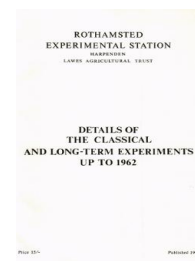


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Details of the Classical and Long-term Experiments Up to 1962

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Ley-arable Rotations- Woburn

Rothamsted Research

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LEY-ARABLE ROTATION EXPERIMENT

WOBURN, STACKYARD FIELD, SERIES D. 1938 ONWARDS

The purpose of the experiment is to test the value of a three year ley, three years of lucerne and an arable rotation with a one year ley, as means of building up soil fertility, in comparison with a rotation without leys. The effects of these crop sequences are measured by the yields of two successive test crops, sugar beet and barley. Each rotation therefore has five courses.

There are five series, one for each course of the five year rotation, all the crops of every rotation being represented every year. Each series has eight main plots, on four of them the same rotation continues throughout the experiment. On the other four plots, ley and arable rotations alternate, two according to the sequence ley, arable with 1-year hay, lucerne, arable without hay, and the other two in the sequence ley, arable without hay, lucerne, arable with hay.

Each main plot is divided into two sub-plots of 0.0413 acres, one of which receives dung at the rate of 15 tons per acre applied to the test crop of sugar beet only. The same sub-plots receive dung throughout the experiment.

The output of the 3-year ley is measured yearly in terms of sheep grazing days. Sampling cuts are also made when grazing begins and (since 1946) when the animals are removed.

The details of the rotations are as follows:-

Rotation Year:	Treatment crops			Test crops	
	1st	2nd	3rd	4th	5th
Ley	Ley, grazed	Ley, grazed	Ley, grazed	Sugar beet	Barley
Lucerne	Lucerne, cut	Lucerne, cut	Lucerne, cut	" "	"
Arable (hay)	Potatoes	Rye*	1 year Hay	" "	"
Arable (roots)	Potatoes	Rye	Carrots	" "	"

*undersown

Varieties: Lucerne Du Puits; Sugar beet Kleinwansleben E; Barley Herta; Potatoes Majestic; Rye King II, Carrots James Scarlet Intermediate.

Hay: 19 lb. Perennial Ryegrass S.24
 9 lb. Late Flowering Red Clover
 2 lb. American Alsike Clover per acre.
 Ley: 20 lb. Perennial Ryegrass S.24
 11 lb. Cocksfoot S.143
 6 lb. Late Flowering Red Clover
 3 lb. White Clover S.100 per acre

The above cropping is that in operation in 1960, the changes introduced in the earlier years are detailed in a later section.

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Table 51

Fertilisers and methods of application
cwt. nutrients per acre.

	N	P ₂ O ₅	K ₂ O	Material	How Applied
Potatoes	1.0	1.0	1.5	12:12:18	on flat
Rye	0.6	-	-	"Nitro-Chalk"	top dressed
Carrots	0.6	-	0.6	16:0:16	in seedbed
1 Year Hay	0.6	-	0.6	16:0:16	in spring
	0.22	-	-	"Nitro-Chalk"	for aftermath
Ley 1st Year	0.2	1.0	1.0	"Nitro-Chalk" and 0:16:16	in seedbed
	0.2	-	-	"Nitro-Chalk"	mid season
	0.2	-	-	"Nitro-Chalk"	late season
2nd and 3rd Years	0.18	-	0.18	16:0:16	in three dressings spread over the growing season
	0.18	-	0.18	16:0:16	
	0.18	-	0.18	16:0:16	
Lucerne 1st Year	-	1.0	1.0	0:16:16	in seedbed
2nd and 3rd Years	-	-	0.55	muriate of potash	top dressed
Sugar Beet*	0.72	0.72	0.9	13½:13½:13½ and 12:12:18	in seedbed
Barley [†]	0.6	-	-	"Nitro-Chalk"	in seedbed.

* Sugar beet also tests 0 v. 15 tons of dung on main plots and (0 v. 0.72 cwt. N) x (0 v. 0.9 cwt. K₂O) on quarter plots in addition to the basal dressing.

[†] Barley has 0.9 cwt. K₂O on those quarter plots which did not receive test potash for the sugar beet.

Table 51 gives the scheme of manuring followed in 1960. The fertilisers used have changed during the course of the experiment owing to the introduction of granular compound fertilisers and higher grade materials.

"Nitro-Chalk" 15.5%N was replaced by a 20.5% grade in 1959 and by 21% in 1960. Potassium sulphate was seldom obtainable after 1943 and was replaced by the chloride. The PK fertiliser 0:13:13 was replaced by 0:16:16 in 1959 and the 7:7:10½ mixture for potatoes by 12:12:18 in 1960. The sugar beet compound 12:12:15 was no longer obtainable in 1959 and a mixture of 13½:13½:13½ and 12:12:18 was used instead.

