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Report for 1976 - Part 1

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Field Experiments Section

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FIELD EXPERIMENTS SECTION

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Field Plots Committee

The field experiments at Rothamsted, Woburn and Saxmundham are controlled by the Field Plots Committee: F. G. W. Jones (Chairman), G. V. Dyke (Secretary), J. McEwen (Deputy Secretary), J. P. Dickinson, L. Fowden, I. J. Graham-Bryce, A. E. Johnston, E. Lester, T. Lewis, R. Moffitt, J. A. Nelder, C. P. Whittingham and T. Woodhead.

Table 1 shows the numbers of plots on the three farms; the grand total exceeded 10 000 for the first time since 1971. At Rothamsted and Woburn there were more plots of hay and green forage crops than in 1975; there were less plots of root-crops than in 1975 at Rothamsted but more at Woburn.

Field Experiments Section

As usual, the main work of members of the Section was service to the field experiments.

We helped sponsors to formulate proposals for experiments; sometimes we encouraged sponsors to join together in multi-disciplinary teams conducting joint experiments. We provided secretaries to the many meetings of the Field Plots Committee and its many subsidiaries. From the resulting decisions we drew up randomisations, sketches, schedules of quantities for the experiments. We made visual notes on the crops on the experiments and advised the Statistics Department on the analysis of the yields from experiments; in particular we scanned yields for trends across sites, some of which were allowed for by covariance. In short, we tried to improve the efficiency of the experiments in every way available to us. (Mainly Dyke, McEwen, Barnard and Stafford)

We arranged 332 separate programmes for visitors to the station. Twenty-three groups and about 100 individuals came from abroad. There were about 4000 visitors in the year, in addition to 600 who came to the station's Subject Days on Cereal Pests and Diseases (Pattison and others). We have made a small test of a program for storing information about visitors on the 4-70 computer so that summaries can be obtained at a computer terminal. (A similar system may be useful for storing information about experiments in progress.) (Pattison and Thomas, Computer Department)

Films were made of Pea Moth Monitoring and Weed Seed Surveying. (Pattison)

Small-plot experiments

The Small-plots staff did some or all of the agricultural operations on 60 experiments totalling 2409 plots. The exceptional season and the great demand for spraying of small

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TABLE 1
Number of plots in 1976

	Grain	Roots	Hay and green crops	Total
Full-scale plots (yields taken):				
<i>Classical experiments:</i>				
Rothamsted	445	35	237	717
Saxmundham	—	—	80	80
<i>Long-period rotation experiments:</i>				
Rothamsted	448	64	144	656
Woburn	346	100	216	662
<i>Crop-sequence experiments:</i>				
Rothamsted	500	150	250	900
Woburn	336	456	64	856
Saxmundham	136	—	—	136
<i>Annual experiments:</i>				
Rothamsted	1560	129	108	1797
Woburn	380	32	48	460
Saxmundham	96	—	—	96
<i>Totals:</i>				
Rothamsted	2953	378	739	4070
Woburn	1062	588	328	1978
Saxmundham	232	—	80	312
Total	4247	966	1147	6360
Full-scale plots (no yields taken):				
Rothamsted				589
Woburn				167
Microplots:				
Rothamsted				2145
Woburn				546
Saxmundham				212
All plots total				10019

plots caused some delays and a few of the less critical applications were omitted. To enable the departmental sponsors of experiments to do some spraying themselves we have designed a simple sprayer and, with help from the Instrument Workshop, one has been built. The operator pushes the machine at a pre-determined speed, checked by a forward-speed indicator, and the spray liquid is expelled by carbon dioxide from an exchangeable bottle. (Wilson, with Kerr, Turnell and Allingham)

The Classical Experiments

Table 2 shows the yields of crops on selected plots of Broadbalk and Hoos Barley in 1974, 1975 and 1976.

