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Results of the Classical and Other Long-term Experiments 2004

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Classical
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Long-term Experiments
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Rothamsted Research

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04/W/RN/3 - Woburn Ley Arable

Rothamsted Research

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04/W/RN/3

LEY/ARABLE

Object: To compare the effects on soil fertility of rotations with or without leys - Woburn, Stackyard D.

Sponsor: P.R. Poulton.

The 67th year, leys, w. beans, w. wheat, w. rye, forage maize.

For previous years see 'Details' 1967 & 1973 and 74-03/W/RN/3.

Design: 5 series of 8 plots, split for treatments other than rotations.

Whole plot dimensions: 8.53 x 40.7.

Treatments: All phases of four five-course rotations were originally present:

ROTATION

LEY	Clover/grass ley:	L, L, L, P, W
CLO	All legume ley:	SA, SA, SA, P, W until 1971 then CL, CL, CL, P, W
A	Arable with roots:	P, R, C, P, W until 1971 then P, B, B, P, W
A H	Arable with hay:	P, R, H, P, W until 1971 then P, B, H, P, W

P = potatoes, R = w. rye, C = carrots, W = w. wheat, B = s. barley,
H = hay, L = clover/grass ley, SA = sainfoin ley, CL = red clover ley

Rotations themselves followed different cycles:

On four plots in each block the rotations were repeated

On four plots in each block arable rotations alternated
each five years with ley rotations

From 1976 all the rotations were changed on all phases
except for the first and second test crops in 1976:

LN 3	(Previous LEY) LN1, LN2, LN3, W, R
LC 3	(Previous CLO) LC1, LC2, LC3, W, R
AF	(Previous A) F, F, BE, W, R
AB	(Previous A H) B, B, BE, W, R

From 1998 rotations AF and AB are replaced by AM and ABe
respectively. Phased in at the beginning of each
treatment crop sequence.

AM	R, BE, M, W, R
ABe	R, M, BE, W, R

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ROTATION (continued)

LN1 to LN3 = three year grass ley with N, 1st year to 3rd year,
LC = clover/grass ley, no N, BE = beans (s. oats until 1980), F = fallow,
M = forage maize

Plots hitherto in alternating rotations were changed to
test eight-year leys and two test crops:

LLN	LLN1, LLN2, LLN3, LLN4, LLN5, LLN6, LLN7, LLN8, W, R
LLC	LLC1, LLC2, LLC3, LLC4, LLC5, LLC6, LLC7, LLC8, W, R

LLN1 to LLN8 = eight year grass ley with nitrogen, first year to eighth
year, similarly for LLC - clover/grass ley, no nitrogen

The new scheme started by sowing these new leys in spring 1976 on four
phases and in spring 1977 on the fifth phase (2nd test crop in 1976).

In 1992 w. rye (R) replaced s. barley (B) as the second test crop.

Yields are taken from the leys, arable treatment crops and the test crops.

Treatments to first test crop w. wheat, all combinations of:

Whole plots:

1. **ROTATION** Rotations before wheat:

LLN 8
LN 3
LLC 8
LC 3
AM
ABe

1/2 plots:

2. **NSPLIT(FYM res)** Farmyard manure residues, last applied 1964:

Nsplit(noFYM)
Nsingle(FYM)

1/8 plots:

3. **N** Nitrogen fertilizer in spring 2004 (kg N) as 27% N:

0			
70	)as a	40 + 30	)split dressings
140	)single	OR 40 + 100	)late Feb/early Mar
210	)dressing	40 + 170	)and GS31 or mid-Apr

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Treatments to second test crop w. rye, all combinations of:

Whole plots:

1. **ROTATION** Rotations before first test crop:

LLN 8
LN 3
LLC 8
LC 3
AF
AB

1/2 plots:

2. **NSPLIT(FYM res)** Farmyard manure residues, last applied 1963:

Nsplit to wheat in 2003 (noFYM)
Nsingle to wheat in 2003 (FYM)

1/8 plots:

3. **N** Nitrogen fertilizer in spring 2004 (kg N) as 27% N:

0
40
80
120

Treatments to leys:

FYM RES Farmyard manure residues:

NONE

FYM 38 t on each occasion, last applied 1967 to 1st
and 6th year leys, 1966 to 2nd and 7th year leys, 1965
to 3rd and 8th year leys, 1964 to 4th year leys, 1963
to 5th year leys.

