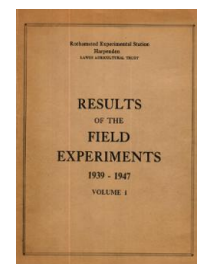


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BA/4 Six-course Rotation

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X

Ba/4.1

SIX COURSE ROTATION EXPERIMENT

ROTHAMSTED, Long Hoos .IV, and WOBURN, Stackyard Field, Series B.

Experiment begun in 1930 (Rothamsted) and 1929 (Woburn)

Seasonal effects of N, P₂O₅ and K₂O

The six crops of the rotation are sugar beet, barley, clover hay, wheat, potatoes and rye. Both at Rothamsted and Woburn there are fifteen plots under each crop in any year, and each plot receives one of the three common fertilizers, sulphate of ammonia, superphosphate and muriate of potash, at one of five levels. The rates of application of fertilizers are

N and P₂O₅: 0.00, 0.15, 0.30, 0.45, 0.60 cwt. per acre

K₂O: 0.00, 0.25, 0.50, 0.75, 1.00 cwt. per acre

Plots do not receive the same treatment 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 treatments are avoided.

0.027

Area of each plot: Rothamsted 0.025 acre Woburn 0.0271 acre. X

Details of the experiment are as given in the 1932 Report, p.131, except that since 1934 the forage crop has been replaced by rye, harvested as a mature crop, and that the green manure crops are now omitted. Since 1934 lime has been applied at the rate of 10 cwt. per acre at two stages in the rotation: immediately after the removal of the potato crop and before sowing barley.

The increments given in the following tables are linear regressions of yield on quantity of fertilizer.

Crop Notes

	ROTHAMSTED			WOBURN		
	Variety	Sown	Harvested	Variety	Sown	Harvested
Sugar beet						
1939	Kuhn	Apr.22	Oct.24	Kuhn	May 4	Nov.14
1940	"	May 3	Nov.26	"	" 6	" 19
1941	"	Apr.30	" 3	"	Apr.29	Dec.12
1942	Klein E.	" 24	Oct.23	"	" 22	" 9
1943	" "	" 14	" 14	Klein E.	" 17	" 17
1944	" "	" 21	" 20	" "	May 4	" 18
1945	" "	" 12	" 18	" "	" 3	Nov.28
1946	" "	" 13	" 22	" "	Apr.16	Oct.12
1947	" "	" 26	" 16	" "	May 3	" 17

✓

Ba/4.2

	ROTHAMSTED			WOBURN		
	Variety	Sown	Harvested	Variety	Sown	Harvested
Barley						
1939	Plumage Archer	Mar. 7	Aug. 16	Plumage Archer	Mar. 1	Aug. 30
1940	" "	" 9	" 3	" "	" 9	" 30
1941	" "	" 25	Sep. 2	" "	" 17	" 27
1942	" "	" 25	Aug. 17	" "	Apr. 1	" 13
1943	" "	" 2	" 7	" "	Mar. 4	Jul. 29
1944	" "	" 6	" 8	" "	" 14	Aug. 28
1945	" "	" 26	" 6	" "	" 5	" 2
1946	" "	" 20	" 15	" "	" 19	" 22
1947	" "	Apr. 12	" 8	" "	Apr. 17	" 6
Clover						
1939	Crimson Clover	Apr. 24 [‡]	Jul. 28	Broad Red	31.3.38, 14.9.38	Jun. 9
1940	Montgomery Red	23.4.39	Jun. 17	" "	17.4.39	" 20
1941	" "	May 3 [‡]	Aug. 25	" "	6.5.40	Jul. 10
1942	" "	9.5.41	Jun. 27	" "	5.5.41	Jun. 26
1943	" "	7.5.42	Jul. 15	" "	20.5.42	" 7
1944	" "	Mar. 27	" 28	" "	16.4.43	" 5
1945	Crimson Clover	12.9.44	Jun. 13	" "	Mar. 7 [‡]	Aug. 3
1946	Montgomery Red	28.3.45	" 22	Montgomery Red	23.4.45	Jul. 22
1947	" "	15.4.46	" 18	" "	2.5.46	Jun. 17
‡ Second sowing; first sowing failed						
Wheat						
1939	Yeoman	22.10.38	Aug. 12	Yeoman	31.10.38	Aug. 14
1940	"	21.10.39	" 6	"	1.11.39	" 12
1941	"	29.10.40	" 22	"	28.10.40	" 14
1942	"	27.10.41	" 12	"	21.11.41	" 19
1943	"	10.10.42	" 2	Eaten by rats		
1944	"	4.10.43	" 3	Yeoman	11.10.43	Aug. 10
1945	"	26.10.44	" 6	Crop failed		
1946	"	17.10.45	" 9	Yeoman	15.10.45	Aug. 21
1947	"	18.10.46	" 5	Squareheads Master	5.11.46	" 6
Potatoes						
1939	Ally	Apr. 17	Sep. 18	Ally	Apr. 12	Sep. 8
1940	"	" 26	" 23	"	Mar. 30	Sep. 17
1941	"	" 29	Oct. 2	"	Apr. 17	Oct. 3
1942	Majestic	" 21	" 2	Majestic	" 16	" 1
1943	"	" 9	Sep. 17	"	" 12	Sep. 20
1944	"	Mar. 28	" 29	"	May 5	Oct. 3
1945	"	" 29	" 22	"	Apr. 24	" 4
1946	"	" 29	Oct. 2	"	" 24	" 3
1947	"	May 2	Sep. 29	"	May 12	" 2
Rye						
1939		8.11.38	Aug. 12		31.10.38	Aug. 11
1940		23.10.39	" 3		1.11.39	" 2
1941		29.10.40	" 14		22.10.40	" 7
1942		28.10.41	" 4		21.11.41	" 1
1943		13.10.42	Jul. 24		10.11.42	Jul. 29
1944		2.10.43	" 22		12.10.43	" 30
1945		2.11.44	" 30		10.11.44	Aug. 3
1946		16.10.45	Aug. 1		5.10.45	" 19
1947		18.10.46	Jul. 29		6.11.46	Jul. 29

