ROTHAMSTED RESEARCH

Rothamsted Report for 1966

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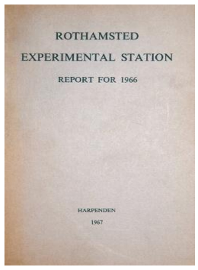

Field Experiments Section

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, F. G. W. Jones, J. R. Moffatt, H. D. Patterson, C. A. Thorold and D. J. Watson.

The Section continued its main job of providing the drawings and instructions needed by the field staff in laying down and harvesting the experiments at the three farms. In addition, its members made systematic notes on the appearance of the crops on each plot of most of the experiments just before harvest, a job previously done by the recorders. Some of the results of this and earlier seasons' notes on lodging are reported below.

A. J. Barnard joined the Section; he will be particularly concerned with the Woburn experiments. C. R. L. Scowen was injured in a road accident in May and is still away.

Members of the Section did more field work than usual; the results are summarised below.

TABLE 1

Number of full-scale plots harvested 1966

	Grain	Roots	Hay	Grazed	Total
Classical experiments:					
Rothamsted	192	—	200	—	392
Saxmundham	30	42	—	—	72
Long-period rotation experiments:					
Rothamsted	466	240	268	—	974
Woburn	202	334	64	12	612
Saxmundham	36	—	—	—	36
Crop sequence experiments:					
Rothamsted	438	81	125	—	644
Woburn	380	96	—	—	476
Annual experiments:					
Rothamsted	360	516	64	—	940
Woburn	226	188	—	—	414
Totals:					
Rothamsted	1,456	837	657	—	2,950
Woburn	808	618	64	12	1,502
Saxmundham	66	42	—	—	108
Total	2,330	1,497	721	12	4,560
Full-scale plots (no yields taken):					
Rothamsted					220
Woburn					138
Saxmundham					8
Microplots:					
Rothamsted					1,320
Woburn					731
Saxmundham					62
				Total	7,039

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Table 1 shows the number of full-scale plots harvested on the three farms classified according to crops and types of experiments. The main changes at Rothamsted are the increase in the number of plots in annual experiments on roots because of increased work on potatoes by the Plant Pathology Department. At Woburn the number of plots in crop-sequence experiments increased, as did the number in experiments on potato diseases. It seems unlikely that any further use will be made of the plots of the Woburn Classical experiments (though part of their site is in use for a modern experiment) and they are omitted from the table.

Broadbalk, Hoos Permanent Barley and Barnfield

It is considered that, if the present schemes of cropping and manuring are continued, Broadbalk and Hoos Barley will yield little new information of importance in the coming years. The best yields from the Broadbalk plots are much less than those obtained by competent growers of wheat in Southern England and less than half the yields recorded on the Rothamsted Ley–Arable experiment; we know that this is partly because of the old variety grown, partly because of soil-borne pathogens. The scheme set out below includes a new variety and, on part of the field, a rotation of crops designed to give wheat little harmed by soil-borne diseases. Hoos Barley has shown that, with a modern variety of barley, good yields can be obtained on land continuously cropped with barley for a century; the new scheme includes continuous barley on some areas and a rotation of crops nearby to give relatively healthy barley. The rotations agreed for the two experiments are:

Broadbalk: Potatoes, spring beans, winter wheat
Hoos: Potatoes, spring beans, spring barley

The yields of wheat and barley on uninfested land and the responses to the cumulative manuring treatments of the different plots are the main objects of the changes proposed. Next in importance will be the responses of the newly introduced "break" crops (which, it is hoped, will also be grown on Barnfield); whether these will differ appreciably between the three fields with such contrasting histories of cropping will also be of interest.

On Barnfield, even were the regular growing of a root crop on the whole area practicable, there is equal need for change if new information is to be gained. It is hoped to maintain some continuity by including sugar beet in the rotation on most of the field. Barnfield has some value as a piece of arable land which has not carried a cereal crop since 1855; the development of soil-borne pathogens in the first cereal crops will be of interest.

"Nitro-Chalk" will be used as a source of inorganic nitrogen in place of both sulphate of ammonia and nitrate of soda. There seems little value in continuing the comparison on large areas of three fields (but it is hoped that bulk samples of soils from the two treatments can be retained in concrete tanks with continued treatment). The use of "Nitro-Chalk" simplifies management and removes the need for routine liming of the plots formerly treated with sulphate of ammonia. On Barnfield, in particular, the use of one form of N instead of two facilitates the introduction of the proposed rotation of crops.

