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Report for 1948

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Rothamsted Experimental Station
Harpenden

LAWES AGRICULTURAL TRUST

REPORT
for
1948

Field Experiments

The Plot Committee

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FIELD EXPERIMENTS

By the Plot Committee

The following members of the staff, who constitute the Field Plots Committee, are responsible for planning and carrying out the programme of field experiments: E. M. Crowther (Chairman), H. V. Garner (Secretary), H. H. Mann, J. R. Moffatt, D. J. Watson, and F. Yates.

Rothamsted Field Experiments, 1948

The season 1948, though dull in the summer months, was not unfavourable to crop growth. Work on the plots proceeded without serious hindrance: cereal and root yields were up to standard while potatoes were excellent.

The drought of 1947 continued till the end of November, consequently the autumn sown wheat and beans were drilled in very dry seedbeds. The beans that were drilled were completely lost through birds, but the ploughed-in beans and the wheat made good plants and came through the very mild winter without appreciable loss. After a rather wet January the spring was dry, mild, and bright and generally favourable. There was plenty of moisture in May and June, but July with less than an inch of rain was unusually dry. In a summer when the press was full of complaints about ruined harvests, the August rainfall at Rothamsted at 2·6″ was practically the average while September was drier than usual. There were, however, a rather large number of wet days during the harvest period, but none the less crops were secured in good condition. October and November were also drier than usual but the weather broke for the lifting of late sugar beet and mangolds. The whole year with 27·2 inches of rain was 1·3 below average.

The number of plots handled by the experimental staff is shown in the following table:—

	Corn and Linseed	Potatoes and Roots	Hay	Grazing	Total
Classical	101	39	47	—	187
Long Period Rotations	215	232	56	3	506
Annual Experiments	501	287	—	—	788
Total	817	558	103	3	1481

Unfortunately 64 plots of beans and two plots of turnips on Agdell were lost through birds and disease respectively so the number of plots harvested was 1,415.

Classical Fields

Broadbalk (Continuous wheat, 105th year)

The wheat was drilled in a very dry seedbed on October 24th. There was a good germination and the plant wintered well. Section II, after bare fallow, was shorter in the straw and weaker than usual. There was little lodging except on the heavier plots of Section I near the Wilderness. The field was hand pulled for wild oats between mid June and the end of July and very few of the panicles

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reappeared before harvest. Bird damage was probably less severe than usual. The crop was cut on August 19th and carted a week afterwards in very good order: it was one of the brightest pieces of wheat carted in a year when much of the corn was blackened.

Wheat and fallow (93rd year)

This was drilled at the same time as Broadbalk. On the whole the crops were better than usual, and better than the continuously unmanured plot on Broadbalk, and appeared to show a slight benefit from the three years' fallow as compared with the one year fallow.

Hoosfield (Continuous barley, 97th year)

The barley was sown on 31st March and early growth was good. Wild oats were pulled during the summer on all plots except 50, 5A, and 3C which were cut green with the exception of a small area that was hand pulled and left to ripen. Before harvest a second lot of oat panicles much less numerous than the first had appeared on all plots. The dung plot was badly laid this year and very weedy on the west end. Elsewhere the field was fairly clean apart from the oats. The promise of the yield was quite up to average.

Barnfield (Continuous mangolds, 73rd year)

The first sowing of mangolds and sugar beet made under good conditions on April 28th was completely ruined by flea beetle in spite of all attempts to save the plant. On June 9th the field was redrilled with mangolds only, and the second sowing grew fast and continued to make growth well into the mild autumn. Lifting commenced in early November and later the conditions became very wet and sticky. In view of the late sowing the crop was better than might have been expected.

Park Grass (Continuous meadow hay, 93rd year)

It was a good year for hay. There was a taller growth of grass than usual on most plots, but legumes were not so conspicuous. The first cut was taken on 16th June; the second crop came away quickly and was cut on the 9th of October to give a much better yield than average.

Agdell Field (Four course rotation. Swedes, barley, clover or fallow, wheat, 101st year, 1st crop of 26th course)

The field was due to carry swedes in 1948, but for many years negligible yields of roots have been obtained on account of finger and toe disease. Only plots 1 and 2, where the disease is most serious, were sown in order to maintain an area of infection in view of the possibility of carrying out field experiments on controlling this disease. There was a splendid plant up to the time of singling, but as usual the roots on plots 1 and 2 were practically entirely destroyed later in the season and no yields were taken.

Long Period Rotation Experiments

Four course rotation (potatoes, barley, ryegrass, wheat 19th year)

The experiment measures the first year and residual effects of dung, straw compost, raw straw plus artificials, and two phosphatic fertilizers. A summary of the results of 14 years of this Rotation will be found in the Report for 1946, p. 82. The potato crop of

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1948 was particularly promising and showed the effect of the extra nitrogen applied to half plots. Barley was about average, the plots receiving straw and extra nitrogen looked very well in the spring but as usual was completely lodged before harvest, nevertheless the direct application gave a yield of 36·5 cwt. grain per acre. Autumn sown wheat failed twice through rough seedbed and bird damage and was finally replaced by Atle spring wheat drilled on March 8th. This germinated well but never made good growth and the wheat came to harvest short, thin, with very poor ears. The ryegrass was poorer than usual particularly on the rock phosphate plots where bare patches were noticeable.

