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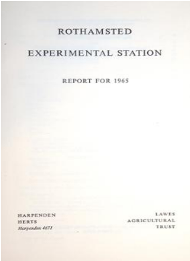
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EXPERIMENTAL STATION
REPORT FOR 1965

The Saxmundham Experiments

G. W. Cooke

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more weeds after the failure of simazine to control them in 1961. There was no residual effect of the prometryne in 1963, when weeds were spread more uniformly over all treatments. The residues of prometryne plus paraquat lessened the yield of barley in 1964 on the R treatment, but weeds were not counted, and there is no explanation for the very small yield (12·1 cwt/acre) with RS.

TABLE 19

Barley—grain cwt/acre at 85% DM
Residual effects of treatments to potatoes 1961–64 (S-M)

	Previous treatment	P	R	T	Mean
1961 (±1·53)	Simazine	1·3	−0·6	−0·5	0·1 (±0·88)
1962 (±2·72)	Simazine	−1·5	−3·3	−3·1	−2·6 (±1·57)
1963 (±1·41)	Prometryne	0·3	−0·2	0·1	0·1 (±0·81)
1964 (±3·61)	Prometryne and paraquat	−1·1	−8·0	0·7	−2·8 (±2·08)
Mean (±1·24)		−0·2	−3·0	−0·7	−1·3 (±0·72)

TABLE 20

Barley 1962, 1963
Mean weed numbers per sq yd

	P		R		T	
Treatment to potatoes	1962	1963	1962	1963	1962	1963
M	83	133	34	117	27	81
Sx	63	232	268	171	344	216
Sy	53	133	20	202	23	108

Although it is too soon to draw firm conclusions from these experiments, some tentative conclusions can be drawn:

1. The three prime cultivations give similar yields of all crops, but weeds are fewer where a mouldboard plough is used.
2. Residual herbicides can control most weeds (other than gramineous ones) in beans and potatoes without decreasing the yield appreciably.
3. Residual herbicides do not affect the yield of the crop in the year after they are applied, and there is no suggestion that they accumulate in the soil.
4. Hormone herbicides usually lessen the yield of wheat at Rothamsted, though they control weeds. Their effects on yield of barley vary, but on average are negligible.

The Saxmundham Experiments

By G. W. Cooke

Weather, cultivation and cropping. Winter 1964/65 was dry, but there was more than average rain in summer and autumn, with 17·5 in. in the 6 months from April to September. The deeper ploughing and mole draining done in autumn 1964 has benefited the field. The soil accepted water and drained much better than in the past and was easier to work; in autumn 1965 old field drains began to run for the first time for many years. There were several periods of very wet weather in 1965, including

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2 days when more than an inch of rain fell, and 1 day with more than 2 in. Surface flooding and run-off from the plots occurred only on the block in winter wheat of Rotation I (which had not been ploughed deeply in 1964) and from roadways, headlands and paths between the plots.

Observations during 1965 on the land in wet weather, on the sugar beet and barley crops and soil analyses all suggested that run-off has often been serious in the past and has carried richer soil from some plots on to poorer plots lower down the slope. The effects on the 1965 crops were most evident with sugar beet on Rotation I Experiment; this crop occupied the block immediately below the site of the Rotation II Experiment, most plots of which get more manure than Rotation I. Areas of bigger beet extended nearly a quarter of the length of some of the plots receiving no phosphate, whereas the crop on the rest of the plot was poor. Soils of long-term experiments are not disturbed in this way by erosion at Rothamsted, but are at Woburn.

Except for the Rotation Experiments, the whole field was cropped with barley, which received an NPK compound fertiliser supplying 0·7 cwt N/acre and a later top-dressing of 0·4 cwt N/acre; only a small area ploughed from a grass–clover ley in 1964 lodged severely. Barley yields were good, and averaged over 2 tons/acre on one area not under experiment.

Rotation I Experiment

Crops in 1965. The manuring used since 1899 was not changed. The legume break was fallowed, winter wheat and spring barley were grown as usual, mangolds were not taken, and only sugar beet was grown on the root break. Table 1 shows yields of the 1965 crops and average yields for the period 1956–65 when sugar beet was grown each year.

