Professional Nutrient Management Group

Report on nutrient management planning

September 2010

Contents

1. Background and aim

In 2009, the Professional Nutrient Management Group (PNMG) introduced the Tried & Tested nutrient management plan. This plan is mainly paper-based but input forms are available also in Excel and there is an associated web site at www.nutrientmanagement.org. In 2010, the PNMG commissioned a report to

i. collate and report evidence of nutrient management planning during the period following publication of the Tried & Tested nutrient management plan;

ii. review this information in the context of historical data;

iii. identify gaps in advice and support on nutrient management planning.

This report does not cover the research and development activities that form the basis for nutrient management. There is a large body of this research, current and past, funded by governments, levy bodies and commercial organizations (Defra, devolved governments, HGCA, BPEX, EBLEX, Dairyco, Potato Council, HDC, fertilizer manufacturers and distributors) and conducted by others (including ADAS, TAG, SAC, Rothamsted Research and contract research companies).

2. Information sources

Principal survey sources were:

Defra Farm Practices Survey (Defra 2010b)	Annual topics covered differ between years. Sample of 4000 farms (around 40% response rate) for population of 68,000 farms in England with at least 50 cattle, 100 sheep, 100 pigs, 1000 poultry or 20 ha of arable crops or orchards.
British Survey of Fertiliser Practice (Defra 2010c)	Annual. Stratified sample of 1500 farms in England, Scotland and Wales but with breakdown for England/Wales and Scotland. From 2000 has included supplementary questions on manure management and spreader testing.

Other sources used included the Defra Farm Business Survey, Agriculture in the United Kingdom and Protecting our Water, Soil and Air and documents at devolved government and at industry web sites.

There were differences in geographical coverage between these sources, some describing UK, others England, Scotland and Wales and others England. The data taken from the British Survey of Fertiliser Practice were for England, Scotland and Wales but those from most Defra documents were for England only.

3. Clarification of terms

3.1 Use of terms

Nutrient management and derivative terms have no concise or universally agreed definitions. Usually, nutrient management is held to cover both economic and

environmental aspects of crop nutrition (Beegle *et al.* 2000). A nutrient management plan sometimes covers amounts of nutrients required and applied and methods of application (for example in the ELS option that was available in England, Appendix 1 or the requirements outlined in Defra Protecting our Water, Soil and Air, Appendix 4) but sometimes is restricted to a nutrient balance or budget (for example in the SEPA Best Management Practice 5 for Scotland, Appendix 2, in DARD agri-environment scheme literature for Northern Ireland and in the Tir Cynnal Resource Management Plan for Wales). Further confusion is due to the use of 'NMP' sometimes to denote nutrient management plan, sometimes nutrient management planning or sometimes nutrient management practices. These terms mean different things but are used sometimes as though they were interchangeable. Clarification of terms is needed to avoid this confusion.

3.2 Nutrient management

For present purposes, nutrient management is the organized and methodical use of best management practices to maximize the effectiveness of applied nutrients and to minimize adverse effects of these applications on the wider environment. It has two components, nutrient management planning and nutrient management practices.

3.3 Nutrient management planning

This is a process, or set of processes, leading from, and including, the assembly of information to decisions affecting farm activities. Nutrient management planning can be deliberate and comprehensive or it can be unrecognised by the farmer and partial. For example, using the results of soil analysis to look up a nutrient recommendation from a table is nutrient management planning but might not be recognized as such by the farmer.

3.4 Nutrient management plan

A nutrient management plan is a record of nutrient management planning and normally is updated annually. A plan is desirable, but is not essential, for effective nutrient management planning. For present purposes, a nutrient management plan covers all aspects of nutrient supply to crops and grass so is more than just a budget or record of nutrient balances.

3.5 Nutrient management practices

These are nutrient-related activities on the farm and include the collection of information (for example soil or plant tissue sampling), the calibration and use of spreading equipment and the training of staff. Nutrient management practices always are under the control of nutrient management planning, however rudimentary that might be. Trends in practices therefore can indicate changes in the effectiveness of planning.

4. Nutrient management planning

4.1 Components

The three main components of nutrient management planning are the assembly, recording and deployment of information to control nutrient management practices. However, these components do not always occur in sequence or cover all aspects of nutrient use. For example on one farm nutrient management planning might comprise only the selection of fields for soil sampling, the examination of laboratory reports and the subsequent choice of nutrient applications from the Fertiliser Manual. Records of all

these steps might not be kept. On another farm, there might be a comprehensive system of nutrient management planning based on Tried & Tested or PLANET. Development and use of a nutrient management plan helps to ensure a methodical approach to nutrient use by directing attention to all three components.

4.2 Tools available to the farmer or adviser

Tools to assist in nutrient management planning are of two main types: those that are used in a component of nutrient management planning and those that are used to construct a nutrient management plan.

Examples of the former are the Fertiliser Manual, NVZ Guidance Leaflets, farm-gate nutrient budgets, MANNER and soil analysis reports. These are used to assist in one or more, but not all, components of nutrient management planning.

Examples of the latter are Tried & Tested, PLANET and some software packages. Use of these results in a plan that records farm and field details, intentions and actions on the farm.

Uptake and trends in both types of tools reflect the extent and intensity of nutrient management planning. Examination of the numbers of nutrient management plans alone will underestimate the effort made by farms in nutrient management planning.

4.3 Current uptake of nutrient management planning

The Defra Farm Practices Survey of 2009 provided information on use of the components of nutrient management planning in England. Information for the survey was requested from a stratified sample of 4000 farms (of whom 40% responded) representing a total population of 68000 farms in England.

Use of the components of nutrient management planning, including preparation of a plan, was related to farm size (Table 1). Larger farms were more likely to have a nutrient management plan, to sample soils regularly and to measure or assess the nutrient content of manures.

Regional differences were less consistent, probably because these were confounded with differences in types of farm (livestock versus arable). Relative to other types (with the exception of pigs and poultry), grazing livestock holdings, both lowland and LFA, were less likely to prepare a nutrient management plan, to sample soils regularly or to measure or assess the nutrient content of manures.

