ROTHAMSTED RESEARCH

Rothamsted Experimental Station Report for 1965

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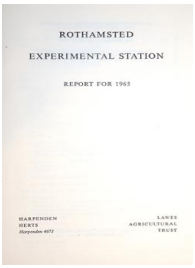

The Farms

J. R. Moffatt

J. R. Moffatt (1966) *The Farms ;* Rothamsted Experimental Station Report For 1965, pp 239 - 258 **- DOI: https://doi.org/10.23637/ERADOC-1-60**

THE FARMS

J. R. MOFFATT

ROTHAMSTED

The early winter of 1964/65 was dry and mild, and land work was well forward at the end of 1964. There was a little snow in December, January and February but no hard weather until early March. February was the eighth consecutive month with less rain than average, and in this period the deficit was 10·3 in. Seedbed preparations started in mid-February, but what promised to be an early season was made late by snow and rain in March. All sowings were finished in good weather in April and early May.

The four months June–September were dull, cool and wet, with total sunshine hours 181 below average; most of the hay was spoilt and cereals were slow to ripen and lodged badly. Harvest was delayed and protracted, and became almost a salvage operation.

Potatoes and beans grew well. Potatoes were burnt off early to lessen the risk of tuber blight in King Edward and to prevent oversized Majestic. Winter beans lodged badly and yields were much lessened by Chocolate Spot disease.

Potato experiments were harvested in the dry October and early November, but lifting was stopped by unusually severe frosts in early November, followed by rain, and several acres are still in the ground. Wheat drilling was delayed by the late corn and potato harvest, and then by frosts and rain in November, so at the end of the year some remains to be drilled and there is much ploughing still to be done.

Scout Farm, Redbourn, which adjoins Rothamsted Farm, was bought late in the year and some of its 224 acres ploughed and treated with herbicides.

The Effect of Weather on Crops

In the fine autumn of 1964 winter wheat and bean seedbeds had to be forced by disc harrows, and most of the drilling was done by the end of October. At the end of 1964 field work was well forward.

The weather in January and February was mainly dry and there were few spells of hard frost. Cold winds about the middle of the month dried the land, and within 2 days of seedbed preparations starting on 15 February most of the spring beans were sown. Rain and snow then stopped land work.

Early March was the coldest part of the winter; snow fell on 3 and 4 March and lay for a week. There were night frosts on each of the first 13 days, the coldest (5° F) on 3 March. The ground dried out slowly and sowing of spring crops, which started on 15 March, was soon stopped by rain. Although heavy rain delayed arable work until 29 March, most of the grassland was chain harrowed and fertilised.

https://doi.org/10.23637/ERADOC-1-60

The last 4 days of March were summery and very hot; the ground dried out rapidly, and spring corn drilling finished on 3 April. The sowing of sugar beet, grasses and clovers followed; potato planting started on 2 April, but a break in the weather delayed the finish until 11 May. In May cold, damp and windy spells delayed cereal spraying. In a warm spell in the third week the early planted potatoes emerged early and were sprayed with herbicide. Grass cutting for silage started on 20 May in ideal weather.

June was mainly dull, cool and wet; rain fell on 16 days and sunshine hours were 40 below average. This weather played havoc with haymaking and delayed other field work. Most of the hay cut was lying for two weeks before it could be baled. Winter beans grew tall and were attacked by Chocolate Spot (*Botrytis cinerea*), and small areas of wheat and barley were lodged. Potatoes and sugar beet grew rapidly.

July was cold, dull and wet. Rain fell on 19 days and totalled 4·16 in. (1·63 in. above average); the mean air temperature was 4·2° F below average, and there was less than half the average hours of sunshine. Field work was much interrupted. The grass for hay was badly battered by the heavy storms and strong wind, and cutting was difficult. Even when cut it did not dry, and some became so badly leached that it was burnt. Most of the barley and winter beans were lodged, and some winter wheat. Potato blight appeared despite several precautionary sprayings.

August was dull, cool and showery, and although there was a warm spell in the middle of the month, this was followed by unsettled weather. Cereals were slow to ripen; most of the lodged barley made second growth, and most of the winter wheats were flat or leaning badly. Harvest started on 26 August.

September was dull, cool and wet, with only a brief spell of good harvest weather. There were 4·02 in. of rain spread over 19 days, and hours of sunshine were 24 fewer than average. Harvesting conditions became so desperate that little notice was taken of moisture content of grain, crops were cut whenever the laid straw was dry enough to go through the combine. Though some grain was moved from the drying bins when only partly dry, the drying plant was over-burdened and 40 tons were dried by a neighbour. Damage by birds was more serious than usual, probably because the grain remained so long in the field. The straw was dull and brittle, and broke in the combine and baler.

Grass weeds in the corn crops were encouraged by the wet summer and grew through the lodged crops. About 56 acres of stubble at Rothamsted were sprayed with aminotriazole to control couch grass (*Agropyron repens*), or dalapon to control *Agrostis* spp. About 3 acres after potatoes was sprayed with TCA. The stubbles in Scout Farm were particularly foul and 62 acres were sprayed.

October brought welcome relief from the bad weather. There was little rain and more than average sunshine. Cereal harvest finished on 5 October and of beans by 12 October, though straw carting lasted until 23 October. Potato lifting started early in the month, and the experiments took 2 weeks, which delayed corn drilling until the end of the month. The fine spell broke in early November and potato lifting was interrupted and then brought to a stop by rain followed by severe frosts (13° F) about the middle

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of the month; about 8 acres remain in the ground. Wheat drilling was also stopped. In December there were 4·73 in. of rain in 23 days, 2·13 in. above average, and ground frosts were 22. This prevented any drilling, and at the end of the year several fields, including Broadbalk, remain to be drilled. Some ploughing was done, but conditions were bad, and a lot remains to be done.

