

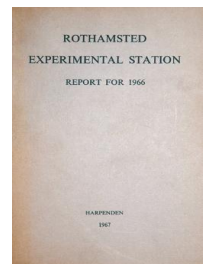
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ESTIMATING TRENDS IN FERTILISER USE

D. A. BOYD

In no other country is so much known as in Great Britain of how farmers manure their crops and of how their practice has changed with the years. This detailed information comes from two main sources. Since 1953 the Ministry of Agriculture has provided annual statements of the amount of fertiliser nutrients applied in each county, based on farmers' claims for subsidy payments. However, as these claims are made for a farm as a whole, the county totals, although useful in many ways, do not show how the manuring of individual crops is changing, information valuable both to the fertiliser industry as a guide to long-term planning and to advisory and research workers. Detailed information of this kind can be collected satisfactorily only by personal interview with farmers, as in the Survey of Fertiliser Practice.

Started 25 years ago, the main purpose of the first war-time surveys was to determine how far farmers were making proper use of their fertiliser ration, when lack of shipping made necessary a choice between imports of fertilisers and imports of food; the results also helped advisory workers by drawing their attention to instances of farm practice not in accordance with their recommendations. From the start the surveys were done by the Regional Soil Scientists of the National Agricultural Advisory Service (formerly the Provincial Soil Chemists); the Statistical Department at Rothamsted planned the surveys, selected the samples of farms and analysed the results, which were reported jointly. However, as the information was of interest not only to research and advisory workers but also to the fertiliser industry, additional fieldmen for large-scale surveys in 1957/8, 1962 and 1966 were provided by the Fertiliser Manufacturers' Association Ltd. The sample is now selected by the Agricultural Census Branch of the Ministry of Agriculture at Guildford. Since 1956, surveys on similar lines have been done by the Scottish Agricultural Colleges and the A.R.C. Statistics Unit, formerly at Aberdeen and now at Edinburgh.

Survey methods. In contrast with many farm surveys, the policy in the Survey of Fertiliser Practice is to survey small districts (counties or part-counties) chosen to be reasonably homogeneous with respect to soil or farming type. For example, in Shropshire the mixed arable and dairy farms on the lighter-textured Triassic drifts in the east and south-east of the county were surveyed separately from the more typical dairy farms on soils derived from boulder clays in the north. The districts are chosen partly for their special interest to the Regional Soil Scientist, and the sample may then be restricted to farms on a particular soil series or to other groups of related soils on which investigations, such as a series of fertiliser experiments, are being made. In South Shropshire and the adjoining area of Herefordshire, for example, farms on the Bromyard and

339

ROTHAMSTED REPORT FOR 1966

Munslow Series were surveyed. However, in years when a national survey is planned, the most important consideration is that the surveyed districts as a whole shall be representative of the main farming types in England and Wales. Thus a national survey yields detailed information for many widely scattered districts, each sampled intensively, in preference to sampling all parts of the country evenly but comparatively thinly. Such national surveys were made in 1954, 1957/8, 1962 and 1966; as the main purpose is to find out how practice is changing, some districts were included in more than one survey, though with a different sample of farms.

Despite the many soil and farming types in England and Wales, comparatively few surveys are needed to obtain reasonably accurate estimates of how fertiliser use is changing in different parts of the country. Although farmers' ideas of how crops should be manured may differ greatly, large groups of farmers facing similar problems tend to make similar decisions. Thus each major farming type has its own pattern of fertiliser use as well as of cropping. Moreover, changes in the pattern occur at about the same time on most farms of the type, regardless of the part of the country where they occur.

The farms to be visited in each district are selected systematically from the four size-groups, 20–50, 50–150, 150–300 and over 300 acres of crops and grass, and the allocation of the sample of farms between these groups is approximately proportional to the total areas in each group. In the earlier surveys only 30–40 farms per district were visited, but for the last 10 years the sample has been about 60 farms, except in 1962 when it was 90 farms per district. A fieldman needs about 6 weeks to visit 60 farms. The fieldwork is usually done in summer or early autumn, by members of the staff of the Regional Soil Science Departments of the N.A.A.S., representatives of fertiliser firms and by agricultural students. The survey information is obtained solely by interview with the farmer, usually in his house or office, and the surveyor is not expected to walk the fields. Sometimes soil samples are taken from a random sample of the fields on each farm; this usually entails a separate visit by someone from the Regional Soil Science Department.