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The proposed changes will take effect in autumn 1967 on Broadbalk and spring 1968 on Hoos Barley and Barnfield.

Broadbalk

Cropping. Sections IA, IB, VA and VB will be cropped with continuous winter wheat except when perennial weeds necessitate a fallow. They will not all be fallowed in the same season. The variety of wheat on these and other sections will be Cappelle Desprez. Section VA will be maintained without using chemical weedkillers.

Sections II, III and IV will be divided into six shorter sections IIa, IIb etc. Of these three will carry a 3-year cycle of fallow, wheat, wheat; the other three a rotation:

Potatoes, spring beans, wheat.

These will be arranged in pairs so that the wheat after beans will always be adjacent to the second wheat after fallow.

Manuring. The old and new manures are set out below. Except as indicated all crops will receive the materials and rates listed (but none to fallows). Symbols:

N1, N2, N3, N4:	"Nitro-Chalk" to supply 43, 86, 129, 172 lb N/acre, all applied in spring (formerly all N as sulphate of ammonia except to plots 9 and 16, which received nitrate of soda).
P:	superphosphate (65 lb P_2O_5/acre).
K:	sulphate of potash (98 lb K_2O/acre).
Na:	sulphate of soda (100 lb/acre).
Mg:	sulphate of magnesia (100 lb/acre).
D:	farmyard manure (14 tons/acre).
C:	castor meal (86 lb N/acre).

Plot No.	Till 1967	From 1968	Notes
2A	D	D	(plus N2 for 3 course rotation *only*)
2B	D	D	
3	Nil	Nil	
5	PKNaMg	PKNaMg	
6	N1PKNaMg	N1PKNaMg	
7	N2PKNaMg	N2PKNaMg	
8	N3PKNaMg	N3PKNaMg	
9	N1PKNaMg	N4PKNaMg	
10	N2	N2	
11	N2P	N2P	
12	N2PNa	N2PNa	(366 lb sulphate of soda)
13	N2PK	N2PK	
14	N2PMg	N2PMg	(280 lb sulphate of magnesia)
15	N2*PKNaMg	N3PKNaMg	
16	N2PKNaMg	N2PKNaMg	
17	N2 } alternating	N2 + ½(PKNaMg)	
18	PKNaMg } alternating	N2 + ½(PKNaMg)	
19	C	C	(provisional)
20	N2KNaMg	N2KNaMg	

* Formerly all N in autumn.

Note: plot 20 does not run the full length and cannot be included in the rotation scheme.

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Tests of fumigants, etc. The small area at the West end of Section IA of each plot (near the Wilderness) that has been discarded at harvest in recent years will be used to test methyl bromide (on sub-plots). Later if chemical control of soil pathogens seems practicable Section IA can be used in comparison with IB.

Hoos Barley

Cropping in 1967. All plots will be fallowed in 1967 to allow cultivations to kill couch grass and coltsfoot. This should give a good start to the new scheme starting in 1968.

Cropping from 1968. *Series O, plots 6–1, 7–1, Series A, plots 6–2, 7–2:* continuous spring barley. *Series C:* divided into four strips running North–South; of these one will carry continuous barley, the others a three-course rotation (one strip in each phase):

Potatoes, spring beans, barley.

Series AA and AAS: each divided into two strips, one in continuous barley, the other to carry the three-course rotation, in one and the same phase. *Plots 1N, 2N, 5–0, 5A:* continuous barley. The variety of barley will be Maris Badger.

Manuring. The strip manures to continue as hitherto:

Strip	1	Nil
	2	P
	3	KNaMg
	4	PKNaMg

(materials and rates as for Broadbalk)

Series O, A each plot divided into four sub-plots receiving "Nitro-Chalk" to supply 0, 43, 86, 129 lb N/acre (N0, N1, N2, N3).

Barley on *Series AA, AAS, C* (whether continuous or in rotation) to receive the same rates of "Nitro-Chalk"; each sub-plot of barley will be further divided into two and the two plots with P will provide room for the four rates of N and similarly the two plots without P.

Silicate of soda has appreciably increased the yield of barley in recent years and will continue to be applied at 400 lb/acre to Series AAS, but castor meal (to Series C hitherto) will *not* be applied. Potatoes and beans will receive strip manures (and silicate on AAS) and (potatoes only) "Nitro-Chalk" at a uniform rate of 129 lb N.

