·0 cwt P_2O_5, 2·0 cwt K_2O.

Small-plot experiments

The small-plot staff undertook all agricultural operations on 18 experiments on the Garden Plots and elsewhere, involving 598 plots in all, and some operations on another 29 experiments.

The Garden Plots were given a basal dressing supplying 1·4 cwt P_2O_5 and 2·8 cwt K_2O applied in autumn 1968. Similar generous dressings will be given to ensure that no crop will be limited in growth by lack of P or K. N alone will be applied in specific amounts for each experiment each year. (Wilson, Dawson and Crabtree)

Machinery for small plots. A special sprayer was built for spraying small plots from the side-paths. It is mounted on a narrow-track 2-wheel tractor and can spray a plot up to 9 feet wide from a path 1 foot wide. The boom can be lifted high enough to spray fully-grown cereals. The machine successfully sprayed about 8 acres in 1969. We hope to build a better version for the 1970 season.

A 21-foot hand-held spray-boom was also made; this is supplied by a stationary tractor-mounted sprayer and is carried by two men walking one on either side of the plot. A spray-lance was also made to apply insecticide to the soil between rows of standing cereals.

The grain hopper of the Fiona drill can now be divided so that a different type of seed can be sown by each spout. This also economises in seed when sowing in rows wide apart.

A hand-propelled model of the Stanhay precision seed drill was found useful in two experiments that required precise seed-rates.

We now have netting and supports to protect two experiments each of 0·25 acres from birds. (Wilson, Dawson and Crabtree)

Effects of seed-spacing, phorate and N on sweet corn. An experiment on the Garden Plots compared seed-spacings of 3, 6, 12 and 18 in. in rows 24 in. apart, with and without phorate applied at sowing for the control of frit-fly (*Oscinella frit*). Additional factors were N at 0·75, 1·50 and 3·00

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cwt/acre and two methods of applying N: all in the seedbed and split equally between seedbed and tasselling.

Fresh weights and numbers of large and medium saleable cobs were recorded. The season favoured sweet corn and the mean yield was 50 900 saleable cobs/acre, weighing 98 cwt. Seed-spacing of more than 6 in. sharply lessened yields; the mean response to phorate was 15%, and the largest dressing of N slightly lessened yields. Splitting the N dressing had little effect. (Wilson)

Residual effects of atrazine. Observation plots were laid down on sweet corn in 1968 to test atrazine at nil, 1½ lb (the recommended rate) and 3 lb/acre. No differences in growth were observed. In 1969 spring wheat, potatoes, peas and swedes were grown in strips across the plots. Wheat and potatoes were unaffected by the previous year's atrazine, The peas grew poorly but this was not attributable to the atrazine. The swedes emerged evenly, but later grew most vigorously on land without atrazine and least vigorously where 3 lb/acre was applied in 1968. Weeds were fewer on the plots treated with atrazine in 1968 than on the untreated.

In 1969 herbicides were applied (dicamba plus MCPA plus mecoprop for wheat, paraquat plus linuron for potatoes, dinoseb for peas and nothing for swedes), and the whole area will be drilled in 1970 with swedes to observe any effects of the combined herbicide residues. (Wilson)

N and growth regulators for spring beans

Two microplot experiments were done on the effects of 'Nitro-Chalk' and growth regulators. One tested all combinations of none and 4 lb (a.i.) B-Nine per acre on three occasions; 0, 1, 2 and 3 cwt N; N in seedbed and N in May; 200 and 400 lb/acre of seed; 5½ in. and 21 in. spacing between rows. The mean yield, 32·6 cwt grain, was rather better than in 1968 despite the dry summer. The mean effects of the treatments were small. 3 cwt N, the most effective amount, increased yield with 21 in. spacing by only 0·8 cwt, with 5½ in. spacing by 3·0 cwt—application in May was less effective than in the seedbed. B-Nine lessened yield with 21 in. spacing (by 1·6 cwt) but increased it with 5½ in. (by 1·1 cwt). Without B-Nine spray 5½ in. spacing gave 0·3 cwt less grain than 21 in. With B-Nine spray 5½ in. row spacing gave 2·4 cwt more grain than 21 in. spacing. Increasing seeding from 200 lb to 400 lb gave 1·0 cwt less grain with 21 in. spacing, but 2·3 cwt more with 5½ in.