National trends in fertiliser consumption. The continuing demand for

TABLE 1
Total fertiliser consumption in England and Wales
(per acre of crops and grass)

Year	(cwt/acre) $\times$ 100		
	N	P ₂ O ₅	K ₂ O
1944–45	(12)	(21)	(7)
1953	15	22	14
1954	16	22	16
1956	19	23	19
1958	21	24	23
1960	27	28	28
1962	33	30	28
1964	38	29	28
1966	40	27	28

Source: 1953–66 Ministry of Agriculture based on subsidy claims. The figures for 1944–45 are estimated from the total consumption in the United Kingdom.

ESTIMATING TRENDS IN FERTILISER USE

surveys has arisen in part from the interest of the fertiliser industry in discovering how the different crops, and in particular grassland, have contributed to the large changes in total consumption shown by the official estimates. Table 1 shows that during the period 1953–66 the amount of P/acre of crops and grass increased by one-quarter, K doubled and N almost trebled. After the war the consumption of N increased slowly at first, but faster in the 1950s, no doubt because the change in fertiliser subsidies favoured nitrogen use. There was a further sharp increase in the early 1960s and consumption is still increasing steadily, but more slowly, and reached 0.4 cwt N/acre in 1966. In the 1950s the increases in K were similar to those for N, but subsequently the average amounts of K remained steady at just under 0.3 cwt K₂O/acre. Having decreased slightly after the war, consumption of P increased to 0.3 cwt P₂O₅/acre by 1962, but is now a little less.

Trends in fertiliser practice for different crops. For comparison with changes in total use Table 2 shows trends in fertiliser used for individual

TABLE 2
Trends in fertiliser practice in England and Wales 1950–66
(cwt/acre) × 100

		N	P ₂ O ₅	K ₂ O
Wheat	1950–52	21	24	11
	1957	36	25	26
	1962	57	31	35
	1966	(66)	(33)	(35)
Barley	1950–52	16	26	16
	1957	24	27	31
	1962	43	30	38
	1966	(54)	(30)	(35)
Potatoes	1950–52	80	88	114
	1957	91	92	143
	1962	118	111	183
	1966	—	—	—
Temporary grass	1950–52	14	28	9
	1957	19	26	16
	1962	37	32	23
	1966	(50)	(29)	(24)
Permanent grass	1950–52	5	18	3
	1957	8	15	6
	1962	16	21	11
	1966	(18)	(17)	(10)

Note: The 1966 figures are provisional.

crops; the estimates for 1966 are provisional, based on the 14 districts so far analysed. Increases in the use of nitrogen on cereals and leys have been greater than the average, those for permanent grass less. In the 1950s the area treated with P fertiliser increased rapidly, but this was offset by a decrease in the average amounts applied per treated acre, associated with combine-drilling of cereals, and, on grassland, with the use of compound fertilisers in place of basic slag. On the average, the amount of P and K used on cereals has gradually increased, mainly because more of the crops

ROTHAMSTED REPORT FOR 1966

are dressed; in some arable districts rates of K have declined since 1962. From 1957 to 1962 more P and K were used on leys and permanent grass, but, since 1962, changes in the amounts of K used have been small, while amounts of P have decreased.

