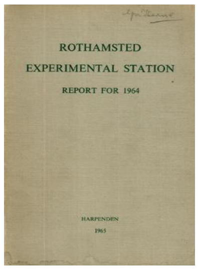
Report for 1964



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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: F. Yates (Chairman), G. V. Dyke (Secretary), F. C. Bawden, G. W. Cooke, P. H. Gregory, J. R. Moffatt, H. D. Patterson, C. A. Thorold, R. G. Warren and D. J. Watson.

The Section provides all plans and instructions needed for the conduct of experiments on the farms and helps the Statistics Department to prepare the *Numerical Results of the Field Experiments* each year. The Section also compiles the fuller record of experiments kept in the *White Books*. Members of the Section assist most of the Station's visitors, particularly by demonstrating the field experiments.

Table 1 shows the number of full-scale plots harvested on the three stations in 1964, classified according to crops and types of experiment.

TABLE 1

Number of full-scale plots harvested 1964

	Grain	Roots	Hay	Grazing	Total
Classical experiments:					
Rothamsted	193	246	122	—	561
Woburn	84	—	—	—	84
Saxmundham	27	34	—	—	61
Long-period rotation experiments:					
Rothamsted	484	520	300	16	1,320
Woburn	84	342	64	12	502
Crop-sequence experiments:					
Rothamsted	463	140	84	—	687
Woburn	280	164	54	—	498
Annual experiments:					
Rothamsted	562	170	16	—	748
Woburn	186	80	—	—	266
Totals:					
Rothamsted	1,702	1,076	522	16	3,316
Woburn	634	586	118	12	1,350
Saxmundham	27	34	—	—	61
Total	2,363	1,696	640	28	4,727
Full-scale plots (no yields taken):					415
Microplots:					1,314
Grand total					6,456

The number fluctuates from year to year, depending on the weather and the research programme. On average in the 5 years 1960–64 the number of full-scale plots has increased by about a third, and of microplots by half. There are now about 8 full-scale plots per acre of farmland; taking into account headlands, about one-third of the land is involved in experiments each year, but a proportion of the remainder is unsuitable for experiments. Three-quarters of the plots in 1964 belonged to experiments lasting several

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years. The number of plots in rotation experiments designed to last a dozen or more years has changed little, but the number has greatly increased in "crop-sequence" experiments designed to last from 2 to about 8 years, running once only through a sequence of crops (in some experiments different sequences run simultaneously on adjacent plots). The siting of new experiments becomes steadily more difficult; requirements such as particular sequences of preceding crops or levels of nutrients in soil are often difficult to meet, and sites are sometimes used for experiments in successive years provided that the treatments compared in the first year are thought to have small residual effects.

Microplots (about 20 sq yd or less) are much used by some departments. More replication is possible on a given area, but the standard error per plot in an experiment of given design usually increases as the size of plot decreases, so microplot experiments provide less information per plot, but more per acre than experiments with large plots. Microplots dug and cultivated carefully by hand do not suffer the irregularities caused by the pressure of tractor-wheels on the soil. Microplots often allow tests (e.g., of expensive chemicals) impossible with large plots. But yields obtained from microplots are more affected by edge-effects—positive or negative—than larger plots, and the crops are often more damaged by birds. The effects of treatments tested in microplots may not be precisely reproduced on large areas.

Rothamsted's work has always blended fundamental research—studies on the principles of crop growth, regardless of their immediate prospect of helping farmers—and applied research, the testing of promising ideas in the confusion of unpredictable effects of soil, weather and pathogens which is inevitable in every field. In such a programme microplots can satisfy many needs, but not all.

Broadbalk. Broadbalk was sown in October in good conditions, with seed from the 1963 crop. Although there was little rain after mid-summer, there was plenty of moisture in the soil when the wheat needed it; indeed, all drains were running on 21 April, an exceptionally late date. There was widespread lodging, severe enough on some plot-sections to affect yields.