The following are the chief changes in cropping and manuring that have been made since the beginning of the experiment. All plots were originally manured with inorganic fertilisers according to the following scale in cwt. per acre:-

	Sulphate of ammonia	Super- phosphate	Sulphate of potash
Potatoes ⁽¹⁾ (Majestic)	3	3	1½
1st Year of 3 year Ley ⁽²⁾	1	3	1½
1st Year Lucerne ⁽³⁾	-	3	1½
Wheat (Red Standard) ⁽⁴⁾	1	-	-
1 Year Ley ⁽⁵⁾	1	-	-
Kale ⁽⁶⁾ (Thousand Head)	3	-	-
Barley ⁽⁷⁾ (Plumage Archer)	1	-	-

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All rotations had equal total amounts of phosphate (1.16 cwt. P_2O_5 -1.00 until 1949) and potash (1.44 cwt. K_2O) per acre, but nitrogen was given according to the needs of the crops.

(1) Both treatment and test crop potatoes received the same fertiliser treatment but only test crop potatoes received dung. The dung was ploughed in until 1947. From 1948 to 1955 it was placed in the ridges. In 1956 sugar beet replaced test crop potatoes and the dung was once more ploughed in.

(2) The seeds mixtures used in the earlier years were in lb. per acre.

	1938-40	1941-47
Italian Ryegrass	-	10
Perennial Ryegrass S. 23	14	14
Cocksfoot S. 143	8	8
Late-flowering Red Clover S. 123	4	4
White Clover S. 100	-	2
Wild White Clover	2	-

(3) Until 1949 Provence (Grimm 1945 ; 1946 Argentine)

(4) Spring sown Atle 1948. Since 1949 Rye.

(5) The seeds mixtures used in the earlier years were in lb. per acre.

	1940-44	1945	1946-47	1949-55
Italian Ryegrass	16	24	24	-
Perennial Ryegrass	-	-	-	27
Broad Red Clover	10	12	-	-
Montgomery Red Clover	-	-	12	12
Alsike	-	-	-	3

In 1948 the undersown seeds failed and were replaced by a spring sowing of 22 lb. Italian Ryegrass and 27 lb. Trifolium.

(6) Sugar beet 1945-1955, with 4 cwt. sodium nitrate in place of 3 cwt. ammonium sulphate since 1947. Since 1956 carrots. Tops of sugar beet and carrots carted off.

(7) Herta since 1956.

In 1949 sulphate of ammonia was replaced by "Nitro - Chalk" (15.5%N) and the level of nitrogen was raised. The new dressing in terms of cwt. "Nitro-Chalk" per acre were Barley $1\frac{1}{2}$, Rye 3, Ley 2nd and 3rd years 1, Hay 1st cut 2, 2nd cut 1.

In 1950 the basal for the block carrying the first crops of all rotations was supplied as compound granular fertiliser 13% P_2O_5 13% K_2O to give 0.6 cwt. each of P_2O_5 and K_2O ; and the block with

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test crop potatoes had a basal dressing of granular compound fertiliser 7%N, 7% P₂O₅, 10½% K₂O to give 0.56 cwt. N, 0.56 cwt. P₂O₅, 0.84 cwt. K₂O per acre.

From 1951 the first year of the three year ley received 1.3 cwt. "Nitro-Chalk" in place of 1.0 cwt. sulphate of ammonia per acre. From 1954 the "Nitro-Chalk" dressings applied to first, second and third year leys in the spring were repeated at the same rates in mid season, thus doubling the total amount of N given.

In 1954 and 1955 the plots in the second cut of the one-year hay were split, one half receiving the standard dressing of "Nitro-Chalk" and the other double the amount. It was suspected that potash shortage on the lucerne plots might be disturbing the results of the experiment and that the nitrogen levels were too low; consequently from 1955 the plots of the test crop potatoes were split into quarters to test sulphate of ammonia and muriate of potash additional to the basal dressing namely

(0 v. 0.56 cwt. N) x (0 v. 0.84 cwt. K₂O)

these amounts being equal to the N and K applied as basal dressing of 7:7:10½ fertiliser. The second test crop, barley, received an equalising dressing of 0.84 cwt. K₂O per acre on those quarters that did not receive extra potash to the potatoes. The sub-plots were not harvested separately in the barley.

In 1956 the system of manuring was again revised on the grounds that levels of nitrogen and potassium were too low. The rotations were still balanced in total phosphate (1.72 cwt. P₂O₅) and potash (3.0 cwt. K₂O) but nitrogen was still given according to the needs of the crops.

