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Continuous Rotation Experiments

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SCHEME FOR CONTINUOUS ROTATION EXPERIMENTS COMMENCING 1930

FOUR COURSE ROTATION EXPERIMENT, ROTHAMSTED.

The Rotation experiment in Great Hoos field 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.
		3. Straw and Artificials.
Phosphatic fertilisers	{	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. K₂O per acre, and 1.2 cwt. P₂O₅ 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 P₂O₅ 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. K₂O 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 Swedes*.—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 .023347 acre in series D).

First Series (Plots 1-25).—Years of Application.

TREATMENTS :	Blocks.					
	A	B	C	D	E	
1	III	V	I	II	IV	(I, II, III, IV, V = the successive years of the cycle.)
2	I	III	IV	V	II	
3	V	I	II	IV	III	
4	II	IV	III	I	V	
5	IV	II	V	III	I	

(Hence treatment 1 is applied to the appropriate plot in block C in the first year of the experiment ; to that in block D in the second year ; A in the third, and so forth.)

Second Series (Plots 26-50).—Years of Application.

TREATMENTS :	Blocks.				
	A	B	C	D	E
1	IV	II	III	I	V
2	I	III	II	V	IV
3	II	V	IV	III	I
4	III	I	V	IV	II
5	V	IV	I	II	III

Third Series (Plots 51-75).—Years of Application.

TREATMENTS :	Blocks.				
	A	B	C	D	E
1	V	III	IV	I	II
2	III	IV	I	II	V
3	I	V	II	IV	III
4	IV	II	V	III	I
5	II	I	III	V	IV

Fourth Series (Plots 76-100).—Years of Application.

TREATMENTS :	Blocks.				
	A	B	C	D	E
1	IV	II	I	V	III
2	I	IV	III	II	V
3	V	I	II	III	IV
4	II	III	V	IV	I
5	III	V	IV	I	II

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, which are cropped in this rotation so that each crop is represented every year. 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.

After 30 years on the same land, each plot has 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.

In 1929-30 the six crops of the rotation 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.

Four-Course Rotation, Great Hoos Field, Rothamsted, 1931 (Second Preliminary Year).

For full particulars of experiment see p. 129.

Plots $\frac{1}{40}$ acre.

TREATMENTS:

1. Farmyard manure.
2. Artificial farmyard manure prepared by Adco process. } 50 cwt. organic matter per acre.
3. Straw equivalent to that used in (2) treated on land with artificial fertilisers.
4. Superphosphate (1.2 cwt. total P_2O_5 per acre) Muriate of Potash (3 cwt. K_2O per acre) Sulphate of Ammonia (altogether 1.8 cwt. N per acre). One-fifth only applied in 1931.
5. As (4) but equivalent Gafsa Phosphate instead of Superphosphate. Nutrient content of (1), (2) and (3) equalised by adding Sulphate of Ammonia, Muriate of Potash and Superphosphate to raise the applications to the level given in (4) and (5).

Plots treated in 1931 shown in bold type.

MANURES APPLIED. Season 1929-30.

Treatment.	Organic Fertilisers.	Artificial Fertilisers.		
	Organic Matter (cwt. per acre).	N. cwt. per acre as Sulphate of Amm.	K_2O cwt. per acre as Mur. of Potash.	P_2O_5 cwt. per acre as Superphosphate (except in T'mt. 5).
1 ..	50 (as F.Y.M.)	0.067	0.168	0.552
2 ..	50 (as Adco)	0.930	2.322	0.741
3 ..	84.58 (as Straw)	1.413	2.355	1.082
4 ..	None	0.36	0.6	1.2
5 ..	None	0.36	0.6	1.2 (as Gafsa rock phos.)

Season 1930-31.

Treatment.	Organic Fertilisers.	Artificial Fertilisers.		
	Organic Matter (cwt. per acre).	N. cwt. per acre as Sulphate of Amm.	K_2O cwt. per acre as Mur. of Potash.	P_2O_5 cwt. per acre as Superphosphate (except in T'mt. 5).
1 ..	50 (as F.Y.M.)	0.317	1.663	0.741
2 ..	50 (as Adco)	0.519	2.530	0.179
3 ..	134.22 (as Straw)	1.358	1.517	1.071
4 ..	None	0.36	0.6	1.2
5 ..	None	0.36	0.6	1.2 (as Gafsa rock phos.)

A W—Wheat (Plots 1-25) (Harvested by sampling method).

Seed sown: Oct. 30th, 1930. Harvested: Aug. 27th. Variety: Yeoman.