Field Experiments

There were 3,222 full-scale field plots, rather fewer than in 1964, and several hundred microplots. All sowings were done in good time, but the late and protracted harvest delayed the lifting of the potato plots, which in turn delayed the sowing of the 1965/66 winter cereal experiments.

The winter wheat and bean experiments were sown in October. Most spring cereal experiments were drilled in mid-March in excellent conditions. All grew well in early summer, but lodging started in June, and got steadily worse, so that nearly all crops were lodged well before harvest; there was a lot of second growth in the barley. In many experiments the plots given most N lodged most and gave less yield. The spring wheat was not lodged. A few areas of cereals were severely damaged by birds.

Broadbalk was drilled on 26 October 1964 and the seed germinated rapidly. There were more wild oats than usual and pulling on four occasions took 80 hours. There were more broad-leaved weeds than in 1964; on Section Va, unsprayed, there were many and on several plots the laid corn was smothered by vetches. Horsetails were numerous on several plots, but were fewer where they were hand-pulled in 1964. Lodging was widespread and severe, and some grain sprouted in the ear. Harvesting was slow, but the combine picked up the crop well in a short spell of fine weather. Black grass (*Alopecurus myosuroides*) seemed more numerous than usual, possibly because it grew through the lodged crop. Couch grass (*Agropyron repens*) was plentiful on several plots of Section Ia and strip 20, so these areas were sprayed with aminotriazole in early October. This delayed ploughing, and frost and rain prevented drilling until January 1966.

On Hoosfield Wheat and Fallow, Cappelle and Squarehead's Master 13/4 were grown side by side, and though Cappelle looked thinner, it yielded slightly more than the Squarehead's Master 13/4. There was much Black Medick (*Medicago lupulina*), and a hormone herbicide will be used in future.

Hoosfield barley plots were again split to compare Plumage Archer with the mildew-resistant Maris Badger, which was given twice the N given to the Plumage Archer. Drilling was delayed until 1 April to get an early germination of wild oats, but there were rather more than usual, and it took 13 hours to pull them on three occasions. Lodging was patchy, and there was less with Maris Badger than Plumage Archer, despite its double dose of N. On the dung plot the Plumage Archer was completely lodged, but yielded 36·7 cwt/acre, and Maris Badger yielded 44·9 cwt/acre. Twelve plots of Maris Badger yielded over 30 cwt/acre, a yield reached on only three plots of Plumage Archer.

The Exhaustion Land was sown with Maris Badger with uniform N

https://doi.org/10.23637/ERADOC-1-60

combine-drilled. The crop grew well, but was rather uneven in wide swathes. Wild oats were pulled in 8½ hours on two occasions. Most plots had couch grass (*Agrostis* spp.), and all were sprayed with dalapon in October 1965. Several plots had much mayweed (*Tripleurosperum maritinum*).

A new liming scheme was introduced (*Rothamsted Report* for 1964, pp. 226–228) on the Park Grass Plots, and the first dressings of carbonate were given in January 1965. Bad weather delayed the grass cutting until the end of June and early July. The field recovered well, but the second cut was delayed by bad weather until early December, and even then the ground was very soft. Yields were taken from all plots. The plentiful moles in winter were destroyed.

Barnfield was fallowed in 1965, but dung and mineral fertilisers were given. Some potatoes left from the 1964 crop grew vigorously and survived many cultivations.

In the Ley–Arable experiment one of the third-year lucerne plots on Fosters and one on High Field were ploughed as there were patches of stem eelworm (*Ditylenchus dipsaci*). The oats on both fields gave very big yields (High Field 51·0 cwt/acre, Fosters 54·3 cwt/acre). The wheat lodged only with the most N, which on some plots lessened the yield.

An annual experiment with winter beans on Long Hoos V looked promising in June, but Chocolate Spot spread rapidly; it was also attacked by aphids when too tall to spray completely, but the outside strip was sprayed with menazon. This not only controlled the aphids, but the crop on this strip was less affected by Chocolate Spot and was less lodged. The experiment was abandoned as the plants grew over 6 ft tall and the unsprayed area was beaten flat by rain and wind.

All potato experiments, except those requiring special lots of seed, were planted with chitted Rothamsted-grown seed produced from selected Northern Irish stock.

Two winter wheat varieties (Cappelle and Rothwell Perdix) and two spring varieties (Kloka and Opal) were compared on a site relatively free from soil-borne diseases and the winter varieties were compared on an infested site where bird damage was severe; there was little difference in yield between the winter varieties, but Kloka outyielded Opal and equalled the yield of winter wheat. The yields of winter wheat differed greatly between the sites. On the uninfested site the Cappelle lodged at all levels of N some time before the Perdix, but the Perdix was more lodged by harvest. Neither of the spring varieties lodged.

Methods of sowing winter wheat and different seed rates were again compared. The broadcast seed at both Rothamsted and Woburn yielded more than the seed drilled at 4 in. or 7 in. spacing, and at both farms seeding with 130 lb yielded better than larger seed rates. A similar experiment with barley showed no difference in yield between the wide and narrow rows or advantage from combine-drilling. However, the yield from broadcast seed was less than from drilled seed.

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Cropping

Of the 451 acres farmed, 281 were under arable crops or fallow, 108 under short-term leys or lucerne–grass mixtures and 62 under permanent grass. The main crops were wheat (86 acres), barley (93 acres), beans (28 acres), potatoes (39 acres), and kale, swedes, sugar beet and oats (5 acres). Thirty acres, including headlands of experiments, were fallowed. The irrigation plant was not used on non-experimental crops.

The basic three-course rotation of wheat, barley and either roots or beans was varied to suit the requirements of experiments. Potatoes were the main root crop, as kale and sugar beet is grown only on experimental plots, and the acreage was more than could be handled. The balance of the root break was sown with beans or fallowed. Several fields are kept acid or deficient in phosphorus or potash to provide sites for fertiliser experiments, and these are usually kept under long-term leys or fallow.

