

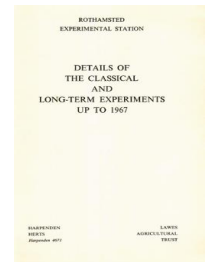
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Four-course Rotation - Rothamsted

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FOUR-COURSE ROTATION EXPERIMENT, RESIDUAL VALUES OF ORGANIC MANURES AND PHOSPHATE FERTILISERS, HOOSFIELD, 1930-56

This experiment falls into two periods: 1930-54, the original scheme which attained full cycle in the crops of 1934; and 1955-56 when a modified scheme was in operation.

The Original Experiment, 1930-54

The five treatments were farmyard manure, straw compost, straw, superphosphate and rock phosphate (Gafsa); the cropping followed a four-course rotation (potatoes, barley, ryegrass, wheat). There were four series, one for each crop of the rotation. Each series had 25 plots.

Farmyard manure and straw compost were each applied at a rate to supply 50 cwt of organic matter. The quantity of raw straw per acre for ploughing in was such that if rotted in the heap it would produce compost containing 50 cwt of organic matter. The nutrient content of the three organic treatments was equalised by adding sulphate of ammonia, muriate of potash and superphosphate, to raise the totals to 1.8 cwt N, 1.2 cwt P_2O_5 and 3.0 cwt K_2O . The phosphate fertilisers were applied at the rate of 1.2 cwt P_2O_5 , together with sulphate of ammonia and muriate of potash at the above rates.

Any given plot always received the same treatment, but the treatment was applied to the plot only once in five years, except that the sulphate of ammonia and muriate of potash on the phosphate plots were applied annually at one-fifth of the full rates. Thus in each of the four crops every manurial treatment had a set of five plots showing respectively its five stages of exhaustion. The full cycle was therefore 20 years.

Each series of 25 plots was divided into five blocks of five. Each treatment was assigned to one plot (chosen at random) in each block. Within each block one plot received its treatment each year; in each year the five treated plots of each series belonged one to each treatment, thus:

Series I Years of application

Treatments	Blocks				
	A	B	C	D	E
FYM	III	V	I	II	IV
Compost	I	III	IV	V	II
Straw	V	I	II	IV	III
Superphosphate	II	IV	III	I	V
Rock phosphate	IV	II	V	III	I

I, II, III, IV, V indicate the successive years of the cycle.

Size of plots: 0.0244 acre (Series IV, 0.0233).

Application of manures. The manures were applied as follows:

Bulky organic manures ploughed in before sowing wheat and autumn-sown ryegrass, and later in the winter for the barley and potatoes. Supplementary fertilisers for farmyard manure and compost applied and ploughed

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down with these organics, the supplementary nitrogen for the straw was applied in three successive dressings. The straw was chaffed to enable it to be ploughed in properly. Superphosphate and rock phosphate with their accompanying potash and half their nitrogen were applied in the seedbed for autumn-sown crops, leaving the remaining half of their nitrogen for a spring top dressing. For barley and potatoes the superphosphate and rock phosphate with their supplementary potash and nitrogen were given in the seedbed and ridges respectively.

The following changes were made:

- 1930–31 Turnips were grown but these gave place to potatoes in 1932 and subsequently.
- 1935 Undersown clover-ryegrass ley replaced by Western Wolth's ryegrass sown in autumn.
- 1942 Variety of potatoes changed from Ally to Majestic and potato plots split to test an extra 0.4 cwt N as ammonia sulphate re-randomised every rotation.
- 1946 Variety of wheat changed from Yeoman to Squarehead's Master.

The Revised Experiment, 1955–56

The rotation was modified by introducing beans (autumn-sown when possible) instead of ryegrass ley, the rotation was: potatoes, barley, beans, wheat.

The application of farmyard manure, straw, straw-compost and rock phosphate was discontinued. The plots originally testing FYM, straw and superphosphate respectively received an annual dressing of 0.24 cwt P_2O_5 applied as superphosphate, while the old compost plots received 0.12 cwt P_2O_5 annually as superphosphate. The rock phosphate plots received no phosphate. All plots had a basal dressing of 0.6 cwt K_2O annually as muriate of potash (but see below for the beans of 1955 and the wheat of 1956).

Each plot of wheat, barley and potatoes was split for nitrogen:

wheat and barley: none; 0.4 cwt N applied as sulphate of ammonia;
potatoes: 0.2; 0.6 cwt N applied as sulphate of ammonia.