Differences between types of farm. From the first, the surveys showed that arable farmers, accustomed to manuring generously cash crops such as potatoes and sugar beet, usually applied fertiliser liberally to cereals and grass also, whereas the wartime grassland farmer, unaccustomed to giving more than an occasional dressing of basic slag to his grassland, often attempted to grow arable crops with little or no fertiliser. On average, arable farmers still use more fertiliser than dairy farmers, although the difference is much less than formerly, and stock farmers have been particularly slow to turn from basic slag to compound fertilisers containing all three nutrients. Thus surveys in four Midland counties in 1957/58 showed that grassland on dairy farms received much more N and K than grassland on stock farms (Table 3); P fertiliser was also used more fre-

TABLE 3
Grassland manuring on dairying and stock farms (1957/58)

	Percentage of acreage receiving:			
	N	P	K	FYM
Leys mown:				
Dairy farms	56	43	26	11
Stock farms	37	37	19	4
Leys grazed:				
Dairy farms	46	40	26	12
Stock farms	23	30	14	6
Permanent grass:				
Dairy farms	24	21	9	8
Stock farms	12	16	6	4

quently on dairy farms, but the amounts applied per acre were less, because most dairy farmers used a compound fertiliser, whereas the stock farmers relied on an occasional large dressing of basic slag. How far these differences persist will be revealed by the 1966 survey, for which an analysis will be made by farming type, as well as by districts.

As there is no up-to-date map of farming types for England and Wales to bring out the differences between arable and grassland farms, and, among the grassland farms, between dairying and other livestock farms, the surveyed districts were grouped according to their acreage of tillage expressed as a percentage of their total area of crops and grass; the "A" groups have at least 60% of their area in tillage, "AG" between 40 and 60% in tillage and the "G" and "U" groups being mainly in grass. Regional subdivision within the "AG" and "G" groups gives a further broad differentiation of farming types (Table 4). The changes in the past 12 years in the use of N on spring barley and grazed leys for these groups are shown in Tables 5 and 6, which include the results of surveys in 85 districts in England and Wales, many of which have been surveyed several times.

ESTIMATING TRENDS IN FERTILISER USE

TABLE 4
Grouping of surveyed districts

Group	Tillage area* (% crops ref. and grass)	Farming type	Counties and districts included
Arable districts			
A0	>80	High-value cash crops	Peat, silt and warp soils
A1	60-80	Mainly cash crops (cereals)	East Anglia (excluding Fens)
A2	60-80	Mainly cash crops (cereals)	Parts of Yorks, Notts, Lincs. (excluding warp soils)
AG1	40-60	Cash crops (substantial dairy side)	Arable areas of southern England
AG2	40-60	Cash crops (less dairy and more sheep and cattle)	Remaining arable areas of E. Midlands and North
Lowland grass districts (England)			
G1	30-40	With substantial dairy side	Home Counties grassland areas
G2	30-40	With less dairy and more sheep and cattle	E. Midlands and N. England
G (N.W.)	<30	Mainly dairying	Dairy grasslands of N.W. Midlands
G (S.W.)	<30	Mainly dairying	West Midlands, W. and S.W. England (excluding moorlands)
Wales and English uplands			
U	<20	Various livestock enterprises	Uplands of S.W. and N. England; Wales

* The percentages are for the period 1957-62; from 1962 to 1966 the tillage area of England and Wales increased from about 37 to 42% of the total crops and grass.

TABLE 5
Use of N on spring barley
(cwt/acre) $\times$ 100

Group of districts	1954	1958	1962	1966
A1	22	36	44	57
A2	21	30	45	58
AG1	24	35	51	64
AG2	14	26	42	54
G2	13	23	37	51
G (N.W.)	9	15	33	44
G (S.W.)	11	16	34	—
U (Wales)	5	8	17	—

TABLE 6
Use of N on grazed ley
(cwt/acre) $\times$ 100

Group of districts	1954	1958	1962	1966
A1	28	39	57	62
A2	17	26	33	—
AG1	23	34	50	65
AG2	13	22	41	48
G2	12	19	31	37
G (N.W.)	16	26	44	60
G (S.W.)	10	18	32	—
U (Wales)	—	7	12	—
U (N.)	—	13	25	—

ROTHAMSTED REPORT FOR 1966

In the early 1950s spring barley grown in the arable areas* of the country received twice as much N as in the grassland areas and about four times as much as in Wales and the uplands of south-west and northern England. The large and fairly constant annual increases in nitrogen use seem to have begun rather sooner in the arable districts and were least and most belated in Wales. Bearing in mind that the 1966 figures are provisional, it seems that in lowland England the use of N for barley has increased at an almost constant rate in all parts of the country.

