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Continuous Rotation Experiments

Rothamsted Research

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FOUR-COURSE ROTATION EXPERIMENT, ROTHAMSTED

RESIDUAL VALUES OF HUMIC AND PHOSPHATIC FERTILISERS

The Rotation experiment in Great Hoos field commenced in 1930, was designed primarily for investigating the residual effects of certain humic and phosphatic fertilisers. Previous rotation experiments, at Rothamsted and elsewhere, suffered from a radical defect in design, which resulted in large experimental errors. The arrangement of these experiments was such that with the same crop, the same treatment fell repeatedly on the same plot of land, and repetitions thus did nothing to eliminate permanent soil differences between the plots. The present experiment avoids this defect by ensuring that the period of the cycle of crop rotation differs from the period of the cycle of manurial treatment.

The cropping follows a Norfolk Rotation, involving a four year cycle of barley, seeds, wheat, swedes.* The seeds mixture is Commercial White Clover and Italian Rye-grass, selected in order to lessen the risk of Clover sickness. To minimise the risk of Frit-fly attack in the subsequent wheat crop, the seeds ley is ploughed in before the middle of August.

There are four areas (termed "Series"), each bearing one crop of the rotation, so that all four crops are represented annually.

Treatments.

The treatments compared are :

Humic fertilisers	{	1. Dung.
		2. Adco compost.
Phosphatic fertilisers	{	3. Straw and artificials.
		4. Superphosphate.
		5. Rock phosphate (Gafsa).

Any given plot receives always the same treatment, but the treatment is applied to the plot only once in five years. The period of the manurial cycle (five years) thus differs from that of the crop rotation (four years).

Information is thus obtained of the effect of the fertilisers, not only in the year of application, but also in the first, second, third and fourth years after application.

Each "series" of the experiment comprises twenty-five plots, and in the fifth year of the experiment and in succeeding years, all plots will have been treated, and there will be represented for each treatment plots which have had application of fertilisers in the current year, and one, two, three, and four years previously. The harvest results for 1930-33, therefore, belong to the preparatory period, and will not be included in the final analysis.

There is no replication in any one year, but this will be provided by carrying on the experiment over a fixed period. In twenty years, on any given plot each stage of the treatment will have occurred once with every crop.

The quantities of fertilisers to be applied are calculated as follows :

Dung and Adco are each given in quantities which supply 50 cwt. of organic matter per acre. As much straw is applied as went to make the calculated amount of Adco, *i.e.*, that amount which gives 50 cwt. of organic matter per acre in the form of Adco. The quantity of straw applied will in general give a considerably greater amount of organic matter than the Dung or Adco, since there is a loss of organic matter during the maturation of these fertilisers.

The Adco is made in a pit or bin, so that there is no outside unrotted portion. To prevent straw (applied as chaff) blowing away, it is thoroughly soaked before application, and moistened subsequently if necessary.

The nutrient-content of the three humic fertilisers is equalised by adding sulphate of ammonia, muriate of potash and superphosphate, to raise the applications to 1.8 cwt. N. per acre, 3.0 cwt. K_2O per acre, and 1.2 cwt. P_2O_5 per acre. The artificials given with the straw are applied in three doses, to minimise loss by leaching.

The phosphatic fertilisers of treatments 4 and 5 are given at the rate of 1.2 cwt. total P_2O_5 per acre, and with them are given sulphate of ammonia at the rate of 1.8 cwt. N. per acre, and muriate of potash at the rate of 3.0 cwt. K_2O per acre.

The rock phosphate is Gafsa, ground so that 90 per cent. passes through the 120 mesh.

The artificials given with the humic fertilisers are all applied with them in the first year of the manurial cycle.

The phosphatic fertilisers of treatments 4 and 5 are applied only in the first year of the manurial cycle, but the accompanying sulphate of ammonia and muriate of potash are applied one fifth annually throughout the cycle.

* It has been decided to substitute potatoes for swedes in 1932 and following years.

Time of Application of Fertilisers.

In determining the time of application of the fertilisers, the principle followed has been to give the fertilisers to each crop at a time when they are likely to be most effective.

The scheme adopted is as follows :

(1) *Wheat*.—Dung and Adco and accompanying artificials in one dose in the Autumn. Straw in one dose in Autumn, but accompanying artificials split into three doses, one applied in Autumn, the remainder through the Winter.