Six course (sugar beet, barley, clover, wheat, potatoes, rye, 19th year)

The experiment measures the responses to each of the three common nutrients yearly. Most of the crops in this rotation were above average in 1948. Potatoes at 9·5 tons were good and responded well to nitrogen and potash, sugar beet 11·5 tons was much above average and an even plant, but apart from the usual increase for nitrogen in the tops, fertilizer responses were small. Rye was tall and even, some of the plots being over 6 feet in height; barley clean, standing and uniform, a very fine crop averaging 36 cwt. per acre. The red clover cropped well with a full plant but haymaking conditions were unsettled and the crop was secured with great difficulty. Potash was the most effective manure for this crop. Wheat was the worst crop; the first sowing failed and a late autumn sowing on November 12th gave an irregular crop which lost further plant in spring, the yield, however, was better than appearances suggested and averaged 26·6 cwt., slightly more than the rye which looked much more impressive in the field. All cereals gave good responses to nitrogen. This rotation is summarized over the 19-year period 1930-48 on (p. 90).

Three course (potatoes, barley, sugar beet, 16th year)

The experiment measures the direct and residual effect of straw compost, raw straw plus artificials, and fertilizers only without organic matter. All the crops in this rotation did well. The barley as usual was a good even clean crop yielding on the average 33·5 cwt. grain. Potatoes at 10·4 tons per acre were well above the average and made such rapid spring growth that they had to be earthed up much earlier in the season than usual. Straw gave quite marked direct and residual effects on potatoes. A strip on the east side of the sugar beet was damaged on May 14th by the drift of weed killer from a neighbouring crop, but was redrilled at once with soaked seed and in the good growing weather which followed the new plants caught up with the rest. The final crop at 34·6 cwt. of sugar was slightly below average.

Two course rotation (7th year)

A long period experiment testing the cumulative effects of various levels of agricultural salt applied to sugar beet, with half rates on the following barley crop. Both sugar beet and barley in this rotation were good crops. One strip of plots of the sugar beet were damaged by weed spraying but immediately repaired (see note on adjoining sugar beet three course rotation). Salt gave an increase

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of up to 10 cwt. of sugar per acre, whether applied in winter or in the seedbed. Muriate of potash had little effect on either beet or barley.

Deep cultivation rotation—six course (5th year)

A rotation of sugar beet, barley, seeds, wheat, potatoes, oats testing 7″ v. 14″ ploughing (for beet, wheat, potatoes only); 0 v. dung; 0 v. superphosphate; 0 v. muriate of potash (for beet and potatoes only). The deep ploughing for sugar beet exposed much subsoil and the plant on these plots was slightly thinner and more irregular than elsewhere. A serious attack of flea beetle was successfully controlled by three dustings. Later in the season the crop made wonderful growth. Heavy yields of 16 tons per acre were recorded, and the final result of the deep ploughing was a loss of 1·1 tons roots per acre. Barley gave the excellent crop of 41 cwt. grain per acre which tended to lodge on the plots previously dunged for sugar beet. On the land deep ploughed in 1947 the barley looked a little better and had a brighter colour than on the shallow ploughed areas, but this was not reflected in the final yield. A good crop of seeds was secured with grasses tall and predominating over the clovers. The wheat on this rotation was the best on the farm with a yield of 41 cwt. There was a slightly thinner plant on the deep ploughed plots which showed much subsoil. These plots looked poorer throughout autumn and winter but they filled out well and all looked excellent at harvest time; they yielded 3·4 cwt. less than the shallow ploughed plots. The potato section was ploughed to full depth (13″) for the first time in 1948. In 1943 the full depth could not be reached and in 1946–47 the ground was too wet to plough deep for wheat. In spite of this the subsoil that came up in 1948 showed less red clay than elsewhere and crumbled easily in the winter. Potatoes made a fine crop of 15 tons per acre and showed big response to dung and potash. Oats started with a rather thin plant in spring but filled out to an excellent crop, tall and heavy headed, in July the oats on plots that had been deep ploughed for potatoes had a better colour than the rest, and the land was somewhat less weedy. There were no marked treatment effects in the final yields. A few plots showed excessive amounts of raw subsoil which on these particular areas appeared to depress the yield.

High Field grazing experiment

This experiment, carried out for the Royal Agricultural Society of England, measures the residual effect of cake fed on pasture as compared with the conventional manurial equivalent applied as fertilizer, the control plots having neither cake nor fertilizer. It was begun in 1937 and was in full cycle by 1940. In 1948 plots 4, 5 and 6 were grazed with cattle and sheep to measure the second year effect of cake or fertilizers applied in 1946. By this time every block of the experiment had completed three cycles and the experiment was terminated.

The Annual Experiments

Potatoes

The annual potato experiments were put down in Sawyers II which had previously carried four corn crops. The experiments were repetitions of those carried out in previous years with only slight

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modifications. The season was excellent for potatoes and all plots grew well and were clean and full of growth right up to lifting time.

Experiments with dungs and organic manures. Ten different types of farmyard manure were tested at single and double rates in this experiment which also included rotted bracken. Rates of application of dung ranged from 2·6 to 8·7 tons per acre in the single dose according to the amount of litter and period of storage. All dung at the single dose gave increases ranging from 1·5 to 3·0 tons per acre; the lightest dressing, 2·6 tons, of an overyear dung from bullock boxes gave an increase of 2·6 tons of potatoes. There was marked falling off at the double rates, the increases ranging from 2·1 to 3·1 tons. In the absence of organics there was no response to nitrogen but a large response to potash of 3.8 tons. In presence or organics the response to nitrogen was good, particularly at the lower level of organic manuring. All dungs and also bracken greatly reduced the potash responses.

Time of planting experiment. This experiment now in its 4th season was designed to test the spread of virus diseases in the potato crop and is more fully discussed by the Plant Pathology Department. The earliest planting, April 10th, gave 12·2 tons of potatoes, the latest, May 22nd, gave 6·9 tons. Potash was by far the most effective nutrient.

