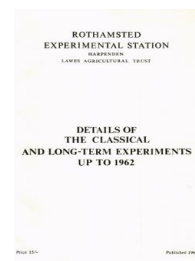


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## Details of the Classical and Long-term Experiments Up to 1962



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### Green-manuring- Woburn

#### Rothamsted Research

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GREEN-MANURING ROTATION EXPERIMENT, 1936 ONWARDS  
WOBURN, STACKYARD FIELD, SERIES A.  
OLD SCHEME 1936-1953.

The experiment was begun in 1936 to measure the effects of the following green manuring crops:-

- (1) Ryegrass undersown in barley for ploughing in in the following July (R)
- (2) Red Clover undersown in barley, ploughed in in July (C)
- (3) Mustard sown in spring and ploughed in in July (M)
- (4) Tares sown in spring and ploughed in in July (T)
- (5) No green manures, i. e. spring and early summer fallow (F).

The test crops were kale (Thousand Head) drilled in July, followed by barley (Plumage Archer) as the second test crop. The undersown green manures were sown in the barley crop, thus continuing the rotation. The tares and mustard were grown as cumulative treatments on their respective plots, the clover and ryegrass were grown alternately, i. e. they returned to their respective plots in every other cycle. The yields of the green manures were estimated by sampling. Until 1942 the undersown crops were cut for hay which was removed before ploughing in the remainder.

Manurial treatments tested on kale were 0 v. 10 tons of dung (D); 0 v.  $1\frac{1}{2}$  tons straw (S); 2 cwt. v. 4 cwt. sulphate of ammonia (N). These treatments were cumulative.

Basal manuring for kale: 3 cwt. superphosphate, 1 cwt. muriate of potash per acre.

The arrangement was thus  $5 \times 2^3$  put down on two blocks of 40 plots each; one for each phase of the rotation. Plot size: 0.0395 acres.

From 1944 onwards a top dressing of sulphate of ammonia at 0.3 cwt. N per acre (0.4 cwt. in 1944) was applied to half the barley plots; the experiment then became a half-replicate with identity I  $\bar{\bar{R}} + C - M - F - T$ DSNA, where A denotes the dressing of sulphate of ammonia to barley.

In 1946 several further changes were made

- (1) Cabbages (January King) transplanted in July replaced drilled kale which had frequently failed.
- (2) Tares were replaced by lupins, and mustard by rape.
- (3) Those plots receiving extra nitrogen to barley also received 0.3 cwt. N as sulphate of ammonia when they carried any of the green manuring crops, including bare fallow.

From 1949 the nitrogen dressings to the rape and ryegrass plots were increased from 0.3 to 0.6 cwt. N, the remaining rape and ryegrass plots, hitherto undressed, received 0.3 cwt. N as sulphate of ammonia.

From 1950 the cabbages following undersown green manures and bare fallow were planted on two occasions (1) early, i. e. as soon as the undersown crops were ploughed in (2) late, i. e. when

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the rape and lupins were ploughed in. These treatments were carried out on half plots. In 1953 owing to the weather all cabbages were planted on the same date.

Liming.

Liming at approximately 5 cwt. CaO per acre applied as ground chalk before barley was given in 1937, 1942, 1943, and 1947-50.

In 1951 clubroot appeared and in 1951 and 1952 calcium carbonate was applied at 40 cwt. per acre for cabbages.

1953 30 cwt. calcium carbonate per acre was applied before barley.

For original design see Rep. Rothamst. exp. Sta. for 1936, p.203.

For results and discussion see Mann, H. H. Field studies in green manuring. II. Emp. J. exp. Agric. 27, (107) p.243-251.



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NEW SCHEME 1954

The former scheme ended after the harvest of 1953 mainly owing to club-root damage to test crop cabbages, and the need to have a rotation in which the test crops could utilise the growing season more fully.

From 1954 onwards the rotation was: early potatoes, barley. As before each crop was grown every year on one of the two blocks of 40 plots. The green manuring crops were grown according to the following scheme which was repeated every two years:-

1st main crop	Early	Early	Early	Early	Early
	Potatoes	Potatoes	Potatoes	Potatoes	Potatoes
Summer sown Green manure	-	Ryegrass	Ryegrass	Trefoil	Trefoil
2nd main crop	Barley	Barley	Barley	Barley	Barley
Undersown Green manure	-	Ryegrass	-	Trefoil	-

8 plots of each block were allocated to each of these sequences. Half the plots of each group carrying ryegrass or trefoil after early potatoes were ploughed in autumn and the remainder were ploughed in the spring before the barley seedbed was prepared. The undersown green manures were ploughed in after February 1st for early potatoes.