Table 1 Components of nutrient management planning in 2009 (% of all holdings)

	Have nutrient management plan	Take professional advice for NMP	Annually update NMP	Regular soil testing	Nutrient analysis of manures	Nutrient assessment of manures	Have manure management plan
Small	42	76	60	62	13	45	52
Medium	59	84	67	75	20	62	74
Large	72	85	72	87	35	74	82
Northeast	40	70	59	63	9	38	68
North west	30	68	57	51	16	43	64
Yorkshire	54	78	62	69	20	53	67
East midlands	62	88	79	76	16	60	61
West midlands	52	68	57	65	24	63	65
East	73	89	74	90	23	67	47
South east	51	81	62	66	17	58	56
South west	39	77	56	61	17	50	67
Cereals	73	88	73	94	19	65	57
Other crops	71	91	80	94	22	69	52
Pigs and poultry	20	88	58	33	29	61	53
Dairy	60	75	53	77	33	69	86
Grazing (LFA)	18	42	38	27	7	23	55
Grazing (lowland)	25	42	42	37	7	38	54
Mixed	56	84	58	79	24	61	77
All farms	51	80	65	68	18	54	62

Source: Farm Practices Survey, 2009

4.4 Preparation of nutrient management plans

In the Farm Practices Survey of 2009, of the holdings with a nutrient management plan, nearly half created their own plan (but 80% of all farms sought professional advice in preparing a plan), 10% used Tried & Tested and 21% PLANET (Table 2). Too much should not be read into the percentages by farm type in Table 2 as statistical errors were relatively large. However, it does appear that, relative to arable farms, livestock farms were more likely to prepare their own nutrient management plan and less likely to use the tools available.

Table 2 Method of creating a nutrient management plan in 2009
(% holdings with a plan)

	Created own plan	PLANET	Muddy Boots	Tried & Tested	Farmade/ Multicrop	Other
Cereals	35	25	15	9	13	19
Other crops	37	23	22	8	17	16
Pigs and poultry	58	7	8	21	0	7
Dairy	50	23	7	12	3	16
Grazing (LFA)	76	3	18	3	6	5
Grazing (lowland)	79	6	6	13	6	4
Mixed	61	18	14	10	2	9
All farms	47	21	14	10	10	15

Source: Farm Practices Survey, 2009

Professional advice for preparing a nutrient management plan was provided mainly by fertilizer advisers/agronomists (Table 3). Animal nutritionists were used as a source of professional advice mainly by grazing livestock enterprises in LFAs (30% of these holdings reported as using them).

Table 3 Source of professional advice in 2009
(% of holdings with a plan)

Fertilizer adviser/agronomist	86
Animal nutritionist	5
FWAG adviser	7
Other	10

Source: Farm Practices Survey, 2009

4.5 Trends in use of nutrient management plans

Some information on trends, albeit over a short period, can be gained by comparing the Farm Practices Survey of 2009 with those of 2006 and 2007. In 2006, 46% of holdings had a nutrient management plan and in 2009 this had increased slightly to 51% due to increased use in livestock enterprises (Table 4). There was a steady increase in the percentage of dairy farms with a nutrient management plan but a rather less convincing increase in grazing livestock farms, both lowland and LFA.

Table 4 Holdings with a nutrient management plan
(% of all holdings)

	2006	2007	2009
Cereals	72	72	73
General cropping/horticulture	71	70	71
Pigs and poultry	13	12	20
Dairy	45	52	60
Grazing (LFA)	15	18	18
Grazing (lowland)	19	17	25
Mixed/other	61	63	56
All holdings	46	47	51

Source: Farm Practices Survey, 2006, 2007, 2009

The Entry Level Scheme of Environmental Stewardship in England included a nutrient management plan option from introduction of the scheme until the 2009 crop year (the

Nutrient Management Plan option in the Scotland Rural Development Programme also closed to new applications in 2010). In 2007, the Farm Practices Survey showed the strong effect of this option on nutrient management plans (Table 5). However, removal of this option from ELS does not seem to have affected the number of holdings that prepare nutrient management plans, at least not yet (Table 4).

Table 5 Preparation of nutrient management plans in 2007
(% of all holdings)

Entry Level Scheme	40
LEAF	5
AIC	4
Use professional advice	2
Use software tool/soil testing	2
Other	6
No plan	53

Source: Farm Practices Survey, 2007

4.6 Tried & Tested

Tried & Tested, a paper-based nutrient management plan was launched in March 2009. It meets the requirements for a nutrient management plan set out in Defra Protecting our Water, Soil and Air (Defra 2009a).

As 51% of all farms reported having a plan, the 10% usage for Tried & Tested within these is equivalent to around 5% of the farms surveyed. Scaling up to the population of 68,000 farms indicates that some 3400 farms in England had used Tried & Tested at the time of the Survey. This is less than the 15,800 copies of Tried & Tested distributed on request by June 2010 and the difference probably is due to the inevitable lag between distribution and reported use. The input forms for the Farm Practices Survey were issued in March 2009 and were returned during March and April. Only those farmers using Tried & Tested during the month after its launch would have been detected by the survey.

The 10% usage for Tried & Tested represented an increase on the 3.8% usage recorded for the previous FMA/FWAG/LEAF/PDA version in the 2007 Farm Practices Survey.

The web site associated with Tried & Tested, www.nutrientmanagement.org, includes a library of relevant publications, case studies and links to sites related to fertilizer use, manure management, precision farming and soil analysis.

4.7 PLANET

PLANET, software for nutrient related decision-making and recording, was developed by ADAS with funding from Defra for use in England and Wales only and was launched in 2004. Since then it has been available as stand-alone software distributed on CD and embedded in several commercial software packages (for example, Muddy Boots). Currently, PLANET is being revised to be consistent with the Fertiliser Manual that has superseded 7th edition RB209 and v3 is to be launched in autumn 2010. PLANET Scotland, developed by ADAS and SAC with additional funding from the Scottish Government to be consistent with SAC Technical Notes, also is intended for launch in 2010.