Cultivation experiment. This was a continuation of an experiment testing the effect of earthing up and of shallow v. deep inter-row cultivation of potatoes. A further treatment was a straw mulch applied along the rows after the first deep cultivation. There was also a test of fertilizers on the flat v. fertilizers in the ridges. The crop was a very good one, and grew so fast in the early summer that it had to be earthed up a fortnight earlier than usual and consequently only one deep inter row cultivation was possible. Neither earthing up nor the inter-row cultivations had any effect on the crop, but the straw mulch increased the yield by 1·8 tons per acre. Fertilizer in the ridges produced 1·1 tons more potatoes than the same quantity of fertilizers broadcast on the flat before ridging. Both earthing up and mulching reduced the proportion of greened tubers.

Linseed experiments

Two experiments were put down on Bones Close.

(1) Testing times of sowing, seed rates, and each of the three common nutrients.

(2) Testing two rates of a complete fertilizer broadcast, and half rates drilled.

The plant came away well but was attacked by flea beetle. The effects of this was very much more serious on the late sown plots which practically failed. There was some indication in the field that the heavier dose of fertilizer drilled with the seed had injured the plant. Both experiments were marred by a very bad infestation of 'goose grass' which in certain cases completely obscured the crop. The weed was worst on plots generously manured. Threshing was exceedingly difficult and there was much weed seed with the grain. The best plots, yielding 11 cwt. per acre, were early sown and without fertilizer. Late sowing owing to flea beetle damage only gave 2

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cwt. per acre. Fertilizers either individually or in mixture had very little effect, and the application of 4½ cwt. with the seed was slightly detrimental.

Wheat

Six experiments were set down on this crop.

(1) Eyespot experiment, Little Knott, a continuation of work carried out by the Plant Pathology Department and reported by them.

(2) Wireworm experiment, Little Hoos, two experiments testing modern fumigants and their method of application against wireworms. These are reported by the Insecticides Department.

(3) Inoculation experiment, Long Hoos. The purpose of this experiment was to test on spring wheat bacterial inoculum containing heteroauxins for which good results had been claimed in France. A fair crop of 22 cwt. of wheat was grown which showed a good response to nitrogen applied as sulphate of ammonia but no effect of the inoculum.

(4) Residuals in autumn wheat of organic manures applied to potatoes in 1947, Great Harpenden. The measurement of dung residuals in cereal crops has been carried out for many years. A heavy crop of 41·9 cwt. of wheat was grown which showed visible residual effects due to the organics in the early stages. These effects were less marked at harvest time but still noticeable. Raw straw plus artificials, which was one of the worst treatments in the potato crop of 1947, gave the most conspicuous residual effect in wheat amounting to 7·2 cwt. for the double dose of straw.

(5) A small experiment was put down to compare 5 varieties of spring wheat and three varieties of autumn wheat sown in the spring. Three nitrogen levels were also tested. Of the varieties used Fylgia and April Bearded were the earliest, but the autumn wheats were very late to harvest and the last of these was not cut till September 12th.

Spring sown cereals

Long Hoos, second year. This was a repetition of the experiment of 1947 on exactly the same lines. The seed was sown on March 17th. The mean yields without nitrogen for the various crops were oats (S.84) 14·6 cwt., spring wheat (Atle) 18·2 cwt., autumn wheat (Bersee) 13·4 cwt., barley (Plumage Archer) 22·5 cwt. All crops responded well to nitrogen up to a level of 3 cwt. of sulphate of ammonia per acre; but the further responses to 4½ cwt. of sulphate of ammonia were negligible. At all nitrogen levels barley was the most productive crop, though at 3 cwt. of sulphate of ammonia and still more at 4½ cwt. lodging occurred. Phosphate responses were insignificant, but barley and Bersee wheat responded to potash.

Beans

Great Field I. Two bean experiments were put down in this field, but one testing the combine drilling of fertilizer was completely destroyed by birds. An experiment testing variety and cultivation factors had all the seed ploughed in, and on the whole gave a very good plant. Two early sown blocks drilled on October 28th, looked better during winter and early spring than the remaining two that were sown on November 18th. Four different strains of seed all yielded much the same, the average yield being 24·5 cwt. grain per

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acre, a very satisfactory crop. As usual a high seed rate, 3 cwt. per acre, was distinctly more satisfactory than a lower rate, 2 cwt. per acre. The extra cwt. of seed gave a further 3½ cwt. grain. The yield of straw was nearly 2 tons per acre for the crop grew very tall.

Fertilizer placement experiments

Two of these were carried out on Long Hoos using the special drill made by the National Institute of Agricultural Engineering, one on sugar beet and the other on peas for threshing. These experiments are part of a series carried out for the most part at outside centres; they are reported by the Chemistry Department.

Woburn Field Experiments, 1948

Classical Experiments

The permanent wheat and barley land was once again fallowed in 1948 making two years' fallow since the last crops were taken.

Long Period Rotation Experiments

Six-course rotation, 19th year

This experiment is on exactly the same lines as the one at Rothamsted except that in recent years the variety of wheat grown has been Square Heads Master instead of Yeoman. Crops were on the whole satisfactory in 1948. Sugar beet gave an average yield of 9·5 tons which is very close to the mean of all years. Potatoes at 8·9 tons were slightly better than usual. Barley produced the excellent crop of 27·5 cwt. per acre, whereas wheat yielded 20·8 cwt. and rye 21·0 cwt. All crops except the clover which this year was trifolium owing to a failure of the main sowing, responded well to nitrogen, but phosphate and potash were ineffective.