Wheat without manure or fertiliser on Broadbalk yielded about as much in 1976 as in 1974 but increases where complete fertiliser or farmyard manure were applied were much less in 1976; the best yield (with FYM) in 1976 was only two thirds of the 1974 yield. The wheat of 1976 grew in exceptional drought from sowing to harvest and ripened prematurely; it seems likely that dryness of the soil prevented the full utilisation of nutrients. In 1975 a dry summer followed a wet spring and the soil remained moist later in the season; best yields then were nearly equal to those of 1974.

A test of fertiliser N applied in autumn was made on small discard areas of wheat on certain plots to attempt to elucidate the difference in yields recorded in recent seasons between FYM and the best fertiliser treatments but results in this most exceptional season were inconclusive.

Barley, which naturally ripens earlier than wheat, apparently suffered less from the

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effects of drought in 1976 and yields on the Hoos Permanent Barley experiment were about equal to those of 1975, a little less than in 1974.

The Exhaustion Land (EX), on similar soil within 200 yards and sown with the same variety as Hoos Barley (HB) gave surprisingly different results on plots of roughly similar history (Table 3). The EX plots were subdivided for a test of 'Nitro-Chalk' at four rates

TABLE 2
Broadbalk (BK) and Hoos Barley (HB): yields of crops from selected treatments
Grain, t ha⁻¹ and total tubers, t ha⁻¹

Treatments		Wheat after potatoes, beans			Barley			Beans			Potatoes				
		1976	1975	1974	1976	1975	1974	1976	1975	1974	1976	1975	1974		
None	BK	2.3	3.1	2.4	—	—	—	0.4	1.1	3.2	11.6	5.0	12.6		
	HB*	—	—	—	2.6	2.8	4.3	0.5	0.9	2.9	12.3	4.8	14.7		
	HB†	—	—	—	0.9	1.1	1.6	—	—	—	—	—	—		
N3PKMg(Na)	BK	3.9	6.7	6.6	—	—	—	0.9	1.6	4.0	32.0	11.2	58.7		
	HB*	—	—	—	4.5	4.7	6.0	0.6‡	1.1‡	4.0‡	—	—	—		
	HB†	—	—	—	3.9	4.5	4.9	—	—	—	—	—	—		
N4PKMg(Na)	BK	3.8	6.5	6.4	—	—	—	1.0	2.2	4.0	29.2	15.5	57.3		
	HB*	—	—	—	—	—	—	—	—	—	40.3	12.4	44.2		
FYM	BK	4.6	6.7	7.4	—	—	—	1.2	1.5	4.0	37.5	13.2	57.7		
	HB†	—	—	—	4.6	2.8	5.8	—	—	—	—	—	—		
FYM+N2	BK	3.9	7.1	7.3	—	—	—	1.1	2.0	3.9	36.6	16.0	67.3		
	HB†	—	—	—	4.4	5.1	4.8	—	—	—	—	—	—		
										Date of planting			29/3	7/5	17/4
										Variety			Pent-land Crown	King Ed-ward	King Ed-ward

* with residues of castor meal, crops in rotation, barley, potatoes, beans

† after barley, no castor meal

‡ PKMg(Na)

Symbols: N2, N3, N4 = 'Nitro-Chalk' at 96, 144, 192 kg N ha⁻¹

P = Superphosphate annually, at 35 kg P ha⁻¹

K = Sulphate of potash annually, at 90 kg K ha⁻¹

Mg = Kieserite applied at 35 kg Mg ha⁻¹ every third year

(Na) = Sulphate of soda annually till 1973

FYM = Farmyard manure annually, at 35 t ha⁻¹

TABLE 3

Hoos Barley and the Exhaustion Land

Mean yields of Julia barley, t ha⁻¹ at 85% dry matter, from certain plots
N in 1976, kg ha⁻¹