The 21% usage of PLANET reported in the 2009 Farm Practices Survey for those farms with a plan was equivalent to around 7500 farms in England. This is consistent with the 8000 registered users of stand-alone PLANET v2 reported at the Farming Futures web

site (www.farmingfutures.org.uk/blog/free-nutrient-planning-kit-could-save-you-cash). The 14% usage of Muddy Boots (Table 2) probably related to embedded PLANET software. Advisers use both stand-alone and embedded versions of PLANET on behalf of their farmer customers so part of the 'created own plan' and 'other' categories in Table 2 also may have related to PLANET.

4.8 Soil testing

The 2010 report of the Professional Agricultural Analysis Group (previous report is at www.nutrientmanagement.org) summarized results from more than 200,000 soil samples taken from arable and grassland in England, Scotland and Wales and analysed by the fourteen participating UK laboratories. These samples were from whole-field sampling and excluded samples taken in precision farming. Allowing for work by non-participating laboratories, the number of routine advisory soil samples taken in 2009/2010 probably was around 250,000. The agricultural area of Great Britain for which soil testing would be recommended (arable and horticultural crops, temporary and permanent grass) was 11,054,000ha in 2009 (Defra June Survey, Scottish Government June Agricultural Survey, Welsh Assembly Government Survey of Agriculture and Horticulture, June 2009). The 250,000 soil samples therefore are equivalent to an average 44 ha/sample. If fields are sampled on average every four years, this is equivalent to around 11 ha/sample. This seems an encouraging intensity of sampling but the Farm Practices Survey revealed significant differences between farm sizes and between farm types (Table 1).

Regular soil testing by sampling and analysis for nutrients was reported for 68% of holdings in England. Regular soil sampling was reported by 94% of cereal and other crops farms but by only 27-37% of grazing livestock farms (Table 1). The Farm Practices Survey of 2006 included data on soil testing but the categories (sample every year, every other year, less often or never) were too different to those of 2009 (regularly test, do not regularly test, not applicable) to enable direct comparison. However, in 2006, the percentage of farms reporting that soils were never sampled was 1-2% for cereals and other crops farms, 18% for dairy, 36% for LFA grazing livestock and 41% for lowland grazing livestock farms. Findings in 2006 and 2009 therefore were consistent. Regular soil sampling was practised widely by arable farms, to a rather lesser extent by dairy farms, but was less common among grazing livestock farms.

4.9 Defra RB209/Fertiliser Manual

The 7th edition of RB209 was introduced by Defra in 2001. It was replaced in June 2010 by the 8th edition, now titled the Fertiliser Manual (RB209). All of the survey data reported here refer to 7th edition RB209 in England. RB209 also has been used in Wales and Northern Ireland. The arable and horticulture sections of the new Fertiliser Manual are very similar to those in 7th edition RB209 so adaptation will be straightforward for farmers and advisers. The grassland section has been changed in structure and now is much more complex. This should be acceptable on dairy farms but might restrict use on grazing livestock farms.

The Farm Practices Survey of 2009 indicated that 88% of all farmers used Defra RB209 for nutrient recommendations in their nutrient management plan and 92% used RB209 for their manure management plan. Applied to the population of farmers who had nutrient or manure management plans, this could indicate that some 30,000-40,000 farmers held copies of RB209. However, this is greater than the number of copies distributed (estimated at around 20,000) and probably reflects access by farmers to copies held and used by their advisers.

In 2009, differences between farm types in use of RB209 were quite small. For preparing a nutrient management plan, 72% of lowland grazing livestock farms and 91% of cereal farms used RB209. For preparing a manure management plan, 79% of LFA grazing livestock farms and 96% of cereal farms used RB209.

The British Survey of Fertiliser Practice for 2001, indicated that, just after launch of the 7th edition of RB209, with the attendant publicity, only 42% of the farmers questioned in England and Wales (RB209 is not used in Scotland) were aware of RB209. Awareness was lower in livestock farms (around 30%) than it was in arable and mixed farms (around 50%). The Farm Practices Survey of 2006 found 26% of all farms surveyed used RB209 for fertilizer recommendations. However, the percentage was 54-58% for cereal and general cropping and horticulture farms and 1-2% for grazing livestock farms.

Awareness and use of RB209 appeared to have increased in recent years, especially among grazing livestock farms. This probably is due to the promotion of RB209 use in crop assurance protocols and NVZ guidance.

4.10 SAC Technical Notes

SAC Technical Notes provide nutrient application recommendations for Scotland so fulfil a role similar to that of RB209 in England. Those Technical Notes funded by the Scottish Executive 'Public Good Funding' are freely available at the SAC web site (SAC 2009).

4.11 MANNER

MANNER was introduced in 1997 to provide predictions of the release of crop-available nitrogen following application of livestock manures. To date, MANNER has been available on CD, alone or with PLANET. The software was designed to be easy-to-use and to require a few simple inputs. Only 11 items of input are needed and defaults are pre-loaded. By 2005, more than 10,000 copies of MANNER v3 (introduced in 2000) had been distributed (Defra 2005). From 2010, MANNER-*NPK* will be an integral part of PLANET v3. This new version will extend output to the phosphate and potash contribution from a manure application. It is not clear at present if a stand-alone version will be available.

4.12 NVZ Guidance

NVZ guidance leaflets have been distributed to farmers in England, Wales, Scotland and Northern Ireland.

In England NVZ guidance leaflets (Defra 2009c) refer to RB209 in places but include nitrogen limits for Nmax calculation that are not based on recommendations in RB209. There is a requirement that nitrogen application must be planned by assessing crop need and the supply from the soil and from any organic manure applied. Where a derogation to the 170 kg N/ha farm organic manure nitrogen limit applies, this planning requirement is extended to phosphorus.

Guidance in Wales is similar to that in England (Welsh Assembly Government 2009).

Guidance booklets in Scotland (Scottish Government 2008) include standard nitrogen rates to be used when calculating Nmax. These are the same as the standard SAC nitrogen recommendations for grass and arable crops. As in England, additional planning requirements are placed on phosphorus where a derogation to the farm limit

applies.

Guidance in Northern Ireland uses recommendations in Defra RB209 as limits for application of nitrogen to crops other than grass and of phosphorus (DARD 2007).