NOTE: Corrective K dressings (kg K₂O) as muriate of potash, applied where
necessary to first test crop w. wheat and long-term leys in the
wheat block, applied 2nd October 2003.

Continuous rotations
before wheat

No FYM
half plots

FYM Res
half plots

ABe
AM
Ln3
LLc8
LLn3
(to be ploughed in 2008)

460
310
50
60
20

520
270
60
0
0

None to other plots.

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Experimental diary:

Grass ley and clover/grass ley, 1st year (ROTATION LN1, LLN1, LC1, and LLC1)

02-Oct-03 Triple superphosphate at 213 kg
Potassium sulphate at 140 kg.
07-Oct-03 Ploughed 30cm wide furrows and power harrowed.
08-Oct-03 Drilled Promesse Timothy + Senu Fescue, 50:50, @ 30 kg and
Promesse Timothy + Senu Fescue + Merwi White Clover,
45:45:10 @ 30 kg with 4.0 m Accord drill. Rolled.
10-Oct-03 27.0% N at 93 kg, 1st year grass/clover leys; at 185 kg, 1st
year grass leys.
24-Mar-04 Muriate of potash at 167 kg.
06-Jul-04 Cut yield strips, weighed and sampled.
14-Jul-04 Mowed for hay.
15-Jul-04 Tedded hay.
17-Jul-04 Tedded hay.
19-Jul-04 Tedded hay.
20-Jul-04 Rowed up hay and baled.
26-Jul-04 Muriate of Potash at 83 kg to all leys.
34.5% N at 217 kg to grass leys only.
03-Nov-04 2nd cut yield strips, weighed and sampled.

Grass leys 2nd to 8th year (ROTATION LN2-3 and LLN2-8)

18-Mar-04 34.5% N at 218 kg
24-Mar-04 Potassium sulphate at 140 kg,
Triple superphosphate at 213 kg.
Muriate of potash at 167 kg.
06-Jul-04 Cut yield strips, weighed and sampled.
14-Jul-04 Mowed for hay.
15-Jul-04 Tedded hay.
17-Jul-04 Tedded hay.
19-Jul-04 Tedded hay.
20-Jul-04 Rowed up hay and baled.
26-Jul-04 Muriate of Potash at 83 kg
34.5% N at 217 kg.
15-Sep-04 2nd cut, sampled, weighed and mowed plots due for wheat (ie.
9, 10, 13, 14).
16-Sep-04 Mowed plots cut previous day, baled and removed.
03-Nov-04 2nd cut yield strips, weighed and sampled (all other long
ley plots).

Clover/grass leys 2nd to 8th year (ROTATION LC2-3 and LLC2-8)

24-Mar-04 Potassium sulphate at 140 kg,
Triple superphosphate at 213 kg.
Muriate of potash at 167 kg.
06-Jul-04 Cut yield strips, weighed and sampled.
14-Jul-04 Mowed for hay.
15-Jul-04 Tedded hay.
17-Jul-04 Tedded hay.
19-Jul-04 Tedded hay.
20-Jul-04 Rowed up hay and baled.
26-Jul-04 Muriate of Potash at 83 kg.
15-Sep-04 2nd cut, sampled, weighed and mowed plots due for wheat (ie.
3, 4, 15, 16).
16-Sep-04 Mowed plots cut previous day, baled and removed.
03-Nov-04 2nd cut yield strips, weighed and sampled (all other long
ley plots)

W. beans, 2nd and 3rd treatment crop (ROTATION AM and ABe)

02-Oct-03 Triple superphosphate at 127 kg.
03-Nov-03 Broadcast, Clipper, recleaned at 25 seeds/m² by hand.
Ploughed 30 cm furrows.