Treatments 4 and 5. Phosphates and potash in seed-bed. Sulphate of Ammonia of treatments 4 and 5, split into two parts, one applied in the seed-bed, the other as a spring top dressing.

(2) *Clover*.—Dung and Adco and accompanying artificials in one dose in Autumn, unless plant is very weak, when the manures should be split into two or three doses.

Straw and artificials—application to be determined by state of plant, but to be completed by the end of January.

Treatments 4 and 5. Phosphates and potash in the Autumn.

Sulphate of Ammonia in two doses, one in Autumn, and one in Spring.

(3) *Barley and Potatoes*.—Dung and Adco and accompanying artificials in one dose in Autumn. Straw in one dose in Autumn, and accompanying artificials in three doses, one in Autumn, and the remaining two through the winter.

Treatments 4 and 5. All artificials to be given in the seed-bed.

Arrangement of Plots.

The experiment consists of four series of plots, each series growing one crop of the Norfolk rotation. Each series has 25 plots, in 5 blocks of 5 plots each. Each treatment is assigned to one plot in each block, chosen at random ; and each block has one treated plot in each year, chosen initially at random ; finally each treatment is applied once in each year to one plot in each series.

Hence treatments are assigned as to five randomised blocks of five plots each in each series, but a Latin Square scheme determines the year of application of the treatment in each series.

The plots are approximately 1/40th acre in area (.02436 acre in series A, B and C, but .02335 acre in series D).

MANURES APPLIED.

Season 1931-2.

Treatment.	Organic Fertilisers.	Artificial Fertilisers.		
	Organic Matter (cwt. per acre).	N. cwt. per acre as Sulphate of Amm.	K ₂ O cwt. per acre as Mur. of Potash.	P ₂ O ₅ cwt. per acre as Superphosphate.
1 ..	50 (as F.Y.M.)	0.775	1.030	0.716
2 ..	50 (as Adco)	0.434	1.569	0.048
3 ..	150.95 (as Straw)	1.053	0.330	0.654
4 ..	None	0.36	0.6	1.2
5 ..	None	0.36	0.6	1.2 (as Gafsa rock phos.)

DATES OF APPLICATION.

Wheat.—Treatments 1 and 2 ; Nov. 2nd. Treatment 3 ; straw, Nov. 4th, artificials Nov. 2nd, Nov. 4th, Jan. 25th, April 5th. Treatments 4 and 5 ; minerals, Nov. 5th, sulphate of ammonia, Nov. 5th, April 5th.

Clover.—Treatments 1 and 2 ; Nov. 2nd, Jan. 25th. Treatment 3 ; straw, Nov. 7th, April 29th, artificials, Nov. 2nd, Nov. 7th, Dec. 7th, Jan. 25th, April 29th. Treatments 4 and 5 ; minerals, Nov. 5th, sulphate of ammonia, Nov. 5th, April 11th.

Barley.—Treatments 1 and 2 ; Dec. 7th. Treatment 3 ; straw, Dec. 12th,* artificials Dec. 7th, Jan. 25th, Mar. 15th. Treatments 4 and 5 ; minerals, April 5th.

Potatoes.—Treatments 1 and 2 ; Nov. 2nd, Nov. 4th. Treatment 3 ; straw, Dec. 7-15th, artificials, Nov. 2nd, Nov. 4th, Dec. 7th, Jan. 5th. Treatments 4 and 5 ; minerals, April 11th.

* Applied after ploughing.

PLAN AND YIELDS

Potatoes—AP, Plots 1-25.

Planted, April 12th. Lifted, Sept. 30th.
Variety, Ally.

Yields in lb.

N.W.

5 400 —	2 277 III	1 409 I	3 264 —	4 367 II
5 321 II	1 217 —	3 335 III	4 299 —	2 270 I
3 258 II	2 201 —	5 284 —	4 427 I	1 251 III
1 305 II	3 196 —	4 272 III	5 225 I	2 238 —
4 288 —	1 159 —	5 164 III	3 232 I	2 176 II

Barley—AB, Plots 26-50.

Seed sown, Mar. 12th. Harvested, Aug. 15th.
Variety, Plumage-Archer.

Yields in lb., grain above, straw below.

N.W.