The first sowing of wheat failed through bird damage and the crop was resown on November 14th, a fair crop resulted but there was much shrivelled grain. Rye sown on November 15th did not suffer from bird damage. The results of this experiment over the 19-year period 1930-48 are summarized on p. 90.

New green manuring experiment, 11th year

This experiment compares undersown clover, undersown ryegrass, lupins and rape as green manures for autumn cabbages followed by barley. In 1948 a fair crop of barley, 22·4 cwt., was grown which showed a striking response of 8 cwt. of grain for 2 cwt. of sulphate of ammonia. Of the green manures turned in for the previous cabbages, clover was the best and ryegrass the worst in its effects on the barley.

Ley arable rotation, 11th year

This experiment tests the value of three years' ley and three years' lucerne as a means of building up soil fertility in comparison with rotations without leys (for full description see Rothamsted report, 1938, p. 135). Block 3 now begins its third rotation. Potatoes showed a pronounced residual effect of 2·23 tons due to 15 tons of dung applied two years previously. The level of cropping was excellent, mean yield 16 tons. The ley plots were sown at the end of March and gave no less than 7 grazings. The grass cuttings from these plots expressed as hay yielded 4·3 tons per acre. This

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was by far the most productive first year grazing season on record. Lucerne sown on May 18th showed some loss of plant during the season especially on plots which had frequently grown lucerne in past years. Block 5 shows the second years' test crop, barley, which at 30·6 cwt. was the best crop so far grown in this experiment. It showed small but appreciable residues of dung applied to the previous potato crop, but very little effect due to the previous systems of cropping. Blocks 1 and 2 showed leys in their 2nd and 3rd years and various arable crops. In 1948 the 2nd year of the ley at 4·4 tons of hay equivalent was more productive than the third year at 3·4 tons. Third year lucerne gave 3·2 tons of hay during the season, and 2nd year lucerne 4·3 tons. Wheat failed twice from autumn sowings due to birds and was resown in the spring. The final yield was only 14 cwt. 1 year seeds for hay undersown in wheat in 1947 failed in the summer drought and were resown on the bare ground in the spring of 1948. Only a poor crop of 1·2 tons per acre resulted. Sugar beet was a satisfactory crop of 10·8 tons with a rather high proportion of tops. This experiment is summarized on p. 94.

Organic manure experiment, market garden crops, 7th year

This experiment tests the effect of yearly applications of dung, vegetable compost, sewage sludge, and sewage sludge compost on a rotation of vegetable crops. The organics are applied at 15 and 30 tons per acre to peas and to red beet. Sulphate of ammonia at several levels is also tested. The peas drilled on March 16th turned out a very weedy crop and there was a rather large proportion of unfilled pods. Better germination was noticed on the plots receiving organic manures, but the crop was very variable. Dung increased the yield of saleable peas and sludge decreased it. There was no advantage from the addition of sulphate of ammonia. Red beet was a gappy plant partly owing to an attack of flea beetle; there were more plants where organics were applied. There were many bolters and the number of these was increased by those treatments which increased the crop yield. The yield of bulbs was very small on the control plots but was considerably increased by organics, especially dung and sewage sludge. Sulphate of ammonia was also effective.

Annual Experiments

The only annual experiments at Woburn in 1948 were replications of the two linseed experiments as carried out at Rothamsted.

Six Course Rotation Experiments, 1930-1948

In 1930 two long-period rotation experiments were started, one at Rothamsted and the other at Woburn. The purpose was to provide data on the effects of varying amounts of the three standard nutrients, nitrogen, phosphate and potash on the yield of the six crops of the rotation in the different weather conditions of successive years.

The rotation is sugar beet, barley, clover, wheat, potatoes, rye. For the first 4 years the rye was harvested as green fodder, but subsequently it has been carried on to maturity and weighed as

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grain and straw. The crops rotate on six areas on each farm so that each crop of the rotation is present every year. Within each area there are 15 plots consisting of three sets of 5 treatments, testing 5 levels of nitrogen, 5 levels of phosphate, and 5 levels of potash respectively. The plots do not receive the same treatment throughout, but on each plot the 15 treatments follow each other in a definite order in successive years, thus avoiding cumulative effects of any nutrient. In each set the order is 4, 3, 2, 1, 0. The 15 treatments are :

Nitrogen set 0, 1, 2, 3, 4 units of N with 2 units of P and 2 units of K
Phosphate set 0, 1, 2, 3, 4 units of P with 2 units of N and 2 units of K
Potash set 0, 1, 2, 3, 4 units of K with 2 units of N and 2 units of P

The fertilisers are sulphate of ammonia, superphosphate, and muriate of potash. The units are 0·15 cwt. N per acre, 0·15 cwt. P_2O_5 per acre, and 0·25 cwt. K_2O per acre. Thus in terms of fertiliser the nitrogen dressings ranged, in round figures, from 0 to 3 cwt. sulphate of ammonia, the phosphate from 0 to 3½ cwt. superphosphate, and the potash from 0 to 2 cwt. muriate of potash. No dung is given, but a uniform application of calcium carbonate is applied after sugar beet and again after potatoes. The experiment has not yet been continued long enough to provide sufficient data for a full statistical examination of seasonal fertiliser responses in relation to weather conditions, but in the meantime the general nature of the fertiliser responses on the two farms has emerged fairly clearly and the 19-year means are recorded in this preliminary statement.

