ROTHAMSTED RESEARCH

Rothamsted Report for 1947

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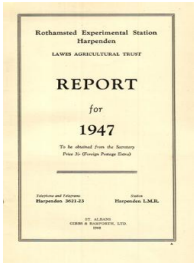

Field Experiments on the Rothamsted Farm

The Plot Committee

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FIELD EXPERIMENTS ON THE ROTHAMSTED FARM

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From the point of view of the field experiments 1947 was an unfavourable year. Wheat and beans were drilled under rather sticky conditions and made very slow progress. At the end of January the great frost set in and lasted till the middle of March. Although the ground was snow-covered wheat and beans suffered badly. Both the bean experiments on Stackyard field were lost, most of the wheat on Agdell field failed, and an experiment put down on Delharding to test the effect of spring mowing on winter-proud wheat was abandoned although the wheat was not actually killed. When the snow cleared the land remained very wet for some weeks. Spring cereals were not drilled till mid-April nor potatoes planted till the end of May. Growth in early summer was very rapid, however, and the heat and drought which set in in July brought on the corn unusually quickly to harvest. No rain came for potatoes which looked very vigorous in the haulm but nevertheless made a rather light crop. Sugar beet grew well but the plant population was low and irregular. The real disappointment of the year was wheat which was the worst crop for many years. Other crops though somewhat below average were reasonably good.

The number of plots handled by the Field Staff in 1947 is shown in the following table:—

	Cereals and beans	Potatoes and roots	Hay	Grazing	Total
Classical	113	72	47	—	232
Long Period Rotations, etc.	215	232	56	9	512
Annual Experiments ...	321	414	—	—	735
	649	718	103	9	1,479

The total number of plots in 1946 was 1,554.

The winter failure of the beans and wheat accounted for the loss of 128 plots, so that the actual number harvested in 1947 was 1,351.

The classical fields

Broadbalk. The field was drilled at the end of October in a rather sticky seed-bed. When the snow melted in spring Section V, which is near the drain and carried the fourth crop after fallow, was badly washed. The wheat never recovered and looked poor throughout the season, with much Slender Foxtail. In fact this part of the field was very similar to the Broadbalk of the pre-fallowing days. None of the other sections were good in 1947, straw was short and there was no lodging. Wild oats were plentiful, but a thorough hand pulling by a gang of German prisoners as soon as the oats topped the wheat made a very good job of the field.

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The wild oats, always worse on the dunged plot on the North side of the field, are gradually spreading southwards and have now reached as far as plot 11.

Great Hoos wheat and fallow. The wheat was the poorest crop for many years. It was thin, straggled, and the ears were very small. The crop was very little better than the unmanured plot on Broadbalk Section V.

Hoosfield. The permanent barley plots were sown on 17th April (on only three occasions in the long history of the field had drilling been so late) and even then the crop was slow to grow away owing to drought. The plots were sprayed with "denocate" quite successfully to reduce broad-leaved weeds, but as in former years the most serious trouble was wild oats. In an attempt to check this weed the same harvesting procedure was adopted as in 1946. On those plots where the infestation was slight the oats were carefully hand-pulled and the barley was cut and harvested in the usual way. Where the oats were too thick for hand-pulling all but a small fraction of each plot was cut green and the produce disposed of, the oats on the remaining area were carefully hand-pulled and the barley allowed to ripen to give an estimate of yield.

Barnfield. Dr. Peters, of the Institute of Agricultural Parasitology, St. Albans, reported on the eelworm infestation of Barnfield as estimated from cyst counts made in soil samples taken after the crop of 1946 had been lifted. The conclusion was that the infestation had not yet reached serious proportions. It was therefore decided that cropping with mangolds and sugar beet should be continued.

The land lay very wet in spring and cultivation could not begin till mid-April. Four rows of sugar beet were again sown on each of the mangold plots. The mangolds were a poor crop. The highest yield (dung and complete fertilisers) was only 14·4 tons per acre, and the plant population was low at about 15,000 per acre. The sugar beet appeared to stand up to the long drought rather better: yields ran up to 8·2 tons where the plots were fully manured, but there were only 16,000 plants per acre. Conditions for lifting the crop were excellent. A fungus disease Phoma Betae was very prevalent on the roots of the sugar beet, particularly on the plots receiving sulphate of ammonia. The mangolds were not affected.