		Yield of Grain in cwt. per acre.					N.W.		Yield of straw in cwt. per acre.				
BLOCKS	a	5	2	1	3	4	↑	1	5	2	1	3	4
		14.4	16.2	14.2	11.2	20.3		1	31.9	30.2	24.4	21.8	37.2
	b	5	1	3	4	2		6	5	1	3	4	2
		19.1	12.4	11.0	10.3	12.5		6	36.6	22.4	20.5	21.4	25.5
	c	3	2	5	4	1		11	3	2	5	4	1
	21.4	10.6	10.5	9.7	11.2	11	45.0	19.3	19.2	21.0	23.6		
d	1	3	4	5	2	16	1	3	4	5	2		
	22.0	11.4	20.2	6.4	6.3	16	44.3	21.3	42.0	16.4	14.5		
e	4	1	5	3	2	21	4	1	5	3	2		
	14.4	10.8	15.5	9.2	19.8	21	28.3	20.1	30.0	17.6	45.0		

A G—Swedes. (Plots 26-50.)

Seed sown: May 20th. Lifted: Nov. 6-17th. Variety: Garton's Magnificent.

		Washed Roots—tons per acre.					N.W.		Tops—tons per acre.				
BLOCKS	a	3	2	5	4	1	↑	26	3	2	5	4	1
		12.74	8.40	5.91	6.70	5.69		26	1.46	1.19	1.20	1.29	1.49
	b	4	2	1	5	3		31	4	2	1	5	3
		10.01	4.54	13.00	5.99	5.73		31	1.17	0.78	1.46	1.14	1.57
	c	1	4	3	5	2		36	1	4	3	5	2
	7.22	6.03	6.86	11.28	13.23	36	1.01	0.90	0.93	1.75	2.50		
d	4	5	3	2	1	41	4	5	3	2	1		
	7.85	10.74	8.11	8.04	11.72	41	1.05	1.11	0.96	1.32	2.02		
e	2	4	3	1	5	46	2	4	3	1	5		
	7.36	10.31	8.73	7.02	8.71	46	1.02	1.03	1.08	1.25	1.64		

A H—Seeds Hay. (Plots 51-75).

Seed sown: April 22nd. Cut: June 24th.

		Yield of Dry Matter in cwt. per acre.				
BLOCKS	a	3	4	1	2	5
		33.0	33.0	31.9	31.2	36.6
	b	3	4	5	2	1
		34.4	43.6	40.3	29.3	30.4
	c	2	4	3	1	5
	35.2	43.6	58.6	30.8	34.8	
d	5	1	3	4	2	
	38.1	46.5	33.7	32.6	43.2	
e	4	2	1	5	3	
	43.6	37.4	46.9	40.0	35.2	

A B—Barley. (Plots 76-100.) (Harvested by sampling method.)

Seed sown: March 6th. Harvested: August 27th. Variety: Plumage Archer.

Yield of Grain in cwt. per acre.

BLOCKS	a	76	4	2	5	3	1	80			
			26.5	20.9	14.0	12.8	12.0				
			b	81	5	2	1		4	3	85
					14.5	14.1	25.9		11.4	26.3	
					c	86	2		1	5	
16.4	18.9	15.5					11.3	22.1			
d	91	2	4	1	5	3	95				
		23.1	8.9	10.5	15.5	12.8					
e	96	5	2	3	1	4	100				
		19.8	7.0	9.0	10.5	23.9					

Yield of Straw in cwt. per acre.

N.W.
↑

BLOCKS	a	76	4	2	5	3	1	80			
			35.4	27.0	18.4	19.0	17.0				
			b	81	5	2	1		4	3	85
					18.9	18.9	35.0		25.2	36.2	
					c	86	2		1	5	
27.2	27.2	25.5					21.2	25.2			
d	91	2	4	1	5	3	95				
		30.2	12.8	17.8	27.1	23.8					
e	96	5	2	3	1	4	100				
		30.9	9.7	16.4	18.2	35.8					

Six-Course Rotation, Long Hoos IV., Rothamsted, 1931.

For full particulars of experiment see p. 131.

Plots 1/40th acre.

TREATMENTS :

- N—4, 3, 2, 1 and 0 units of N, each with 2 units P₂O₅ and 2 units K₂O.
- K—4, 3, 2, 1 and 0 units of K₂O, each with 2 units N and 2 units P₂O₅.
- P—4, 3, 2, 1 and 0 units of P₂O₅, each with 2 units N and 2 units K₂O.
- 1 unit of N—0.15 cwt. N per acre as Sulphate of Ammonia.
- 1 unit of K—0.25 cwt. K₂O per acre as Muriate of Potash.
- 1 unit of P—0.15 cwt. P₂O₅ per acre as Superphosphate.