The arrangement of the levels of nitrogen was randomised afresh each season. The beans did not receive nitrogen.

The phosphate and potash fertilisers were applied in autumn for beans and wheat, half-plots of wheat receiving a single top dressing of nitrogen in spring. All fertilisers for barley were applied to the seedbed. All fertilisers for potatoes were broadcast on the flat before planting by machine.

In 1955 the plots of beans were split into three for a test of potash:

none; 0.8; 1.6 cwt K_2O applied as muriate of potash.

The wheat following these beans received equalising amounts of potash:

1.6 cwt K_2O following none; 0.8 following 0.8 and none following 1.6.

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Subsequent cropping

1957 After the harvest of 1956 the second scheme was terminated and the four series were each sown with five strips of cereals. The cereal plots coincided with the blocks of the old rotation. The crops were:

Wheat: Yeoman, Squarehead's Master, Cappelle

Barley: Proctor

Oats: Sun II.

Studies were made of the incidence of take-all (*Ophiobolus graminis*) and eyespot (*Cercospora herpotrichoides*) in relation to the previous cropping.

1958 In autumn 1957 the whole area was sown with winter beans.

1959 Yeoman wheat, 0.6 cwt N as 'Nitra-Shell', 20.5% N.

References

For the design of the original experiment see *Rep. Rothamsted exp. Stn for 1930*, 125–126.

For summaries of the original experiment see *Rep. Rothamsted exp. Stn for 1946*, 82–84, and *for 1954*, 153–156.

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TABLE 29

Four-course rotation, Hoosfield

Means over 21 years, 1934-54

Years after application	Farmyard manure	Straw compost	Straw	Super-phosphate	Rock phosphate	S.E.
Potatoes: tons (no additional N)						
0	6.41	6.18	6.89	6.90	4.49	$\pm 0.18^*$
1	5.35	4.92	5.01	5.76	4.49	$\pm 0.16^\dagger$
2	5.17	4.47	5.22	5.86	4.69	
3	4.79	4.51	5.10	5.74	4.54	
4	4.58	4.33	4.95	5.60	4.58	
Mean	5.26	4.88	5.43	5.97	4.56	± 0.11

Response by potatoes to 0.4 cwt additional N, 1942-54

0	+1.49	+0.82	+1.19	+0.78	+0.12	
1	+1.82	+1.47	+1.59	+1.00	+0.81	
2	+1.15	+1.46	+1.53	+0.68	+0.21	± 0.28
3	+1.64	+0.90	+1.08	+0.57	+0.41	
4	+1.54	+0.78	+1.38	+0.75	-0.18	
Mean	+1.53	+1.09	+1.35	+0.76	+0.27	± 0.12

Barley, grain: cwt

0	28.0	27.5	29.3	27.6	23.4	$\pm 0.41^*$
1	22.8	22.0	22.0	25.8	24.0	$\pm 0.48^\dagger$
2	20.7	19.9	21.2	26.4	25.0	
3	19.0	19.6	20.9	26.4	24.3	
4	18.9	18.6	20.5	25.8	25.6	
Mean	21.9	21.5	22.8	26.4	24.5	± 0.31

Ryegrass, dry matter: cwt, means over 18 years
1935-40, 1942-48, 1950-54

0	19.2	19.5	30.9	19.5	17.6	
1	12.5	13.1	11.6	19.3	16.7	
2	11.2	10.3	12.6	18.8	17.0	
3	9.6	9.7	10.7	18.0	16.8	
4	9.6	9.8	9.6	18.0	16.6	
Mean	12.4	12.5	15.1	18.7	16.9	

Wheat, grain: cwt

0	20.9	22.2	23.6	18.7	18.7	$\pm 0.31^*$
1	17.0	17.0	15.9	17.8	18.3	$\pm 0.32^\dagger$
2	15.3	15.0	16.8	18.4	18.2	
3	15.1	15.2	15.7	18.1	18.3	
4	15.2	14.8	14.9	18.6	18.0	
Mean	16.7	16.8	17.4	18.3	18.3	± 0.17

Note: All yields except those of ryegrass have been adjusted for block differences. The adjustment of the ryegrass yields is complicated, and has not been carried out; these adjustments are, however, almost certainly small, as they were in the case of the other crops, as each block has in some year carried nearly all of the treatment-phase combinations.

* S.E. for vertical comparisons and interactions.

† S.E. for horizontal comparisons.