This scheme was very similar to the final one. Only the points of difference are listed here.

Manuring scheme for Spring 1956

Crops not mentioned were manured as in Table 51

	cwt. per acre			
	N	P ₂ O ₅	K ₂ O	Materials
Carrots	0.48	-	0.6	Sulphate of ammonia,
1 year Hay	0.48	-	0.6	muriate of potash
				ditto
Ley 1st year	0.6*	1.0	1.0	"Nitro-Chalk" and 0:16:16
Ley 2nd and 3rd year	0.6*	-	0.55	"Nitro-Chalk" and
				muriate of potash

*Total. In 1956 in two dressings; 1957 three dressings.

This year also, owing to the build up of potato root eelworm, test crop potatoes were replaced by sugar beet and treatment crop sugar beet by carrots. Test crop carrots failed in 1957 and were replaced by turnips.

Owing to an attack of lucerne stem eelworm plots 27, 28 were ploughed up and fallowed in 1958 at the end of their second year, and in 1959 plots 3, 4, 9, 10 were similarly treated.

Cereals were combine harvested for the first time in 1959.

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Liming: Commencing in 1947 an application of ground chalk was applied before every barley crop. The rate of dressing was approximately 15 cwt. carbonate per acre. In 1953 the dose was raised to 10 cwt. calcium oxide, i.e. about 19 cwt. ground chalk per acre. In 1958 the dressing was further raised to the maximum amount of ground chalk delivered by one passage of the manure drill. This was about 23 cwt. per acre. In spite of rotational liming before the barley crop, blocks 2 and 3 were still found to be slightly acid in 1957 and corrective dressings of ground chalk were applied in 1958 at the rate of 10 cwt. on block 2 and 23 cwt. on block 3.

For design and cropping see Rep. Rothamst. exp. Sta. for 1938, 135-136.

For a summary of the first eight years' results see Rep. Rothamst. exp. Sta. for 1948, 94-97.

For a full discussion of the results to 1956 see Mann, H.H. and Boyd, D.A. Some results of an experiment to compare ley and arable rotations at Woburn. J. agric. Sci. (1958) 50, 297-306.

LEY-ARABLE ROTATION WOBURN STACKYARD FIELD

Table 52

Means over 5 years 1956-60

Sugar beet, Total Sugar: cwt per acre

	Previous Rotation				Mean
	Ley	Lucerne	Arable (Hay)	Arable (Roots)	
Mean	56.4	52.0	48.0	52.6	52.2
Dung: tons per acre					
None	53.1	47.7	42.4	45.9	47.3
15	59.7	56.3	53.5	59.4	57.2
Diff.	+6.6	+8.6	+11.1	+13.5	+9.9
N: cwt per acre					
0.72	57.8	53.3	49.2	52.3	53.1
1.44	55.0	50.7	46.7	53.0	51.4
Diff.	-2.8	-2.6	-2.5	+0.7	-1.7
K ₂ O: cwt per acre					
0.90	54.7	50.7	47.0	52.6	51.3
1.80	58.1	53.3	48.9	52.6	53.2
Diff.	+3.4	+2.6	+1.9	0.0	+1.9

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LEY-ARABLE ROTATION WOBURN STACKYARD FIELD

Table 52 continued
Sugar beet, Tops: tons per acre

	Previous Rotation				Mean
	Ley	Lucerne	Arable (Hay)	Arable (Roots)	
Mean	16.55	14.65	14.41	12.62	14.56
Dung: tons per acre					
None	15.89	13.86	13.26	11.70	13.68
15	17.22	15.43	15.56	13.54	15.44
Diff.	+1.33	+1.57	+2.30	+1.84	+1.76
N: cwt per acre					
0.72	15.25	13.50	13.15	11.03	13.23
1.44	17.86	15.80	15.67	14.20	15.88
Diff.	+2.61	+2.30	+2.52	+3.17	+2.65
K ₂ O: cwt per acre					
0.90	15.97	14.46	14.55	12.80	14.44
1.80	17.13	14.84	14.27	12.43	14.67
Diff.	+1.16	+0.38	-0.28	-0.37	+0.23

Table 53

Barley, Grain (at 85% dry matter): cwt per acre.

Dung tons per acre	Means over 6 years 1957-62				Mean
	Ley	Lucerne	Arable with Hay	Arable with Roots	
None	34.0	32.4	31.0	31.4	32.2
15	33.6	33.8	33.8	34.5	33.9
Mean	33.8	33.1	32.4	32.9	33.1
Diff.	- 0.4	+ 1.4	+ 2.8	+ 3.1	+ 1.7