BW—Wheat—(Plots 1-15) (Harvested by sampling method).

Manures applied : Oct. 29-30th, 1930. Seed sown : Oct. 3rd, 1930. Harvested - Aug. 21st. Variety : Yeoman II.

Yield of Grain in cwt. per acre.

Yield of Straw in cwt. per acre.

					N.					
3P	0P	0N	4K	2K	↑	3P	0P	0N	4K	2K
23.8	22.7	14.2	18.3	20.6		43.2	42.8	27.7	36.7	44.1
4N	2P	3N	0K	1K		4N	2P	3N	0K	1K
23.8	21.8	19.5	17.5	17.9		51.0	40.9	42.7	36.8	38.4
1P	2N	1N	3K	4P		1P	2N	1N	3K	4P
18.5	19.8	14.0	19.3	16.4		38.2	42.2	28.1	41.9	35.0

BS—Sugar Beet—(Plots 16-30)

Manures applied : May 9th. Seed sown : May 9th. Lifted : Nov. 3-6th. Variety : Kuhn.

Washed Roots—tons per acre.

Tops—tons per acre.

					N.					
3N	4P	2P	3P	3K	↑	3N	4P	2P	3P	3K
6.04	6.32	6.99	7.40	7.33		8.65	7.80	9.67	10.23	9.07
0N	2N	1P	0K	4N		0N	2N	1P	0K	4N
5.88	6.54	6.39	6.89	7.81		8.04	8.24	9.54	9.99	11.33
1N	0P	4K	2K	1K		1N	0P	4K	2K	1K
5.53	6.40	7.34	7.11	7.16		9.33	10.70	10.28	10.40	9.56

Sugar Percentage in Roots

3N	4P	2P	3P	3K
17.76	17.81	18.11	17.88	17.87
0N	2N	1P	0K	4N
17.65	17.99	17.54	17.99	17.48
1N	0P	4K	2K	1K
17.82	17.99	17.87	18.24	18.14

BB—Barley—(Plots 31-45) (Harvested by sampling method)

Manures applied : Feb. 27th. Seed Sown : March 6th. Harvested : Aug. 29th. Variety : Plumage Archer.

Yield of Grain in cwt. per acre.

Yield of Straw in cwt. per acre.

					N.					
2K	0K	0P	2P	3N	↑	2K	0K	0P	2P	3N
22.2	19.2	19.2	22.6	20.4		27.4	23.7	23.4	23.6	23.8
3K	1K	4N	4K	0N		3K	1K	4N	4K	0N
20.0	25.2	21.4	20.9	13.2		27.7	30.4	31.9	30.4	18.3
4P	3P	1P	2N	1N		4P	3P	1P	2N	1N
19.4	19.6	18.9	20.6	18.9		23.0	26.7	24.9	27.5	22.2

B C—Clover—(Plots 46-60).

Manures applied: Oct. 31st, 1930. Seed sown: April 22nd. Cut: June 10th.

Yield of Dry Matter in cwt. per acre.

N.
↑

3P 12.9	0P 12.9	1K 11.8	4N 15.0	2N 13.2
1P 18.9	4K 20.0	2K 18.2	3N 16.1	1N 10.0
2P 23.2	0K 18.9	3K 17.5	0N 13.6	4P 18.2

B P—Potatoes—(Plots 61-75)

Manures applied: April 14th. Planted: April 14th. Lifted: Oct. 1st. Variety: Ally.

Yield of Roots in tons per acre.

N.
↑

4P 8.04	0K 4.33	1P 7.46	0P 6.52	1N 7.63
3K 8.82	1K 7.16	2P 8.73	0N 7.83	4K 10.28
2K 7.79	3P 8.45	4N 8.40	2N 8.14	3N 7.67

B F—Forage Crop—(Plots 76-90).

Manures applied: March 18th. Seed sown: Oct 3rd, 1930. Harvested: June 10th (followed by mustard).

Yield of Dry Matter in cwt. per acre.

N.
↑

4K 29.3	0P 29.3	3K 29.3	0K 28.2	0N 22.5
2P 30.7	3P 31.8	4N 43.9	2N 32.9	3N 38.9
1P 40.4	2K 33.6	1K 32.1	4P 30.4	1N 27.1

SUMMARY OF RESULTS.

1.—Table showing increments in yield per cwt. of N, P₂O₅ and K₂O, together with the standard errors of the increments.