- 08-Dec-03 tm)Carbetamex at 3.0 kg in 200 l.
tm)Alpha Simazine 50 SC at 2.0 l in 200 l.
- 24-Mar-04 Potassium sulphate at 140 kg
- 25-May-04 tm)Amistar at 0.5 l in 200 l.
tm)Folicur at 0.5 l in 200 l.
- 05-Sep-04 Combine harvested plots for yield, combined discards. Straw
swathed.
- 18-Sep-04 Straw baled and removed.
- Forage maize**, 2nd and 3rd treatment crop (**ROTATION** Abe and AM)
- 02-Oct-03 Triple superphosphate at 127 kg.
- 03-Nov-03 Ploughed 30cm furrows.
- 24-Mar-04 Potassium sulphate at 140 kg
- 09-Apr-04 Glydate at 3.0 l in 200 l
- 12-May-04 Power harrowed. Drilled, Hudson, tr. Mesuro1, at 10.2
seeds/m² with the Nodet drill.
- 24-May-04 34.5% N at 290 kg.
- 22-Sep-04 Cut sampled and weighted.
- 05-Oct-04 Cut and removed discards.
- W. wheat**, 1st test crop (W)
- 16-Sep-03 Touchdown at 4.0 l in 200 l (to previous ley plots: 21, 22,
27, 28, 29, 30, 31, 32.
- 02-Oct-03 Triple superphosphate at 127 kg.
Muriate of potash (corrective K) at 460 kg K₂O to plot 17,
520 kg to 18, 310 kg to 19, 270 kg to 20, 60 kg to 22 and
32, 20 kg to 26 and 50 kg to 31.
- 07-Oct-03 Ploughed 30 cm wide furrows and power harrowed.
- 08-Oct-03 Drilled Hereward, tr. Sibutol Secur, at 350 seeds/m² with
the Accord drill. Rolled.
- 17-Dec-03 Arelon 500 at 3.5 l in 200 l.
- 15-Mar-04 1st N (27% N) applied to split N sub-plots.
- 24-Mar-04 Potassium sulphate at 140 kg
- 10-Apr-04 27% N to single application plots
- 17-Apr-04 Quantum 75 DF at 20 g in 200 l.
- 05-May-04 2nd N (27% N) applied to split N sub-plots.
- 03-Jun-04 Opus at 0.75 l in 200 l.
- 04-Sep-04 Combine harvested plots for yield, combined discards. Straw
swathed, sampled and weighed.
- 18-Sep-04 Straw baled and removed.
- W. rye**, 2nd test crop and 1st treatment crop (**ROTATION** Abe and AM)
- 02-Oct-03 Triple superphosphate at 127 kg.
- 03-Oct-03 Chalk at 5.0 t.
- 07-Oct-03 Ploughed 30cm wide furrows and power harrowed.
- 08-Oct-03 Drilled, Picasso/Nikita blend (90:10), tr. Baytan, at 306
seeds/m² with 4.0 m Accord drill. Rolled.
- 19-Dec-03 Lexus Class WSB at 60 g in 200 l.
- 24-Mar-04 Potassium sulphate at 140 kg
- 23-Apr-04 27% N at 296 kg to 2nd test crop only.
- 03-Jun-04 Opus at 0.75 l in 200 l.
- 04-Sep-04 Combine harvested plots for yield, combined discards. Straw
swathed, sampled and weighed.
- 18-Sep-04 Straw baled and removed.

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LEYS

1ST CUT (6/7/04) DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM_RES	NONE	FYMRes	Mean
LEY			
LC1	1.40	2.18	1.79
LC2	3.46	3.53	3.50
LC3	5.79	5.28	5.53
LN1	4.55	3.49	4.02
LN2	6.58	6.08	6.33
LN3	5.98	5.83	5.91
LLC1	3.54	3.26	3.40
LLC2	4.52	5.00	4.76
LLC3	5.39	4.86	5.12
LLC4	6.62	5.69	6.16
LLC5	2.86	2.80	2.83
LLC6	6.52	6.76	6.64
LLC7	5.39	6.22	5.81
LLC8	4.46	2.75	3.61
LLN1	7.46	6.35	6.91
LLN2	7.24	6.97	7.10
LLN3	5.81	6.29	6.05
LLN4	7.26	6.99	7.12
LLN5	8.19	7.96	8.08
LLN6	5.99	6.45	6.22
LLN7	7.31	8.17	7.74
LLN8	5.27	5.98	5.63
Mean	5.53	5.40	5.47