The second experiment tested seven growth regulators each at two amounts (a.i. per acre): B-Nine (2, 4 lb), morphactin (derived from fluorene-9-carboxylic acid) IT3233 (0·025, 2·5 g), morphactin IT3456 (0·25, 25 g), Ethrel (2-chloroethanephosphonic acid) (0·1, 1·0 lb), C011 (N-dimethylmaleamic acid) (1, 4 lb), JF2578 and JF2579 (two related new materials from I.C.I.) (1, 4 lb). The chemicals were tested on beans grown at 21 in. spacing sown at 200 lb seed per acre. B-Nine was sprayed on three occasions (4-leaf stage and successive monthly intervals)—the other materials at 4-leaf stage only. All the chemicals shortened the beans

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(means of both rates):

Treatment	Height (in.) in August
Unsprayed	48
B-Nine (applied 3 times)	33
Ethrel	40
C011	41
JF2578	42
JF2579	43
Morphactin IT3456	45
Morphactin IT3233	47

The larger amounts of morphactins, 'Ethrel', JF2578 and JF2579 all caused various symptoms on leaves, flowers or stems; 'Ethrel' (only) caused symptoms in new growth made after the application. The smaller amounts caused no symptoms. Yield of untreated beans was 32·8 cwt grain; none of the chemicals increased yield significantly and the larger amounts of morphactin IT3233 and 'Ethrel' significantly decreased yield (to 15·7 and 25·7 cwt respectively). (McEwen)

Soil fumigation and nitrogen for spring beans at Woburn

Observation last year suggested that free-living nematodes might damage field beans, so an experiment to test effects of soil fumigation was started in co-operation with the Plant Pathology Department, on the sandy soil at Woburn. The site chosen had not grown beans for many years but is infested with species of *Trichodorus*, *Pratylenchus* and *Tylenchorhynchus*, but not of *Longidorus*. The experiment tested all combinations of no fumigant and dazomet (applied in autumn at 400 lb/acre) with 0, 1 and 2 cwt N as 'Nitro-Chalk'.

Soil samples taken in March showed dazomet had almost entirely eliminated potentially parasitic nematodes from the top 9 in. of soil. Samples taken after harvest showed *Trichodorus* had increased to 400/litre of soil (500 unfumigated), *Tylenchorhynchus* to 300/litre (2400 unfumigated) but *Pratylenchus* was still absent (150 unfumigated).

Nitrogen fertiliser had no effect on nematode numbers in fumigated plots but greatly affected *Trichodorus* and *Tylenchorhynchus* in unfumigated plots: 1 and 2 cwt N increased *Trichodorus* equally (from 350 to 600); 1 cwt N increased *Tylenchorhynchus* from 1400 to 2200, and 2 cwt N to 3600 (Nematode counts by Fraser, Nematology Department).

The summer was dry and yields small, untreated plots gave only 13·4 cwt/acre. Dazomet alone increased this to 16·0 cwt. Nitrogen (2 cwt N) lessened yield on unfumigated plots to 8·2 cwt but increased it on fumigated plots to 18·1 cwt. (McEwen with Hornby and Salt, Plant Pathology Department)

Rothamsted Garden Clover. Yields from the 1969 sowing were poor (three cuts gave a total of only 25 cwt dry matter), and neither magnesium nor nitrogen increased them. Examination of root systems and soil after harvest by Franklin (Nematology Dept.) showed a fairly large infestation of *Heterodera trifolii*—60 cysts per 100 g of soil, 21 eggs per g. This is the first time *Heterodera trifolii* has been recorded on this site. (McEwen)

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Staff

Dyke was seconded to the Ministry of Overseas Development early in the year and gave a course of lectures on field experimentation to post-graduate students of agriculture in the University of Khartoum.

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