The extra 224 acres provided by Scout Farm will permit a longer crop rotation than previously possible and, by giving a 2-year break from cereals, will provide land free from soil-borne diseases for cereal experiments. The 7-year rotation chosen consists of two cereals, a "break" crop, two cereals and two "break" crops, which provides land with different amounts of disease. Beans, potatoes and short-term leys will be used as "break" crops, with fallows where necessary to control twitch. The flexibility in the "break" crops enables a limit to be put on the area given to any one crop. The new rotation will start in 1966, and should be in full operation in 1967 or 1968.

Crops

Wheat. Because of the big yield given by Rothwell Perdix in 1964, this variety replaced Cappelle where little eyespot was expected. Seedbeds were difficult to prepare in the dry autumn of 1964, but sowing was done in late October. Germination was slow and uneven, and the crop looked yellow in March, but recovered and grew well in early summer. It was slow to ripen and early lodging lessened yields. The biggest winter wheat yield was over 50 cwt/acre, but yields varied according to the time and degree of lodging; the average was about 35 cwt/acre.

Opal was the main spring wheat and very little lodged; some Kloka was grown for seed in 1966, but though the germination was poor it will be used. Kloka will be the only spring variety in 1966.

Eyespot was worse than usual, and both Cappelle and spring wheats were attacked. Take-all varied from field to field, and was severe on some areas.

Barley. Maris Badger is the standard variety, but Procter is still grown on some of the long-term experiments. Cambrinus and Maris Badger were both grown on non-experimental fields, and some Impala, which lodged less than the Maris Badger or Cambrinus, was grown for seed in 1966. This and Zephyr are likely to be the main varieties grown in 1966.

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Most of the barley was sown in late March or early April, and germination and early growth were good. The much rain in June caused some lodging long before ear emergence, but most of these areas recovered. All the barley was lodged later, some quite flat, and there was much second growth and sprouting in the ear. Despite this, yields averaged about 35 cwt/acre; the grain was of poor quality.

Oats. The small area of Condor, spring grown, yielded exceptionally well.

Beans. The 8 acres of winter beans survived the winter well and grew rapidly in early summer, but were attacked early by Chocolate Spot and later by aphids. The stems grew very tall and many were lodged; yields varied greatly according to the intensity of disease and degree of lodging, but were mostly small.

Spring beans grew well in early summer, but because of a bad aphid attack the whole area was sprayed once with menazon and the headlands twice. Chocolate spot was also widespread. The crop grew tall and ripened rather unevenly, but was harvested in good conditions in early October. Yields averaged about 26 cwt/acre.

Sugar beet, kale, swedes. These crops were grown only in experiments. Sugar beet and kale gave satisfactory crops, and the yield of swedes was considerably more than on a similar experiment in the dry year 1964. Weeds were controlled by few mechanical and hand operations.

Potatoes. The 39 acres grown were more than usual because of the many experiments and the need to crop fields uniformly. In addition to King Edward and Majestic grown for ware, some Pentland Dell and Maris Piper were grown to give seed for 1966. Planting tilths were reasonably good, but wet weather delayed the finish of planting until 11 May. The seed was chitted and the sprouts of all except the late-planted ones emerged during a warm spell towards the end of May, so spraying with a mixture of linuron and paraquat had to be done hurriedly. This controlled all weeds except Cleavers (*Galium aparine*), the seeds of which were deep, and so the roots escaped contact with the herbicide. About 14 acres were sprayed with linuron + paraquat, and about 7 acres with a diquat–paraquat mixture which had to be followed by cultivations and earthing up.

In the wet summer the haulm grew rapidly, and earthing up was finished before the end of June. As conditions favoured the spread of blight, the first spraying was done at the end of June, earlier than usual. Two later sprayings were delayed by rain, and there was some blight on the haulm by the end of July. The disease spread rapidly on King Edward in August, and haulm burning was started about the middle of the month, much earlier than usual. The Majestic haulm was burnt off to prevent the tubers growing too big and cracking.

Yields were big, Majestic about 20 tons/acre and King Edwards 18 tons/acre total yield, but many tubers of King Edward were blighted; there was very little scab on either variety.

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New certified stock of King Edward, Majestic and Pentland Dell were grown in isolation to produce seed for 1966, and were given an H certificate. A few Maris Piper, an eelworm-resistant variety, were grown to provide seed to plant infested areas at Woburn. A granular insecticide was applied at time of planting to all crops grown for seed. All varieties grew well; the haulm was burnt off on 10 August, and two of the varieties were lifted later in the month. Some of the King Edward and all the Majestic are still unlifted and will not be used for seed.

Grassland. A high-nitrogen compound fertiliser was given to most of the leys in mid-February, and to the older grass a month later. There was little growth until April, since when there has been ample grass for the stock, with no irrigation and with mid-season N to a few fields only.

Grass grew rapidly in May; silage cutting started on 20 May and finished on 4 June. Weather was favourable and the silage was of good quality.

Most of the grass for hay was badly laid, and without any fine spells good-quality hay could not be made. Most of it was badly leached.

Livestock

Cattle. The eight cattle not fattened on grass in 1964 were brought into covered yards in November 1964. Fifty-two younger cattle were bought in autumn and were yarded in December 1964, and seventeen bought in January 1965 were put straight into yards. They were fed on silage, brock potatoes, hay and the most forward were given home-grown concentrates. These were fed to gain about 2 lb/day. The smaller beasts gained between $1\frac{1}{4}$ and $1\frac{3}{4}$ lb/day. These were turned out at the end of April and the forward cattle two weeks later. Grass was plentiful and live-weight gains averaged over 2 lb/day in June. In August and September gains dropped to about $1\frac{1}{2}$ lb/day. More young cattle were bought in spring, and fat cattle were sold throughout the summer. Altogether 80 cattle were sold fat during the year.

Eighty-three young Hereford beasts about 15 months old were bought in autumn and most were yarded in early winter and fed to give a live-weight gain of 1 lb/day. Because of the wet winter, the remaining 23 bought in spring were yarded in November 1965 for fattening.