During 2009, guidance leaflets were complemented in England by a series of free Defra-funded workshops for farmers and advisers and by a telephone help-line operated by Momenta.

4.13 Other nutrient management planning tools

Several other management planning tools, not covered by the Farm Practices Survey, are available.

HGCA publish a series of Topic Sheets many of which relate to nutrient use and recently have launched their booklet 'Nitrogen for winter wheat – management guidelines'. These are freely available to the HGCA web site www.hgca.com. HGCA also have introduced 'Be Precise', a knowledge transfer initiative on precision farming.

In 2009, the Potato Council published 'Crop nutrition for potatoes' available to levy payers and corporate members. To date 4000 copies have been distributed with a further print run expected. A web-based calculator is under development to complement tables in the *Fertiliser Manual*.

LEAF members have access to use LEAF Audit. This is a whole farm management tool, which incorporates nutrient management planning and signposts LEAF members to use Tried & Tested where appropriate. See www.leafaudit.org for more information.

BPEX is funding development of a decision support system to help minimize phosphorus excretion by pigs and has an environment hub at the web site www.bpex.org/KTRandD/environmentHub/default.aspx. BPEX also has published an advisory leaflet on phosphorus requirements of pigs at www.bpex.org/Publications/ResearchintoAction.aspx. This material is freely available.

EBLEX operates 'Grasswatch' that monitors grass growth across England to help in grass management. Supporting advisory leafets have been published, including optimum herbage heights for use when using the Sward Stick (moving plate device for measuring herbage height) www.eblex.org.uk/research/-Grasswatch.aspx. This material is freely available at the EBLEX web site.

Dairyco has published 'grass+', a grassland improvement manual for farmers that is available free in hardcopy or pdf from www.dairyco.org.uk/library/farming-info-centre/grass-management.aspx. Advice on grazing management and use of plate meter also is published at www.dairyco.org.uk/farming-info-centre/grassland-management.aspx. This material is freely available. Dairyco also has issued more than 2000 copies of a dairy wizard that contains a spreadsheet calculator to help farms identify current slurry storage capacity and allows them to look at the impact of different slurry management options and more than 2000 copies of the 'Cost effective slurry strategies' booklet. Nutrient management has featured in the 140 discussion groups that Dairyco runs.

Farming Futures has issued a series of facts sheets, many related to nutrient use and climate change, that are freely available at www.farmingfutures.org.uk.

Fertilizer manufacturers and suppliers provide information and services related to

nutrient management planning. These range from simple advisory leaflets covering product use to paper, software and hardware-based services. The Nmin and Nplan services of GrowHow and Yara respectively are used to predict crop nitrogen requirement. Yara also offer their N Tester handheld device for adjusting nitrogen recommendations and tractor-mounted N Sensor for variable rate application. Although some of these services can be used on grassland, their use mainly is on arable land.

Mechanized soil sampling to 90 cm was introduced as an advisory tool in the early 1990s. This has made the measurement method for soil nitrogen supply, described in RB209, practically feasible. One company, Envirofield, now operates four samplers throughout England taking samples from a total of more than 1000 fields annually.

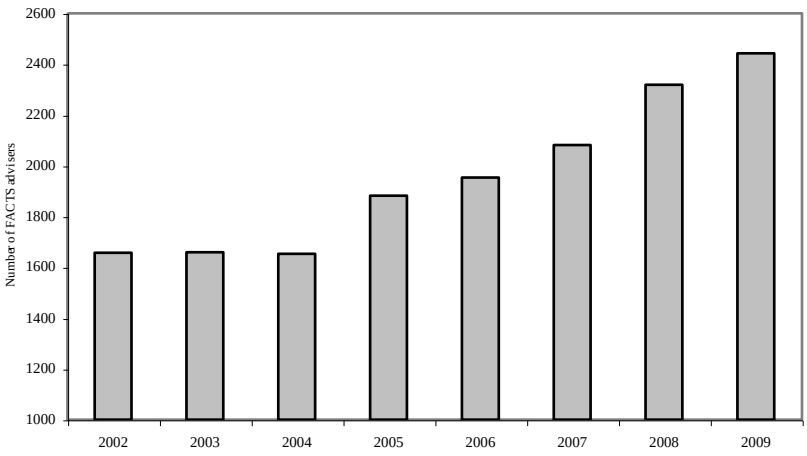
4.14 Advisers

Advisers are important as they assist farmers in nutrient management planning and they have a magnifier effect on uptake of some planning tools. A proportion, probably a large proportion in some cases, of these planning tools is used by advisers rather than directly by farmers. Numbers of theses tools distributed therefore can lead to underestimates of their impact. This probably applies especially to PLANET, MANNER and Fertiliser Manual/RB209 where the adviser can use one copy of the tool on behalf of several farmers. The magnifier effect will be less for paper-based plans like Tried & Tested that are one copy per farm (but the adviser can be a distributor for these tools, so promoting their use).

Advisers on nutrient management include those employed by organizations (commercial companies, Environment Agency, Defra, Natural England, FWAG etc.) and independent farm consultants (often members of AICC or BIAC). Most advisers who deal directly with farmers are now FACTS qualified.

FACTS (Fertiliser Advisers Certification and Training Scheme) was introduced in 1992 and converted to an annually renewable scheme in 2002. Since then the number of FACTS advisers has increased to rather more than 2400 in 2009 (Fig 1). It appears that the number might be stabilizing, probably because almost all those giving advice on nutrient use are now FACTS qualified. FACTS Qualified Advisers (FQAs) now include Environment Agency, Defra, FWAG and water company staff as well as the traditional commercial and independent advisers. Increasingly, farmers are taking the qualification. Recent changes to the scheme require all members to undergo formal training on a five-year rolling basis to help ensure they remain up-to-date as FQAs. A technical information service comprising email and phone help-lines, quarterly newsletter and on-line library is available to FQAs.

Fig 1 FACTS Annual Scheme members
(2010 number to end-June)



NVZ guidance in England and in Wales permits application of manufactured nitrogen fertiliser in closed periods to non-listed crops and of high readily available nitrogen organic manures in closed periods on registered organic farms on advice from a FACTS Qualified Adviser.