The use of nitrogen on grazed leys shows similar differences. Again the increases have been almost linear over the whole period: those parts of the country where most nitrogen was used on leys in the early 1950s have continued to use most, although many are now using three times as much as formerly. The order of the groups is somewhat different from that of Table 5, the dairy grasslands of the north-west Midlands using more, whereas the east Midlands and Yorkshire have somewhat lagged behind in nitrogen use on grassland, perhaps because in these districts there is less dairying and more sheep and cattle grazing.

Using approximate crop areas for each group of districts, estimates of fertiliser consumption from the survey can be checked against the national totals from subsidy payments. Comparisons for 1957/58 and 1962 are given in Table 7. The survey estimates were very similar to the official figures.

TABLE 7
Official and survey estimates of fertiliser use in England and Wales
(cwt/acre) $\times 100$

Year	N		P ₂ O ₅		K ₂ O	
	Official	Survey	Official	Survey	Official	Survey
1957-58	20	21	24	25	22	23
1962	33	34	30	30	28	27

Changes revealed by the 1966 survey. The 1966 survey will give the most comprehensive information on trends in fertiliser use on individual crops since 1962. All the results are not yet in, but those for 14 districts give some indication of current trends in most parts of the country, although the grassland areas of west and south-west England and of Wales are each represented by only one district.

Cereals. The amount of N applied for winter cereals (Table 8) continued to increase in all the districts for which there are comparable results for 1962; the increases were slight for the two fen soils, but averaged about 0.1 cwt N/acre elsewhere. N.W. Norfolk, growing about 25,000 acres of winter wheat, seems the first district to record an average dressing of more than 100 units on a cereal crop (winter wheat). In most districts the area of spring barley is much greater than in 1962, partly replacing other arable crops but mainly leys and permanent grass. For spring cereals also,

* In referring to arable areas we must exclude the peat, silt and warp soils where barley almost always follows a heavily manured potato or other root crop; even in these districts, however, the barley crop participated in the general increase in nitrogen use in the latter part of the period.

ESTIMATING TRENDS IN FERTILISER USE

TABLE 8
Manuring of winter cereals

		(cwt/acre) $\times$ 100								
Group	District	N			P_2O_5			K_2O		
		1957–58	1961–62	1966	1957–58	1961–62	1966	1957–58	1961–62	1966
A	Isle of Ely (peat)	15	14	16	12	11	16	14	7	7
	Holland (silt)	—	31	36	—	3	3	—	3	4
	N.W. Norfolk	30	—	99	27	—	34	36	—	39
AG	Berkshire (Chalk)	48	65	74	32	28	36	38	33	38
	Glos. (Cotswolds)	42	66	83	25	36	40	31	42	39
	Dorset (Chalk)	37	56	65	29	29	31	37	40	38
	N.E. Northants.	31	56	70	31	40	46	22	33	39
	N.E. Leicestershire	30	45	64	23	36	35	21	43	34
G	Hereford (Bromyard)	26	43	53	32	34	39	22	37	37

the amounts of N continued to increase, but, whereas in many arable districts the rate of increase was similar to that before 1962 (an average rate of 0.7 cwt/acre was reached in some districts), information for two western grassland areas (the Fylde district of Lancashire and the Bromyard district of Herefordshire) shows a much smaller increase, possibly because much of the additional area now under barley was formerly grassland. For winter cereals there were small increases in the use of P since 1962, related to the increase in N. There was a large increase on winter cereals in Berkshire because more of the crop received fertiliser (66% in 1962, 96% in 1966).

The average change in use of K was small. However, in the arable districts (but not in other areas) less K was applied to spring cereals in 1966 than in 1962; the decrease was particularly large on the chalk soils of Berkshire and Dorset. Excluding the Fenland districts, the range of the average rates of application per district decreased from 0.21–0.38 cwt/acre in 1957/58 and 0.30–0.42 in 1962, to 0.34–0.39 cwt K_2O /acre in 1966. When the recently-introduced “High-N” compounds become more familiar to farmers, amounts of K for cereals are likely to decrease further.