3 76.0 77.2 II	2 74.4 67.6 III	5 79.2 99.2 —	4 85.5 95.2 I	1 65.9 79.8 —
4 86.2 99.6 III	2 89.1 96.9 I	1 61.4 67.9 II	5 78.8 98.0 —	3 70.1 79.9 —
1 109.7 156.6 I	4 80.5 91.0 —	3 65.1 69.4 —	5 88.2 95.2 III	2 80.2 80.5 II
4 88.2 99.2 —	5 86.1 101.1 II	3 74.5 69.8 I	2 55.0 52.8 —	1 78.9 82.3 III
2 62.2 58.8 —	4 81.5 85.5 II	3 74.8 68.8 III	1 56.4 53.6 —	5 89.5 93.5 I

Wheat—AW, Plots 51-75.

Seed sown, Nov. 5th. Harvested, Aug. 15th.
Variety, Yeoman.

Yields in lb., grain above, straw below.

N.W.

3 77.8 120.0 III	4 88.9 127.6 —	1 78.1 110.1 —	2 94.0 152.0 I	5 77.8 135.8 II
3 73.9 104.8 —	4 86.4 132.4 II	5 86.4 126.4 III	2 69.0 100.8 —	1 82.6 187.1 I
2 75.6 115.4 III	4 82.1 126.1 —	3 77.9 113.4 II	1 63.3 97.2 —	5 79.4 136.6 I
5 84.4 129.9 —	1 73.1 105.4 III	3 69.8 93.8 —	4 78.6 118.1 I	2 72.1 116.2 II
4 77.2 161.5 III	2 59.5 72.0 —	1 75.6 103.4 II	5 80.1 107.2 —	3 81.8 129.8 I

Seeds Hay—AH, Plots 76-100.

Seed sown, April 22nd. Cut, June 22nd.

Yields in lb., green weights.

N.W.

4 142.0 II	2 105.5 III	5 142.0 I	3 71.5 —	1 76.0 —
5 168.0 —	2 95.5 —	1 95.0 II	4 139.0 I	3 112.0 III
2 196.0 I	1 113.0 III	5 158.0 —	4 142.0 —	3 131.0 II
2 120.0 II	4 163.0 —	1 77.5 —	5 126.5 III	3 45.0 I
5 159.0 II	2 96.5 —	3 80.5 —	1 278.0 I	4 162.0 III

Treatment symbols in heavy type, year of cycle in roman figures (see note on next page).

I

SUMMARY OF RESULTS, 1932

Manure.	Year of Cycle.	Wheat cwt. per acre.		Potatoes tons per acre.	Barley cwt. per acre.		Seeds Hay cwt. per acre dry matter.
		Grain.	Straw.		Grain.	Straw.	
Manure as F.Y.M.	—	28.6	40.4	3.98	24.2	29.2	19.3
	—	23.2	35.6	2.91	20.7	19.6	19.6
	I	30.3	68.6	7.50	40.2	57.4	70.6
	II	27.7	37.9	5.59	22.5	24.9	24.1
	III	26.8	38.6	4.60	28.9	30.2	28.7
Manure as Adco	—	25.3	36.9	3.69	20.2	19.3	24.2
	—	21.8	26.4	4.36	22.8	21.6	24.5
	I	34.4	55.7	4.94	32.7	35.5	49.8
	II	26.4	42.6	3.23	29.4	29.5	30.5
	III	27.7	42.3	5.07	27.3	24.8	26.8
Manure as Straw	—	27.1	38.4	4.84	25.7	29.3	18.1
	—	25.6	34.4	3.59	23.8	25.4	20.4
	I	30.0	47.6	4.25	27.3	25.6	11.4
	II	28.5	41.6	4.74	27.8	28.3	33.2
	III	28.5	44.0	6.14	27.4	25.2	28.4
Super.	—	32.6	46.8	5.48	29.5	33.4	36.0
	—	30.1	46.2	5.27	32.3	36.4	41.4
	I	28.8	43.3	7.82	31.3	34.9	35.3
	II	31.7	48.5	6.72	29.9	31.3	36.0
	III	28.3	59.2	4.99	31.6	36.5	41.1
Rock Phosphate	—	30.9	47.6	7.32	29.0	36.4	42.6
	—	29.3	39.3	5.21	28.9	35.9	40.1
	I	29.1	50.1	4.12	32.8	34.3	36.0
	II	28.5	49.8	5.88	31.6	37.1	40.4
	III	31.7	46.3	3.00	32.3	34.9	32.1

The number I denotes application of manure at the beginning of the present season (1931-2); II application in the previous season, etc. The plots above the lines have not yet had any manure, except those due to receive superphosphate and rock phosphate, which in the season 1931-2 received one fifth of their quinquennial total of potash and nitrogen. In the two previous seasons these plots, like the corresponding plots due to receive organic manures, were untreated.