It was soon apparent that nitrogen was by far the most effective nutrient on both farms and on almost all crops. The average responses to phosphate and potash were in general much smaller, although certain crops, notably potatoes at Rothamsted, gave big returns for potash and appreciable increases for phosphate. In Table 1 will be found the mean yields for all crops at the five levels of nitrogen, but for the much smaller effects due to phosphate and potash the mean linear regressions give a sufficient picture of the results, and these are therefore tabulated. For comparison the regression figures for nitrogen are also included.

At Rothamsted almost all crops show clear responses to nitrogenuous manuring. Thus 1½ cwt. sulphate of ammonia (the mean rate of dressing) gave increases of 0·74 tons sugar beet, 1·2 tons potatoes, 5·2 cwt. barley, 3·5 cwt. wheat, 5·7 cwt. rye per acre, but for clover hay the increases for nitrogen although appreciable are probably due in part to the presence of self-sown barley and weeds. For most crops there is a distinct falling off in the responses at the higher rates of fertiliser application. In rye straw and in particular in sugar beet tops the nitrogen responses are well maintained at the higher levels ; for the sugar beet tops the higher dressings appear to be if anything more effective than the lower ones.

At Woburn all crops except clover responded well to nitrogen. The increases for 1½ cwt. sulphate of ammonia were 1·6 tons sugar beet and potatoes, 7·7 cwt. barley, 3·5 cwt. wheat, and 4·9 cwt. rye. The actual responses were usually higher than the corresponding ones at Rothamsted, though the level of cropping was better at Rothamsted than Woburn. As at Rothamsted the increases tended

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to fall off at the higher levels, but once again sugar beet tops kept up their responses to the highest level of manuring. The nitrogen responses vary considerably from year to year. Taking sugar beet as an example, the most favourable year on both farms was 1943 when Rothamsted showed an increase in roots at the rate of 7·4 tons per 1 cwt. N, and Woburn 9·5 tons per 1 cwt. N; on the other hand in 1932 both farms showed a loss of 2 tons roots for 1 cwt. N, the worst result on record. The parallelism between the nitrogen effects at these two localities is by no means always as close as this; the nitrogen effects observed yearly at Rothamsted are much nearer to the general behaviour of nitrogen on sugar beet in the Eastern Counties, as measured by experiments carried out annually on commercial farms in all sugar factory areas, than are those at Woburn. In 1948 for instance, a year of low nitrogen response generally, Rothamsted gave practically no increase for nitrogen, while Woburn gave no less than 9·1 tons per 1 cwt. N.

As will be seen by the regressions, there are few striking responses to either phosphate or potash. The only crop that shows appreciable responses to phosphate is potatoes; this is found on both farms. Potash at Rothamsted gives a big response in potatoes, the successive increases over no-potash being 1·27 tons for ½ cwt. muriate of potash, 1·77 for 1 cwt., 2·07 for 1½ cwt., 2·43 tons for 2 cwt. muriate of potash per acre. In addition there is some evidence of a small response to potash in sugar beet and clover hay. At Woburn the small responses to potash in sugar beet and clover hay are very similar to these obtained at Rothamsted, but the potato crop behaves quite differently on the two farms. At Woburn 2 cwt. of muriate of potash gives only 0·3 tons of potatoes in contrast to the 2·4 tons obtained at Rothamsted.

The productivity of the two farms may be compared by examining the mean yield for each of the crops over the whole period of the experiment. Each crop had exactly the same manurial treatment on the same variety for the whole course of the experiment, except that from 1947 Squareheads Master wheat was substituted for Yeoman at Woburn on the grounds that it was more suited to the light soil. Rothamsted is on the whole the more productive farm, particularly for wheat where the yields exceed those at Woburn by 12·3 cwt. grain and 15·5 cwt. straw per acre; it also grows 0·81 tons more sugar beet with 3·23 tons more tops, and substantially more barley and rye. Woburn on the other hand gives somewhat bigger crops of clover hay and slightly more potatoes.

In Table 1 will be found the mean yield of each crop taken over three successive periods of six years. Such figures should reveal any pronounced tendency towards soil exhaustion during the course of protracted cropping with fertilisers alone, the only organic matter given being the sugar beet tops ploughed in on their respective plots. It should be noted however that certain changes in crop variety were made on both farms. In 1942 Majestic potatoes were substituted for Ally and in 1943 Kleinwanzleben sugar beet was substituted for Kühn. In other words during the last six-year period slightly heavier yielding varieties of roots were being grown, and in particular the yield of tops of the sugar beet might be expected to be appreciably increased by the change from Kühn to Klein-