Park Grass. Growth started very late on the grass plots, and owing to pressure of other work the first spring dressings of nitrogen could not be applied till 15th May and the second dressings till 29th May. Nevertheless in June growth was very rapid and the crop, though in general lighter than average, was very much better than might have been expected; indeed the unmanured plots and plot 7, Minerals only, gave well above their average yields. The hay was cut on 12th June.

Agdell. Most of the wheat failed on this field. On the fallow section practically none was found after the snow melted, the adjacent side of the clover strip carried an exceedingly poor plant, but the east side of the clover section nearest Harwoods Piece

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carried a reasonably good plant. This plant was left, but the whole of the fallow section and the remaining half of the clover section was drilled with spring wheat.

LONG-PERIOD EXPERIMENTS

Four-course rotation. This experiment tests the first year and residual effects of dung, straw compost, and raw straw plus fertiliser, and also of superphosphate and rock phosphate. The cropping is potatoes, barley, ryegrass, wheat. The results of the first 13 years cropping were summarised in the Station Report for 1946.

The wheat of 1947 was the poorest crop ever grown in this experiment, the mean yield being only 8·5 cwt. per acre. There was a good plant in the autumn but the crop wintered out very badly. In particular certain plots treated with rock phosphate in previous years practically failed. The ground was too wet in the autumn to make the usual sowing of ryegrass; the seed was put in in spring, 12th April, and growth was so small at the time of cutting that very light hay yields were obtained. The potatoes started in an unusually good tilth but suffered from drought before the end of the season. Barley was an even crop but rather below average.

Six-course rotation. This experiment tests 5 levels of each of the three main nutrients, N, P, and K applied direct to every crop of the rotation sugar beet, barley, clover, wheat, potatoes, rye.

Clover was very good in this rotation, most crops were up to the average but rye was poorer than usual, the straw being about a foot below the average height. Sugar beet was a rather gappy plant and gave only 4 tons of tops per acre.

Two-course rotation. The main point under test in this rotation of sugar beet and barley is the cumulative effect of dressings of agricultural salt when applied to the same plots year after year. There are also comparisons of salt and muriate of potash.

In 1947 the barley was fairly good and as usual showed little effect either from applications of salt or from residual potash. The sugar beet was rather a thin plant, except where 5 or 7½ cwt. of salt per acre had been applied, and the crop was much below the usual level. Salt again appeared to be much more effective than muriate of potash.

Highfield grazing experiment. This experiment carried out for the Royal Agricultural Society of England to measure the manurial value of cake fed on pasture is nearing the end of its third cycle. The first-year effect of cake feeding has been measured as live-weight increase of cattle and sheep, three times on each of the three cake-treated plots, and only the figures for 1948 are required to complete the corresponding nine measurements of second-year effects.

There could hardly be a greater contrast in weather between 1946 and 1947, the first was exceptionally wet in summer and the second exceptionally dry, nevertheless the gains made on the plots during the grazing season were similar.

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The unmanured plot No. 9 in block III is comparable for the two years in question and gives the following figures:—

	1946	1947
Live-weight increase lb. per acre		
Cattle	278	319
Sheep	66	38
Total	344	357
Starch equivalent lb. per acre		
Cattle	1,254	1,409
Sheep	712	383
Total	1,966	1,792
Grazing days per acre		
Cattle	108	123
Sheep	309	180
Grazing period		
Cattle	May 9–Oct. 31	May 15–Sept. 18
Sheep	June 5–Nov. 28	June 11–Nov. 25

In the wet year the grass carried a higher sheep-stock and carried the cattle longer in autumn, but the starch equivalent and live-weight increase were similar in the two years, as they are largely determined by the amount of herbage produced early in the season.