SIX COURSE ROTATION EXPERIMENT

ROTHAMSTED AND WOBURN

This experiment is designed to furnish data on the effect of varying amounts of the three standard fertilisers, nitrogen, phosphate, and potash, on the yield of six crops of a rotation in the different weather conditions of successive years.

Rotation.

The six courses of the rotation are: barley, clover hay, wheat, potatoes, forage-crop, sugar-beet. The forage-crop consists of equal parts (1 bushel per acre each) of rye, beans and vetches. It is sown in autumn, cut green and followed by a catch crop of mustard. The mustard is ploughed in in early autumn, and followed by rye to be ploughed in before sowing sugar-beet. After wheat, rye is sown and ploughed in in spring before planting potatoes.

The variety of barley used is Plumage-Archer, and of wheat Yeoman II.

Arrangement.

There are six areas, called "series," in Long Hoos IV at Rothamsted, which are cropped in this rotation so that each crop is represented every year and a similar set in Stackyard at Woburn. There are fifteen plots of 1/40th acre in each series, each of which receives a different treatment. Thus there is no replication of a given crop with a given treatment in any one year. Plots do not receive the same treatments throughout, but on each plot the fifteen treatments follow one another in a definite order in successive years, and in this way cumulative effects of a treatment are avoided.

Treatments.

The fifteen treatments are:

Nitrogen set.	4, 3, 2, 1, 0 units of N, each with 2 units P and 2 units K.
Phosphate set.	4, 3, 2, 1, 0 units of P, each with 2 units K and 2 units N.
Potash set.	4, 3, 2, 1, 0 units of K, each with 2 units N and 2 units P.

1 unit of N = 0.15 cwt. of N per acre.
1 unit of P = 0.15 cwt. of P_2O_5 per acre.
1 unit of K = 0.25 cwt. of K_2O per acre.

The fertilisers used are Sulphate of Ammonia, Superphosphate and Muriate of Potash. The amount of Superphosphate applied is calculated on the basis of total P_2O_5 content.

The potassic and phosphatic fertilisers are applied to the autumn sown crops, wheat and forage-mixture, and to the clover, sown under barley in the previous spring, in the Autumn, and the nitrogenous fertiliser is given as a spring top dressing. The spring sown crops receive all their fertilisers at the time of sowing.

Within each of the three sets of treatments, the treatments 4, 3, 2, 1, 0 units follow each other in that order in successive years.

On series 2, 4, 6 the order of the sets of treatments is N, P, K, and on series 1, 3, 5 the order is N, K, P, *i.e.*, on plots of series 2, 4, 6 treatment ON is followed by treatment 4P, OP by 4K and OK by 4N, while on series 1, 3, 5, ON is followed by 4K, OK by 4P, and OP by 4N.

Continuance of the Experiment.

In 1929-30 the six crops of the rotation at Rothamsted were scattered in various fields of the farm, so that the experiment proper started on its permanent site in Long Hoos IV in season 1930-31, while at Woburn in 1929-30 only potatoes, barley, and sugar beet were grown.

After 30 years on the same land, each plot will have completed 5 rotations by crops, and 2 by treatments. If continued for a further period, it will be necessary to omit one stage of the crop rotation on each series, without breaking the sequence of manurings. After two such breaks the experiment could be continued until every crop with every treatment had occurred on each plot.

Estimate of Error.

Although there is no actual replication, an estimate of error can be made from the deviations of the yield/quantity of fertiliser curve, from a smooth form.

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Potatoes—BP, Plots 1-15.

Manures applied, April 11th. Planted, April 12th. Lifted, Sept. 30th. Variety, Ally.

Yields in lb.

N.