The seed was treated with a fungicide dressing only. The change from a combined dressing with insecticide and fungicide was made to help work on Wheat Bulb Fly (see p. 181), which was less damaging than in 1963.

In 1964 all sections under crop, except Va, were sprayed with a selective weedkiller. Sprays will be applied as necessary in future, but section Va will remain unsprayed until observations on weeds are complete.

Section Va received 5 tons ground chalk/acre, equal to the amount applied to section Vb in autumn 1954.

Alternate Wheat and Fallow. The sections cropped in 1963/64 were divided between Squarehead's Master 13/4 (the traditional variety) and Rothwell Perdix. Both germinated well and grew normally in autumn, but in the winter the Perdix looked thin and poor. In late April the remaining

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plants of Perdix began to make good growth and yielded nearly twice as much as Squarehead's Master:

	After	
	1 year's fallow	3 years' fallow
Squarehead's Master 13/4	6·4	6·3
Rothwell Perdix	12·4	11·0

Permanent barley, Hoosfield. In 1964 the permanent barley plots were split for comparison of a new variety, Maris Badger (MB), with Plumage Archer (PA), the variety invariably grown since 1917. MB was expected to give a greater increase per unit of nitrogen applied than PA and to withstand heavier dressings of N without lodging. It was therefore decided to apply sulphate of ammonia (series A), nitrate of soda (series AA and AAS) and castor meal (series C) to MB at rates to supply 86 lb N/acre; each was applied to PA at the traditional rate (43 lb N). Farmyard manure was applied to both varieties at the usual rate of 14 tons/acre.

Both varieties were sown in good conditions on 10 April, sowing being delayed (as usual) to allow wild oats to germinate. The usual signs of P- and K-deficiencies appeared on the appropriate plots of each variety. There was no serious lodging, and both varieties were cut by combine-harvester in good condition on 31 August. Table 2 shows the yields of grain of the 4 main series and the dung plot.

TABLE 2

Yields of grain (85% dry matter) cwt/acre

		Strip treatment and variety									
		O		P		KNaMg		PKNaMg		Mean	
		PA	MB	PA	MB	PA	MB	PA	MB	PA	MB
Series treatment (and lb N/acre):											
O	0	5·3	7·4	9·1	11·3	7·8	8·0	10·9	10·8	8·3	9·4
Sulphate of ammonia	43	7·5		17·4		15·3		24·2		16·1	
	86		11·5		24·4		24·9		37·6		24·6
Nitrate of soda	43	7·8		20·1		13·0		21·3		15·6	
	86		10·4		28·7		21·9		40·0		25·2
Nitrate of soda*	43	18·4		24·6		18·4		24·9		21·6	
	86		18·4		28·7		31·3		37·5		29·0
Castor meal	43	19·6		21·3		21·3		23·8		21·5	
	86		31·6		38·1		37·4		38·8		36·5
FYM	—	33·2	37·0								
Increase for:											
Sulphate of ammonia	43	+2·2		+8·3		+7·5		+13·3		+7·8	
	86		+4·1		+13·1		+16·9		+26·8		+15·2
Nitrate of soda	43	+2·5		+11·0		+5·2		+10·4		+7·3	
	86		+3·0		+17·4		+13·9		+29·2		+15·8
Castor meal	43	+14·3		+12·2		+13·5		+12·9		+13·2	
	86		+24·2		+26·8		+29·4		+28·0		+27·1
Silicate of soda	—	+10·6	+8·0	+4·5	0·0	+5·4	+9·4	+3·6	−2·5	+6·0	+3·7

* And silicate of soda at 400 lb/acre to each variety.

MB yielded more than PA with added N, but not without it. The response of MB to 86 lb N was almost exactly double that of PA to 43 lb N. With any one variety the response to 86 lb N may be expected to be about 140% of the response to 43 lb N, so it is clear that MB is more responsive per unit N than PA. Silicate of soda increased the yield of MB on average by about 4 cwt/acre, and of PA by 6 cwt; the difference comes mainly from plots with P, where silicate produced an increase with PA (as usual in recent years) but not with MB. With FYM MB yielded 4 cwt more than PA. The mineral fertilisers had relatively little effect on series C, where the continued application of castor meal (earlier rape cake)

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provided almost enough P, K, Na and Mg for the full yield of each variety.