15.4.46

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Six Course Rotation Experiment

Ba/4.3

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

Sugar Beet

	ROTHAMSTED				Mean Yield	WOBURN		
	Mean Yield	N	P ₂ O ₅	K ₂ O		N	P ₂ O ₅	K ₂ O
Roots (Washed): tons per acre								
1939	9.98	2.16	-1.07	2.03	8.76	3.75	-1.71	0.44
1940	8.25	3.64	-2.67	-0.24	5.84	2.40	-0.39	0.79
1941	9.30	4.17	0.47	0.83	7.87	3.11	-1.19	0.81
1942	12.48	0.76	-0.35	0.39	6.78	-0.24	-5.33	1.53
1943	12.21	7.36	-1.29	-1.05	7.54	9.52	-0.98	-1.52
1944	6.45	-1.25	2.75	2.26	11.56	4.53	1.60	-1.24
1945	12.44	5.06	-2.01	0.38	12.75	6.47	-2.47	3.12
1946	11.18	3.71	-0.99	-0.16	5.11	2.97	-2.83	0.33
1947	6.80	-1.88	2.55	0.62	8.06	-1.23	1.93	0.26
Sugar Percentage								
1939	17.86	1.00	-0.20	1.33	18.25	-0.05 10.05	0.18	-0.10
1940	19.25	-0.25	0.75	0.04	18.66	-1.52	-0.13	0.07
1941	19.52	-0.01	0.81	0.77	18.35	-0.71	-0.52	0.20
1942	17.92	-2.87	1.46	0.90	17.88	-0.59	-0.97	-0.04
1943	18.56	-1.16	0.45	-0.03	17.67	-1.27	-0.40	-0.44
1944	16.58	-1.79	2.63	1.32	17.76	-0.35	-0.09	0.26
1945	19.24	1.07	-0.27	0.42	17.98	-0.41	0.57	0.56
1946	18.10	-0.85	-0.16	0.36	19.50	0.11	0.82	0.80
1947	19.22	-0.65	-1.76	0.26	20.06	0.10	0.53	1.01
Total Sugar: cwt. per acre								
1939	35.7	9.6	-4.1	9.9	32.0	13.5	-5.9	1.4
1940	31.8	13.3	-8.9	-0.9	21.7	7.0	-1.6	3.0
1941	36.3	16.3	3.3	4.8	28.9	10.3	-5.2	3.3
1942	44.7	-4.4	2.6	3.5	24.2	-1.5	-20.0	5.2
1943	45.3	24.4	-4.0	-4.0	26.6	31.5	-4.1	-6.0
1944	21.4	-6.3	12.5	9.4	41.1	15.2	5.6	-3.9
1945	47.9	21.6	-8.5	2.6	45.9	22.0	-7.6	12.4
1946	40.4	11.4	-4.0	0.2	19.9	11.7	-10.3	2.2
1947	26.2	-8.4	7.4	2.8	32.3	-4.7	8.6	2.6
Tops: tons per acre								
1939	11.01	3.40	-1.00	-0.32	5.73	2.42	-0.52	-0.62
1940	4.81	2.25	-0.98	-0.25	2.93	0.98	-0.65	0.42
1941	8.92	8.18	-0.22	-0.86	6.03	4.47	-1.41	0.52
1942	12.73	9.99	-3.08	-1.28	2.78	-0.51	-1.66	0.49
1943	6.94	8.75	1.82	-0.93	3.62	3.71	1.84	-0.28
1944	9.31	3.95	0.35	1.84	5.95	1.37	3.61	-2.70
1945	10.46	7.20	1.22	1.06	4.82	3.49	-0.73	1.94
1946	9.98	8.97	2.33	0.10	3.27	2.80	-1.65	-0.46
1947	4.28	1.37	1.63	0.04	3.56	0.93	1.00	0.21