2P 387	4N 472	4K 467	3K 451	1K 404
3N 436	1P 408	2N 419	4P 465	0K 359
0P 427	1N 432	0N 355	2K 408	3P 427

Barley—BB, Plots 16-30.

Manures applied, March 19th. Seed sown, March 12th. Harvested, Aug. 15-16th. Variety, Plumage-Archer.

Yields in lb., grain above, straw below.

N.

2N 99.5 101.8	3P 98.5 112.5	1P 96.2 112.1	2P 100.9 113.8	2K 98.2 101.1
4P 94.9 109.4	1N 101.4 111.4	0P 95.6 107.6	4N 103.2 120.0	3N 99.2 107.5
0N 99.1 103.1	4K 96.6 110.4	3K 94.4 111.4	1K 94.7 104.6	0K 91.6 91.1

Clover—BC, Plots 31-45.

Manures applied, Nov. 9th, Mar. 21st. Seed sown, April 29th. Cut, June 17th. Ploughed, Aug. 15th.

Yields in lb., green weights.

N.

1K 85	4P 86	4N 124	1P 86	2N 95
2K 92	0K 102	3N 113	3K 104	4K 97
3P 85	2P 91	0P 98	1N 90	0N 81

Wheat—BW, Plots 46-60.

Manures applied, Oct. 16th, Mar. 21st. Seed sown, Oct. 16th. Harvested, Aug. 15-16th. Variety, Yeoman II.

Yields in lb., grain above, straw below.

N.

2P 76.6 161.6	4K 80.8 165.8	0K 74.6 168.6	3N 68.2 170.2	1N 80.9 156.6
0P 90.0 167.8	3K 75.4 171.3	1K 80.7 169.3	2N 82.9 166.4	0N 83.9 148.1
1P 72.0 176.2	4N 57.2 182.1	2K 72.9 175.6	4P 73.6 173.4	3P 76.9 168.4

Forage—BF, Plots 61-75.

Manures applied, Oct. 16th, Mar. 21st. Seed sown, Oct. 16th. Harvested, June 4th.

Yields in lb., green weights.

N.

3P 185	4P 168	0P 153	4N 171	0N 141
2K 204	0K 189	1P 179	4K 182	3K 186
1K 177	2P 176	3N 176	1N 163	2N 178

Sugar Beet—BS, Plots 76-90.

Manures applied, May 5th. Seed sown, May 19th. Lifted, Nov. 4th. Variety, Kuhn.

Yields in lb., roots (dirty) above, tops centre, sugar percentages below.

N.

3K 524 786 16.82	4K 540 703 17.27	2K 599 754 17.16	4N 438 890 16.93	4P 514 863 16.64
1P 524 815 16.70	2P 504 804 17.10	3N 499 904 17.04	1N 401 719 16.70	2N 464 848 16.70
0P 560 880 16.70	1K 559 873 16.59	0K 522 813 16.13	3P 601 923 16.47	0N 596 973 16.19

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Forage—CF, Plots 1-15.

Manures applied, Oct. 23rd, Mar. 21st. Seed sown, Oct. 23rd. Harvested, May 31-June 1st.

Yields in lb., green weights.

1N 92.8	3K 122.0	2K 116.2	1K 114.0	2P 104.2
2N 121.2	4K 114.2	4P 112.5	4N 162.8	1P 138.2
0N 88.8	3P 133.8	0K 129.8	0P 136.5	3N 146.5

Sugar Beet—CS, Plots 16-30.

Manures applied, May 10th. Seed sown, May 10th. Lifted, Nov. 2-4th. Variety, Kuhn.

Yields in lb., roots (dirty) above, tops centre, sugar percentages below.

1K 335 202 16.76	4N 410 257 16.30	3P 521 378 17.78	2N 613 370 18.58	1P 568 313 18.30
0K 385 215 16.70	3N 538 340 16.87	0N 581 369 17.44	4K 674 420 17.73	3K 625 364 18.35
2K 435 331 17.21	1N 467 369 17.44	4P 630 521 17.78	2P 623 473 18.24	0P 637 396 17.67

Potatoes—CP, Plots 31-45.

Manures applied, April 6th. Planted, April 7th. Lifted, Sept. 27th. Variety, Ally.

Yields in lb.

2N 311	3K 286	2K 513	0K 253	0P 322
4K 293	1N 283	4P 176	4N 521	1P 359
0N 259	1K 412	3P 434	3N 490	2P 322

Clover—CC, Plots 46-60.