Long-term treatment		0	48	96	144	Mean
None	HB	1.0	1.2	1.2	1.5	1.2
None	EX	0.2	0.1	0.2	0.3	0.2
(D)	HB	1.9	3.3	2.5	2.8	2.6
(D)	EX	2.2	2.2	2.2	1.9	2.1

HB = Hoos Barley (after barley)

EX = Exhaustion Land (after fallow)

None = no FYM, P, K, Na or Mg since 1851 (HB)
1855 (EX)

(D) = residues of FYM applied: HB 1852-71

EX 1856-1901 (2 plots)

1856-1881 (1 plot)

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in 1976; the whole area was fallowed in 1975 to control perennial grass weeds. Yields on plots without residues of PKNaMg or FYM were much smaller on EX than on HB. Inspection revealed that on these plots a good deal of small grain had been left on the ground, probably carried through the combine harvester because the exceptionally small amount of straw on these plots upset the working of the machine. On these impoverished plots of both experiments there was little or no response to applied N. On plots with residues of FYM applied about a century ago yields were much greater and about equal on the two experiments; N gave no increase on EX, but an increase of about 50% on HB. Whether these differences between the two sites can be attributed to the different cropping in 1975 or to the sowing of EX two days later than HB when seedbeds were drying out rapidly we do not know; this is an example of the difficulty of interpreting differences between sites.

Yields of spring beans (Table 2) were very poor in 1976; on well-manured plots they were about half of those of 1975, about a quarter of those of 1974. By chance, the best yields in Table 2 (4.0 t ha⁻¹ from well manured plots in 1974) were equal to the best yields of spring beans achieved elsewhere on our Farm in 1976, by the combination of irrigation and maximum control of pathogens—see p. 151.

Potatoes, by contrast, yielded in 1976 at least double the 1975 yields, though much less than in 1974. Early planting in 1976 (contrasted with an exceptionally late planting in 1975 due to the wet spring) may partly explain the difference, but the rain of September 1976 probably came early enough to increase yields substantially.

Garden clover. Nutrients (N, P, K and Mg) are now applied basally and the experiment was re-designed to examine the effects of pathogens. Two varieties of red clover were grown: S.123, susceptible to clover-rot (*Sclerotinia trifoliorum*), and Hungaropoly, resistant. Each variety was grown with and without aldicarb applied to the soil in spring.

New sowings established slowly in the extreme drought, despite occasional watering (total 87 mm). Total yield of dry matter (three cuts) from S.123 was 2.1 t ha⁻¹, increased to 3.7 t by aldicarb. Hungaropoly gave 3.0 t increased to 4.6 t by aldicarb. (McEwen)

Spring beans (*Vicia faba*) seasonal variation and maximum yields. Spring beans show greater seasonal variation in yield than most crops. Seasons differ in many respects — weather, incidence of pests and diseases, efficiency of nitrogen fixation, etc — and the treatments necessary to produce maximum yield will vary accordingly.

Much of our work on beans in previous years had been done by individuals or small teams working on individual problems. This type of work has often been very successful but is too limited in scope and often continued for too few seasons to reveal the multiple causes of seasonal variability of yields. This year a co-operative approach was adopted in the first of a series of annual experiments designed to study the causes of seasonal variations of yield on Rothamsted Clay-with-flints soil and thereby determine maximum attainable yields. Members of eight Departments co-operated — Entomology, Field Experiments, Insecticides and Fungicides (Chemical Liaison Unit), Nematology, Physics, Plant Pathology, Soil Microbiology and Statistics.

The experiment excluded three organisms known often to cause large yield loss — stem-eelworm (*Ditylenchus dipsaci*), seed-borne viruses and black aphids (*Aphis fabae*). If not controlled these could have severely damaged the crop on most of the plots. Seed known to be free from viruses and stem-eelworm was used, sown on a site free from stem-eelworm. It was intended to apply pirimicarb to the whole experiment to control black aphids but, exceptionally, they were so few that this was unnecessary.