Ba/4.4

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

	ROTHAMSTED				Mean Yield	WOBURN		
	Mean Yield	N	P ₂ O ₅	K ₂ O		N	P ₂ O ₅	K ₂ O
Barley Grain: cwt. per acre								
1939	38.3	18.5	7.1	-1.9	21.6	8.1	-6.7	7.1
1940	30.4	19.6	-3.9	-0.2	22.3	13.9	9.9	-0.3
1941	28.5	11.7	6.0	-1.6	16.4	5.4	2.1	-4.9
1942	31.0	21.3	-3.7	1.4	25.0	22.4	8.5	-1.0
1943	32.4	10.6	2.3	0.6	15.1	15.7	0.5	2.2
1944	30.8	13.7	3.8	-0.9	19.4	9.5	-5.4	7.1
1945	30.7	10.9	2.7	2.2	16.0	12.7	-3.5	-5.4
1946	33.0	7.1	-6.3	0.4	24.0	8.9	-1.1	-1.3
1947	27.5	14.7	-5.2	-3.8	18.4	26.7	5.1	-1.0
Barley Straw: cwt. per acre								
1939	41.8	17.1	9.5	0.6	32.7	20.1	-3.6	-8.4
1940	31.6	24.5	2.7	0.6	21.7	33.9	8.5	0.1
1941	30.4	16.0	10.9	-2.6	21.7	8.7	-2.8	-0.8
1942	31.8	26.9	-2.5	4.4	34.0	38.5	6.0	-3.6
1943	33.6	17.4	1.7	-1.0	30.7	31.7	-4.9	8.4
1944	29.7	20.2	8.0	-0.9	19.0	16.4	-6.1	4.8
1945	33.1	6.6	0.7	0.3	21.0	20.5	1.3	-4.1
1946	43.5	22.6	-7.3	0.5	24.6	15.4	-2.9	-4.4
1947	26.1	19.9	-4.3	-2.0	16.9	19.9	-2.7	-5.2
Clover Hay. Dry matter: cwt. per acre								
1939	22.3	9.4	4.7	2.9	25.1	-12.3	13.7	-1.7
1940	39.6	9.5	5.1	2.3	42.5	1.5	4.8	4.1
1941	19.8	6.4	-0.3	-0.4	21.0	-7.7	3.6	-4.5
1942	23.5	4.7	-4.3	-4.7	21.6	-7.4	11.5	3.7
1943	40.4	9.3	-14.5	6.6	15.6	20.7	-2.9	-4.4
1944	15.6	6.2	0.3	6.2	6.6	11.6	-3.9	1.8
1945	36.3	4.9	-1.4	-0.9	27.5	12.5	1.3	5.9
1946	31.9	21.3	13.8	-6.6	55.0	4.7	-8.7	-2.3
1947	32.0	1.8	-2.5	0.7	23.9	12.1	-2.9	1.7
Potatoes: Total tubers, tons per acre								
1939	8.10	1.31	2.60	2.35	6.86	6.39	0.57	-0.03
1940	6.72	1.38	3.01	2.12	7.07	5.20	2.68	1.00
1941	9.24	5.79	0.63	0.64	8.52	9.63	-4.29	-0.83
1942	9.47	1.95	-0.33	3.71	8.46	4.72	4.03	-0.25
1943	8.50	4.29	0.15	2.50	5.90	3.55	1.07	-1.15
1944	10.07	6.38	2.05	0.84	9.98	2.07	4.97	-2.10
1945	9.55	3.79	-0.95	3.59	10.61	5.46	-2.05	0.90
1946	10.75	7.97	-1.73	2.49	6.60	6.35	-1.79	-2.51
1947	5.69	1.52	1.61	1.29	6.51	1.42	-1.02	2.90