Manures applied, Nov. 20th, Mar. 21st. Seed sown, May 7th. Cut, June 27th.

Yields in lb., green weights.

0N 86.5	4P 86.0	2P 90.5	4K 87.0	4N 54.0
1N 92.0	2N 98.0	0P 95.0	2K 85.5	3N 47.5
3P 90.0	1P 99.0	3K 81.5	0K 72.0	1K 77.5

Barley—CB, Plots 61-75.

Manures applied, Mar. 21st. Seeds sown, Mar. 17th. Harvested, Sept. 2nd. Variety, Plumage-Archer.

Yields in lb., grain above, straw below.

0K 31.0 72.0	4P 44.0 87.0	1P 44.8 103.5	3N 60.5 114.8	2N 56.0 122.5
3P 39.0 82.0	1K 43.8 88.5	4N 64.0 116.5	0N 25.8 105.0	4K 49.0 128.5
2K 49.2 93.5	2P 44.2 104.0	0P 40.2 90.0	3K 53.0 109.0	1N 30.8 86.5

Wheat—CW, Plots 76-90.

Manures applied, Oct. 28th, Mar. 21st. Seed sown, Oct. 23rd. Harvested, Aug. 11-12th. Variety, Yeoman.

Yields in lb., grain above, straw below.

4N 18.0 88.0	0K 12.8 73.2	3P 17.5 83.8	4P 8.2 57.0	0P 7.0 57.0
1K 16.5 93.0	3N 20.2 88.0	2N 18.2 85.8	4K 12.2 68.0	3K 11.0 68.2
2K 18.0 98.0	0N 11.0 67.0	1N 17.0 76.2	1P 15.5 79.2	2P 18.5 73.5

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1. Mean yields per acre and increments in yield per cwt. of N, P₂O₅ and K₂O.

		Average, 1930-1	1932	Standard error, 1932			Average, 1930-1.	1932	Standard error, 1932.
Sugar Beet Roots, (washed) tons	Yield.	6.61	7.17		Clover Hay Dry Matter, cwt.	Yield.	25.8	22.5	
	N	2.20	-2.01	1.61		N	22.3	17.0	3.0
	P	1.04	-0.15	1.61		P	3.3	-3.9	3.0
	K	-0.12	0.00	0.96		K	2.3	0.8	1.8
Tops, tons	Yield.	9.43	14.94		Wheat. Grain, cwt.	Yield.	19.2*	27.3	
	N	5.26	0.22	2.84		N	16.4*	-15.8	4.1
	P	-0.68	0.87	2.84		P	1.4	-6.6	4.1
	K	-0.70	-2.19	1.70		K	3.6	1.0	2.5
Sugar Percentage	Yield.	17.36	16.74		Straw cwt.	Yield.	39.3*	60.0	
	N	-0.76	1.21	0.50		N	41.0*	19.4	3.4
	P	-0.29	-0.23	0.50		P	3.6	0.8	3.4
	K	0.12	1.00	0.30		K	5.4	-0.5	2.1
Barley Grain, cwt.	Yield.	23.6	34.9		Potatoes tons	Yield.	7.02	7.52	
	N	11.2	1.5	1.8		N	1.77	2.83	0.83
	P	-1.5	0.1	1.8		P	-0.44	1.14	0.83
	K	-0.4	1.4	1.0		K	4.48	1.88	0.50
Straw cwt.	Yield.	28.5	38.5		Forage Dry Matter, cwt.	Yield.	39.6	30.3	
	N	16.2	7.1	3.7		N	24.8	8.4	4.3
	P	9.5	1.1	3.7		P	-0.8	4.2	4.3
	K	4.0	6.5	2.2		K	-2.4	-0.4	2.6

* 1931 only.
Significant results in heavy type. Negative sign means depression.