All cattle likely to be on the farm next spring were treated with an organophosphorus insecticide against warble fly in November.

Sheep. In October 1964, 172 ewes, mainly Scotch Half-breds were mated to Suffolk rams after flushing on grass brought on by irrigation. Hay was fed from early in December and concentrates from the end of January. The lambing percentage of 148 was satisfactory, considering there was no stockman at the time; 14 ewes died during the year. The lambs, creep fed, fattened readily, and the first were sold when 9 weeks old at 40 lb dead weight; all were sold by the end of November.

The flock was culled to 125, and in September 105 Scotch Half-bred gimmers were added to it. After flushing on fresh grass they were mated to Suffolk rams to lamb in early March 1966, a little earlier than usual.

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Because of hard frosts, hay was fed from mid-November, and towards the end of the year silage was fed and was eaten with relish.

The ewes were injected before lambing with a combined vaccine that protects them and the lambs against many diseases. Ewes and lambs were sprayed once or twice against sheep maggot fly and were dosed against worms regularly.

Equipment

To deal with the output of the bigger combines and the more grain to come from the extra land at Scout Farm, a vertical-flow grain drier was ordered and air-sweep floors will be fitted to the Simplex drying bins to empty them pneumatically.

Cottages

Four new cottages for farm workers are being built and should be finished in spring 1966.

WOBURN

After the fine autumn of 1964 land work was well forward at the beginning of 1965. Spring seedbeds were good, and all sowings were done before the end of April. The four summer months were abnormally cold, dull and wet; most of the hay was spoilt and the corn lodged badly, but potatoes, sugar beet and grass grew well. Harvest was late and yields were lessened by the lodging. In the dry October all potatoes were lifted and some sugar beet. Most of the winter corn was sown early, but some drilling and a lot of ploughing remained to be done at the end of the year.

The Effect of Weather on Crops

The autumn and early winter of 1964 was dry and mild; the land after potatoes was cultivated deeply for winter wheat, and the seedbeds were almost too fine, but the wheat was drilled late in October. The heavy land was hard and the ploughing rough, and drilling was delayed until rain in November softened the clods.

The winter was mostly dull and dry, with a few short spells of snow and frost. January had average rain, but February only 0·55 in.; as the ground became dry some barley was sown about the middle of the month, but rain soon stopped drilling, and snow and hard frosts early in March delayed the resumption until 11 March. Seedbeds were good, and all cereals were drilled by the end of the month.

There were 3 days of hot, sunny weather at the end of March. April was cold with average rain, but there was little interference with land work, and all potatoes, sugar beet and small seeds were planted before the end of April. May was wet and windy, which delayed cereal spraying, but encouraged the growth of potatoes, sugar beet and grass.

June was dull, cool and wet with 2·12 in. of rain and less than average

https://doi.org/10.23637/ERADOC-1-60

sunshine. Haymaking was interrupted and the hay was badly leached and of little value. One field of winter wheat was badly lodged in the middle of the month and never recovered.

July gave 3·19 in. of rain in 17 days, but hours of sunshine were about half the average. Hay cut early in the month was still lying in the field at the end, and was burnt. Potatoes and sugar beet grew rapidly; potato blight appeared despite frequent sprayings.

August and September were cold, wet and dull; September had well over twice the average rainfall (4·67 in.), and it rained on 17 days. Corn ripening was delayed; harvest began on 18 August, and the tedious operation was not finished until 23 September. Most of the winter wheat and spring barley was lodged badly, and there was a lot of second growth in the barley; grass weeds flourished in the lodged wheat. The 6 months April–September all had less than average sunshine, giving a total deficit of 182 hours.

October gave little rain (0·61 in.) and above average sunshine. Potatoes were lifted in excellent conditions and yielded well; sugar beet lifting started.

The first week of November was dry; good progress was made with sugar-beet lifting, wheat drilling and ploughing, then three severe frosts (16° F on 14 November) and rain prevented work. Rain was less than average, but it fell on 23 days. Early December was mild and wet, and little land work was done. Rain was twice the average (4·05 in.) and there were 21 wet days; frost at the end of the month also prevented land work, so at the end of the year there was some sugar beet unharvested, a field of wheat to drill and much land unploughed.

Field Experiments

There were 1,343 full-scale field plots, fewer than in 1964, and several hundred microplots. The full programme was completed. Many of the cereal plots were badly lodged, but the combine-harvester dealt with them all satisfactorily. All potato plots and most sugar beet were lifted quickly and easily, but frosts in November damaged some sugar beet and delayed the lifting on the last experiment.

Grazing on the Ley–Arable experiment started earlier and finished later than usual; the second-year leys were grazed 10 times, the third-year 9 times and the first-year, where grazing started in June, 8 times. The barley was damaged by birds and was redrilled. The haulm of the Majestic potatoes began to die early in August, so it was burnt off, and the poor crop was lifted later in the month. The lucerne coming into its third year in 1965 was ploughed, and sainfoin sown at the same time as the first-year sainfoin. Both gave two cuts late in 1965. The second-year sainfoin became very weedy, so was killed with paraquat, the land was rotary cultivated and drilled again in August. The seed germinated well, but there was much chickweed.

In the Market-Garden experiment the leeks planted during the dry summer of 1964 failed. The early carrots grew fast, as did weeds, which were

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suppressed by a post-emergence spray with linuron. There were two liftings 12 days apart, and in this interval the yield of many plots doubled. The main-crop carrots germinated rapidly, grew well and yielded 24 tons/acre. The roots were well shaped, but could not be sold, so most were fed to cattle.

The undersown seeds in the experiments established themselves well, except on the plots in the Green Manuring experiment given the most nitrogen.

The S22 ryegrass sown on the Irrigation Experiment in March grew rapidly throughout the season and gave five cuts, the last in mid-October. Three good cuts were taken from the Dorset Marl clover.