Potatoes. The information on trends in potato manuring is very limited, but includes two important groups of fenland farms, peat farms in the Isle of Ely and silt farms in Holland (Lincs.). The N.A.A.S. has made many manurial trials in both Fenland areas; those on peaty soils (Pizer *et al.*, 1961) are already the basis of advice to farmers, and those on silt soils are now being written up. Farmers on peat soils were recommended to apply 100–120 units N, 180–200 units P_2O_5 and 150–200 units K_2O /acre for maincrop potatoes; these amounts were for fertilisers applied over the ridges or placed, and more would be needed when broadcast “on the flat”.

Potato-growers have often been criticised for taking little account in their manurial policy of the kind of soil they farm. Although crop requirements differ greatly from one soil to another, average fertiliser use in different parts of the country was surprisingly uniform. The 1966 survey results (Table 9) are of special interest in showing that growers of potatoes

ROTHAMSTED REPORT FOR 1966

TABLE 9
Manuring of potatoes

District	Soil type	(cwt/acre) $\times$ 100								
		N			P ₂ O ₅			K ₂ O		
		1957–58	1961–62	1966	1957–58	1961–62	1966	1957–58	1961–62	1966
Isle of Ely	Peat	102	116	134	125	148	186	158	182	206
Lincs. (Holland)	Silt	—	130	132	—	134	130	—	174	197

on peaty soils seem to have rapidly adapted their manuring to advisory recommendations by substantially increasing their P and K dressings. This change of practice is in sharp contrast with that of potato growers on the nearby fen silt soils, who used much the same dressings as in the previous survey in 1961.

Sugar beet. The only available information on sugar-beet manuring is for three districts of East Anglia and shows no large or consistent trend (Table 10). The small ratio of P (80 units/acre) to N and K (150 units/acre) in N.W. Norfolk is interesting.

TABLE 10
Manuring of sugar beet

District	(cwt/acre) $\times$ 100								
	N			P ₂ O ₅			K ₂ O		
	1957	1962	1966	1957	1962	1966	1957	1962	1966
Isle of Ely (peat soils)	79	68	74	75	108	114	106	137	126
Holland (silt soils)	—	106	112	—	96	96	—	140	167
N.W. Norfolk	114	—	149	84	—	78	194	—	146

Leys. As indicated in Table 6, the trends to increased N manuring of grazed leys have continued with little change, and in many districts the average dressing exceeded 0.60 cwt/acre in 1966. Some fields received much more than this: for five of the districts surveyed in 1966 there is information on the manuring of strip-grazed fields, and of fields that were both mown and strip-grazed; the average dressing on strip-grazed fields was 1.04 cwt N/acre and on fields both mown and strip-grazed, 1.24 cwt N/acre.

The changes in nitrogen use on mown leys were similar to those of grazed leys, but average dressings were 0.10–0.20 cwt N/acre larger. As with grazed leys, the available information suggests that the rate of increase in the average amount used on treated fields was much the same as in earlier years. However, the increase in nitrogen use on grassland in the early 1960s resulted from more fields being dressed, as well as from the changes in the amounts applied on these fields. In many districts almost all the leys now receive some nitrogen, so the average increase may in future be less rapid.

Although some districts of west and north-west England used P fertiliser very generously on leys—average dressings were about 0.6 cwt P₂O₅/acre in the Fylde district of Lancashire and in central Cheshire—most other parts of England applied only about 0.3 cwt/acre. Average amounts of potassium, ranging from 0.3 to 0.5 cwt/acre, seem to have