2. Average percentage increments in yield for each application of N, P₂O₅ and K₂O.

	N		P		K		Standard error, 1932
	Average 1930-1	1932	Average 1930-1	1932	Average 1930-1	1932	
Sugar Beet —Roots (washed) Tops Sugar Percentage	4.97	-4.20	2.39	-0.31	-0.51	-0.01	3.36
	8.38	0.22	-1.03	0.88	-1.88	-3.67	2.85
	0.44	1.09	0.25	-0.21	0.18	1.50	0.45
Barley —Grain Straw	7.34	0.63	-0.74	0.06	-0.50	1.00	0.75
	8.74	2.75	4.56	0.42	3.56	4.23	1.43
Clover Hay —Dry matter	10.82	11.32	1.94	-2.62	2.62	0.91	2.00
Wheat —Grain Straw	12.83*	-8.68	0.21	-3.63	3.50	0.92	2.28
	15.58*	4.85	0.22	0.20	2.14	-0.22	0.86
Potatoes	4.07	5.65	-1.73	2.27	15.78	6.26	1.65
Forage —Dry matter	10.13	4.16	-0.04	2.08	-2.08	-0.29	2.14

* 1931 only.
Significant results in heavy type. Negative sign means depression.

WOBURN, 1932

1.—Mean yields per acre and increments in yield per cwt. of N, P₂O₅ and K₂O.

		Average 1930-1.	1932.	Standard error 1932.			Average 1930-1.	1932.	Standard error 1932.
Sugar Beet Roots (washed) tons	Yield.	5.33	6.08		Clover Hay Dry matter cwt.	Yield.	24.4*	23.2	
	N	2.20	-2.04	1.68		N	5.9*	-18.4	7.0
	P	0.04	-0.46	1.68		P	-1.1*	-6.0	7.0
	K	1.06	3.95	1.01		K	5.4*	3.4	4.2
Tops tons	Yield.	7.10	6.33		Wheat Grain cwt.	Yield.	11.2†	5.3	
	N	3.14	-3.01	1.91		N	16.5†	4.1	3.2
	P	-0.40	3.75	1.91		P	-2.4†	1.0	3.2
	K	2.27	4.08	1.15		K	-2.2†	-1.0	1.9
Sugar percentage	Yield.	16.86	17.54		Straw cwt.	Yield.	27.2†	27.5	
	N	-1.01	-1.90	1.21		N	36.5†	12.8	9.2
	P	0.16	-0.20	1.21		P	2.1†	1.1	9.2
	K	0.54	1.46	0.73		K	-7.9†	-5.0	5.5
Barley Grain, cwt.	Yield.	22.2	16.1		Potatoes tons	Yield.	10.98	6.23	
	N	16.8	25.2	4.0		N	5.95	8.70	3.65
	P	0.5	0.3	4.0		P	2.13	-2.61	3.65
	K	2.6	6.4	2.4		K	1.41	-0.33	2.19
Straw cwt.	Yield.	44.6	35.8		Forage Dry matter, cwt.	Yield.	41.0†	27.4	
	N	28.0	12.2	7.6		N	27.6†	30.0	4.9
	P	-0.8	-6.5	7.6		P	12.7†	-7.8	4.9
	K	4.6	19.1	4.5		K	0.1†	-2.0	3.0

* 1931 only, and in this year the crop was Tares. † 1931 only.
Significant results in heavy type. Negative sign means depression.

2.—Average percentage increments in yield for each application of N, P₂O₅ and K₂O.

	N		P		K		Standard error, 1932.
	Average 1930-1.	1932.	Average 1930-1.	1932.	Average 1930-1.	1932.	
Sugar Beet —Roots (washed)	6.32	-5.03	-0.81	-1.14	4.23	16.24	4.14
Tops	6.62	-7.14	-1.46	8.88	6.87	16.13	4.53
Sugar percentage	0.00	-1.62	0.16	-0.17	0.80	2.08	1.04
Barley —Grain	11.28	23.52	0.08	0.31	2.74	10.02	3.74
Straw	9.68	5.11	0.00	-2.71	2.50	13.33	3.17
Clover Hay —dry matter	3.68*	-11.87	-0.70*	-3.85	5.48*	3.66	4.58
Wheat —Grain	22.01†	11.58	-3.18†	2.85	-4.99†	-4.56	9.13
Straw	20.02†	6.98	1.15†	0.58	-7.28†	-4.58	5.04
Potatoes	8.07	20.95	2.86	-6.28	3.17	-1.33	8.78
Forage —dry matter	10.03†	16.45	4.65†	-4.29	0.06†	-1.83	2.70

* 1931 only, and in this year the crop was Tares. † 1931 only.
Significant results in heavy type. Negative sign means depression.