A barley experiment, comparing broadcast seed with seed drilled at two spacings and seed rates, gave an average yield of 49 cwt/acre. Broadcasting and close spacing of rows yielded more than wide spacing, and the small seed rate (108 lb) did better than the large.

The barley in the long-term Cultivation–Weedkiller experiment on very light land has yielded poorly for several years. In 1965 three amounts of N were compared, but yields were twice those in the part with the smallest amount of N, which was about the same as given previously.

Cropping

Of the 172 acres farmed, 21 carried wheat, 45 barley, 16 potatoes and 7 sugar beet. There were small areas of rye, sainfoin, carrots and other market-garden crops. There were 39 acres of temporary grasses and clovers, and 15 acres of permanent grass.

Because of root-eelworm in the light land, the rotation is being extended to a six-course one consisting of two cereals, two "break" crops, a cereal and another "break" crop. The double "break" crops will be a 1-year ley or fallow in the first year, and potatoes in the second; the 1-year "break" will be sugar beet, 1-year ley or eelworm-resistant potatoes. Sugar-beet acreage will be small, because labour for singling is scarce. This rotation provides land for cereal experiments after either a 1- or 2-year break, which gives different intensities of soil-borne diseases. The heavy land will have a similar six-course rotation, except that spring beans replace sugar beet in the 1-year "break" and can replace potatoes as the second crop of the double "break".

Crops

Wheat. The Cappelle wheat sown in October and November 1964 germinated unevenly in the dry seedbed, but growth later was good, and the crop looked very promising in early June. It then lodged badly, and the many "ground-keeper" potato plants grew through; yields were small and quality was poor. Opal spring wheat grew well, lodged little and yielded 35 cwt/acre.

Barley. Maris Badger was the only variety grown. The seed was combine-drilled early with a compound fertiliser containing 75 units of nitrogen, and an extra 30 units were applied soon after drilling. The crop grew well,

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but lodged badly, and there was much second growth. The average yield was 33 cwt/acre, with grain of poor quality.

Potatoes. King Edward was the main variety grown, with Majestic in a few experiments. Seed, grown and chitted at Rothamsted, was planted in April, emerged quickly in a warm spell and some leaves were damaged by the linuron and paraquat herbicide used. Many cleavers (*Galium aparine*) germinated deep in the soil and were unaffected by the herbicide, and the worst areas were grubbed and ridged. As weather favoured the spread of blight, crops were sprayed four times, starting early in July. The haulm started to die in August and was burnt off, as the tubers were large. The crop was lifted in October in good conditions. King Edward yields averaged about 15 tons/acre total produce. The tubers were of good size and shape; there is some blight in the tubers, but less scab than usual.

Sugar beet. Drilling was spread to extend the period of singling, but all was sown in April. The non-experimental areas were thinned mechanically, the final singling and weeding being done by hand. The crops grew vigorously during the summer and, as aphids were few, weeds were not sprayed. Weeds between the rows were controlled mechanically and in the rows by hand. There was more mayweed than usual. The roots were large, and the yield averaged 16 tons/acre. The sugar content of the early loads was over 16%, but only 14% for the last few loads.

Grass. This was given a high-nitrogen compound fertiliser in February, and two small areas had a dressing of "Nitro-Chalk" in June. The grass grew rapidly and hay crops were heavy, but most were spoilt. There was too much grass throughout the summer for the cattle, and more were bought in October to graze it. Grass remained plentiful until almost the end of the year.

Livestock

Cattle. Eighteen of the most forward Hereford bullocks bought in autumn 1964 were yarded during the winter, and 14 were outwintered. The 18 were sold fat off the grass in early summer, and the others were transferred to Rothamsted for finishing. Another 33 were bought, and they were still outside at the end of the year. In both winters the cattle were fed on hay, sugar-beet tops and brock potatoes, with a small ration of home-grown concentrates.

Sheep. A few Rothamsted-bred ewe tegs were wintered at Woburn. They were used to graze the grass plots on the Ley–Arable experiment, and were returned to the Rothamsted breeding flock in early autumn. As further grazing was needed, draft ewes from Rothamsted were used.

Pigs. Analysis of the herd costings under the Pig Industry Development Association's feed-recording scheme again showed the labour costs to be large, and the attempt to cheapen these by keeping more of sows failed

https://doi.org/10.23637/ERADOC-1-60

because the housing was unsatisfactory. It was therefore decided to stop keeping pigs, and by the end of the year all the breeding stock and most of the young pigs had been sold.

The litter average rose from 8·9 to 9·4, and 155 more pork pigs were sold than in 1964, of which 84% were in grade "A" or the "Quality" grade.

https://doi.org/10.23637/ERADOC-1-60

WOBURN EXPERIMENTAL STATION

C. A. THOROLD

Total rain (28·03 in.) exceeded the average (24·78 in.), and on the light land at Woburn cereals and roots yielded well.

TABLE 1

Monthly mean temperatures (means of maximum and minimum), total rainfall and daily means of bright sunshine (departures from long-period means in brackets)

	Mean temperature (° C)	Rainfall (in.)	Bright sunshine (daily mean) (hours)
March	5·3 (−0·2)	2·10 (+0·52)	4·18 (+0·27)
April	7·9 (−0·3)	1·88 (−0·05)	3·99 (−0·92)
May	11·3 (+0·1)	2·00 (−0·20)	5·28 (−0·76)
June	13·9 (−0·5)	2·12 (+0·42)	6·00 (−0·61)
July	13·7 (−2·6)	3·19 (+0·75)	3·09 (−2.95)
August	14·7 (−1·3)	2·40 (+0·07)	5·39 (−0·47)
September	12·3 (−1·4)	4·67 (+2·64)	4·07 (−0·56)
October	10·3 (+0·6)	0·61 (−1·69)	3·58 (+0·19)

From April to September mean temperatures and hours of sunshine were less than average, and rain more than average; the September rain (4·67 in.) exceeded twice the average (2·03 in.).