The treatments chosen were all combinations of eight two-level factors:

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- (i) Full irrigation (260 mm in 1976) (limiting soil moisture deficit to 50 mm), none.
- (ii) N at 300 kg ha⁻¹ as 'Nitro-Chalk' divided dressing (half to seedbed, half in June at flowering), none.
- (iii) Aldicarb at 10 kg ha⁻¹ to the seedbed, none.
- (iv) Benomyl at 15 kg ha⁻¹ to the seedbed, none.
- (v) Dieldrin at 1.5 kg ha⁻¹ to the seedbed, none.
- (vi) Fenitrothion at 0.75 kg ha⁻¹ as foliar spray in April and May, none.
- (vii) Pirimicarb at 0.14 kg ha⁻¹ as foliar spray in May, none.
- (viii) Benomyl at 1 kg ha⁻¹ as foliar spray in June, none.

The design chosen was a half replicate of 2⁸ in eight blocks of two whole plots (for irrigation treatment) split into eight sub-plots. Because the season was so dry, chocolate spot (*Botrytis* spp.) failed to develop and the test of benomyl foliar spray was omitted — the design becoming a single replicate of 2⁷.

The season was exceptionally dry and hot; despite a normal sowing date (5 March), unirrigated crops matured about two months earlier than usual and were harvested on 21 July. Even full irrigation had little effect on hastened maturity and these plots were harvested on 11 August. Perhaps for this reason the only treatments having marked effects were irrigation, aldicarb and dieldrin.

The smallest yield of grain, 1.1 t ha⁻¹, came from the sub-plot given none of the above treatments. This yield was similar to those obtained from crops grown on our farm this year in accordance with normal farming practice. The best individual plot yield was 4.0 t ha⁻¹. Table 4 shows the effects of irrigation, aldicarb and dieldrin, meaned over other treatments which had little effect.

TABLE 4
Spring beans: effects of irrigation, aldicarb and dieldrin on yield

	Mean yields of grain, t ha ⁻¹			
	No irrigation		Full irrigation	
	None	Dieldrin	None	Dieldrin
None	1.3	1.5	2.8	2.8
Aldicarb	1.9	2.0	3.2	3.4

SED 0.11 (except for comparisons of none v. full irrigation)

The considerable pest control afforded by dieldrin + aldicarb caused a substantial and similar increase in grain yield in both unirrigated and irrigated crops. This represented a 54% increase in unirrigated crops and 21% in irrigated.

Total above-ground dry matter was determined on four occasions. The first sample, on 3 May, two months after sowing, showed a mean total dry matter of 0.1 t ha⁻¹ which increased to 1.1 t ha⁻¹ by 2 June with little effect of treatments in this period. At the third sampling on 5 July unirrigated plots without aldicarb had 3.5 t ha⁻¹, increased by aldicarb to 4.5 t ha⁻¹. Irrigated plots had 6.0 t ha⁻¹ without aldicarb, increased to 7.0 t ha⁻¹ with it. At the fourth sampling on 2 August, after unirrigated plots were harvested, total dry matter yields on the irrigated plots had fallen to 5.1 t ha⁻¹ without aldicarb but increased slightly to 7.1 t ha⁻¹ with it.

Results from co-sponsors sampling are reported briefly below. (McEwen)

Sitona. *Sitona lineatus* is a weevil that hibernates as an adult in the soil of uncropped fields, hedgerow bottoms, etc. Adults feed on the foliage of various legumes in the spring and then lay eggs which hatch into larvae feeding on the root nodules. Feeding adults can transmit some viruses (although *Apion* weevils are more effective) but otherwise adults

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are at present thought to have little effect on bean yields. Other experiments (see Bardner and Fletcher, Entomology Department Report p. 128) have shown substantial benefits from controlling larvae.