TABLE 1

Yields per acre of crops grown in Rotation I Experiment at Saxmundham in 1965 and averages for 1956–65

	Wheat			Barley			Sugar beet			
	Grain (cwt)		Straw (cwt)	Grain (cwt)		Straw (cwt)	Roots† (tons)		Sugar (cwt)	Tops (tons)
Annual treatment*	1965	1956–65	1965	1965	1956–65	1965	1965	1956–65	1965	1965
None	18·2	10·4	11·8	6·4	5·3	2·1	1·4	2·3	4·7	1·7
N	24·6	18·6	12·7	12·4	10·9	5·3	2·9	3·0	10·0	2·2
P	15·9	13·6	9·8	5·4	7·2	1·3	7·6	6·2	28·4	2·6
K	13·9	9·9	9·4	3·7	4·8	0·7	2·4	2·8	8·7	1·2
NP	24·3	24·0	10·5	23·6	16·7	10·4	10·2	9·6	38·2	3·1
NK	26·5	19·0	10·0	8·8	11·2	2·0	0·9	2·4	2·8	1·3
PK	16·9	13·5	10·2	5·9	7·3	0·6	6·8	6·0	25·6	1·9
NPK	24·8	23·3	13·2	21·2	18·6	7·6	11·0	10·0	41·4	3·1
Bone meal	20·9	14·3	11·1	9·8	8·2	3·0	10·0	7·2	36·6	3·2
FYM	29·4	22·6	18·1	23·2	18·6	10·7	13·9	13·1	51·0	9·3

* The manuring per acre was: 2 cwt of sodium nitrate (N), 2 cwt of superphosphate (P), 1 cwt of muriate of potash (K), 4 cwt of bone meal and 6 tons of FYM.

† Poorer yields in 1965 from some of the plots receiving no phosphate than on average of 1956–65 may have been because the big beet grown on areas where downwash had deposited better soil were all discarded at harvest; in earlier years discard areas were much smaller.

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Cappelle winter wheat, sown under good conditions in autumn 1964, grew and yielded well, although the plant on many plots was seriously damaged by wheat-bulb fly. Yields on all plots were above the 10-year average; with some treatments 6–8 cwt/acre more. This improvement could not be attributed to deeper ploughing, which was not done on the wheat area; ploughing-in the peas that failed in 1964, and bastard fallowing, the dry autumn and winter, undoubtedly made more nitrogen available to the crop, but there were big responses to fresh N fertiliser. Although crops on phosphate-treated plots grew better and ripened earlier, phosphate did not increase grain yields in 1965. This is an unusual result that cannot be explained. On average of earlier years wheat yields were increased by about 5 cwt/acre by superphosphate dressings. There was no gain from potash manuring. Best wheat yields (of nearly 1½ tons/acre) were from 6 tons/acre of FYM annually; this plot was least affected by wheat-bulb fly.

Proctor barley was sown under good conditions. Yields without NP fertilisers were less than averages for 1956–65. There were good responses to nitrogen and phosphate used together, but potash tended to decrease yields; with NP fertiliser (and with FYM) yields were above the 10-year averages. All sugar beet were very small at harvest without phosphate, and yields were less than average on these plots. Largest responses were to phosphate and to N with P; there was a small gain from potassium fertiliser. Yields of beet from all plots treated with phosphate were above average. Yields from fully manured plots (2 tons of sugar with NPK fertiliser and 2½ tons with FYM) were good considering the small dressings used (only 6 tons/acre of FYM and only about one-third as much fertiliser as is commonly used for beet).

Nutrients removed by the crops. Analyses of the crops grown in 1964 and 1965 are reported because they are the only ones made during the period when manuring remained unchanged. Table 2 shows annual averages for all three crops (sugar beet, wheat and barley), of the amounts of six nutrients taken up.

TABLE 2

Average annual amounts of nutrients (lb/acre) taken up in 1964 and 1965 by wheat, sugar beet and barley grown in Rotation I Experiment at Saxmundham

Annual treatment	N	P	K	Mg	Na*	Ca
None	17	2·9	17	2·4	2·3	6·2
N	27	4·5	22	3·3	5·5	9·2
P	24	5·5	28	4·4	3·9	10·7
K	13	2·2	15	1·9	1·3	5·2
NP	40	9·3	37	5·7	7·6	12·4
NK	25	4·3	21	2·8	3·3	7·3
PK	22	5·2	25	3·4	2·4	8·5
NPK	43	10·1	48	7·1	8·7	15·7
Bone meal	30	6·7	30	5·3	4·5	12·1
FYM	60	13·9	73	10·8	12·6	22·4

* Crops varied greatly, ranges of Na removed yearly were 0·3–2·1 lb by cereals and from 3 to 35 lb by sugar beet.

