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Woburn Ley-arable Experiment

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wanzleben. These changes may have tended to obscure in part any deterioration in fertility as far as the roots were concerned.

Taking the crops in which little or no change was made, namely barley, wheat, and rye, it appears that at Rothamsted the last six-year period gave better yields than either of the two preceding periods. Wheat in particular was much better at the end than at the beginning of the experiment. The yield of cereal straws showed a depression in the middle period, especially in rye, but recovered in the final period. At Woburn barley and rye showed a fairly marked decline in yield in the final six-year period, amounting to 3.8 cwt. and 5 cwt. grain respectively, the reduction in straw was even more marked. There was no definite trend in wheat yields at Woburn, where the level of production was low in any case.

Woburn Ley-Arable Experiment, 1938-1948

In 1938 a long period rotation experiment was begun at Woburn to test the effects on soil fertility of leys, lucerne and different systems of arable cropping. The cropping schemes under test are :

1. A three-year ley, grazed by sheep.
2. Lucerne, cut for hay for three years.
3. An arable sequence with one-year seeds : potatoes, wheat, one-year ley for hay.
4. A purely arable sequence without ley : potatoes, wheat, kale.

The results of these four methods of cropping the land are measured in two test crops, potatoes followed by barley. There are thus a series of five-course rotations in which the fourth and fifth crops are always potatoes and barley. There are five blocks, each of eight main plots, on four of these plots the above four cropping systems are tested without change to bring out cumulative effects. Since it is possible that some of the continuous rotations might lead to rather large differences in fertility, as for example by the exhaustion of organic matter, the remaining four plots carry the ley and arable sequences alternately, thereby testing the effects of the cropping at a steadier fertility level. The blocks were started off at yearly intervals so that after five years all phases of the rotations were represented annually. The only manurial factor in the experiment is the effect of 15 tons of dung per acre applied to the potato test crop. Its residual effects are followed through the subsequent crops. The dung treatments are repeated on their respective plots. Phosphate and potash applications are equalised for all treatments over a five-year period, but nitrogenous manures are applied according to a schedule based on crop requirements. Certain modifications in cropping have taken place in the course of the experiment. Kale was never a very satisfactory crop at Woburn, mainly owing to damage by birds and vermin, and in 1945 it was replaced by sugar beet. In 1940 Italian ryegrass was included in the mixture for the three-year ley to add bulk to the produce of the first year. In the autumn of 1948 rye was introduced in place of wheat, on the grounds that it was a more suitable crop and less damaged by birds.

To illustrate the information that becomes available as the experiment proceeds we may take the sequence on the first block

started in 1938. For the three years 1938-40 the eight plots of this block carried each of the above treatments in duplicate, since at this stage there is no difference between continuous and alternating treatments. In 1941 potatoes were grown on the whole block, but each potato plot was split to test the direct application of 15 tons of dung per acre. The effect of the previous cropping was therefore measured in presence and absence of dung on a basis of two plots per treatment. In 1942 barley followed potatoes to give the second year effects of the treatment crops and the residuals in barley of dung applied to the previous potatoes. In 1943 the distinction between the continuous and alternating rotations began to operate on the first block. For example, of the two plots which had previously tested lucerne residues in barley, one went back into lucerne to give the continuous lucerne treatment, while the other changed over to an arable rotation beginning with potatoes in 1943. All the main contrasts are tested at all stages of the rotation every year, but there are only a few plots for each contrast in individual years. In presenting results over the period 1941-8 in Table 2, the continuous and alternating rotations have been taken together.

The level of potato yields in Table 2 is high and the standard errors year by year have been satisfactorily low. Barley has produced only moderate crops and, largely owing to game damage, yields have been much more variable. The wheat yields are low. The effect of the previous rotations on the yield of the test crops in the absence of dung may first be considered. The potato test crop receives a basal dressing of 0.6 cwt. N, 0.5 cwt. P_2O_5 and 0.75 cwt. K_2O per acre. In spite of this fairly generous treatment there is a considerable difference in yield due to the previous sequence of cropping. The residues of the ley give the best result with the very creditable average yield of 12.3 tons per acre. Lucerne is only half a ton behind, but the two arable rotations give significantly lower yields, the hay rotation being somewhat better than one with tillage crops. The difference in yield between potatoes following ley and those following arable crops is no less than 2.3 tons per acre. The barley crop, which follows potatoes and receives 0.2 cwt. N per acre as a basal dressing, gave a significantly better yield after lucerne than any of the other rotations. One year later the plots come into potatoes, which again receive the same fertilizer treatment as before. Yields are still good and at this stage the residues of the three-year ley stand out above all the other treatments. The same result is obtained with wheat in the fourth year when the effect of ley was significantly better than that of either of the arable rotations.

Direct dunging or dung residues has shown certain differential effects. In the first year when a direct application of dung is made to the potato test crop, the increase produced by the farmyard manure on the crops after ley is only moderate, about 1 ton per acre, but when the potatoes follow either lucerne or the arable rotations the dung effect is large, over 2 tons per acre. It is possible that the ley residues leave a better soil structure and the lucerne more available nitrogen. In barley the only case of a significant increase due to dung occurs after the arable rotation with hay, the dung raising yield to about the value produced by the other treatments. In spite of the poor residual effect in barley the effect

on potatoes of dung applied two years previously is large after lucerne and small after ley. On wheat in the fourth year, the residual dung effect is small. Effective as dung has been on both potato crops, it has not masked the larger differences between the after effects of ley rotation and arable rotation.