Aldicarb, a nematicide but also a general soil and systemic insecticide, had substantial effects on adult *Sitona* activity but dieldrin, a general soil insecticide, had very little — as measured by feeding notches on leaves and by adults collected from foliage (Table 5). Larval populations were assessed on 11 June at the height of the attack and on 25 June, when the attack was nearly over. Both aldicarb and dieldrin greatly diminished larval populations and increased the number of undamaged root nodules — aldicarb was rather more effective than dieldrin (Table 5).

TABLE 5
Spring beans: effects of irrigation, aldicarb and dieldrin on Sitona

	Notches per plant 23 April	Adult <i>Sitona</i> per 10 m row 3 June	Undamaged root nodules		Larvae per root	
			11 June	25 June	11 June	25 June
No irrigation						
Neither	24	17	38	26	15	5
Dieldrin	20	19	59	43	5	4
Aldicarb	1	2	60	58	2	3
Dieldrin and aldicarb	1	2	58	78	1	1
SED			7.3	9.0	2.0	1.3
Full irrigation						
Neither	24	20	20	26	14	3
Dieldrin	19	20	42	33	4	4
Aldicarb	1	3	43	57	2	4
Dieldrin and aldicarb	1	4	45	56	1	2
SED			7.3	9.0	2.0	1.3

It is impossible to be certain of the effects of *Sitona* larvae on yield as both aldicarb and dieldrin could have affected other pests; as these were few it is likely that control of *Sitona* was responsible for most of the yield increase in dieldrin-treated unirrigated plots and for part of the additional increase on plots treated with aldicarb. (Bardner and Fletcher, Entomology Department)

Viruses and vectors. All plots were free of broad bean stain and *Echtes Ackerbohnenmosaik* viruses but a few seedlings (c. 0.02%) were infected in the surrounding crop (from a different seed source). However, the main vector, *Apion vorax*, was rare (0.3 per 10 m row early in June) and the viruses did not spread into the experiment.

Acyrtosiphon pisum, the main vector of bean leaf roll virus, was common at the beginning of June (48 alatae per 10 m row in plots without aldicarb, fenitrothion or pirimicarb) and leaf roll symptoms started to develop while the crop was in flower. Spread was checked by aldicarb but apparently not by fenitrothion or pirimicarb. At the beginning of July, 25% of plants in irrigated plots without aldicarb but only 3% in irrigated plots with aldicarb showed typical leaf roll symptoms. Infected plants were difficult to identify in unirrigated plots because high temperatures and drought caused much wilting of the leaves, severe stunting and early senescence.

Two other aphid-borne viruses, bean yellow mosaic and pea enation mosaic, were detected in a few plants early in June but they seemed to spread little and at the beginning of July only 6% of plants in irrigated plots without aldicarb showed symptoms of either virus. (Cockbain and Bowen, Plant Pathology Department)

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Fungal diseases. No foliar diseases of any importance were found. Roots were examined for disease or discolouration on three occasions by lifting about 10 plants from each of the 128 plots and classifying tap-roots and laterals of individual plants separately on a 0 to 5 scale (0 = healthy, 5 = completely black). A mean disease rating of the whole sample of ten plants was calculated as a percentage (100% = all roots of all 10 plants completely black).

On 10 May most roots were healthy and a mean disease rating of only 6% was recorded. By 21 June extensive blackening was recorded as disease ratings of 32% on tap-roots and 64% on laterals. The disease rating of tap-roots was decreased by aldicarb from 42 to 22% and by benomyl applied to soil in the absence of aldicarb from 47 to 38%. Irrigation decreased the disease rating of lateral roots from 72 to 56% but had little effect on tap-root disease at this stage. By 13 July the disease ratings of tap-roots had increased to 56% and of laterals to 84% and were decreased by aldicarb, benomyl and irrigation. Table 6 shows interactions between these three treatments and a striking difference in disease rating between plots that had received no treatment and those that had received all three. However, grain yields were not affected by benomyl although they were doubled by irrigation and increased 23% by aldicarb.