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Average apparent recoveries of applied fertilisers by the three crops were 60%, 35% and 25% for N, P and K respectively; wheat recovered less than half of the applied N, beet and barley over two-thirds. Sugar beet apparently recovered over half of both the P and K applied, wheat and barley recovered less P and very little K. On well-manured plots sugar beet took up from two to three times as much magnesium as the cereals; sugar beet also took up much sodium (23 lb and 35 lb Na/acre on plots treated with NPK fertiliser and FYM respectively); the largest cereal crops removed only 1–2 lb Na/acre.

The FYM applied in 1964 and 1965 was remarkably similar in composition; averages were:

	% in fresh material
N	0·72
P	0·24
K	0·50

The 6 tons/acre dressings used supplied on average each year 97 lb N, 33 lb P and 68 lb K/acre; three times as much total N, twice as much P and 150% as much K as was given by the full NPK dressing. It is not surprising that the crops grown with FYM contained more nutrients than those given fertilisers, and that all crops yielded better in 1965 with FYM than with the NPK fertiliser dressings used. Table 3 shows annual amounts

TABLE 3

Amounts of nutrients taken up by crops grown with NPK fertilisers and FYM in Rotation I Experiment

Annual averages for 1964–65

	N	P	K	Mg	Na	Ca
	lb/acre in total crop					
Wheat						
With NPK	49	11·2	36	5·2	1·3	8·9
With FYM	62	13·9	47	6·0	1·3	13·4
Barley						
With NPK	33	8·2	24	3·6	1·8	8·2
With FYM	40	10·8	32	4·4	1·4	9·8
Sugar beet						
With NPK	46	10·8	85	12·4	23·0	30·0
With FYM	80	17·2	140	21·8	35·0	43·9

of nutrients removed by the crops grown in 1964/65 with the two kinds of manuring. Except for sodium in cereals, all crops given FYM contained more nutrients than those given fertilisers. Most of the differences with cereals were small, but they were large with sugar beet, which contain 60% more N, P and K when grown with FYM than when grown with fertiliser, though yield in 1964/65 was only 30% larger. The FYM plots yielded much better than usual relative to the NPK fertiliser plots, suggesting that the FYM may have been of better quality than in the past (when NPK gave 3% more wheat, 11% more barley and 6% more mangolds than FYM). For this reason FYM has been excluded from the following discussion of longer-term changes in nutrient reserves in the soils.

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In earlier work on the soils of this experiment (Cooke, Mattingly and Williams, *J. Soil Sci.*, (1958) **9**, 298–305) a tentative balance sheet was based on average values of crop composition, because the Saxmundham crops had not been analysed. The values in Table 2 were used to calculate rate of change in nutrient balances for the 2 years and for the crops grown (fertilisers supplied 35 lb N, 16 lb P and 47 lb K/acre, bone meal was assumed to supply 16 lb N and 43 lb P), without allowing for the nutrients returned in the sugar-beet tops that were ploughed-in. As surplus inorganic N is lost by leaching and denitrification, and more has been added by the legume break and by other natural means, no balance sheet for nitrogen is possible. Table 4 shows annual changes (additions minus losses) and also the estimated total changes between 1901 and 1956. The calculations make no allowance for the legume crop and assume the annual rates of change measured in 1964 and 1965 (when average crop yields from well-manured plots were not far from average). These changes correspond to those calculated by Cooke *et al.* from assumed crop compositions and known yields in 1901–58; agreement for phosphorus losses and gains is reasonably good, for potassium the earlier calculations seem to have exaggerated the size of both losses and gains. A surprising feature of the 1964/65 nutrient balance calculation was that the crops grown removed all of the potassium supplied by NPK fertilisers and also all of the larger quantity supplied by FYM. (R. J. B. Williams)

TABLE 4

Estimates of annual and long-term changes in nutrients in soils of Rotation I Experiment

(Additions in manures and fertilisers minus amounts in crops in lb/acre)

	Annual changes			Total change in 56 years	
Annual treatment	N	P	K	P	K
None	−17	− 2·9	−17	− 160	− 900
N	+ 7	− 4·5	−22	− 250	−1,200
P	−24	+10·5	−28	+ 590	−1,600
K	−13	− 2·2	+32	− 120	+1,800
NP	− 5	+ 6·7	−36	+ 380	−2,000
NK	+10	− 4·3	+26	− 240	+1,400
PK	−22	+10·8	+22	+ 600	+1,200
NPK	− 8	+ 5·9	− 1	+ 330	− 60
Bone meal	−14	+36·3	−30	+2,000	−1,700