Ba/4.5

Six Course Rotation Experiment

ROTHAMSTED					WOBURN			
	Mean Yield	N	P ₂ O ₅	K ₂ O	Mean Yield	N	P ₂ O ₅	K ₂ O
<u>Wheat. Grain: cwt. per acre</u>								
1939	27.7	0.7	-5.8	0.2	23.3	-1.1	9.7	-3.1
1940	27.7	11.7	-1.5	-1.6	18.7	16.6	-7.1	0.2
1941	19.3	6.1	-10.2	-4.3	19.5	11.4	10.7	1.4
1942	37.2	10.5	2.8	-1.4	10.8	10.5	13.4	-3.6
1943	36.8	3.9	-0.5	3.8	(Crop eaten by rats in barn)			
1944	41.1	11.9	-1.5	-1.6	9.9	6.3	0.6	1.2
1945	25.8	12.3	2.1	1.2	(Crop failed)			
1946	29.2	13.8	12.7	-2.4	13.4	16.5	1.7	2.7
1947	25.1	10.1	-0.4	0.5	9.5	8.2	-7.3	5.3
<u>Wheat Straw: cwt. per acre</u>								
1939	48.0	22.7	-1.1	-0.3	35.5	8.7	20.2	-6.3
1940	34.1	23.9	-1.9	-1.6	32.3	28.5	-5.7	-2.2
1941	24.3	9.5	-11.3	-3.3	31.3	24.2	17.6	3.3
1942	44.8	14.8	3.5	-1.0	20.7	13.9	11.6	0.0
1943	49.0	5.1	-1.7	3.9	(Crop eaten by rats in barn)			
1944	52.8	15.4	-14.1	-1.5	29.7	10.5	-3.2	6.5
1945	36.8	22.9	0.7	1.8	(Crop failed)			
1946	47.3	19.3	18.7	-3.5	22.4	25.9	-2.1	6.6
1947	27.5	15.0	0.9	-1.6	15.4	14.8	-7.3	6.5
<u>Rye Grain: cwt. per acre</u>								
1939	22.1	19.9	1.2	0.0	15.7	11.2	0.5	0.7
1940	26.8	11.1	-0.3	0.1	20.3	13.6	1.7	-0.3
1941	16.7	10.5	0.3	-4.0	18.9	5.1	-3.7	1.0
1942	27.8	24.4	-0.3	-2.0	23.7	33.8	-4.5	-3.6
1943	32.2	27.5	-7.1	1.5	8.7	13.3	2.7	0.0
1944	31.0	15.9	-1.5	-2.6	17.1	17.6	3.1	0.4
1945	25.7	12.9	-0.9	2.3	14.2	11.5	-1.1	-1.7
1946	29.4	10.4	-3.1	0.4	14.8	9.1	-2.9	-3.5
1947	15.8	9.8	1.5	1.2	14.9	21.3	2.7	-2.0
<u>Rye Straw: cwt. per acre</u>								
1939	42.8	32.9	7.7	-2.1	33.3	28.6	-6.1	3.5
1940	36.7	19.5	-0.6	-1.3	37.7	30.3	-1.9	3.2
1941	25.3	17.1	2.2	-1.9	36.3	15.1	-0.5	5.0
1942	36.5	24.3	2.3	1.6	42.2	53.2	-6.3	-5.9
1943	47.0	32.7	-9.9	2.9	25.5	28.9	7.4	-6.8
1944	62.3	11.6	2.8	-3.0	37.8	31.3	2.3	0.7
1945	32.7	14.7	0.7	1.6	29.1	26.5	5.1	-0.2
1946	55.7	17.5	-5.9	-2.5	26.3	16.3	1.7	-3.3
1947	21.8	11.4	1.6	-2.4	18.3	26.9	-8.9	3.3

TABLE 1
 SUMMARY OF THE DATA FOR THE PERIOD 1950-1959

Year	1950-1959			1960-1969			1970-1979		
	Mean	Std. Dev.	Skewness	Mean	Std. Dev.	Skewness	Mean	Std. Dev.	Skewness
1950	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1951	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1952	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1953	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1954	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1955	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1956	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1957	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1958	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1959	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1960	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1961	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1962	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1963	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1964	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1965	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1966	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1967	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1968	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1969	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1970	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1971	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1972	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1973	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1974	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1975	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1976	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1977	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1978	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0
1979	1.0	0.5	0.0	1.0	0.5	0.0	1.0	0.5	0.0