Cereals on the heavier soils and some plots on the lighter ones were severely lodged in July, with much second growth later. Moisture contents of grain at harvest ranged from about 20 to 30%. In spite of adverse conditions, 736 cereal plots were harvested, over 100 more than in 1964.

Wet weather favoured potato growth and blight; four fungicidal sprays increased King Edward yields from 13·13 tons/acre to 17·67 tons/acre. In a fertiliser experiment with this variety, symptoms of *Verticillium* wilt were prevalent on plots without compound fertiliser (13 : 13 : 20) and became less with increasing amounts. *Verticillium dahliae* was isolated, and seems likely to have contributed to the large differences in yield (see p. 132).

Applying formalin and other sterilants to soil again greatly increased the yield of spring wheat, mainly by affecting take-all and cereal cyst-nematode (*Heterodera avenae*) as described on pp. 49, 127 and 149.

A sticky trap operated from May to October caught about the same number of aphids as in 1964, but aphids flew earlier. Although some *Aphis fabae* and *Myzus persicae* were caught in May, sugar-beet yellows was again negligible. The vector of carrot motley dwarf virus (*Cavariella aegopodii*) did not become numerous until June. Menazon granules applied with the seed increased yield of carrots (Clucas New Model) by about 1 ton/acre, as also did spraying with "Saphicol", which adequately controlled aphids (see p. 116).

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Intensive cereals experiment. One-third of the area of the old "continuous wheat and barley land" was allocated to a new experiment. Mustard, sown on 28 June as a protection from wheat-bulb fly, was ploughed in on 13 October. Winter wheat was drilled on some plots of the wheat area on 2 November, and spring barley will be sown on the barley area in 1966. Continuous wheat or barley on their appropriate sites will be compared with a five-course rotation in all phases: clover–ryegrass ley (1 year), potatoes (1 year), winter wheat or spring barley (3 years). The winter wheat plots have received basal PK fertiliser and will get different dressings of "Nitro-Chalk". This "intensive cereals" experiment makes use of the peculiar features of the site, particularly the history of almost continuous cereal cropping since 1876, without any organic manures for the last 40 years.

Irrigation experiment

Wheat. Opal spring wheat was given "Nitro-Chalk" at 0·4, 0·8, 1·2 or 1·6 cwt N/acre immediately after drilling on 29 March. It grew well on all plots at first, but mildew became prevalent later, especially on plots given most N. "Scorch" symptoms did not occur until July, when they were slightly more severe in the north block of eight plots than in the south block. This difference corresponds with a decline in fertility from south to north, known since the start of the irrigation experiments in 1951. The north block averaged 2½ cwt less grain/acre than the south block. Table 2 shows that the grain yield was largest with 0·8 cwt N/acre and the straw with 1·2 cwt N/acre, both in combination with extra water. This agrees with previous experience on this site that water is needed to ensure response of spring wheat to nitrogen. Take-all and cereal cyst-nematode attack were negligible. The mean yield (36·8 cwt grain/acre) considerably exceeded previous cereal yields on this site, where the "scorch" condition has sometimes occurred, particularly on unirrigated plots given most nitrogen.

TABLE 2

Effects of four rates of "Nitro-Chalk" on spring wheat yields with and without irrigation†*

	N, cwt/acre							
	0·4		0·8		1·2		1·6	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Without irrigation	32·8	26·5	38·1	32·6	36·8	29·7	35·8	31·4
With irrigation	34·8	32·3	42·0	35·1	38·7	36·3	35·2	31·9

* Yields: Grain and straw cwt/acre at 85% dry matter.
† Irrigation: 1·5 in. May–July.

Sugar beet. Seed was drilled on 2 April, and the experiment compared nitrogen at 0·75 cwt and 1·50 cwt N/acre applied to the seedbed and early and late singlings (17 May and 2 June). The first watering (0·5 in.) was to plots getting "full" (C) and "early" (A) irrigation. With more than 2 in. rain in June, more water was not needed until 1 July, when 0·5 in. was given to C and "late" irrigated (B) plots, and this was repeated on 9 July, which was the last watering. Plots singled early yielded on average 63 cwt sugar/acre, and those singled late 61 cwt.

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Some plants showed symptoms of magnesium deficiency and of virus yellows in August, when some also wilted. The unirrigated plots (O) yielded most (65 cwt sugar/acre), almost 6 cwt more than with "full" irrigation (C) and 3 cwt more than with A or B waterings. Roots and tops responded to extra nitrogen (Table 3), but sugar percentage was unaffected (17·6%).

TABLE 3

Effects of nitrogen on sugar-beet yields

	N, cwt/acre	
	0·75	1·50
Yield (tons/acre):		
Roots	17·15	18·03
Tops	16·09	20·89
Sugar	3·03	3·18

Clover. The Dorset Marl clover undersown in barley on 27 April 1964 developed unevenly and grew better under the barley with 0·3 cwt N/acre than with 0·6 cwt. The extra nitrogen gave 7·6 cwt more grain/acre; the straw was not weighed, but was obviously increased by the extra N. The depression of clover growth by the extra N persisted until the first of the three cuts in 1965, but later yields on these plots were larger (Table 4).

TABLE 4

Yields of clover (cwt dry matter/acre) at three cutting dates in 1965

	N, cwt/acre applied to barley in 1964	
	0·3	0·6
First cut (11 June)	34·1	31·8
Second cut (5 August)	15·7	16·1
Third cut (19 October)	17·1	17·8
Total (3 cuts)	66·9	65·7

Irrigation of the clover started on 17 May 1965, with 0·5 in. given to plots receiving "full" (C) and "early" (A) treatments. "Late" (B) and (C) plots were watered again (0·5 in.) on 30 June, 7 July, 18 August. Irrigation depressed yields, and unwatered plots yielded an average of 68 cwt dry matter/acre, 2 cwt more than the average of the three irrigation treatments (A, B, C).