Manuring of *Plots 6–1, 6–2, 7–1, 7–2, 1N, 2N, 5–0, 5A* is not decided.

Plots 1N, 2N, 5–0, 5A will be used for a test of methyl bromide.

Barnfield. Spring beans will be sown in 1967 with farmyard manure and non-nitrogenous fertiliser treatments as hitherto, but sulphate of ammonia, nitrate of soda and castor meal will not be applied. A scheme for a rotation of crops, not yet worked out in detail, will be proposed to start in 1968.

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Rothamsted Ley-arable

Lodging of cereal test-crops. For 1964, 1965 and 1966 we have estimates of the area lodged for each sub-plot of wheat and of barley. These are expressed in tenths of area, and in some cases lodging and leaning were estimated separately. The estimates were made when the crops had changed colour, and although some more lodging may have occurred, it is unlikely to have affected yields much. In all the rotations compared, wheat (the first test-crop) follows a 3-year break from crops susceptible to eyespot (*Cercosporella herpotrichoides*) and barley (third test-crop) follows potatoes; soil pathogens are unlikely to contribute to the lodging of either crop.

In each year each field has two main plots of wheat after each rotation and two of barley. Each main plot has eight sub-plots, testing four levels of N. Half the sub-plots received FYM to potatoes (5 years before wheat, 1 year before barley) the others received equivalent amounts of P and K fertiliser.

TABLE 2

Wheat: yields of grain, cwt/acre (and lodging, tenths of area)

N* cwt/acre	Highfield				
	Lu	L	Cg	A	R
	1964 (Leaning only)				
0·0	46 (0)	52 (0)	38 (0)	31 (0)	48 (0)
0·3	61 (0)	51 (0)	48 (0)	47 (0)	49 (2)
0·6	54 (1)	53 (1)	54 (0)	54 (0)	50 (1)
0·9	62 (1)	51 (3)	56 (1)	61 (0)	47 (3)
	Lu	Lc	Ln	A	R
	1965 (means of 0, 0·6 cwt N/acre in winter)				
0·0	44 (0)	45 (0)	48 (0)	41 (0)	50 (0)
0·3	46 (4)	48 (0)	52 (1)	50 (0)	49 (1)
0·6	42 (4)	46 (0)	48 (0)	49 (1)	49 (1)
0·9	42 (3)	47 (1)	48 (1)	48 (3)	50 (0)
	1966 (means of 0, 0·6 cwt N/acre in autumn)				
0·0	51 (0)	45 (0)	36 (0)	32 (0)	
0·3	42 (3)	52 (0)	45 (0)	45 (0)	
0·6	50 (5)	45 (1)	46 (1)	50 (2)	
0·9	34 (6)	42 (4)	48 (4)	47 (4)	

N† cwt/acre	Fosters				
	Lu	L	Cg	A	R
	1964				
0·0	47 (0)	56 (0)	44 (1)	27 (0)	54 (0)
0·4	56 (0)	57 (1)	56 (0)	45 (0)	58 (1)
0·8	60 (1)	56 (2)	58 (1)	57 (0)	57 (4)
1·2	58 (4)	54 (5)	57 (4)	63 (1)	56 (4)
	Lu	Lc	Ln	A	R
	1965				
0·0	48 (0)	46 (0)	42 (0)‡	36 (0)	48 (0)
0·4	53 (0)	51 (2)	44 (0)‡	47 (0)	49 (0)
0·8	50 (2)	49 (1)	44 (0)‡	50 (0)	46 (0)
1·2	50 (0)	47 (1)	42 (0)‡	51 (0)	47 (0)
	1966				
0·0	51 (0)	46 (0)	49 (0)	32 (0)	
0·4	59 (0)	54 (2)	56 (0)	50 (0)	
0·8	59 (3)	57 (1)	56 (4)	58 (0)	
1·2	56 (4)	54 (6)	55 (6)	57 (1)	

* On the arable rotation rates are 0·0, 0·4, 0·8, 1·2 cwt N/acre.
† On the arable rotation rates are 0·0, 0·53, 1·07, 1·6 cwt N/acre.
‡ Wheat after "Ln" badly thinned by stem-boring larvae.