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TABLE 1

Mean yields per acre at 5 nitrogen levels, Rothamsted and Woburn 1930-48

	Nitrogen cwt. per acre	Sugar Beet Roots tons	Sugar Beet Tops tons	Sugar Beet Total Sugar cwt.	Barley Grain cwt.	Barley Straw cwt.	Clover Hay Dry Matter cwt.	Wheat Grain cwt.	Wheat Straw cwt.	Potatoes Total Tubers tons	Rye Grain cwt.	Rye Straw cwt.
Rothamsted	0	7·98	7·57	28·8	25·9	28·3	22·1	24·1	34·5	6·48	19·8	35·1
	0·15	8·46	8·15	30·7	28·9	32·1	24·5	26·7	40·9	7·06	22·8	38·1
	0·30	8·72	8·75	31·6	31·1	35·2	26·0	27·6	42·0	7·64	25·5	41·9
	0·45	9·01	9·47	32·3	32·2	37·1	27·6	27·9	44·8	7·91	27·2	45·2
	0·60	9·28	10·50	33·1	32·7	38·8	27·5	28·4	45·9	8·32	27·6	45·8
Woburn	0	6·56	4·59	23·5	15·3	23·9	28·5	11·4	20·1	6·40	13·4	22·7
	0·15	7·35	5·02	26·4	19·8	27·9	28·0	12·7	22·5	7·10	15·9	29·9
	0·30	8·11	5·66	29·0	23·0	30·5	26·6	14·9	29·0	8·03	18·3	33·4
	0·45	8·60	5·93	30·3	24·2	31·5	24·2	18·2	32·5	8·73	20·8	37·2
	0·60	8·73	6·34	30·6	25·1	35·5	27·2	18·2	34·0	9·27	22·1	39·2
Mean Yield :												
Rothamsted		8·72	8·65	31·4	30·4	34·5	21·4	27·5	43·3	7·69	24·5	41·1
Woburn		7·91	5·42	28·2	22·5	30·5	27·0	15·2	27·8	8·05	18·0	32·9
Increase for :												
1 cwt. N	Rothamsted ..	2·11	4·79	7·5	11·3	17·3	8·7	6·4	17·5	3·01	13·2	19·0
	Woburn	3·73	3·02	12·2	16·0	20·7	–4·2	12·8	25·2	4·90	14·9	26·9
1 cwt. P_2O_5	Rothamsted ..	–0·28	–0·42	–0·5	1·3	3·0	–0·2	0·0	0·9	0·91	–0·5	1·2
	Woburn	–0·37	0·16	–0·9	1·5	0·5	0·0	–0·7	–0·7	0·68	–1·1	–1·6
1 cwt. K_2O	Rothamsted ..	0·27	–0·38	1·8	0·0	1·8	1·8	0·4	1·0	2·27	–0·3	–0·9
	Woburn	0·45	0·37	2·3	0·9	0·7	1·8	–0·3	–0·7	0·29	–0·2	0·5

Six Course Rotation. 6 year means

Yield per acre

	Sugar Beet Roots tons	Sugar Beet Tops tons	Sugar Beet Total Sugar cwt.	Barley Grain cwt.	Barley Straw cwt.	Clover Hay Dry Matter cwt.	Wheat Grain cwt.	Wheat Straw cwt.	Potatoes tons	Rye Grain cwt.	Rye Straw cwt.
Rothamsted											
1931–1936	7·68	8·43	27·1	28·6	36·3	14·4†	23·2	41·7	6·80	22·5*	45·7*
1937–1942	8·75	8·79	31·7	31·2	33·3	23·6	28·4	40·6	7·48	23·4	35·5
1943–1948	10·10	8·62	37·1	31·8	34·3	21·4	30·8	43·5	9·01	26·6	44·5
Woburn											
1931–1936	7·88	6·67	26·8	23·9	39·5	23·0‡	12·2	26·0	8·13	20·2*	36·8*
1937–1942	7·58	4·79	27·6	23·9	27·8	29·9	19·5	30·2	7·39	19·8	33·8
1943–1948	8·92	4·69	32·6	20·1	23·1	26·9	13·4†	26·9†	8·09	15·2	30·0

* 3 years only. † 4 years only. ‡ 5 years only.

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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

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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

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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 tons per acre		Three years Ley Dry matter in sample cuts, tons per acre		Sheep Grazing 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.

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	Lucerne Hay : tons per acre	
	Following 3 Years Lucerne	Following 3 Years 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)					
POTATOES. Tons per acre					
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)					
BARLEY. Grain cwt. per acre					
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
BARLEY. Straw cwt. per acre					
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)					
POTATOES. Tons per acre					
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)					
WHEAT. Grain cwt. per acre					
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
WHEAT. Straw cwt. per acre					
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	

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Rothamsted Ley-Arable Experiment, started 1948

After eleven years experience with the ley-arable experiment at Woburn, two similar but more comprehensive experiments were begun at Rothamsted in the autumn of 1948. The general purpose is the same as at Woburn, but since permanent grass plots are included it will be possible in the newer experiments to compare the two systems, permanent grass plus permanent arable, with alternating grass and arable. There are also additional cropping and manurial treatments included, and the productivity of the grass is estimated by the live weight increase and grazing days of sheep as well as by sampling methods. Moreover the Rothamsted experiments provide a direct comparison of the output from permanent grass as compared with temporary grass under the same conditions; and in one of the experiments a comparison of old permanent grass with reseeded permanent grass. The experiments have been started on two fields: (1) Highfield, on part of the land formerly occupied by the R.A.S.E. grazing experiment. This is a very old grass field and the new experiment has been established on the ploughed up turf. (2) Fosters Field, an old arable field. The treatments whose output and effect on soil fertility are under test are:

1. Three year ley, grazed by sheep.
2. Three year cut grass, as for drying.
3. Three year lucerne, cut as for hay.
4. Three year arable rotation: one year seeds for hay, potatoes, barley.

The three test crops which follow all the above preparatory treatments are wheat in the first testing year, potatoes in the second year, and barley in the third. Outside this sequence of treatment crops and test crops there are permanent grass treatments: on Highfield (1) old grass and (2) reseeded grass. On Fosters reseeded grass only. All the permanent grass plots are grazed with sheep for two years and hayed in the third year. The experiment on Highfield is set out in 6-plot blocks and on Fosters in 5-plot blocks. Each plot in a block is assigned to one of the rotation or permanent grass treatments. The method is illustrated by the following scheme showing the cropping in the 6-plot blocks of Highfield commencing in 1949 and covering the first six-year cycle.