There is no evidence that the new variety is especially susceptible to any factor that may have been induced by growing barley continuously on Hoosfield. Considering the preceding cropping and the late sowing, the mean yield of MB plots receiving N, P, and K (38·5 cwt/acre) is remarkable.

Rothamsted ley–arable rotation experiments. In 1962 leys of two new types were introduced into these experiments. Each is sown in spring in the open and is intended to give three years' production before being ploughed for the first test crop, wheat. One ley (Ln), of grass only, is given large amounts of fertiliser nitrogen; the other is of grass and clover and receives no fertiliser nitrogen. Both are managed for maximum production of silage. The clover–grass ley is sown on plots which had in earlier cycles carried the 3-year grazed ley. The seeds mixture sown at 33 lb/acre is: 5 lb Timothy S51; 6 lb Meadow fescue S215; 1 lb White clover S100.

The all-grass ley is on plots formerly in the "cut grass" rotation. P and K are applied with 0·6 cwt N as "Nitro-Chalk" for each cut. In 1962 and 1963 cocksfoot S37 was sown at 30 lb/acre. The 1962 sowing on Highfield failed after the exceptionally hard winter of 1962/63 and was resown with cocksfoot. On Fosters the 1962 sowing became infected with cocksfoot mottle and streak viruses during 1963, and in 1964 Italian ryegrass was grown to complete the 3-year period. Resowing was done after applying paraquat and light cultivations, without ploughing. From 1964 the all-grass ley will be sown with timothy and meadow fescue as above, without clover.

Corresponding changes in the management of the long-term grass plots were introduced, in 1962 on the permanent old grass (Highfield only) (G) and on some of the "reseeded" plots (R) on both fields, beginning in 1963. Each plot is split lengthwise for a comparison of PK (c) *v.* PK with 0·6 cwt N/cut (n), with management (as for the 3-year leys) to obtain maximum benefit from clover or nitrogen fertiliser. Cutting is frequent but not necessarily on the same dates on the half-plots.

TABLE 3

Yields of leys, etc., under cutting. Dry matter, cwt/acre/annum

	Clover–grass ley Lc			All-grass ley Ln			Reseeded grass		Old grass		Lucerne Lu		
Year	1st	2nd	3rd	1st	2nd	3rd	Rc	Rn	Gc	Gn	1st	2nd	3rd
						Highfield							
1962	28·7	—	—	56·9	—	—	—	—	31·6	57·8	32·6	66·8	58·2
1963	41·5	66·6	—	63·6	23·2*	—	49·5	92·6	47·4	85·2	47·1	61·3	39·0
1964	19·1	48·8	41·8	24·8†	63·8	66·4‡	37·1	66·3	36·4	64·2	41·2	67·6	48·6
						Fosters							
1962	26·9	—	—	47·8	—	—	—	—			36·1	71·8	76·9
1963	34·4	71·0	—	63·7	83·9	—	50·2	89·9			45·2	76·8	46·3
1964	4·6	55·4	48·8	9·2†	59·3	36·8§	46·0	66·9			33·2	79·1	62·5

* Resown with cocksfoot.
† Meadow fescue and timothy.
‡ 2nd year of resown cocksfoot.
§ Resown with ryegrass.

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Table 3 shows the yields of dry matter so far obtained; for comparison the yields of the 3-year lucerne (cut for hay as since the beginning of the experiments) are included.

The clover–grass leys sown in 1962 and 1963 yielded 25–40 cwt dry matter per acre in their first season, rather less than the old and reseeded grass under similar treatment. The all-grass leys sown in these years yielded about 50–60 cwt, also (in 1963) clearly less than the long-term grasses with N fertiliser. The summer drought of 1964 caused small yields of the newly sown leys, especially on Fosters. The ryegrass sown on Fosters in place of the failed 3rd-year all-grass ley yielded comparatively well; the lucerne on both fields established and yielded well in spite of the drought.