1ST CUT MEAN DM% 43.9

04/W/RN/3

LEYS

2ND CUT (15/9 & 3/11/04) DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM_RES	NONE	FYMRes	Mean
LEY			
LC1	1.48	1.61	1.55
LC2	0.58	0.23	0.40
LC3	0.64	0.45	0.54
LN1	2.48	2.44	2.46
LN2	2.64	2.55	2.59
LN3	1.90	1.70	1.80
LLC1	1.58	1.63	1.60
LLC2	1.05	0.93	0.99
LLC3	0.61	0.68	0.65
LLC4	0.90	0.56	0.73
LLC5	0.16	0.23	0.20
LLC6	1.77	1.23	1.50
LLC7	0.67	1.11	0.89
LLC8	0.94	0.61	0.78
LLN1	2.59	2.52	2.55
LLN2	2.88	2.65	2.76
LLN3	1.99	1.91	1.95
LLN4	3.04	3.64	3.34
LLN5	4.00	4.27	4.13
LLN6	3.15	3.22	3.19
LLN7	3.14	3.45	3.30
LLN8	2.10	1.78	1.94
Mean	1.83	1.79	1.81

2ND CUT MEAN DM% 22.7

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LEYS

TOTAL OF 2 CUTS DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM_RES	NONE	FYMRes	Mean
LEY			
LC1	2.89	3.79	3.34
LC2	4.03	3.77	3.90
LC3	6.43	5.72	6.08
LN1	7.03	5.94	6.48
LN2	9.23	8.63	8.93
LN3	7.89	7.53	7.71
LLC1	5.12	4.89	5.00
LLC2	5.57	5.93	5.75
LLC3	6.00	5.53	5.77
LLC4	7.52	6.26	6.89
LLC5	3.02	3.03	3.03
LLC6	8.29	7.99	8.14
LLC7	6.06	7.33	6.70
LLC8	5.41	3.36	4.38
LLN1	10.05	8.87	9.46
LLN2	10.12	9.62	9.87
LLN3	7.80	8.20	8.00
LLN4	10.29	10.63	10.46
LLN5	12.19	12.23	12.21
LLN6	9.14	9.67	9.40
LLN7	10.45	11.62	11.04
LLN8	7.37	7.77	7.57
Mean	7.36	7.19	7.28

TOTAL OF 2 CUTS MEAN DM% 33.3

PLOT AREA HARVESTED 0.00200

04/W/RN/3

MAIZE

WHOLE CROP (100% DRY MATTER) TONNES/HECTARE

***** Tables of means *****

FYMRES	NONE	FYMRes	Mean
ROTATION			
AM	12.69	13.83	13.26
AB	15.23	14.43	14.83
Mean	13.96	14.13	14.05

MEAN DM% 40.6

PLOT AREA HARVESTED 0.00108

W. BEANS

GRAIN (85% DRY MATTER) TONNES/HECTARE

***** Tables of means *****

FYMRES	NONE	FYMRes	Mean
ROTATION			
ABe	0.10	0.10	0.10
(AM)BE	0.89	1.01	0.95
Mean	0.49	0.56	0.53