ESTIMATING TRENDS IN FERTILISER USE

TABLE 11
Manuring of leys 1957-66
 (cwt/acre) $\times 100$

Group	District	N			P ₂ O ₅			K ₂ O		
		1957-	1961-	1966	1957-	1961-	1966	1957-	1961-	1966
A1	N.W. Norfolk	58	62	88	58	62	30	58	62	30
A2	E. Durham	—	—	64	—	—	35	—	—	29
AG1	Dorset (Chalk)	26	39	73	20	22	33	27	27	34
	Berkshire (Chalk)	37	55	64	23	38	33	29	46	30
	Gloucestershire (Cotswolds)	16	36	53	21	19	29	12	15	20
AG2	N.E. Northants.	14	32	47	30	35	21	9	15	12
G2	S. Warwickshire	—	20	40	—	33	42	—	8	13
	E. Leicestershire	24	42	58	23	47	17	8	17	19
G	Lancashire	22	46	87	33	29	64	29	43	49
(N.W.)	(Fylde)	—	—	—	—	—	—	—	—	—
	C. Cheshire	—	—	84	—	—	38	—	—	33
G	Hereford	—	—	—	—	—	—	—	—	—
(S.W.)	(Bromyard)	10	29	30	36	44	29	7	19	21
U	W. Carmarthen	10	—	48	33	—	52	10	—	23
	N. Lancashire	—	—	61	—	—	41	—	—	34

changed little in the last 4 years. It is interesting that the strip-grazed fields mentioned above received no more P and K than other grazed or mown fields in the same districts.

Permanent grass. Although fertiliser use on leys was similar to that on barley, the 10m. acres of permanent grass in England and Wales still

TABLE 12
Manuring of permanent grass
 (cwt/acre) $\times 100$

Group	District	N			P ₂ O ₅			K ₂ O		
		1957-	1961-	1966	1957-	1961-	1966	1957-	1961-	1966
A1	N.W. Norfolk	18	—	65	7	—	15	10	—	19
A2	E. Durham	—	—	36	—	—	26	—	—	16
AG1	Dorset (Chalk)	12	20	31	5	10	11	7	11	10
	Berkshire (Chalk)	17	29	25	9	13	16	13	15	12
	Gloucestershire (Cotswolds)	5	12	22	13	11	10	5	7	7
AG2	N.E. Northants.	4	13	14	5	24	10	2	7	5
G2	S. Warwickshire	—	6	14	—	18	21	—	1	4
	E. Leicestershire	6	18	19	14	19	10	2	9	9
G	Lancashire	15	28	39	28	30	33	18	31	33
(N.W.)	(Fylde)	—	—	—	—	—	—	—	—	—
	C. Cheshire	—	—	50	—	—	23	—	—	24
G	Hereford	—	—	—	—	—	—	—	—	—
(S.W.)	(Bromyard)	5	12	13	18	25	15	3	9	9
U	W. Carmarthen	6	—	25	28	—	28	6	—	15
	N. Lancashire	—	—	24	—	—	33	—	—	20

Notes (Tables 8, 11 and 12): S. Warwickshire: the first survey was in 1960.
 N.E. Leicestershire: the area surveyed in 1966 differed from that of the previous surveys.
 C. Cheshire: this survey was done in 1965.

ROTHAMSTED REPORT FOR 1966

receive little fertiliser, no more than was used on leys 10–15 years ago. Even on the intensive dairy farms of Lancashire and Cheshire, less than two-thirds of the grazed and mown permanent grassland received nitrogen in 1966, and the average amount applied on the treated fields was only about 0·6 cwt N/acre. Nor was permanent grass more generously treated in the arable districts: in the Cotswolds and West Berkshire only 40% of the permanent grass acreage received N at an average of about 50 units per treated acre. In the surveyed areas of the east and west Midlands, covering parts of the counties of Hereford, Leicester, Northampton and Warwick, average amounts of N ranged only from 0·11 to 0·17 cwt/acre on grazed fields and from 0·17 to 0·27 cwt/acre on mown fields.

These small dressings might indicate that many farmers, particularly those producing fat sheep and cattle from grass, are still relying on clover-N, but this is not borne out by the use of P fertiliser on permanent grass, which shows fairly consistent decreases on grazed fields, and except in some arable districts, on mown fields also.

Little potassium fertiliser was used except in arable and dairying districts; amounts were similar to 1962. These results suggest that grassland farmers, particularly sheep and cattle graziers, have reacted to unfavourable prices by restricting expenditure on fertilisers for permanent grass.

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