Barley: yields of grain, cwt/acre (and lodging, tenths of area)

N cwt/acre	Highfield				
	Lu	L	Cg	A	R
	1964				
0·0	57 (4)	57 (1)	49 (0)	51 (0)	
0·1	57 (3)	58 (3)	51 (1)	55 (0)	
0·2	56 (4)	60 (6)	56 (2)	56 (0)	
0·3	57 (5)	57 (6)	56 (4)	54 (1)	
	1965				
0·0	44 (6)	45 (6)	46 (8)	50 (4)	45 (8)
0·1	44 (7)	45 (8)	48 (8)	48 (5)	42 (9)
0·2	43 (6)	44 (8)	48 (8)	48 (6)	42 (9)
0·3	43 (8)	44 (9)	49 (8)	41 (3)	42 (9)
	1966				
0·0	43 (0)	50 (1)	44 (0)	45 (0)	53 (2)
0·1	50 (0)	55 (1)	52 (0)	49 (0)	54 (2)
0·2	52 (0)	54 (0)	52 (0)	52 (0)	53 (2)
0·3	54 (0)	54 (2)	56 (0)	54 (1)	50 (4)

N cwt/acre	Fosters				
	Lu	L	Cg	A	R
	1964				
0·0	56 (0)	54 (0)	50 (0)	46 (0)	
0·2	59 (2)	56 (1)	54 (1)	—	
0·4	59 (2)	56 (4)	56 (4)	56 (1)	
0·6	58 (6)	57 (7)	55 (6)	57 (3)	
0·8	—	—	—	59 (4)	
	1965				
0·0	47 (8)	46 (8)	48 (8)	46 (6)	46 (8)
0·2	47 (8)	46 (8)	46 (7)	—	44 (7)
0·4	47 (8)	45 (8)	43 (8)	47 (8)	43 (8)
0·6	46 (8)	46 (8)	44 (7)	50 (8)	44 (8)
0·8	—	—	—	47 (8)	—
	1966				
0·0	42 (0)	50 (1)	45 (1)	44 (2)	54 (3)
0·2	51 (0)	57 (1)	51 (0)	—	58 (2)
0·4	54 (2)	56 (4)	55 (2)	52 (0)	53 (4)
0·6	56 (2)	52 (3)	56 (1)	55 (1)	52 (7)
0·8	—	—	—	54 (3)	—

Lu = lucerne, cut (3 years); L = ley, grazed (3 years); Cg = grass, cut (3 years); A = arable (1-year hay, sugar beet, oats—slightly different in earlier years); R = reseeded grass 12–15 years old; Lc = grass/clover ley, cut, no N; Ln = all-grass ley, cut, much N.

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Table 2 shows the mean yields and mean scores for lodging (in 1964 wheat did not lodge on Highfield, and the scores for leaning are shown).

Differences between seasons did not affect the two crops in the same way. 1965 was the worst year of the three for barley, which lodged badly on almost all plots of both fields (but wheat stood well), and in 1964 barley also lodged more than wheat, but in 1966 barley stood fairly well (though much of it was leaning), whereas wheat was moderately lodged.

In each year each crop was sown on the same day in the two fields, but comparisons between the fields are complicated by the different N dressings. In the earlier years of the experiment lodging was more severe on Highfield than on Fosters, especially in barley. The results considered here show that this tendency is now less, and occasionally reversed (e.g. wheat 1964 and barley without N 1965).

The different crop-sequences preceding the test-crops affect lodging, but by no means consistently. "Lucerne" often produced much lodging, as did "reseeded" (except for wheat in 1965 on both fields), "arable" usually gave the least, despite the larger N dressings on these plots.

In general, lodging increased with increasing N dressings and, although there are some anomalies, there seem to be plots where yield was diminished by lodging at the largest dressing of N (e.g. wheat 1966, Fosters).

Comparing the different N dressings suggests that the maximum yield obtainable with a given proportion of lodging differs with the different rotations. The results for the 3 years are not consistent, but the outstanding example is wheat in Fosters 1964, which after "arable" yielded 63 cwt with $\frac{1}{10}$ lodging, whereas after "ley", "cut grass" and "reseeded" yields could not be increased beyond 58 cwt and a good deal of lodging occurred. In Highfield 1965 "lucerne" caused wheat crops of 42–46 cwt to lodge worse than crops of 50–52 cwt after "all grass ley", "arable" and "reseeded".

Sugar beet. In recent years the mean yields of the first and third test crops, wheat and barley respectively, have been much the same on the two fields (*Rothamsted Report* for 1965, pp. 216–221). The rates of N applied on the two fields differ, but for each rotation the maximum yield obtainable by varying N is about the same on Highfield and on Fosters. Potatoes (the second test crop) have yielded about 10% more on Highfield (old grass) than on Fosters (old arable).