Future treatments. The results of Rotation I Experiment obtained up to 1961 were prepared for publication during the year (P. J. O. Trist and D. A. Boyd, *J. agric. Sci. Camb.* (1966)). There is no point in continuing the demonstration on whole plots that unfertilised crops grow badly at Saxmundham and that phosphate fertiliser is essential. The main part of each plot of the experiment has therefore been modified to make it useful in investigating the manuring of crops that can be grown in the farming systems possible on this difficult soil. The aim is to produce consistently large yields from a rotation suited to the area, identifying causes of any poor crops and correcting faults in manuring. The experiment will also show the value of the reserves of phosphorus (accumulated on some

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plots from past manuring) and of potassium supplies from soil minerals. The manuring of all plots except those receiving bone meal is changed. FYM dressings are now 12 tons/acre. The nitrogen test will be of 0·5 *v.* 1·0 cwt N/acre as "Nitro-Chalk", and the larger amount should be enough for the crops grown. Plots not given phosphate in the past now have 0·8 cwt P_2O_5/acre, and they provide a useful comparison with the plots that will continue to have 0·4 cwt P_2O_5/acre for each crop and already contain nearly enough residual phosphate from past manuring for maximum yields. The P residues from the larger dressings now given to the deficient soil will be measured. The potassium test is of none against 1·0 cwt K_2O/acre. At present there are only small responses to K fertilisers after 65 years of cropping, and only sugar beet responds consistently. The larger crops which will be grown with more nitrogen will considerably increase the potassium removed. A knowledge of the extent to which potassium can be supplied from this "K-release" soil, and how long the supply can continue, is important both in farming soils of this kind and in our work on potassium fixation and release. The existing four-course rotation is maintained with spring beans as the legume and sugar beet on the root break; all crops will receive the same manuring, except that for beans the N test will be 0 *v.* 0·5 cwt N/acre. The old treatments will be maintained on small areas at an end of each plot for observation and to provide soils for laboratory and glasshouse experiments.

Rotation II Experiment. This experiment was modified in 1965 to measure residues of phosphate applied between 1899 and 1964 (*Rothamsted Report* for 1964, p. 230). Fresh dressings of phosphate (as triple superphosphate) were applied to some plots (Table 5) before sowing Proctor barley in spring 1965. All plots were given "Nitro-Chalk" (100 lb N/acre) and muriate of potash (200 lb K/acre). Samples of the crop were taken in July, and whole plots were harvested in September. Table 5 gives the main treatments and yields.

TABLE 5

Yields of barley in Rotation II Experiment at Saxmundham

Plot No.	Total treatment per acre 1899–1964 (per 4 years)	Phosphate applied in 1965 (cwt P_2O_5/acre)	Yields cwt/acre: Green crop in July (dry matter)	Yields cwt/acre: Grain at harvest (85% dry matter)
1	None	None	23·5	15·9
2	10 tons FYM	None	50·7	31·3
3	10 tons FYM plus 5 cwt superphosphate (to 1920) or 7½ cwt since 1921	None	54·8	34·6
4		None	54·1	34·2
5		1·50	56·7	34·3
6		1·50	56·6	34·1
7		3·00	62·8	33·2
8	Manuring stopped in 1952. Until then 10 tons FYM plus 10 cwt superphosphate (to 1920) or 15 cwt superphosphate (since 1921)	None	51·5	31·4

Residues from phosphate applied in farmyard manure, at an average annual rate of 2·5 tons/acre for 65 years, doubled the yield of grain. There

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were only small further increases in yield from fresh dressings of superphosphate applied before sowing. (G. E. G. Mattingly)

Continuous wheat experiment. There have been few experiments in East Anglia to measure the incidence of take-all and eyespot and how these diseases affect yields of wheat and responses to nitrogen fertiliser. An experiment was begun in 1965, superimposed on plots of Rotation II Experiment that were abandoned in 1952. Winter wheat will be grown continuously and in rotations with 1-year or 2-year breaks of grass leys. Observations on the site suggest it is suitable for disease studies, as the 1965 crop had considerable differences in disease, reflected in yield, from previous differences in cropping:

		A	B
Cropping			
	1962	Sugar beet	Spring oats
	1963	Spring barley	Winter wheat
	1964	Winter wheat	Spring beans
Yield of 1965 barley crop			
	(cwt/acre)	29·8	43·2
Approximate estimates of soil-borne disease			
	% plants with take-all	82 (52 severe)	10 (6 severe)
	% straws with eyespot	22 (6 severe)	2 (none severe)

(D. B. Slope)

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