FACTS Qualified Advisers are not based evenly across the geographical area of the UK (see the map at www.basis-reg.com/agriculture/factsqualifiedadvisers.aspx) but tend to be concentrated in the mainly arable and mixed farming areas.

4.15 Catchment Sensitive Farming

The England Catchment Sensitive Farming Delivery Initiative (ECSFDI) was established in April 2006 to increase awareness among land managers of diffuse water pollution from agriculture and to encourage farm practices that helped to minimize this pollution. ECSFDI, part of the Defra-funded Catchment Sensitive Farming Programme, was targeted at 40 priority catchments and the emphasis in nutrient advice was on phosphorus. Around 50 Catchment Sensitive Farming Officers, some of whom are FACTS Qualified Advisers, work with farmers. An evaluation report was published in May 2008 (Defra 2008). At that time around 6100 farmers had received advice, 517 group events had been attended by 3882 farmers, 147 advice clinics had been attended by 497 farmers and 4736 farm visits had been made. Efforts tended to be targeted at larger farms to make most efficient use of limited staff. Up to October 2007, the reduction in phosphorus loss was estimated to be 1-3% across all priority catchments.

From 2009, the ECSFDI has been complemented by regional programmes established by the Regional Development Agencies. These cover nutrient management among other issues (www.defra.gov.uk/foodfarm/landmanage/water/csf/documents/regional-approaches.pdf).

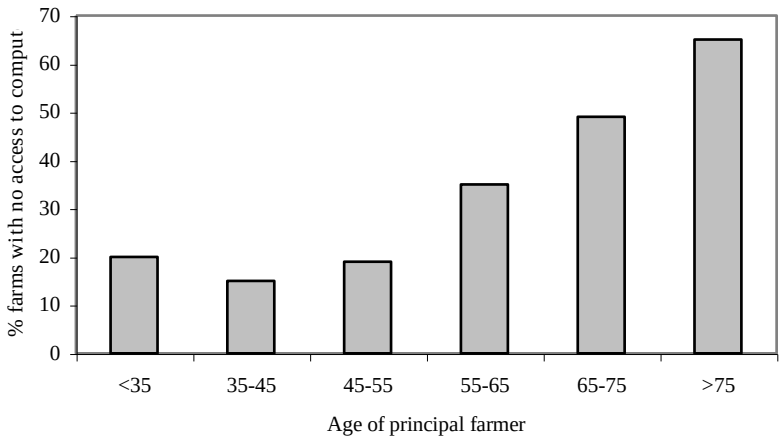
4.16 Computers and the internet

Computers and the internet are important for nutrient management planning, firstly because some of the major tools (for example PLANET, MANNER) require their use and secondly because computers provide an effective way to record and store information.

The Defra Farm Business Survey of 2001 included questions on the use of computers

on farms. It was reported that 55% of the 69,000 farms in England used a PC and 45% used the internet for business purposes. However, 28% had no access to computers or the internet for business or personal use. The proportion of farms with no access to computers was related to age of the principal farmer (Fig 2) so a reduction in this proportion over time should be expected.

Fig 2 Percentage of farms with no access to computers in 2001
(farms in England)



The Farm Practices Survey of 2006 also included questions on computer use so provides a check on progress. In that year, 75% of farms in England reported access to a computer and 25% no access. Of those with access to a computer, 13% had no access to the internet. Access to a computer was least in dairy and grazing livestock farms (Table 6).

Table 6 Farms with access to a computer in 2006
(% of all holdings surveyed in England)

Cereals	81
General cropping/horticulture	83
Pigs and poultry	87
Dairy	77
Grazing livestock LFA	70
Grazing livestock (lowland)	61
Mixed/other	79

Source: Farm Practices Survey, 2006

Despite progress, there remained in 2006 a significant proportion of farms without access to a computer and therefore restricted in the nutrient management planning tools they could use. These tended to be smaller, grassland-based farms.

4.17 Record keeping

Record keeping is a key part of nutrient management planning and the need for it is a good reason to prepare a nutrient management plan. Methods for record keeping were included in the British Survey of Fertiliser Practice for 2005-2009 (Table 7). In all years, the farm diary most commonly was used for records of fertilizer and manure applications. Around 20% of farms used a computer to record fertilizer applications and around 10% to record manure applications.

Table 7 Record keeping methods for fertilizer and manure applications where these were applied (% of farms where fertilizer or manure used, Great Britain)

	2005	2006	2007	2008	2009
Fertilizer					
Computer programme	16.3	19.6	21.1	17.6	19.0
Farm diary	40.5	38.9	40.0	41.2	42.7
Farm notebook	25.3	25.0	28.9	28.7	27.4
File record sheet	19.9	22.3	21.0	28.0	19.5
Other paper record	3.7	4.3	3.5	0.4	2.8
No records kept	10.0	9.7	5.9	5.2	4.9
Manure					
Computer programme	6.9	9.4	12.0	8.0	8.8
Farm diary	27.5	29.4	29.3	32.7	37.4
Farm notebook	15.0	14.8	18.3	18.8	18.5
File record sheet	12.7	13.4	12.7	16.8	12.9
Other paper record	1.4	3.1	2.2	0.3	2.6
No records kept	12.3	9.0	10.4	9.6	7.3