Phase A	Phase B	Plots (1)	(2)	(3)	(4)	(5)	(6)
1949	1952	L	Lu	CG	H	G	R
1950	1953	L	Lu	CG	P	G	R
1951	1954	L	Lu	CG	B	G	R
1952	1949	W	W	W	W	G	R
1953	1950	P	P	P	P	G	R
1954	1951	B	B	B	B	G	R

L = 3-year ley Lu = lucerne CG = cut grass
G = old permanent grass R = reseeded grass
H = 1 year arable hay P = potatoes
B = barley W = wheat

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There are two blocks started in phase A (treatment crops followed by test crops) and a further two blocks in phase B which is three years behind phase A and leads off with the three test crops before the treatment crops come into operation. In 1949 there will thus be four blocks started as above in each field; on Fosters there is no treatment G, but otherwise the arrangements are the same. In 1950 an exactly similar set of four blocks will be started in each field, and again in 1951, when all six stages of all the rotations will be represented in duplicate. In 1952 measurement fertility effects built up by the leys, lucerne and other treatment crops, will begin in the test crops on two blocks in each field.

Manuring: Phosphate and potash in the form of a compound fertiliser with 13% P_2O_5 and 13% K_2O are applied in standard amounts to all crops according to their requirements in dressings providing in all 2·4 cwt. P_2O_5 and 2·4 cwt. K_2O per acre over the six-year cycle. The manurial tests are made on nitrogen fertiliser and dung. The treatment crops are grown at two levels of nitrogenous manuring appropriate to the crops (lucerne has no nitrogen); and the effects of the crop grown at each level of manuring is measurable at two nitrogen levels in the subsequent test crops. The schedule for nitrogen application is as follows:

Crop	N cwt. per acre Low Level	High Level	Applied
Wheat	0·3	0·6	Spring top dressing.
Potatoes ..	0·5	1·0	In ridges.
Barley	0·2	0·4	In seedbed.
One year Hay ..	0·3	0·6	Early spring.
3 year Ley ..	0·15	0·3	Every year—half in spring, half in summer.
Cut Grass ..	0·15	0·3	In early spring and after 1st, 2nd, 3rd cut yearly.
Lucerne ..	none	none	
Permanent Grass / Reseeded ..	0·15	0·3	Yearly. In the first two years in divided dressings (half in spring, half in summer); in the third (hay) year in a single early spring dressing.

Dung is also tested at 15 tons per acre in the ridges on potatoes both in the arable rotation and as the test crop. It is applied on quarter plots to show the combinations of dung and levels of nitrogen (O v D) (N_1 v N_2). As the experiment develops the dressings of dung are arranged on the sub-plots so as to bring out direct, cumulative and residual dung effects. The size of the main plots is 1/11 acre, the largest obtainable in the fields in question. When the experiment is fully started there will be 72 of these main plots on Highfield and 60 on Fosters. Fertiliser effects of nitrogen and dung are measured on a quarter plot basis, except that on permanent and reseeded grass and three-year ley the grazing unit which tests the direct effect of nitrogenous applications is a half-plot of 1/22 acre.

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Irrigation Experiments, 1947 and 1948

At the request of the Sugar Beet Research and Education Committee of the Ministry of Agriculture, Rothamsted undertook the control of experiments on the irrigation of sugar beet. Members of the Physics and Chemistry departments and the Field Experiments Section took part in the work.

A preliminary trial took place in 1947 on the farm of Mr. F. A. Secrett at Milford, Surrey, and in the following year a much bigger experiment was laid down on the same farm.

The main points in regard to these two trials are briefly recorded below.

The soil at Hurst Farm, Milford, is a deep sandy loam derived from the Greensand formation. It is intensively manured for market garden crops with bulky and concentrated organic manures and also fertilizers. Overhead irrigation with oscillating spray lines is an essential part of the system and for certain crops a very dilute solution of potassium nitrate (one part in at least 5000 parts of water) is applied through the spray lines instead of pure water.

In 1947 half an acre of sugar beet was drilled after a crop of spinach had been harvested. This small area was used for a pilot experiment whose main object was to gain experience of the practical problems arising in the carrying out of irrigation trials. Two plots each of $\frac{1}{6}$ acre received the irrigation, four others of 1/24 acre were dry controls. The provision of water was from the main commercial installation, which was naturally being used simultaneously in other parts of the farm, consequently strict control of water supply, and more particularly of the supply of nutrients in the water was difficult to achieve. The treatments were:—

1 and 2	No water.
3	Irrigation with water only.
4	Irrigation with water containing potassium nitrate.
5 and 6	No water, but dry potassium nitrate top dressed in amount equivalent to 4.

The season was a particularly dry one especially in summer and autumn. The period July-October inclusive gave only 3·3″ rain, whereas the average for 55 years in the neighbourhood was 10·1″.

On June 25th irrigation started. The crop at this time was a practically perfect plant, 35,000 per acre, in full vigour of growth, with the promise of very heavy yields. Seven irrigations in all at approximately fortnightly intervals were given ending on September 26th, the total quantity of water applied being approximately 10″. In the very dry summer weather the effects of the water were visible three days after application, and showed in larger leaf area and brighter and fresher leaf colours. The crop was lifted on November 4th. The dry potassium nitrate application, and the potassium nitrate applied in the irrigation water, estimated as 121 lb. per acre, had effects so small that in a non-replicated trial they might easily occur by chance, so they are omitted for the following presentation of the main results.