The mean yields of starch equivalent and the mean live-weight increases over two seasons following the feeding of cake and the application of the conventional fertiliser equivalent of the cake averaged over the eight years of the experiment were as follows:—

	Starch equivalent cwt. per acre	Live-weight increase cwt. per acre
No cake or fertilisers ...	14·1	2·6
Fertilisers	15·4	2·7
Cake feeding	15·5	2·9

Deep-cultivation rotation experiment. This experiment, begun in 1944, consists of 6 blocks cropped with sugar beet, barley, seeds, wheat, potatoes, oats respectively, with the crops rotating on the blocks in the above order. In each block there are 16 plots testing all combinations of the following pairs of factors: 7 v. 14 inch ploughing, 0 v. dung, 0 v. superphosphate, 0 v. muriate of potash.

Deep ploughing is given for sugar beet, wheat, and potatoes. Dung is given to sugar beet (10 tons) and potatoes (20 tons), and these crops also receive the phosphate and potash treatments. The contrasted ploughings are given for the sugar beet, wheat and potato crops. All dung is applied before these ploughings, but the phosphate and potash are ploughed down on half of the plots and applied on the surface or in the drills on the other half.

In 1947 deep ploughing gave somewhat better yields of potatoes on plots receiving potash in the drills. Deep ploughing gave spectacular improvements in the sugar beet, the average increase on deep-ploughed over shallow-ploughed plots being 3·2 tons washed roots, 1·7 tons tops and 12·4 cwt. sugar per acre. This

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gain from deep ploughing was attributed largely to the fact that the deep-ploughed plots were clean early in the season when the shallow-ploughed ones carried a very heavy crop of annual weeds. After weeding and singling the plants on the deep-ploughed land showed much more vigorous growth, the difference persisting throughout June and July.

THE ANNUAL EXPERIMENTS

1. *Potatoes. Organic manures.* An experiment testing eleven different kinds of bulky organic manures, each at two levels and in the presence and absence of the three standard fertilisers has been conducted each year from 1940 to 1946 in three 5 × 5 lattice squares with each main plot divided into quarters making 300 sub-plots. In 1947 a similar experiment was carried out on 150 sub-plots, the phosphate test being omitted. Nine farmyard manures of known history and composition, a bracken compost and raw straw were tested. Single dressings of all farmyard manures gave increases between 10 and 30 cwt. per acre. The double dressings of the well-rotted manures showed further increases but the double dressings of the fresh strawy manures gave poorer results than the single dressings. The bad effect of incorporating dry bulky material in the ridges in a dry summer was seen in an aggravated form with raw straw which at the double rate seriously reduced the crop even where sulphate of ammonia was applied with the straw.

2. *Potatoes. Time of planting. Fertilisers.* This annual experiment has with minor modifications been conducted since 1945, its primary purpose being to provide the Plant Pathology Department with material for the field study of the spread of virus diseases. Normally the experiment tests dung, nitrogen, phosphate and potash in relation to four times of planting. In 1947 owing to the late season the planting times were reduced to two, and the phosphate comparison was omitted. There was no early planting in the ordinary sense of the word, the first possible date was 5th May and the late planting was carried out on 27th May. Farmyard manure behaved very differently according to the time of planting of the tubers. On the "early" planting dung was quite effective, giving an increase of 2·46 tons of potatoes in the absence of potash; on the later-planted potatoes dung had practically no effect: it increased the yield, even in the absence of potash, only by 0·7 tons per acre.

3. *Potatoes. Cultivation experiment.* The factors tested in this experiment were earthing-up, depth of inter-row cultivation, and the application of a straw mulch between the rows. In addition, the fertiliser was either broadcast before drawing the drills or applied in the ridges before planting. With yields in the neighbourhood of 8 tons per acre none of the treatments showed marked or consistent effects.