Source: British Survey of Fertiliser Practice, 2009 report

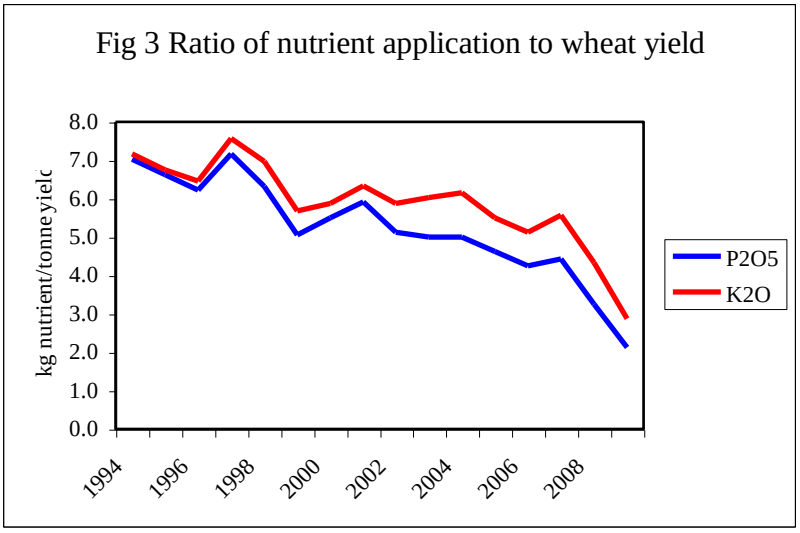
5. Nutrient management practices

5.1 Components

Nutrient management practices are of interest here as indicators of the role and effectiveness of nutrient management planning. A comprehensive survey is not required and the key components are the rates of nutrient applications, the account taken of nutrients supplied by manures, the setting of fertilizer spreading equipment and the techniques for spreading manures.

5.2 Trends in amounts of major nutrient applied

In recent decades, the overall rates of fertilizer phosphate and potash application have decreased on both tillage crops and grassland (Appendix 5). The overall rate of fertilizer nitrogen application has decreased on grassland but has remained fairly stable on tillage crops. Since the mid-1990s, the amounts of fertilizer phosphate and potash applied to the major arable crops have been less than the amounts removed at harvest. For example, the ratio of fertilizer phosphate and potash application to national average wheat yield has declined from around 7 kg nutrient/t in 1993 to less than 3 kg/t in 2009 (Fig 3). These amounts now are much smaller than typical removal in grain alone (7.8 kg P_2O_5/t and 5.6 kg K_2O/t). In 2009, results of the British Survey of Fertiliser Practice indicated that nearly 70% of the wheat area in England, Scotland and Wales received no fertilizer phosphate or potash. It seems unlikely that this conforms to recommendations for nutrient use as recommended rates of application to wheat have not changed significantly since the mid-1990s. It is more likely that agronomic requirements have taken second place to short-term considerations based on fertilizer prices.



5.3 Nutrients from organic manures

The nutrient value of organic manures has been expounded for several decades with variable impact. Uptake of MANNER indicates interest but survey data are not consistent with widespread appreciation of nutrient values. The British Survey of Fertiliser Practice reports for 2003, 2006, 2007 and 2009 included tables showing average and overall rates of nutrient application separately for fields where manures had been applied and for fields where manures had not been applied. Results for 2009 were typical for all years and showed that some account might be taken of manure nutrients but that this often might be inadequate (Table 8). The differences in application rates of phosphate and potash between fields with and without manure were much smaller than might have been expected for arable crops with the exception of potatoes. For example the average application of fertilizer phosphate to winter wheat was 9 kg P_2O_5/ha in fields with manure and 18 kg P_2O_5/ha in fields without manure. The difference of 9 kg P_2O_5/ha was much smaller than the amount of available phosphate that would have been supplied by a manure application

Table 8 Overall nutrient application rates with and without applications of organic manures in 2009 (kg/ha, England/Scotland/Wales)

	N		P_2O_5		K_2O	
	with manure	without manure	with manure	without manure	with manure	without manure
Winter wheat	180	192	9	18	21	23
Winter barley	138	142	20	23	29	35
Potatoes	155	185	108	164	176	291
Sugar beet	88	101	13	24	64	80
Spring osr	94	123	18	10	41	12
Winter osr	176	191	5	23	12	26
Peas – feed	0	1	6	40	47	67
Beans – feed	16	10	33	43	41	52
Forage maize	50	81	39	20	44	55

Source: British Survey of Fertiliser Practice, 2009

There are several reasons why full account might not be taken of nutrients in manures. One is the difficulty of assessing the nutrient content in a particular batch of manure. Manure analysis often is advocated but taking a representative sample can be very difficult. The tables of typical nutrient contents in *RB209*/*Fertiliser Manual* would not be available where these documents are not used. Ongoing research into near infrared reflectance spectroscopy (NIRS) for analysis of organic manures could reduce the time needed for, and cost of, manure analysis and promote the practice (LINK project

LK0988).

5.4 Setting of fertilizer spreaders

For proper operation, fertilizer spreaders require calibration to ensure correct rate of application and tray-testing to ensure even spreading. Usual recommendation would be for calibration before first application in spring and whenever the fertilizer product is changed and for at least annual tray-testing.

Questions on tray-testing were included in the British Survey of Fertiliser Practice in 2000, 2005-2009 and on calibration in 2000. In 2000, 66% of all spreaders had been calibrated at least once and 28% of spreaders had been tray-tested (or nozzle tested for liquids) at least once since first use. A summary of results for 2005-2009 was provided in the 2009 report. Data in this summary differed slightly to those in 2005-2008 annual reports indicating some re-analysis and are shown in Table 9.

Table 9 Frequency of tray-testing fertilizer spreaders
(% of all farms)

	2005	2006	2007	2008	2009
At each change of fertiliser type	3	5	7	7	5
Once per year	39	38	36	37	36
Less than once per year	12	11	13	11	10
Factory set, does not need checking	11	10	9	8	7
Never checked	26	21	22	23	23
Other	3	7	4	2	2
No spreader	3	3	4	8	6
Contract applied	4	5	5	4	10

Source: British Survey of Fertiliser Practice, 2009 report

The frequency of tray-testing remained fairly stable between 2005 and 2009. Around 40% of farms tested spreaders at least once per year as would be recommended and around 30% used but never tray-tested their fertilizer spreader.

These survey data indicate scope for improving nutrient management planning by better organization of spreader testing.

5.5 Techniques for manure application

Techniques for spreading slurry were recorded in the Farm Practices Survey 2001 and in the British Survey of Fertiliser Practice every year from 2005. The Farm Practices Survey showed that in 2001, 74-91% of the slurry produced was broadcast, 6-7% band spread, 0-1% shallow injected, 0-2% deep injected, 1-13% spread by rain gun and 3-11% spread by rotating boom. The British Survey of Fertiliser Practice expressed data as proportions of farms rather than of slurry produced. In all years, broadcasting was the dominant method but there was a trend towards band spreading (trailing hose, trailing shoe) and shallow injection (Table 10). There was at the time no regulatory requirement for a change from broadcasting.