Since 1961 sugar beet has been grown as the second treatment crop of the "arable" rotation. Yields of roots and tops have been consistently heavier on Highfield than on Fosters; the percentage of sugar has differed in the opposite sense (except in 1964), but in each year the total yield of sugar from Highfield has exceeded that from Fosters. The average difference is nearly 10 cwt sugar/acre, or about 15%. (Table 3)

Plenty of P and K are applied throughout the rotation (1·0 cwt P_2O_5 and 2·4 cwt K_2O/acre to the beet). From 1961–63 N was applied at 1·0 cwt/acre. In 1964 a test was made on sub-plots of 1·0 *v.* 1·5 cwt N, but this was not continued because of the risk of residual effects that might affect later crops. From the results in 1964 (and later when 1·5 cwt N was applied) it seems unlikely that the difference between yields can be

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TABLE 3

Yields of sugar beet

		Roots (tons/acre)		Sugar %		Total sugar (cwt/acre)		Tops (tons/acre)	
	N cwt/acre	H	F	H	F	H	F	H	F
1961	1·0	23·1	18·1	16·6	17·2	77·0	62·3	20·6	12·9
1962	1·0	21·4	16·6	16·1	16·7	69·1	55·4	21·1	15·1
1963	1·0	16·7	14·5	17·1	18·5	57·2	53·6	17·4	12·7
1964	1·0	14·8	12·4	20·3	20·2	60·0	50·1	6·2	5·0
1964	1·5	15·7	12·9	20·0	19·6	62·8	50·8	6·5	5·6
1965	1·5	20·5	17·9	17·8	18·5	72·9	66·4	22·6	20·1
1966	1·5	23·7	20·8	16·2	17·0	76·7	70·8	22·1	19·0
Mean 1961–64	1·0	19·0	15·4	17·5	18·2	65·8	55·4	16·3	11·4
Mean 1964–66	1·5	20·0	17·2	18·0	18·4	70·8	62·7	17·1	14·9
Mean 1961–66	1·0 and 1·5	19·4	16·2	17·7	18·2	68·0	58·5	16·6	12·9

H = Highfield F = Fosters

explained simply in terms of N, P or K. In 1967 to 1969 beet will be grown on plots of the old "Reseeded Grass" treatment that were ploughed up in 1962–64, as well as on plots of the "arable" rotation, and the results should indicate whether soil organic matter is the important factor.

Other experiments in 1966

Residual effects of an excessive application of simazine. For some years we have observed a patch of soil in Great Knott III on which no crop or weed has survived because of the residual effect of an accidental excessive application of simazine in 1961. Each crop sown or planted since then has died in late spring (in 1963 winter wheat looked normal until early April) and, except for a few plants of cleavers near the edge, no weeds have grown. The patch has shrunk a little in the 5 years and is now roughly circular and about 15 ft in diameter.

In 1966 different crops were grown in strips across the area. In each crop plants either grew normally throughout the season or failed soon after emergence, died and withered away; there were scarcely any plants between these extremes. The crops were roughly grouped for sensitivity:

Crop	Critical concentration of simazine (ppm in dry soil 0–9 in.)
1. Spring wheat Spring oats Sugar beet Peas	Less than 0·05
2. Potatoes Spring barley	0·05–0·1
3. Tick beans Broad beans	More than 0·2
4. Sitka spruce (transplanted at 1 year old)	1
5. Maize (which grew well at the centre of the patch)	More than 10

(Allen, with J. D. H. Williams, Chemistry Department)

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Effect of N on spring beans. Yields of spring beans at Rothamsted have been roughly constant at 25–35 cwt/acre since the control of blackfly (*Aphis fabae*) was achieved about 1950. In the same period yields of well-grown cereals have increased substantially; yields of wheat on the Ley–Arable experiment, for instance, were about 25 cwt in 1950, about 50 cwt in 1964. This increase can be attributed to known improvements in husbandry, e.g. a better variety, better manuring and better control of soil-borne diseases by a change in one crop-rotation.