GRAIN MEAN DM% 78.0

PLOT AREA HARVESTED 0.01573

04/W/RN/3

W. WHEAT

GRAIN TONNES/HECTARE

***** Tables of means *****

NSPLITFYM	Nsplit (noFYM)	Nsingle (FYMRes)			Mean
ROTATION					
LLN 8	2.67		3.19		2.93
LN 3	4.21		4.27		4.24
LLC 8	3.83		4.00		3.92
LC 3	4.62		4.62		4.62
AM	3.82		4.15		3.98
ABe	3.68		3.61		3.64
Mean	3.81		3.97		3.89
N	0	70	140	210	Mean
ROTATION					
LLN 8	2.01	3.08	3.07	3.56	2.93
LN 3	2.73	3.92	5.06	5.27	4.24
LLC 8	2.77	3.87	4.55	4.48	3.92
LC 3	2.95	4.38	5.32	5.84	4.62
AM	1.58	3.82	4.98	5.56	3.98
ABe	1.52	3.79	4.58	4.69	3.64
Mean	2.26	3.81	4.59	4.90	3.89
N	0	70	140	210	Mean
NSPLITFYM					
Nsplit (noFYM)	1.99	3.73	4.46	5.04	3.81
Nsingle (FYMRes)	2.52	3.89	4.73	4.75	3.97
Mean	2.26	3.81	4.59	4.90	3.89
N	0	70	140	210	
ROTATION NSPLITFYM					
LLN 8 Nsplit (noFYM)		0.84	3.34	2.63	3.87
Nsingle (FYMRes)		3.18	2.82	3.50	3.25
LN 3 Nsplit (noFYM)		2.61	3.77	4.85	5.62
Nsingle (FYMRes)		2.84	4.06	5.27	4.92
LLC 8 Nsplit (noFYM)		2.58	3.83	4.85	4.07
Nsingle (FYMRes)		2.95	3.90	4.25	4.89
LC 3 Nsplit (noFYM)		3.05	4.18	5.07	6.17
Nsingle (FYMRes)		2.85	4.57	5.57	5.51
AM Nsplit (noFYM)		1.43	3.51	4.74	5.61
Nsingle (FYMRes)		1.72	4.13	5.22	5.51
Abe Nsplit (noFYM)		1.44	3.75	4.61	4.92
Nsingle (FYMRes)		1.60	3.83	4.55	4.46

GRAIN MEAN DM% 86.2

PLOT AREA HARVESTED 0.00192

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W. RYE

GRAIN TONNES/HECTARE

***** Tables of means *****

FYMRES	NONE	FYMRes	Mean
ROTATION			
LLN 8	5.49	5.53	5.51
LN 3	4.83	4.44	4.64
LLC 8	4.45	4.70	4.58
LC 3	5.35	5.35	5.35
AM	3.42	3.61	3.51
ABe	4.00	3.87	3.93
Mean	4.59	4.58	4.59

N	0	40	80	120	Mean
ROTATION					
LLN 8	4.35	5.27	5.64	6.78	5.51
LN 3	3.77	4.34	5.41	5.03	4.64
LLC 8	3.24	4.86	4.66	5.55	4.58
LC 3	4.35	4.75	5.76	6.55	5.35
AM	2.24	3.32	4.12	4.37	3.51
ABe	2.87	3.57	4.15	5.15	3.93
Mean	3.47	4.35	4.96	5.57	4.59

N	0	40	80	120	Mean
FYMRES					
NONE	3.36	4.35	5.02	5.64	4.59
FYM	3.58	4.36	4.89	5.50	4.58
Mean	3.47	4.35	4.96	5.57	4.59

	N	0	40	80	120
ROTATION	FYMRES				
LLN 8	NONE	4.35	5.62	5.12	6.86
	FYMRes	4.36	4.92	6.15	6.70
LN 3	NONE	3.76	4.19	6.03	5.36
	FYMRes	3.78	4.48	4.79	4.70
LLC 8	NONE	3.05	4.74	4.83	5.19
	FYMRes	3.44	4.97	4.48	5.92
LC 3	NONE	4.23	4.51	5.97	6.70
	FYMRes	4.47	4.99	5.55	6.40
AM	NONE	1.89	3.31	4.00	4.48
	FYMRes	2.60	3.33	4.25	4.26
ABe	NONE	2.87	3.71	4.16	5.26
	FYMRes	2.87	3.43	4.13	5.04

GRAIN MEAN DM% 86.8

PLOT AREA HARVESTED 0.00192