TABLE 6

Spring beans: effects of aldicarb, benomyl and irrigation on percent disease rating of tap-roots (13 July)

	None		Aldicarb	
	None	Benomyl	None	Benomyl
No irrigation	83	74	66	45
Full irrigation	64	46	44	27

Discoloured lateral roots, when washed and incubated on water-agar, produced mostly cultures of *Pythium* from the field samples taken in May and of *Fusarium* (*F. avenaceum*, *F. oxysporum* and *F. solani*) from the July samples. Several different species of *Pythium* were distinguished but their identity has not yet been established.

When black or white roots from field samples were mixed with sharp sand in pots which were sown with *Vicia* seed, black lesions appeared on the seedling roots within two weeks. Seedlings in pots with sand only remained healthy.

Although *Vicia* roots may react to *Pythium* and *Fusarium* attack by turning black they seem prone to react similarly to any damage and it would be misleading to attribute all discolouration to fungal attack until we have more information. (Salt, Plant Pathology Department)

Nematodes. The only parasitic nematodes consistently found in the roots were species of root-lesion nematodes, mainly *Pratylenchus neglectus* (96% of total) with small numbers of *P. thornei* and *P. pinguicaudatus*. Total *Pratylenchus* in plots not given aldicarb reached maxima of 64 and 186 g⁻¹ roots in May and June and 14 650, 3450 and 7950 litre⁻¹ soil in May, June and August, the last after harvest when all nematodes were in the soil. Aldicarb significantly decreased numbers in roots and soil at all sampling dates.

P. neglectus is less injurious to bean roots than *P. pinguicaudatus* (Rothamsted Report for 1974, Part 1, 182) and *P. thornei* intermediate between them. Nevertheless large numbers of *P. neglectus* may cause significant damage and aldicarb probably contributed to yield increase by decreasing the numbers of this and other species of root-lesion nematodes in bean roots. (Webb, Nematology Department)

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Nodulation and nitrogen fixation. Nitrogenase activity, estimated by the acetylene reduction assay, and nodulation were estimated on the same four occasions as total above-ground dry matter was determined.

The pattern of nitrogenase activity in the untreated crop was similar to that reported for other grain legumes i.e. increasing during vegetative development with a post-flowering decline during pod development and seed filling. This was complicated by predation of the active nodules by *Sitona* larvae.

None of the insecticides, fungicides or nematicides appeared to have any deleterious effect on the nodulation process. Of all the treatments applied nitrogen, as expected, had the most pronounced effect on nodule formation. Fertiliser nitrogen had little effect on the number of nodule primordia formed but severely limited the final number and their rate of development into functional nodules. Throughout the life cycle of the plant the amount of N fixed on plots given N fertiliser was much less than on those not given N (Table 7).

TABLE 7

Spring beans: effects of irrigation, fertiliser nitrogen, aldicarb and dieldrin on nitrogenase activity and nodule weight

	Nitrogenase activity (moles ethylene per plant per hour)			Nodule weight (mg per plant) At pod development
	4-leaf stage	Early flowering	At pod development	
Irrigation	1.6	5.8	0.7	54
None	1.8	7.2	1.1	39
Nitrogen	0.3	3.3	0.4	23
None	3.1	9.7	1.3	70
Aldicarb	1.6	6.7	1.2	70
None	1.7	6.3	0.5	23
Dieldrin	1.6	6.4	1.0	49
None	1.7	6.6	0.8	44

Irrigation increased plant growth and also the amount of nodule tissue but nodule activity and in particular the specific activity (N fixed per unit weight of nodule tissue) was less with irrigation. This contrasts markedly with the total nitrogen uptake by grain (Table 8) where the irrigated plants accumulated most nitrogen. The soil in the upper horizons of non-irrigated plots was apparently so dry that the N present was unavailable; water taken up lower in the profile would be less rich in combined nitrogen and thus limit nitrogenase activity less, resulting in higher specific activities.