In addition chaffed barley straw at the rate of 30 cwt. per acre was applied after harvesting the barley to the 20 plots receiving straw in the original scheme. Two levels of nitrogen were tested on each of the two main crops.

0.23 v. 0.46 cwt. N per acre as "Nitro-Chalk" to barley

0.6 v. 1.2 cwt. N per acre as "Nitro-Chalk" to potatoes. the higher level in each case being applied to the same plots.

The fallow plots of the original scheme remained fallow between each main crop in the revised scheme. The new green manuring treatments were superimposed on the plots carrying the original treatments in such a way that one comparison of the latter (lupins and rape v. clover and ryegrass) could be examined for possible residual effects. Residual effects of the original dung treatment, now discontinued, could also be determined, but any residual effects of the nitrogen treatments applied before 1954 were eliminated by randomisation. The green manuring and subsidiary treatments were arranged on the 32 non-fallow plots of each block in a quarter replicate with identities:

I  $\equiv$  (D) SPUGN  $\equiv$  (D) (X)UN  $\equiv$  S(X)PG

where (D) = (residual) dung.

(X) = (residual) rape and lupins v. clover and ryegrass.

S = straw

P = time of ploughing green manures after early potatoes

U = green manures undersown (in addition to those sown after early potatoes)

G = trefoil v. ryegrass

N = nitrogen levels to both crops.

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Basal dressing: Early potatoes, 0.75 cwt.  $P_2O_5$ , 1.5 cwt.  $K_2O$  per acre as granular compound fertiliser 0:10:20 till 1959 then 0:12:24 broadcast on the flat before machine planting. Barley and green manures, nil.

Varieties: Early potatoes: Ulster Chieftain  
Barley: Herta  
Trefoil: English  
Ryegrass: English Leafy Italian

Liming: 1953-1957 Ground chalk at 10 cwt. CaO per acre was applied before each barley crop, from 1958 onwards the carbonate dressing was raised to 23 cwt. ground chalk per acre.

Yields: Until 1958 the crop was harvested by binder, then a single combine cut was taken per plot.

Yield of Green Manures: The yield of dry matter and nitrogen in all green crops was estimated by sampling.

Transition Period: The barley of 1954 received two levels of nitrogen and was undersown according to the new scheme.

The early potatoes of 1954 received two levels of nitrogen according to the new scheme.

For a summary of the results 1955-1962 see Rep. Rothamst. exp. Sta. for 1962, 193-197.



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GREEN-MANURING ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Table 43

Kale, total produce: tons per acre.  
Mean over 3 years 1939, 40 and 42\*

	Green Manures					Mean
	None	Tares	Clover	Mustard	Rye-grass	
Mean	7.31	7.45	8.84	7.12	5.47	7.24
No dung	6.48	6.42	7.70	6.08	4.31	6.20
Dung	8.14	8.48	9.97	8.17	6.64	8.28
No straw	7.32	7.33	8.78	7.18	5.85	7.29
Straw	7.30	7.56	8.90	7.06	5.09	7.18
N: cwt per acre						
0.4	6.34	6.52	8.73	6.13	4.08	6.36
0.8	8.27	8.37	8.95	8.12	6.86	8.11

\*Crop failed in 1941 and 1943

Table 44

Barley, Grain: cwt per acre. Mean over 6 years 1938-43

Mean	13.5	14.1	15.0	13.2	13.4	13.8
No dung	11.9	12.9	13.8	12.0	11.6	12.4
Dung	15.1	15.3	16.2	14.5	15.3	15.2
No straw	12.6	13.6	14.8	13.4	13.2	13.5
Straw	14.4	14.6	15.2	13.0	13.8	14.2
N: cwt per acre						
0.4	12.8	13.8	15.0	12.7	12.9	13.4
0.8	14.2	14.4	15.0	13.7	14.0	14.3

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GREEN-MANURING ROTATION EXPERIMENT

WOBURN STACKYARD FIELD

Table 45

Cabbages, total produce: tons per acre.  
Mean over 4 years 1946-49

	Green Manures					Mean
	None	Lupins	Clover	Rape	Ryegrass	
Mean	5.18	5.04	4.81	3.91	3.98	4.58
No dung	4.57	4.54	4.30	3.24	3.38	4.01
Dung	5.80	5.54	5.33	4.58	4.57	5.16
No straw	5.02	5.23	4.90	4.14	4.14	4.69
Straw	5.34	4.85	4.73	3.68	3.82	4.48
N to cabbages:						
cwt per acre						
0.4	4.87	4.26	4.42	3.31	3.64	4.10
0.8	5.49	5.82	5.20	4.50	4.32	5.07
N to green manures:						
cwt per acre						
None	4.73	5.18	5.12	3.56	4.00	4.52
0.4	5.63	4.91	4.50	4.26	3.95	4.65