Crop.	Mean Yield.	N		P		K	
Wheat—Grain, cwt. ..	19.2	16.4	± 4.8	-4.9	± 4.8	1.2	± 2.8
Straw, cwt. ..	39.3	41.0	± 7.5	-7.1	± 7.5	1.3	± 4.5
Sugar Beet—Roots, tons ..	6.74	2.91	± 1.02	0.57	± 1.02	0.43	± 0.61
Tops, tons ..	9.52	3.94	± 1.87	-3.41	± 1.87	0.04	± 1.12
Sugar Per Cent- age	17.88	-0.27	± 0.44	-0.01	± 0.44	-0.20	± 0.26
Barley—Grain, cwt. ..	20.1	11.8	± 4.6	0.7	± 4.6	-0.6	± 2.7
Straw, cwt. ..	25.6	19.2	± 5.1	0.7	± 5.1	4.3	± 3.1
Clover—dry matter, cwt.	15.7	5.7	± 6.2	2.1	± 6.2	2.3	± 3.7
Potatoes—tons	7.82	0.79	± 1.21	2.70	± 1.21	5.42	± 0.72
Forage—dry matter, cwt.	32.0	29.9	± 9.0	2.7	± 9.0	-6.1	± 5.4

2.—Table showing the average percentage increments in yield for each application of N, P₂O₅ and K₂O, with their standard errors.

Crop.	N	P	K	Standard Error.
Wheat—Grain ..	12.83	-3.85	1.56	± 3.73
Straw ..	15.58	-2.72	0.80	± 2.87
Sugar Beet—Roots	6.48	1.26	1.59	± 2.27
Tops	6.20	-5.36	0.09	± 2.94
Sugar Percentage	-0.22	-0.01	-0.28	± 0.37
Barley—Grain ..	8.88	0.55	-0.78	± 3.41
Straw ..	11.23	0.37	4.22	± 2.98
Clover—dry matter ..	5.41	1.97	3.63	± 5.92
Potatoes	1.51	5.15	17.34	± 2.31
Forage—dry matter ..	14.04	1.25	-4.76	± 4.22

Significant results are in bold type. Negative sign means depression.

Six-Course Rotation; Stackyard Field, Woburn, 1931

For full particulars of experiment see p. 131, Rothamsted Report.

Plots: 1/40th acre.

Treatments:

N=4, 3, 2, 1 and 0 units of N, each with 2 units P_2O_5 and 2 units K_2O .
 K=4, 3, 2, 1 and 0 units of K_2O , each with 2 units N and 2 units P_2O_5 .
 P=4, 3, 2, 1 and 0 units of P_2O_5 , each with 2 units N and 2 units K_2O .
 1 unit of N=0.15 cwt. N per acre as Sulphate of Ammonia.
 1 unit of K=0.25 cwt. K_2O per acre as Muriate of Potash.
 1 unit of P=0.15 cwt. P_2O_5 per acre as Superphosphate.

C P—Potatoes (Plots 1-15).

Manures applied: April 30th. Planted: May 1st. Lifted: Sept. 29-30th. Variety: Ally.

Yield of Roots in tons per acre.

2N 11.07	4K 11.39	3K 11.46	2K 11.57	3P 11.30
3N 12.66	0N 9.45	0K 11.18	0P 10.18	2P 11.91
1N 8.28	4P 9.91	1K 10.20	1P 9.68	4N 10.64

C F—Forage Crop (Plots 16-30)

Manures applied: April 4th. Seed sown: October 18th. Harvested: June 15th (followed by mustard).

Yield of Hay containing 15 per cent. water, in cwt. per acre.

2K 49.3	0K 52.9	4P 55.7	3N 52.3	2P 43.3
1K 47.7	4N 51.6	1N 41.3	0P 48.4	4K 53.4
3K 47.0	2N 45.4	0N 32.9	3P 54.8	1P 47.0

C W—Wheat (Plots 31-45)

Manures applied: April 4th. Seed sown: Oct. 18th. Harvested: Aug. 11-20th. Variety: Yeoman II.

Yield of Grain in cwt. per acre.

3N 10.2	4K 9.2	3K 10.9	1K 13.5	1P 14.2
0N 5.0	2N 9.3	0K 10.7	0P 11.3	2P 14.1
1N 9.7	2K 10.4	4P 10.4	4N 17.1	3P 12.6

Yield of Straw in cwt. per acre.

3N 26.2	4K 22.2	3K 25.2	1K 29.6	1P 30.0
0N 13.3	2N 25.0	0K 29.9	0P 27.6	2P 32.6
1N 21.9	2K 25.7	4P 27.9	4N 38.4	3P 32.4

C B—Barley (Plots 46-60).