Ryegrass. The Italian ryegrass sown in March gave 19·7 cwt dry matter/acre at the first cut on 11 June. The total yield from five cuts was 93·2 cwt dry matter/acre. There was no response to irrigation (May 0·5 in., July 1·0 in.).

These plots, which have carried leys since 1951, were ploughed and, in combination with others which have carried rotations of arable crops, will be used for a new experiment to test the effect of irrigation on potato cyst-nematode populations.

Green-manuring experiment. The interactions of green manures with fertiliser nitrogen, discussed by Dyke (*Br. Sug. Beet Rev.* (1965) **34**, 94–98), were studied further in a short-term experiment on slightly heavier land in 1965, where sugar beet followed barley, with and without undersown trefoil or ryegrass (Table 5).

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With larger potential yields than previously, the maximum response to nitrogen was reached with 0·6 cwt N, but trefoil increased yield not only with this amount of "Nitro-Chalk" but also with more N. Ryegrass did

TABLE 5

Effects of green manures and different rates of "Nitro-Chalk" on sugar beet

"Nitro-Chalk" applied (N, cwt/acre)	Yield without green manure (sugar, cwt/acre)	Increase from: Trefoil (cwt)	Ryegrass (cwt)
None	58·6	+3·6	−5·3
0·6	72·7	+1·0	+2·9
1·2	71·4	+5·4	+7·3
1·8	73·2	+8·8	+1·5

not increase yield without fertiliser nitrogen, and did so most with 1·2 cwt N.

In the 1955–62 period of the long-term experiment on green manuring, when "Nitro-Chalk" was applied to the barley seedbed at 0·23 and 0·46 cwt N/acre, the barley responded less to nitrogen after trefoil than after ryegrass. This difference was perhaps associated with the larger mean nitrogen content of the legume (*Rothamsted Report* for 1962, p. 196). In the new scheme of cropping and treatments started in 1963, N fertiliser is given at 0, 0·3, 0·6 and 0·9 cwt N/acre in barley seedbed. Table 6 shows that yields of barley were increased by each increase in nitrogen, but it is probable that the maximum response was nearly reached at 0·9 cwt, especially as on other plots where green manures have not been given since 1936, 0·9 cwt N/acre gave the same yield as did 1·2 cwt. Table 6 also

TABLE 6

Effects of green manures and different rates of "Nitro-Chalk" on barley

"Nitro-Chalk" applied (N, cwt/acre)	Yield without green manure (grain, cwt/acre)	Increase from: Trefoil (cwt)	Ryegrass (cwt)
None	13·2	+18·8	−3·0
0·3	24·8	+10·0	−3·7
0·6	34·8	+ 3·6	−1·5
0·9	37·4	+ 1·4	+0·6

shows that the responses to trefoil were positive and large with small dressings of N, but diminished as the amount of N applied increased. By contrast, ryegrass depressed yields except with the largest amount of N. During this experiment samples of green manures have been taken to provide estimates of amounts of dry matter and nitrogen ploughed in. These estimates have rarely helped to explain effects on crop yields, which have depended greatly on when the green manures were ploughed in; and on the amount of nitrogen given to the barley. From 1955 to 1962 autumn and spring ploughings were compared, but since 1962 the green manures have been ploughed in in the spring. Short-term green-manuring experiments have shown the importance of suitable growing conditions for both "test" crop and green manures for these to be effective (*Rothamsted Report* for 1964, p. 217).

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TABLE 7

Effects of "Nitro-Chalk" applied to barley seedbed in 1964 on amounts of dry matter and nitrogen (cwt/acre) in green manures

"Nitro-Chalk" applied (N, cwt/acre)	Trefoil		Ryegrass	
	Dry matter (cwt)	N (cwt)	Dry matter (cwt)	N (cwt)
None	15·3	0·43	6·2	0·08
0·3	11·6	0·30	5·4	0·07
0·6	8·0	0·17	4·9	0·07
0·9	5·5	0·13	3·4	0·05

Table 7 shows that amounts of green manures, especially of trefoil, ploughed in, varied inversely with amount of nitrogen applied to the barley. The plots were scored for lodging of the barley (L) and awarded marks from 0 (crop standing) to 3 (crop completely lodged). Immediately after the barley was harvested the undersown plots were scored for amount of ground covered (C) and awarded marks from 0 (crop failed) to 5 (full cover). Table 8 suggests that there was more lodging on plots undersown with trefoil in 1964 and 1965 than on plots not undersown or undersown with ryegrass; ground covered by trefoil was lessened by N.

TABLE 8

Effects of "Nitro-Chalk" applied to barley on lodging (L: 0–3) with and without green manures, and on ground covered (C: 0–5) by trefoil and ryegrass

"Nitro-Chalk" applied (N, cwt/acre)	Trefoil*		Ryegrass†		Not undersown‡
	L	C	L	C	L
None	0·3	3·6	0·0	4·5	—
0·3	0·5	3·1	0·0	4·8	0·0
0·6	1·8	2·1	0·2	4·8	0·0
0·9	2·7	0·9	2·0	4·2	1·9
1·2	—	—	—	—	2·3

* Trefoil: undersown in 1964 and 1965.
† Ryegrass: undersown in 1964 and 1965.
‡ Not undersown: no green manures since 1936.

Ley–arable rotations experiment

Sugar beet. Additions of Mg, K and P have accounted for most but not all of the large differences in yield of plots with and without FYM, and for part of the differences in yield between the different rotations. To discover whether the remaining effects of dung and rotation could be accounted for by nitrogen, a test of four rates of N was started in 1965 and will be continued for successive sugar-beet crops. Because the optimal dressings of N are expected to differ greatly from rotation to rotation, larger ones are given in some rotations than others. Table 9 gives the mean yields from 1963 to 1965 and shows that beet after lucerne (LU) did particularly well in 1965. In former years the "arable with hay" (AH) gave the smallest yields and it seems that this was partly from insufficient N.

https://doi.org/10.23637/ERADOC-1-60

TABLE 9

Effects of previous rotation on sugar-beet yields in 1963, 1964 and 1965

Previous rotation:	1963	1964	1965
	(sugar, cwt/acre)		
L	67·7	68·5	66·0
LU	69·9	60·9	77·4
AH	63·9	52·2	67·4
A	71·9	63·9	70·6
Mean	68·4	61·4	70·3

Table 10 shows the effects of nitrogen; as expected, the optimal nitrogen dressing was larger for plots following the arable rotations (AH, A) than for plots following the ley rotations (L, LU).