In the later productive years the clover–grass leys yielded 40–70 cwt, 5–20 cwt more than the similarly treated long-term grass. The all-grass ley (where it did not fail) yielded 60–85 cwt; on Highfield about equal to, on Fosters about 7 cwt less than, the yield of the long-term grass dressed with N.

Newly sown lucerne (especially in Fosters) was clearly able to produce more in the 1964 summer drought than the other leys; in 1962 and 1963 its yield was intermediate between the all-grass and clover–grass leys. 2nd-year lucerne compared well with all other types of herbage in 1964, but in the other years it was outyielded by the all-grass ley and long-term grass with N. 3rd-year lucerne yielded less than 2nd-year partly because it (and other 3rd-year leys) are now ploughed rather earlier than formerly and some production is lost. This is done to lessen the risk of damage to the test crop wheat from insects present in the leys. All established lucerne (i.e., plots beginning their second and third years) was sprayed with paraquat in early spring. Grass weeds were well checked without apparent damage to the lucerne.

In 1964 potatoes were planted for the first time after "reseeded" grass, on plots ploughed in 1963 after 12 years under grass, mostly grazed. Throughout the season the haulms on the "reseeded" plots were more vigorous than on any of the other cropping sequences; on Fosters about $1\frac{1}{2}$ tons extra yield was recorded and about $\frac{1}{2}$ ton on Highfield. The comparisons made on sub-plots (no dung *v.* dung, 2 levels of N, 2 levels of P, 2 levels of K) did not point to any immediate explanation of the effect of the 12-years grass.

Short-term green manuring experiments at Woburn. In 1964 two more experiments came to harvest, one in barley, one in sugar beet. Each included all combinations of:

Green manures: none, trefoil, ryegrass, ryegrass with 0·6 cwt N/acre.
"Nitro-Chalk" to test crop: none, 0·3, 0·6, 0·9 cwt N/acre for barley, double these rates for sugar beet.
Ploughing: autumn, spring.

For barley the green manures were sown in the open after early potatoes; for sugar beet they were undersown in barley. Earlier experiments similar except that dates of ploughing were not compared are described in *Rothamsted Report* for 1962, p. 183.

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The green manures after early potatoes all grew excellently, but those undersown in barley were poor; there was some grass weed, and the trefoil germinated and grew unevenly, although the seed was inoculated and the land limed. The mild winter allowed some growth in the ryegrass sown after early potatoes (Table 4).

TABLE 4

Dry matter and N *in samples of green manures* (*roots plus tops*) *cwt/acre*

	For barley				For sugar beet			
	DM		N		DM		N	
Ploughing	A	S	A	S	A	S	A	S
None	*	2†	*	0·1†	*	8†	*	0·2†
Trefoil	18	14	0·6	0·5	21	9	0·5	0·2
Ryegrass	33	70	0·5	0·6	20	15	0·2	0·2
Ryegrass with N	49	91	1·4	0·9	23	24	0·5	0·5

* Not sampled. † Weeds.

The site of the barley experiment showed strong evidence of a fertility trend and the yields presented (Table 5) have been adjusted accordingly

TABLE 5

Barley, grain, cwt/acre

	N, cwt/acre				Ploughing		
	0	0·3	0·6	0·9	A	S	Mean
No green manure	16·7	20·0	30·2	35·7	27·7	23·6	25·7
Trefoil	27·0	34·8	40·9	44·2	38·0	35·4	36·7
Ryegrass	19·8	26·6	30·4	35·3	28·0	28·0	28·0
Ryegrass with N	26·0	36·0	39·7	43·9	36·3	36·5	36·4
Mean	22·4	29·3	35·3	39·8	32·5	30·9	31·7

(the unadjusted yields showed less regular N responses, and rather greater effects of green manures than the adjusted).