4. *Potatoes. Residual values of applications of organic manures over seven seasons.* This experiment on dung, town refuse, fermented town refuse and screened dust began in 1940 and until 1947 carried crops of sugar beet, mangolds, barley, beans, wheat and sugar beet. Over this period the bulky manures applied amounted

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to 56 tons per acre. The plots also tested the effects of muriate of potash and sulphate of ammonia applied annually. In 1947 no organic manures were given and potatoes were grown to test the residual effects. The residues from dung increased the crop by 2·2 tons per acre, those from screened dust by 0·9 tons per acre, and those from composted town refuse by 0·5 tons per acre.

5. *Potatoes. Fertiliser placement.* This experiment formed one of a series of ten. Growth was seriously checked by placing the fertiliser in a band in direct contact with the sets. The best yields were obtained from side-band placement, though on the average of all ten experiments this method had little advantage over broadcasting after ridging.

6. *Sugar beet. Fertiliser placement.* Placing fertilisers 2 in. below the seed and at either 0, 1 or 3 in. to the side gave better yields than broadcasting the fertilisers. In seven parallel experiments elsewhere different results were obtained, localised placement often being inferior to broadcasting.

7. *Wheat. Residuals from bulky organic manures applied to potatoes in* 1946. A good crop of Bersee wheat showed no residual effects from farmyard manures applied to potatoes in 1946 at rates of about 8 and 16 tons per acre.

8. *Wheat. Eyespot experiment.* The effects of rate and depth of sowing, nitrogen and spraying with sulphuric acid on eyespot, lodging and yield of wheat were tested for the second year. The late dry season (contrasting with 1946) resulted in exceptionally low eyespot incidence and very short straw; there was no lodging but weeds were unusually prevalent. Spraying reduced eyespot and greatly reduced weeds; it increased yield by 1·6 cwt. per acre. Increased rates of sowing from 1 to 2 and 3 bushels per acre increased yields only where nitrogen was applied. Both 2 and 4 cwt. sulphate of ammonia gave increased yields.

9. *Spring-sown cereals.* The yields and fertiliser responses of four spring-sown cereals were tested for the first time in 1947. Atle wheat, Plumage Archer barley, Star oats and Bersee autumn wheat were all sown on 12th April and received test dressings of 0, 0·3, 0·6, 0·9 cwt. N per acre as sulphate of ammonia, and 0 and 0·6 cwt. P_2O_5 per acre as superphosphate, 0 and 0·6 cwt. K_2O per acre as muriate of potash. All crops grew very well and responded well to nitrogen. The wheats and oats stood up at harvest but part of the barley was lodged. The responses to the heaviest dressings of nitrogen were: oats 9·4 cwt., Atle wheat 5·4 cwt., Bersee wheat 5·2 cwt. and barley 3·7 cwt. per acre. The barley showed a good response to potash and the oats to phosphate.

10. *Three-course rotation experiment on the use of straw.* Several experiments of both long and short terms have been carried out in recent years to test various methods of utilising straw on the land. The Rothamsted Report for 1946 contains a summary of the results of a four-course experiment started in 1930. A similar summary is given below for a three-course experiment commenced in 1933 in Long Hoos Field, Section VI.

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The main purpose of the experiment is to study the immediate, residual and cumulative effects of straw-ploughed in and made into compost. All plots receive equal amounts of N, P, K fertilisers; half of the plots receive raw straw in addition and one-quarter receive a compost made from the straw and the fertilisers. The treatments tested are:—

Ar Fertilisers only, no organic manure
Ad Straw made into compost and applied in autumn
St1 Raw straw ploughed-in in autumn, fertilisers in spring
St2 Raw straw ploughed-in in autumn, half the fertilisers applied in autumn and the remainder in spring.

These treatments are applied to their respective plots in alternate years, so that both the immediate and the residual effects are measured. The eight treatments are repeated three times in each block. There are three blocks cropped with potatoes, barley, sugar beet, which follow one another in that order. The straw applied directly to the land or used to make compost is at the rate of 53·3 cwt. per acre. The fertilisers provide 0·4 cwt. N, 0·4 cwt. P_2O_5 and 0·5 cwt. K_2O per acre. On the compost plots the whole of the nitrogen and phosphate fertilisers are used to rot the straw, the potash fertiliser being applied separately in spring. In addition to these treatments all sugar beet plots receive 0·2 cwt. N, 0·2 cwt. P_2O_5 and 0·25 cwt. K_2O per acre, and all potato plots double these amounts.