TABLE 10

Effects of previous rotation and nitrogen on sugar-beet yields

	Nitrogen applied (N, cwt/acre)					
	0·35	0·70	1·05	1·40	1·75	2·10
Previous rotation:	(sugar, cwt/acre)					
L	65·1	64·8	70·7	63·3	—	—
LU	74·3	79·9	76·2	79·1	—	—
AH	—	—	64·2	68·6	69·9	67·0
A	—	63·4	72·5	72·9	73·6	—

Barley. Maris Badger was drilled on 8 April with basal seedbed "Nitro-Chalk" dressing (0·6 cwt N/acre). In August many plots were lodged, but they differed in the proportions of crop affected, as shown in Table 11, which gives mean scores for lodging (L : 0–3) and barley yields.

TABLE 11

Effects of previous rotation on barley yields and proportion of crop lodged (L : 0–3)†*

Previous rotation:	Grain (cwt)	Straw (cwt)	L (0–3)
L	37·5	50·9	2·5
LU	43·7	35·1	1·8
AH	42·1	31·0	0·8
A	42·2	37·6	0·8

* Yields: grain and straw cwt/acre at 85% dry matter.
† Lodging: scored as for Table 8.

The dressing of 0·6 cwt N/acre was probably excessive for the plots following the ley rotation (L), which produced 16 cwt more straw/acre (with more lodging) than the mean (34·6 cwt) of those following the lucerne (LU) and arable rotations (AH, A).

Rye. This crop grew well, but all plots were lodged, many severely and gave much green second growth when combine-harvested on 14 September. There was more straw than grain, the reverse of 1964, a drier year.

Carrots. The crop was sprayed three times with "Saphicol", which prevented aphid infestation. As in 1964, the variety Autumn King did not

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respond to the FYM. The yields of roots and tops (30·9 and 13·2 tons/acre) exceeded any since carrots replaced sugar beet in 1956 as the third course of the arable rotation; the mean yields of roots and tops up to 1964 were 11·5 and 4·2 tons/acre.

Potatoes. Some plots of Majestic were again affected by potato cyst-nematodes; others less severely affected yielded 15·7 tons tubers/acre.

Sainfoin. This crop in its second year yielded 43·4 cwt dry matter/acre at the first cut on 31 May, but failed to recover after the second cut on 4 August and was reseeded on 19 August.

Seeds hay. The first cut on 31 May gave 59·7 cwt dry matter/acre and the second on 5 August 38·4 cwt, exceptionally large for this experiment. In some past years there was no second cut, and in others it was less than half the amount at the first cut.

Grazed leys. There was more grazing than usual on all plots, in contrast to 1964, when there was less. Table 12 shows these extremes and the mean of the previous 20 years, as numbers of sheep/days grazing/acre.

TABLE 12

Number of sheep/days grazing/acre for 1st-, 2nd- and 3rd-year leys in 1965, 1964 and 1944–63 period

	1st year	2nd year	3rd year
1965	2,168	3,541	2,915
1964	1,253	1,512	1,012
1944–63 (mean)	1,098	1,806	1,708

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BROOM'S BARN EXPERIMENTAL STATION

R. HULL

P. B. H. Tinker left and A. P. Draycott joined the staff. W. J. Byford, R. A. Dunning, R. Hull and R. K. Scott attended the winter congress of the International Institute of Sugar Beet Research in Brussels, and R. Hull attended the joint meeting of the Institute with the American Society of Sugar Beet Technologists in June in North America. W. J. Byford, R. A. Dunning, R. Hull and G. H. Winder contributed to the Insecticide and Fungicide Conference at Brighton. Mr. Gul Nawab of Pakistan, studying sugar beet in this country under the Colombo Plan, was with us for a few months.

The open day in July attracted about 300 people, and throughout the summer we had many parties of visitors. His Excellency the Minister of Agriculture of Afghanistan spent a day at the Station in July. The scientific meetings during the winter were well attended by visitors and have proved useful to us.

As usual, the agricultural staff of the British Sugar Corporation have helped us greatly with surveys and field experiments. A 2-day course of instruction at Broom's Barn on pests, diseases, fertilisers and field experimentation was attended by 30 fieldmen, and steckling inspectors and seed merchants met in July and October to discuss experimental work and arrange the steckling inspections. Work continued on pests, diseases and manuring of sugar beet, which is our special responsibility for the Sugar Beet Research and Education Committee, but this year emphasis has been on the study of factors affecting plant stands and their yield and the production of seed. Several long-term fertiliser and rotation experiments were started on the farm.

Yellows and Aphids on Sugar Beet

In eastern England mean temperature in February deviated from the average by −1·3° F and in March by −2·0° F. On average in past years, such weather has produced a mean incidence in the country's sugar-beet crop of 8% yellows at the end of August, ranging from 4 to 18% in individual years; in 1965 yellows incidence was 7·2%. Few green aphids infested sugar beet until the middle of June, when they increased rapidly and approached an average of 1 per plant in the middle of July, a pattern of infestation closely resembling that of 1964. The increasing infestation during favourable weather after the middle of June justified the sugar factories sending spray warnings to growers in some areas, and 171,000 acres of sugar beet were sprayed with systemic insecticide. This also helped to control black aphids, which were numerous on beet in the Midlands at the end of July.

https://doi.org/10.23637/ERADOC-1-60