TABLE 8

Spring beans: effects of irrigation, aldicarb and dieldrin on nitrogen uptake by grain

	N uptake (kg N ha ⁻¹)			
	No irrigation		Full irrigation	
	None	Dieldrin	None	Dieldrin
None	61	70	141	136
Aldicarb	92	97	163	176

SED 6.0 (except for comparisons of none v. full irrigation)

Aldicarb had little effect on pre-flowering nodule development or function but was beneficial to these after flowering. Treated plants retained far more nodules than untreated plants and nitrogen fixation (N ha⁻¹ day⁻¹) was maintained at a greater rate for a longer period in treated plants.

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Dieldrin alone had similar beneficial effects to aldicarb on nodule longevity and the duration of active nitrogen fixation. Combining aldicarb and dieldrin did not further increase nitrogen fixation although this combination, in unirrigated plots, did increase numbers of undamaged root nodules (see Bardner and Fletcher, Entomology Department). Benomyl, fenitrothion and pirimicarb had no significant effects on nitrogen fixation. (Day and Witty, Soil Microbiology Department)

Uptake of aldicarb. Residues of aldicarb (including those of aldicarb sulphoxide and aldicarb sulphone) were determined in plants throughout the season. On 10 May plants contained about 30 μg aldicarb residues per g of stem and leaves. These residue levels declined slowly, and even just before harvest non-irrigated and irrigated plots contained 3.5 and 4.0 $\mu\text{g g}^{-1}$ aldicarb residues, respectively, in the top 30 cm of plants. (Briggs, Bromilow and Jabbar, Chemical Liaison Unit)

Lupins for grain

Two experiments were done in 1976 on grain lupins, one at Rothamsted and one at Woburn. Several of the factors tested in 1975 were included (*Rothamsted Report for 1975*, Part 1, 147) but pirimicarb replaced menazon for control of aphids. Unicrop, a variety of *Lupinus angustifolius*, which yielded poorly in 1975, was omitted, both experiments being sown with *L. albus* (Kievsky). All seed was inoculated with *Rhizobium lupini* and no fertiliser N was applied. A test of fenitrothion (to control *Sitona*) was included. At Woburn yields where aldicarb was applied to the soil were about 2 t ha⁻¹, equal to those at Rothamsted in 1975 (see Table 9).

TABLE 9
Grain lupins
Yields of grain (at 85% DM) t ha⁻¹
Main effects, averaged over other treatments

Factor	Rothamsted (Harvested 6.9.76)			Woburn (Harvested 17.8.76)		
	Absent	Present	% increase (± 5.1)	Absent	Present	% increase (± 3.2)
Aldicarb (10 kg ha ⁻¹)	0.89	0.98	+10	1.70	1.99	+17
Fenitrothion (0.75 kg ha ⁻¹)	0.91	0.96	+5	1.86	1.83	-2
Pirimicarb (0.14 kg ha ⁻¹)	0.96	0.91	-5	1.80	1.89	+5
Mean	0.94			1.85		

At Rothamsted, despite protection by a net, pigeons (mostly domestic ones) destroyed many plants at emergence and yields were poor. Here, however, as at Woburn, aldicarb significantly increased yields of grain. The effects of fenitrothion and pirimicarb were not significant. The planned test of benomyl sprayed on the growing crop was not applied because no mildew was seen.

A small experiment at Rothamsted was sown with lupins in autumn. Seeds germinated satisfactorily and the plants survived most of the winter but in February they succumbed to fungi attacking the roots (see p. 269). (Wilson, with members of the Plant Pathology Department)

The effects of incorporating P and K into the subsoil. The experiment started in autumn 1973 (*Rothamsted Report for 1974*, Part 1, 132) was continued to determine further residual effects of subsoiling and of P and K applied to the subsoil.