Table 10 Techniques for applying slurry
(% of farms surveyed that spread slurry)

	Broadcast	Band spread	Shallow injection	Deep injection	Rain gun	Rotating boom
2005	92	5	1	0	1	1
2006	86	6	1	1	2	4
2007	87	8	2	0	2	1
2008	89	8	5	1	2	2
2009	88	9	6	1	1	1

Source: British Survey of Fertiliser Practice, 2009 report

The time of manure incorporation after application also was recorded in 2005, 2006 and 2009 though the method of reporting differed between years (as % of farms in 2005 and 2006 but as % of area applied or manure amount in 2009). In 2009, manures were incorporated within 24 hours on 42% of the tillage land to which manures were applied (Table 11). A rather greater percentage might have been expected as the new NVZ rules introduced in England required incorporation within 24 hours from January 2009 in NVZs designated by 2002.

Table 11 Incorporation of manures after application in 2009
(% area on tillage fields)

6 hours or less	6-24 hours	1-7 days	More than 7 days	Not incorporated
12	30	40	11	6

Source: British Survey of Fertiliser Practice, 2009 report

5.6 Precision farming

The Farm Practices Survey of 2009 included data on the use of precision farming technology, an indicator of attention to fertilizer and pesticide applications.

Use of different components of this technology was greater on larger than on smaller farms and was greatest on cereal and other crops farms and least on grazing livestock farms (Table 12). This might be expected as the technology is best suited to larger fields and can be costly to introduce.

Table 12 Holdings using precision farming technology in 2009
(% of all holdings in England)

	GPS	Soil mapping	Yield mapping	Variable rate application	Telemetry	Guidance	Auto-steering
Large	7	11	6	10	0	7	3
Medium	14	14	8	14	1	13	6
Small	25	23	13	24	2	23	13
Cereals	23	26	16	23	2	22	13
Other crops	21	26	12	24	2	22	13
Pigs and poultry	4	3	3	7	0	4	1
Dairy	10	11	3	11	0	6	1
Grazing (LFA)	2	5	0	2	0	1	0
Grazing (lowland)	0	3	2	4	0	1	1
Mixed	6	13	6	14	0	9	2
All farms	11	14	7	13	1	11	6

Source: Farm Practices Survey, 2009

5.7 Feed management

Considerable amounts of nutrients are imported to livestock farms in livestock feeds. In the twelve months to June 2010, nearly 10 million tonnes of feeds were produced in England, Scotland and Wales (Defra 2010a) (Table 13).

Table 13 retail production of feedstuffs in GB 2009/10 ('000 tonnes)

Cattle and calf feed	3840
Pig feed	1427
Poultry feed	3054
Sheep feed	745
Horse feed	197
Other compounds, blends, concentrates	364
Other straights	145
Total feeds	9772

Source: Defra GB Animal feed statistical notice – June 2010

Of the 3.8 million tonnes of cattle and calf feed, around 3 million tonnes was for dairy cattle or calves leaving around 800,000 tonnes for beef.

Nitrogen and phosphorus concentrations in the feed raw materials were taken from The Feeds Directory (Ewing 1997) and used to estimate the total amounts of these nutrients in the feeds (Appendix 6). In the twelve months to June 2010, around 290,000 t N and 126,000 t P_2O_5 were supplied to livestock farms in feed (this excludes Northern Ireland). The phosphate content of feed is smaller than the 220,000 t P_2O_5 estimated by Withers *et al.* (2001) but this reflects the reduction in cattle population since 2000 and the exclusion of Northern Ireland.

Most livestock farmers probably do not appreciate the amount of phosphate imported in feed. A one-off calculation of farm gate phosphate balance would draw attention to the extent of this 'invisible' import. However, regular estimation of the phosphate applied in organic manure and soil testing should ensure benefit is gained from the imported phosphate.

Calculation of a phosphate balance also might draw attention to the need to match nutrient supply from imported feeds to animal requirements.

There may be potential for reducing the nitrogen and phosphate contents of feeds for pigs and cattle without impairing animal performance (for example see AFBI (undated)). A decision support tool to help reduce phosphorus excretion by growing and finishing pigs is under development and research into low protein diets for pigs is underway (BPEX undated).

5.8 NVZ rules

The revised NVZ rules introduced in England in 2009 brought a more prescriptive approach to nitrogen use and included measures intended to improve nitrogen management. Examples of the latter are the need for risk assessment where organic manures are used and planning of nitrogen application by assessing soil nitrogen supply, nitrogen requirement of the crop and any nitrogen contribution from organic manures. The full impact of these new rules on nutrient management practices has yet to be seen in survey data.

The Rural Payments Agency reported just 41 failures of NVZ rules in Cross Compliance inspections during 2009, 67 failures in 2008 and 83 failures in 2007. The most common reasons for failure were lack of adequate farm records in 2008 and 2009 and lack of records, exceeding the field limit for organic manure application and exceeding crop nitrogen requirement in 2007 (RPA 2010).

6. Role of nutrient management planning

6.1 Driver of change

Four main drivers of change in nutrient management practices are farm costs, nutrient management planning, regulations and technology. These drivers interact and identifying all their separate effects in a particular situation can be difficult if not impossible. However, some conclusions can be drawn.

Firstly, farm input costs are important and a short-term benefit from a reduction can outweigh longer-term risks. This is illustrated by the trends in fertilizer phosphate and potash applications where ‘P K holiday’ has become a widely used euphemism for allowing soil reserves to deplete. At some point, the negative phosphate and potash balances in arable crops will result in a decrease, perhaps quite sudden, in crop yields. Until then, the caution indicated by nutrient management planning has taken second place to the immediate benefit of lower fertilizer costs.

Secondly, although regulations might have a prescriptive component, they can encourage elements of effective nutrient management planning. For example, NVZ rules require assessment of the nitrogen supply to, and requirement of, crops and the keeping of adequate records of intended and actual nitrogen applications.