Over the whole four-year sequence of test crops the position may be examined by averaging the two potato crops and the two grain crops.

Average of two potato crops, tons per acre ; and two grain crops, cwt. per acre :

		Ley	Lucerne	Arable with hay	Arable without hay
Potatoes without dung	..	11.8	10.9	10.1	9.9
„ with dung	..	12.6	13.2	11.9	11.4
Grain without dung	..	15.6	16.3	12.6	13.8
„ with dung	..	15.7	16.0	15.1	15.2

Without dung ley produces considerably more potatoes than any other treatment, lucerne also gives more than either of the arable rotations. The grain yields are also in favour of the ley and lucerne treatments. When a dressing of dung is given to the first potato crop lucerne gives slightly more potatoes than ley, and both of them much more than the arable rotations. The grain yields are in the same order but show much smaller differences.

For both kinds of test crop the yields without dung after leys are similar to those with dung after arable crops.

Productivity of Treatment Crops

The lucerne plots are cut green and their production of dry matter for each cut is calculated. Sample cuts are taken from the ley plots immediately before the sheep are put in. A record is also kept of the number of grazing days per plot per season. For each of the years 1945-48 there are first, second and third year yields of ley and lucerne. The figures are as follows :

	Lucerne Hay		Three years Ley		Sheep Grazing	
	tons per acre		Dry matter in sample cuts, tons per acre		days per acre	
	Mean	Effect of residual dung	Mean	Effect of residual dung	Mean	Effect of residual dung
1st year	0.50	0.07	1.59	0.00	607	6
2nd „	2.64	0.17	4.32	0.42	1700	—3
3rd „	3.16	0.27	5.15	0.77	1782	—21
Total	6.30	0.51	11.06	1.19	4089	—18

In terms of dry matter per season the leys gave very high yields, 11 tons of dry matter over the three years, and were much more productive than the lucerne under the system of management adopted. This was particularly noticeable in the first year. The residual effect of dung applied two years previously was small, the leys proving more responsive than the lucerne. The yield of continuous lucerne as compared with lucerne alternating with an arable rotation was examined in the years 1945-48 in which comparisons within blocks was possible.

					Lucerne Hay : tons per acre	
					Following	Following
					3 Years	3 Years
					Lucerne	Arable Rotations
1st year	..	..	..	..	0.51	0.42
2nd "	..	..	..	..	2.84	2.70
3rd "	..	..	..	..	3.31	3.47
Total	..	..	..	..	6.66	6.59

At this early stage there was no indication that the previous lucerne had any bad effect on the following lucerne.

TABLE 2

Mean yields of After 3 year's cropping with

					Ley	Lucerne	Arable with Hay	Arable without Hay	Standard Error
1st Year (1941-48)									
<i>POTATOES. Tons per acre</i>									
No dung	..	..	..	..	12.3	11.9	10.6	10.0	±0.22
Dung to potatoes	..	..	..	..	13.4	14.1	12.7	12.0	±0.22
Mean	..	..	..	..	12.9	13.0	11.6	11.0	±0.18
Increase for dung	..	..	..	..	1.1	2.2	2.1	2.0	±0.26
2nd Year (1942-48)									
<i>BARLEY. Grain cwt. per acre</i>									
No dung	..	..	..	..	17.4	20.5	16.2	17.8	±0.84
Dung one year before	..	..	..	..	17.5	19.8	19.6	18.6	±0.84
Mean	..	..	..	..	17.4	20.2	17.9	18.2	±0.60
Increase for dung residues	..	..	..	..	0.1	-0.7	3.4	0.8	±1.17
<i>BARLEY. Straw cwt. per acre</i>									
No dung	..	..	..	..	23.0	24.3	19.6	22.0	
Dung one year before	..	..	..	..	22.8	25.2	25.2	23.4	
Mean	..	..	..	..	22.9	24.7	22.4	22.7	
Increase for dung residues	..	..	..	..	-0.2	0.9	5.6	1.4	
3rd Year (1943-48)									
<i>POTATOES. Tons per acre</i>									
No dung	..	..	..	..	11.2	9.9	9.6	9.8	±0.46
Dung two years before	..	..	..	..	11.8	12.1	11.1	10.8	±0.46
Mean	..	..	..	..	11.5	11.0	10.3	10.3	±0.36
Increase for dung residues	..	..	..	..	0.6	2.2	1.5	1.0	±0.58
4th Year (1944-48)									
<i>WHEAT. Grain cwt. per acre</i>									
No dung	..	..	..	..	13.9	12.1	9.0	9.8	±1.23
Dung three years before	..	..	..	..	13.9	12.3	10.6	11.8	±1.23
Mean	..	..	..	..	13.9	12.2	9.8	10.8	±0.97
Increase for dung residues	..	..	..	..	0.0	0.2	1.6	2.0	±1.50
<i>WHEAT. Straw cwt. per acre</i>									
No dung	..	..	..	..	29.2	22.5	19.9	21.6	
Dung three years before	..	..	..	..	27.9	23.6	20.7	26.9	
Mean	..	..	..	..	28.5	23.1	20.3	24.2	
Increase for dung residues	..	..	..	..	-1.3	1.1	0.8	5.3	