Many factors have been tested on beans without substantial consistent increase in yield—fertiliser placement, different seed-rates and spacing between the rows, irrigation and sprays designed to increase the proportion of flowers that set pods. This year two experiments were done to test the idea that fixation of N by *Rhizobium* in the root-nodules is inadequate for yields of more than about 35 cwt. One experiment, on full-scale plots, tested nitrogenous fertiliser of three types, applied at 1, 2 or 3 cwt N/acre. The other experiment, on microplots, tested similar total amounts but applied in divided dressings, together with the checking of growth by topping or applying a chemical growth regulator. Ironically, beans given the customary treatment yielded exceptionally well (40 cwt/acre in the large-scale experiment, 47 in the other), and none of the treatments produced large increases. In the microplot experiment, however, the combination of 3 cwt N and chemical restriction of growth gave a mean yield of 54 cwt.

In the small experiment the beans were cut by hand and threshed with special care; this may explain the difference of 7 cwt between similarly treated plots in this and the nearby large experiment. This observation suggested that there may be appreciable loss of grain in combine-harvesting (which was done in good conditions this year). Counts of plants germinating from shed grain indicated a loss of at least 5 cwt/acre. (McEwen)

Green manures at Rothamsted. In 1965 duplicate strips in a barley crop were undersown with green crops: Italian rye-grass, trefoil, birdsfoot trefoil, lucerne, sainfoin, red clover (with unsown strips as controls). In spring 1966 duplicate strips at right angles were sown with seven test crops: oats, wheat, kale, sugar beet, red beet, carrots, rye-grass.

The sainfoin failed to establish, the trefoil and birdsfoot trefoil established on about half the area sown, whereas rye-grass, red clover and lucerne all established well.

Yields were not measured for oats, wheat and rye-grass (none of which showed signs of being affected by the treatments). Trefoil, lucerne and red clover increased the yields of kale, sugar beet, red beet and carrots. With red beet the increases were small (5–10%); with the other crops they ranged from 10 to 60%.

This experiment was intended to discover which green crops most benefited which test-crop, but it was not very satisfactory because two-fold replication was inadequate and because the variations of different test-crops are probably correlated.

Green manures at Woburn. A small experiment was done in 1965–66 to investigate the mode of action of green manures which, in some seasons,

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have increased the yield of sugar beet and barley whatever amount of nitrogen fertiliser was applied to the test-crops. The site carried early potatoes in 1965, and the test-crop in 1966 was barley.

The design was a 4 × 4 Latin square. On two of the four treatments trefoil was sown in August 1965. In January 1966 the trefoil was forked out (tops plus as much root as possible) and the other plots were forked over. The trefoil grown on plots of one treatment was removed and spread on plots of one of the treatments where no trefoil had grown, and the whole area was dug over with spades. The treatments, and mean yields of grain were:

(i)	No green manure	36·0 ± 0·81 cwt/acre
(ii)	Trefoil grown, removed	37·0
(iii)	No green manure sown, trefoil from (ii) dug in	40·3
(iv)	Trefoil grown and dug in	38·5

The trefoil grew unevenly; on average the material forked out contained about 8 cwt dry matter and 0·24 cwt N/acre. The barley received 0·5 cwt P_2O_5 and 1·0 cwt K_2O/acre as granular fertiliser, but no inorganic N.

As far as it goes, this experiment suggests that trefoil increases yield through some action of the greenstuff incorporated with the soil, not because of any change in the properties of the soil caused by the growing trefoil.

Methods of Sowing and Manuring Winter Wheat and Spring Barley Rothamsted and Woburn, 1964–66

By J. R. Moffatt and F. V. Widdowson

British drills usually sow grain in rows 7 in. apart, and most can be used to combine-drill fertiliser and seed. Scandinavian grain drills have coulters spaced only about 4 in. apart and sow only seed. Combine-drills are costly to maintain and sow fewer acres in a day than the Scandinavian drills, but make better use of fertiliser on infertile soils.

In each year 1964–66 experiments at Rothamsted and Woburn compared yields of winter wheat and spring barley from broadcast seed (by a drill modified to broadcast seed), and from seed sown either in rows 4 in. apart (by a Scandinavian drill) or 7 in. apart (by a British drill). Basal fertiliser was broadcast, and a fourth treatment was included to test combine-drilled fertiliser.

The treatments were:

1. Seed broadcast	basal fertiliser broadcast
2. Seed drilled at 4-in. spacing	
3. Seed drilled at 7-in. spacing	
4. Seed drilled at 7-in. spacing	basal fertiliser drilled

Seed was sown by each method at two rates, to give eight sowing treatments, and each plot was then split to test three amounts of N. There were four blocks in each experiment.

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