Manures applied : March 17th. Seed sown : March 18th. Harvested : Aug. 21st. Variety : Plumage Archer.

Yield of Grain in cwt. per acre.

1N	0N	3P	0P	0K
19.8	17.0	25.8	20.9	18.4
2N	3N	1P	3K	4N
25.3	25.3	26.4	23.9	29.3
4P	2P	4K	1K	2K
24.8	24.3	26.1	29.1	27.7

Yield of Straw in cwt. per acre.

1N	0N	3P	0P	0K
41.6	51.6	49.3	52.7	52.9
2N	3N	1P	3K	4N
41.8	43.0	50.2	68.7	72.2
4P	2P	4K	1K	2K
48.8	51.4	53.7	53.7	55.4

C S—Sugar Beet (Plots 61-75).

Manures applied : May 6th. Seed sown : May 7th. Lifted : Oct. 29-31st. Variety : Kuhn.

Washed Roots—tons per acre.

1K	0K	2P	4N	3N
4.93	5.70	6.92	7.73	7.54
4P	2K	0P	1N	0N
7.38	6.70	6.68	6.61	6.22
3K	3P	1P	4K	2N
7.18	7.32	6.94	6.97	5.86

Tops—tons per acre.

1K	0K	2P	4N	3N
4.28	4.36	6.62	10.21	8.50
4P	2K	0P	1N	0N
6.94	6.55	7.78	8.61	8.63
3K	3P	1P	4K	2N
8.61	7.64	7.20	10.25	8.66

Sugar Percentage in Roots.

1K	0K	2P	4N	3N
16.86	16.58	17.08	16.90	16.31
4P	2K	0P	1N	0N
17.37	17.42	17.76	17.28	17.19
3K	3P	1P	4K	2N
17.54	17.40	17.48	17.43	16.74

C C—Tares (for Clover) (Plots 76-90).

Manures applied : April 28th. Seed sown : May 28th. Cut : Sept. 9th.

Hay containing 15% Water—cwt. per acre.

0K	1K	4P	0N	1P
26.6	23.8	26.0	24.5	27.9
2K	4N	3N	0P	4K
32.0	29.5	29.5	28.6	30.8
3K	1N	2N	2P	3P
31.1	29.0	32.2	27.8	31.1

SUMMARY OF RESULTS

1. Table showing increments in yield per cwt. of N, P₂O₅ and K₂O, together with the standard errors of the increments

Crop.	Mean Yield.	N	P	K
Potatoes—tons ..	10.72	4.52 ± 2.34	0.72 ± 2.34	0.67 ± 1.40
Forage—dry matter, cwt.	41.0	27.6 ± 6.5	12.7 ± 6.5	0.1 ± 3.9
Wheat—Grain, cwt. ..	11.2	16.5 ± 4.0	-2.4 ± 4.0	-2.2 ± 2.4
Straw, cwt. ..	27.2	36.5 ± 5.2	2.1 ± 5.2	-7.9 ± 3.1
Barley—Grain, cwt. ..	24.3	20.0 ± 6.2	4.8 ± 6.2	4.1 ± 3.7
Straw, cwt. ..	52.5	28.5 ± 18.0	-5.7 ± 18.0	6.7 ± 10.8
Sugar Beet—Roots, tons	6.71	2.64 ± 1.10	1.19 ± 1.10	1.91 ± 0.66
Tops, tons* ..	8.15	3.56 ± 1.71	1.50 ± 1.71	4.71 ± 1.02
Sugar Percentage	17.16	-1.04 ± 0.58	-0.58 ± 0.58	0.95 ± 0.34
Tares—dry matter, cwt.	24.4	5.9 ± 4.6	-1.1 ± 4.6	5.4 ± 2.7

* Tops partially eaten by barking deer, damage visually estimated.

2. Table showing the percentage increments in yield for N, P₂O₅ and K₂O with their standard errors

Crop.	N	P	K	Standard Error.
Potatoes	6.30	1.01	1.57	± 3.26
Forage—dry matter	10.03	4.65	0.06	± 2.38
Wheat—Grain ..	22.01	-3.18	-4.99	± 5.29
Straw ..	20.02	1.15	-7.28	± 2.87
Barley—Grain ..	12.32	2.98	4.19	± 3.84
Straw ..	8.13	-1.64	3.20	± 5.13
Sugar Beet—Roots	5.88	2.65	7.14	± 2.46
Tops	6.51	2.75	14.45	± 3.13
Sugar Percentage	-0.90	-0.50	1.39	± 0.50
Tares—dry matter	3.68	-0.70	5.48	± 2.79

Significant results are in bold type. Negative sign means depression.