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	Dry plots (1, 2, 5, 6)	Irrigated plots (3, 4)	Effect of 10″ water
Clean roots tons per acre	20·10	29·76	+9·66
Sugar per cent	19·22	16·71	—2·51
Sugar cwt. per acre ...	77·3	99·5	+22·2
Tops tons per acre ...	9·25	14·48	+5·23
Plants thousands per acre	35·6	34·4	—1·2
Noxious N	43	42	—1

There was a first rate crop without irrigation, a result largely due to the very high plant population. In this dry summer the effect of watering was very striking indeed, it increased the yield of clean roots by 9·66 tons to give the astonishing figure of nearly 30 tons per acre. It increased the average root weight from 1·26 lb. to 1·94 lb. The sugar content of the roots was depressed by watering to the extent of 2·5 per cent. There was a gain of 22·2 cwt. sugar per acre. Tops on the dry plots were fairly heavy for such a droughty year, but they were increased by a further 5·2 tons by irrigation. Plant number and noxious nitrogen were practically unaffected.

In 1948 a much larger experiment was put down on the same farm, in this case on a field that had recently been taken over and never before irrigated. It had not received the long course of heavy manuring practised on the older land. A special pumping plant was installed completely under the control of the experimenter, the water being supplied from a nearby lake. Arrangements were made for the introduction of dilute potassium nitrate solution into the water system as required. A full time supervisor, Mr. A. B. Venables, was seconded from the British Sugar Corporation to take charge of the experiment. A meteorological station was set up on the plots and a small laboratory for nitrate determinations.

The design of the experiment was a six by six Latin Square with plots of $\frac{1}{16}$ acre to carry the irrigation treatments. Within each main plot 4 sub-plots tested supplementary fertilizer treatments with nitrogen and potash. The basal treatment was 30 tons of dung per acre applied in January 1948, and 7 cwt. I.C.I. compound fertilizer No. 1 containing 12% N; 12% P_2O_5; and 15% K_2O with 3 cwt. agricultural salt per acre in addition.

The treatments were:—

Main plots:—

1 and 2 No water
3 Full irrigation at Mr. Secrett's discretion
4 As 3 with dissolved potassium nitrate
5 Restricted irrigation based on climatic data
6 As 5 with dissolved potassium nitrate

Sub-plots:—

a. No additional fertilizers
b. 2 cwt. of nitrate of soda per acre
c. 1 cwt. of muriate of potash (60%) per acre
d. Nitrate of soda + muriate of potash

The crop was sown very early (March 23rd) and singled (April 27th) and almost immediately suffered from a bad attack of fleabeetle which was energetically combated by dusting, but none

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the less some plants were lost. The result was that the plant population was 29·2 thousand instead of the 35,000 attained in the previous year. Subsequently the crop grew exceedingly well without any checks apart from a severe infestation with virus yellows. The crop was lifted on October 18th while still in full growth.

The season was in great contrast to the previous year as the following figures show:—

	Rainfall inches 1948	1947	Excess in 1948
May	2·06	1·67	0·39
June	2·60	2·14	0·46
July	0·96	1·06	—0·10
August	4·02	0·52	3·50
Total	9·64	5·39	4·25

The summer of 1948 was dull and distinctly wetter than 1947, particularly in August. There was a dry period in early May at the time of the beetle attack and a second dry period in July.

Full irrigation with and without salts was given on 6 occasions, starting on 12th May and finishing on 30th July to provide a total of 4·7″ water. Restricted irrigation with and without salts was applied on three occasions May 22nd, July 18th, and August 4th to a total of 2·6″. The salts included in the irrigation water were estimated at 83 lb. per acre for the full and 59 lb. for the restricted irrigation. These salts at most supplied 11 per cent of the nitrogen and 33 per cent of the potash given in the basal dressing. The effects of irrigation were seldom apparent in the cool, dull summer of 1948, only on one occasion during a hot spell in July it was noted that the dry plots were wilting while the irrigated plots were not. The results were as follows:—

Sugar Beet, Milford, 1948

Effect of irrigation ; dissolved salts, fertilizer N and K

(Each set of comparisons averaged over all other factors)

	Water, inches 0	2·6	4·7		Increase for dissolved KNO_3		Increase for 2 cwt. Nitrate of Soda	1 cwt. Muriate of Potash	
Clean roots tons/acre ..	22·0	22·6	21·9	±0·19	−0·2	±0·26	−0·4	0·2	±0·18
Sugar percentage ..	14·9	14·7	14·7	±0·37	−0·1	±0·52	−0·3	0·2	±0·09
Sugar, cwt./acre ..	65·5	66·7	64·1	±0·76	−0·8	±1·07	−2·5	1·3	±0·68
Tops, tons/acre ..	30·6	31·6	32·8	±0·35	−0·2	±0·50	1·4	0·2	±0·23
Plant No., thous./acre ..	29·0	29·5	29·2	±0·29	−0·6	±0·41	−0·2	0·2	±0·22

There were 22 tons of clean roots per acre with the rather low sugar content of 14·8 per cent, giving a mean sugar production per acre of 65·4 cwt. The plant number at 29 thousands was high, but considerably lower than the perfect plant secured in the year before. The tops at 31 tons were the heaviest ever recorded in any Rothamsted experiment. The precision was satisfactory.

Watering did practically nothing so far as yield of sugar per acre was concerned under the conditions prevailing in 1948. It tended to reduce the sugar content of the roots and increased the top yield significantly. Plant number was unaffected. The effect of added

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salts was small and non-significant. Fertilizer nitrate of soda reduced the yield of roots and the percentage of sugar significantly. As usual nitrogen increased the top yield. Muriate of potash gave a slight increase in sugar per acre. There were no significant interactions between any of the treatments.

So far as they have gone these preliminary trials have encountered extreme conditions under which water either gave an enormous increase or practically no increase at all. They have been valuable in enabling a start to be made on working out the technique of such trials. Two further experiments are being laid down for 1949.