Ryegrass without N improved yields of barley a little, provided no N or only 0·3 cwt was applied to the barley, but not with more. Trefoil and ryegrass with N acted very similarly; each gave 8–16 cwt more grain. The effect of each was greatest where 0·3 cwt N was applied to barley, but even barley given 0·9 cwt N (yield 36 cwt without green manure) showed an increase of 8 cwt or 22%.

Yields were much the same whether the land was ploughed during autumn or spring, except that with trefoil (or no green manure) spring ploughing decreased yields by 3–4 cwt.

By contrast, the sugar beet, whether given N or not, failed to respond to any of the green manures (Table 6). This also contrasts with previous

TABLE 6

Sugar beet, total sugar, cwt/acre

	N, cwt/acre				Ploughing		
	0	0·6	1·2	1·8	A	S	Mean
No green manure	34·0	54·2	55·1	50·1	48·0	48·7	48·3
Trefoil	36·3	48·8	57·9	50·5	48·0	48·7	48·4
Ryegrass	32·1	49·6	52·2	53·8	47·8	46·1	46·9
Ryegrass with N	36·0	51·2	55·0	45·7	46·2	47·7	47·0
Mean	34·6	51·0	55·1	50·0	47·5	47·8	47·7

results (*Rothamsted Reports* for 1962, p. 183, and for 1963, p. 200), and green manures probably failed to increase yields in 1964 because they grew

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poorly and because the sugar beet suffered from drought in the later part of the growing season.

Broadbalk Wilderness

History (***H. V. Garner***). J. B. Lawes told the 39th wheat crop occupying the top end of Broadbalk just before the harvest of 1882—"I am going to withdraw all protection from you, and you must for the future make your own seedbed and defend yourself in the best way you can against the natives, who will do everything in their power to exterminate you" (Lawes, 1884 b).

The half acre of standing corn thus abandoned to fight it out with the weeds turned into the Wilderness that has provided a fascinating side-show for thousands of visitors to the fertiliser plots. The sequence of events on this area and the observations arising from them have been written up from time to time, but not recently; since the last account an additional treatment has been introduced. The early effects of this grazing treatment are recorded here, with an historical note on the Wilderness and a brief summary of some of the scientific investigations based on it.

On a map of the Rothamsted Estate dated 1623 the Lower Shepcote Fielde of 16·3 acres is shown with the same boundaries as the present Broadbalk. The centre of this piece, amounting to about 12 acres, was under arable cultivation; the remainder was accounted for by broad grass verges, of which the lower one at the western end of the field was the largest. The oldest surviving plan of the wheat experiment was made in 1851, after the plots had been in existence for 8 years. The total area of the plots was then 11·2 acres. This comprised 9·2 acres of full-length manurial plots almost coincident with the present ones, some shorter ones at the side of the field, later abandoned, and two transverse half-acre strips: the Upper Butts at the top of the field and the Lower Butts at the bottom. These butts were always unmanured, and their yields, which were measured from 1851 to 1872, supplemented that of the better-known control plot which ran the full length of the field. It is on these butts that the history of the Wilderness begins.

In the Broadbalk *White Book* there is an entry for 1882 that says "Top and Bottom Butts. No wheat grown on this portion of the field after the harvest of 1882." The writer of this note did not mention that the wheat standing on these areas was not harvested, and the record says nothing more about them for the next 20 years. Our information comes from Sir John Lawes himself: in March 1884 and again in September of the same year he wrote articles for *The Country Gentleman* describing the fate of the abandoned crop (Lawes, 1884). It shed its seed, estimated at about 13 bushels/acre, in an exceptionally wet autumn and weeds grew strongly during the following mild winter. The crop came up, but was almost completely suppressed by a dense mass of couch grass (*Agropyron repens*). So little survived at the harvest of 1883 that Lawes estimated the produce of the top half acre at only a few pints. He decided to leave this crop to shed its seed once more, although its chance of growth was small. Nothing more is heard of this experiment for 11 years till Lawes (1895) came back

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