Subsoiling done in 1973 substantially increased yields of wheat and barley (by 17 and

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32% respectively) but had little effect on sugar beet and potatoes. P and K worked into the subsoil in 1973 increased yields of potatoes by 15% and of sugar from sugar beet by 11% but had no effect this year on wheat or barley. (McEwen)

Professor Laloux's method of growing wheat

Professor Laloux (of Gembloux University, Belgium) has developed a method of growing winter wheat which is said to give consistently better yields than traditional methods. His recommendations include thin sowing, nitrogen fertiliser applied in three separate dressings at rates determined by plant counts and by amounts of rainfall, and the use of the growth regulator chlormequat (CCC) and fungicides including sulphur.

We laid down a complex experiment to test his combined recommendations and to determine the separate effects of various individual factors, all in comparison with more conventional husbandry. Two varieties, Cappelle and the semi-dwarf Hobbit, were included.

Yields averaged 4.4 t ha⁻¹ and most treatment-effects were small (though our standard seed rate of 370 seeds m⁻² gave appreciably more grain than half this rate) and there was no dramatic increase from any combination of treatments relative to our normal practice. In a season so exceptional no detailed report seems justified. (Dyke and McEwen, with R. Moffitt, Farm and D. B. Slope, Plant Pathology Department)

Analysis of yields of field experiments with many plots per block

We have now done two experiments of serially-balanced designs (*Rothamsted Report for 1974*, Part 1, 133 and *for 1976*, p. 257, and Paper 3). These are of necessity arranged with the plots in one line. Such designs, and others that involve randomised blocks containing large numbers of plots (e.g. the one-sixth replicate of 6 × 6 × 6 factorial experiments used by ADAS) are particularly vulnerable if the chosen site has a trend of 'fertility' (i.e. yield under uniform treatment). The two serially-balanced experiments each showed evidence of a curve of fertility which can be well represented by a four-term Fourier series. The coefficients of variation were 6.2 and 6.6% (16 degrees of freedom) without fitting fertility curves, 2.5 and 2.7% (12 degrees of freedom) respectively with four-term curves fitted; the relative efficiency was 6.3:1 in 1975, 6.0:1 in 1976, if the loss of degrees of freedom is ignored. (Dyke, with Jenkyn and Bainbridge, Plant Pathology Department)

Staff

M. J. Allen retired after 35 years of service to the Section and Rothamsted. His skill and care in drawing plans and his assurance and good nature in handling visitors, expected or unexpected, will be hard to replace.

C. J. Stafford transferred from the Entomology Department and D. P. Yeoman from the Chemistry Department. R. W. Allingham joined the Section, replacing A. P. Harmer, who resigned.

Publications

PAPER IN ROTHAMSTED REPORT, PART 2

- 1 DYKE, G. V., (PATTERSON, H. D.) & BARNES, the late T. W. (1977) The Woburn long-term experiment on green manuring, 1936-67; results with barley. *Rothamsted Experimental Station. Report for 1976*, Part 2, 119-152.

FIELD EXPERIMENTS SECTION

RESEARCH PAPERS

- 2 DYKE, G. V. & BARNARD, A. J. (1976) Suppression of couch grass by Italian ryegrass and broad red clover undersown in barley and field beans. *Journal of Agricultural Science, Cambridge* **87**, 123–126.
- 3 DYKE, G. V. & SHELLEY, C. F. (1976) Serial designs balanced for effects of neighbours on both sides. *Journal of Agricultural Science, Cambridge* **87**, 303–305.
- 4 WILSON, J. C. (1976) Experiments to test the performance of a small plot combine harvester, Part II: Effects of previous treatment and turning on combine yield. *Experimental Husbandry* **30**, 59–62.
- 5 WILSON, J. C. & MOFFITT, R. (1976) Experiments to test the performance of a small plot combine harvester. Part I: Effects of nitrogen and plot length on combine yield. *Experimental Husbandry* **30**, 55–58.