Table 46

Barley, Grain: cwt per acre. Mean over 6 years 1944-49

	None	Lupins	Clover	Rape	Ryegrass	Mean
Mean	15.6	16.1	14.8	15.0	14.3	15.2
No dung	15.0	15.3	13.7	13.8	13.0	14.1
Dung	16.2	16.9	16.0	16.1	15.7	16.2
No straw	16.0	15.6	14.8	14.8	13.7	15.0
Straw	15.2	16.5	14.9	15.1	15.0	15.3
N to cabbages:						
cwt per acre						
0.4	16.0	15.8	14.1	15.5	13.4	15.0
0.8	15.2	16.4	15.6	14.5	15.3	15.4
N to barley:						
cwt per acre:						
None	12.3	13.1	11.8	11.7	11.4	12.1
0.4	18.9	19.0	17.9	18.3	17.3	18.3

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WOBURN STACKYARD FIELD

Table 47

Cabbages, total produce: tons per acre  
Mean over 4 years 1950-53

	Green Manures					Mean
	None	Lupins	Clover	Rape	Rye-grass	
Mean	6.32	6.74	8.23	5.22	5.55	6.41
No dung	5.54	6.04	7.46	4.75	4.80	5.72
Dung	7.10	7.45	9.00	5.69	6.30	7.11
No straw	6.23	6.86	8.31	5.58	5.78	6.55
Straw	6.42	6.61	8.14	4.86	5.32	6.27
N to cabbages: cwt per acre						
0.4	5.82	6.40	7.66	4.90	4.93	5.94
0.8	6.82	7.08	8.80	5.54	6.16	6.88
N to green manures:						
Low	6.09	6.65	8.10	5.02	5.30	6.24
High	6.55	6.83	8.36	5.41	5.80	6.59

Table 48

Barley, Grain: cwt per acre. Mean over 4 years 1950-53

Mean	17.9	19.6	18.0	18.6	17.7	18.3
No dung	16.8	19.1	17.2	17.4	16.5	17.4
Dung	18.9	20.1	18.8	19.8	19.0	19.3
No straw	17.4	19.2	17.6	18.5	17.1	17.9
Straw	18.4	20.0	18.3	18.8	18.4	18.8
N to cabbages: cwt per acre						
0.4	18.0	19.1	17.4	18.2	16.4	17.8
0.8	17.7	20.1	18.5	18.9	19.0	18.9
N to barley: cwt per acre						
None	15.6	17.6	17.7	16.5	16.0	16.7
0.3	20.1	21.6	18.2	20.6	19.6	20.0



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GREEN-MANURING ROTATION EXPERIMENT  
WOBURN STACKYARD FIELD

Table 49

Barley, Grain: cwt per acre. Mean over 8 years

Green manure	Time of ploughing	Nitrogen (cwt per acre) to barley		Mean	Difference
		0.23	0.46		
		(+0.86)		(+0.61)	(+1.22)
Trefoil	Autumn	25.8	28.0	26.9	2.2
Ryegrass	Autumn	21.8	25.8	23.8	4.0
Trefoil	Spring	28.7	30.4	29.5	1.7
Ryegrass	Spring	25.6	30.4	28.0	4.8
Fallow		18.8	23.5	21.2	4.7
		(+0.54)		(+0.38)	(+0.76)
FYM (tons per acre)	0	23.3	26.9	25.1	3.6
applied before 1955	10	24.9	28.3	26.6	3.4
Mean (+0.38)		24.1	27.6	25.8	3.5

Table 50

Early Potatoes: tons per acre: Mean over 8 years

		F	T <sub>u</sub>	R <sub>u</sub> (+0.188)	T	R	Mean (+0.084)
Straw (cwt per acre)	0	5.12	5.95	5.54	5.33	5.35	5.46
	30	5.30	5.56	5.72	5.64	5.30	5.50
FYM (tons per acre)	0	4.81	5.34	5.16	4.98	5.11	5.08
	10	5.60	6.14	6.10	5.99	5.54	5.87
N (cwt per acre) to potatoes	0.6	4.96	5.63	5.51	5.45	5.18	5.35
	1.2	5.46	5.88	5.75	5.52	5.46	5.62
Mean (+0.134)		5.21	5.76	5.63	5.48	5.32	5.48

T: trefoil grown as a green manure after early potatoes, in preparation for barley.

R: ryegrass grown after early potatoes, in preparation for barley.

T<sub>u</sub>: as T, but with trefoil undersown in the barley in preparation for the coming potato crop.

R<sub>u</sub>: as R, but with ryegrass undersown in the barley in preparation for the potato crop.