The average yields over fourteen seasons are given below:—

3-course rotation experiment—Rothamsted
Mean yields per acre, 1934 *to* 1947, *inclusive.*

		Potatoes	Barley		Sugar Beet		
			Grain	Straw	Washed Roots	Tops	Sugar
		tons	cwt.	cwt.	tons	tons	cwt.
Immediate effects							
Yields in year of application							
Ar	No straw	9·15	32·3	37·4	11·60	10·63	43·5
Ad	Straw-compost ...	7·89	27·6	29·8	9·88	8·09	37·3
St1	Raw straw, fertilisers in spring	9·70	30·8	34·5	10·91	9·32	41·4
St2	Raw straw, fertilisers in autumn & spring	9·20	30·7	32·8	11·05	9·29	42·0
	Mean ...	8·99	30·4	33·6	10·86	9·33	41·1
Residual effects							
Yields in year after application							
Ar	No straw	6·95	27·4	29·1	10·07	8·16	38·0
Ad	Straw-compost ...	7·42	26·0	28·3	9·78	8·11	36·9
St1	Raw straw, fertilisers in spring	7·97	26·9	29·0	10·13	7·84	38·2
St2	Raw straw, fertilisers in autumn & spring	7·96	27·8	29·9	10·30	8·36	39·1
	Mean ...	7·58	27·0	29·1	10·07	8·12	38·1

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In the year of application both raw straw and straw compost reduced the yields of barley and sugar beet. The reduction was particularly noticeable in barley straw and sugar beet tops, both of which are sensitive to the supply of available nitrogen. These results show that straw locked up some of the fertiliser nitrogen in forms which did not become available to the immediately following crop.

In the year of application potatoes gave different results from barley and sugar beet. Provided the fertilisers were applied in the normal way in spring, ploughing-in straw during the previous autumn gave 11 cwt. per acre more potatoes. Where half the fertilisers were applied in the autumn with the straw there was no such benefit from straw. These results suggest that the benefit from ploughing-in straw is mainly physical. For potatoes, but not for sugar beet and barley, this improvement more than makes up for the inevitable loss of immediately available nitrogen as the straw decomposes, provided that the nitrogen fertiliser for the potatoes is held over until spring. Straw compost gave much lower yields than fertilisers alone for all three crops.

The residual effects on the second crop after application were somewhat different from the immediate effects. Straw ploughed-in had negligible residual effects on sugar beet and barley but had marked residual effects on potatoes, both series of plots with straw ploughed-in giving 20 cwt. per acre more potatoes than plots without organic manures. The plots with residues from straw compost gave lower yields of sugar beet and barley but higher yields of potatoes than those without organic manures.

The results as a whole show that ploughing-in straw improves the physical properties of this heavy soil and gives better yields of potatoes. The straw locks up available nitrogen and it is necessary to give additional nitrogen fertiliser to the following crops. This extra nitrogen should be given at the normal time for the crop and not applied with the straw. Composting straw locks up available nitrogen and composts should not therefore be regarded as effective substitutes for inorganic nitrogen.

From 1934 to 1937 the experiment also included tests on the effects of autumn-sown rye and vetches or catch crops. Rye between barley and sugar beet averaged only 3·4 tons green stuff per acre and the rye between the other crops were much smaller. The vetch crops were very small. The rye reduced the yields of the following crops, the reduction being largest for barley grain and straw and sugar beet tops. The rye, like the straw, reduced the amount of nitrogen available to the following crops. The small crops of vetches had negligible effects apart from a small reduction in the potato crop.

In 1942 the sugar beet crop showed symptoms of magnesium deficiency, which was confirmed by leaf analysis. Magnesium sulphate at 2·5 cwt. per acre was added to some of the sugar beet crops in each subsequent year but there were no effects on yields and the symptoms of the deficiency were not observed again.

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