Thirdly, new technology can affect nutrient management planning by extending the information available to the farmer or adviser. For example, development of mechanized soil sampling to 90cm depth made widespread measurement of soil mineral nitrogen practical. Increasing use of computers and extension of broadband should improve access to information and record keeping.

Fourthly, there can be a two-way interaction between nutrient management planning

and practices. During periods of change, practices can affect planning as well as vice-versa. Precision farming, made possible by GPS and other technologies, has spawned new ways of assessing crop nutrient need and of recording application data.

The four drivers of change seem only occasionally to work in isolation. Greatest effect on nutrient management practices might be expected where they work in a mutually supportive way. Nutrient management planning, with its economic and environmental goals, can then play a central co-ordinating role. In fact, integration seems to be proceeding as guidance on regulations now commonly refers to RB209, PLANET, MANNER and FACTS Qualified Advisers while the internet is broadening the range of freely available advisory documents and tools.

6.2 Benefits of nutrient management planning

By promoting best practices, nutrient management planning should bring both economic benefit to the farmer and environmental improvement. However, actual and perceived benefits are very difficult to quantify. Some information on the perceived benefits of a nutrient management plan (note that a plan is only one aspect of nutrient management planning) was provided by the Farm Practices Survey in 2009. Over all surveyed farms that had a plan, 37% reported they could see an economic benefit (Table 14). A smaller percentage of grazing livestock farms reported seeing an economic benefit than did dairy or cropping arms.

Table 14 Benefits of a nutrient management plan in 2009
(% farms with a plan)

	Financial benefit seen
Cereals	38
Other crops	40
Pigs and poultry	26
Dairy	40
Grazing livestock LFA	30
Grazing livestock (lowland)	20
Mixed	37
All farms	37

7. Present gaps in provision and uptake of nutrient management planning

There are clear differences between farm types in the extent of nutrient management planning. Arable farms are well provided for in nutrient management tools, generally make good use of them and are receptive to new technology. For example, there is little likelihood of improving on the 94% of cereals and other crops farms that report regular soil testing. RB209/the Fertiliser Manual, NVZ Guidance Leaflets and PLANET are suitable tools for these farms where they re used directly or through advisers. While there is always scope for improvement, these farms do not appear to need more management tools, just to make even more use of those already available.

However, the situation seems to be quite different in grazing livestock farms. Relative to arable and dairy farms, grazing livestock farms are less likely to:

- have a nutrient management plan
- use professional advisers to help formulate a plan
- have access to a FACTS Qualified Adviser
- use RB209, PLANET or other tools available for nutrient management planning
- update a plan annually
- conduct regular soil sampling

- sample manures for analysis
- assess the nutrient content of manures
- use a computer or have access to the internet
- see a financial benefit from having a nutrient management plan

There are other differences between arable and grazing livestock farms. For several years, the Farm Business Survey has shown that net farm income has been lower for grazing livestock than for other farm types. Investment by commercial companies in nutrient management planning tools and in practices like precision farming has been directed largely towards the more profitable arable sector.

Grazing livestock farms are large in number and in total land area. In 2009, temporary grass and grass more than five years old (excluding rough grazing) accounted for 7.3 million ha in the UK (Defra 2009). Allowing around 1 million ha for dairy enterprises leaves an area for grazing livestock enterprises that is about the same as that for all cropping. In 2008, there were 66,000 holdings with beef cattle (on 57,000 of which there were less than 50 head) and 74,000 holdings with breeding sheep (on 46,000 of which there were less than 125 head) (Defra 2009). Most of these farms in England would not be included in the Farm Practices Survey (minimum 50 cattle or 100 sheep) but it seems unlikely that nutrient management would be any more effective on excluded farms than it was on those surveyed.

There appears to be a gap in the provision of nutrient management planning tools for grazing livestock farms and scope for greater uptake by these farms. Few of the existing tools are suitable for grazing livestock farms. The Fertiliser Manual, especially the re-structured grassland section, is likely to be seen as too complex. This is not a statutory document in England and Wales so, in principle, a simpler advisory document could be developed. However, recommendations to use RB209 or the Fertiliser Manual are embedded in much crop assurance and regulatory guidance so negotiation would be needed for such a development.

Some 60-70% of grazing livestock farms had access to a computer in 2006 so PC or web based nutrient management planning tools could be suitable now and increasingly become so. However, uptake probably would be eased if these tools were not too complex and if a clear economic benefit from their use could be demonstrated. For instance, a stand-alone version of MANNER-*NPK* might be suitable whereas, embedded in PLANET, it would not be used.

8. Conclusions

Several broad conclusions can be drawn:

a. A wide range of nutrient management planning tools already is available, including advisory documents and software, advisers and paper or computer-based plans.

b. Many of these tools are complex and depend on technical skills and knowledge or access to, and familiarity with, computers and the internet.

c. Uptake of planning tools generally is good among arable farms and larger farms. In particular, these farms should have little difficulty implementing the new Fertiliser Manual or NVZ Guidance. Both PLANET and Tried & Tested are suitable for nutrient management plans.

d. Nutrient management practices also are most advanced on arable farms but there

appears to be scope for improving the use of nutrients in organic manures. A stand-alone version of the new MANNER-*NPK* would be helpful. Currently, this version is expected to be available only embedded in PLANET.

e. Nutrient management planning on dairy farms may be less detailed than it is on arable farms but most farms have a formal plan and there is a good uptake of soil analysis.

f. Uptake of nutrient management planning is relatively low among grazing livestock (beef and sheep) farms. Low inputs and low margins influence the level of interest. The range of available planning tools is less suitable for these farms due to their type, complexity and requirement for computer use.

g. Most grazing livestock farms are small, too small to be included in the Farm Practices Survey. In total, they account for around half the agricultural area of the UK, although their input use will be low as typified by mainly extensive grassland systems.

h. The scope for improving nutrient management planning and practices is greatest in grazing livestock farms. However, improvements depend on whether this is a business and environmental priority and the availability of appropriate planning tools. In particular, a simplified version of the Fertiliser Manual grassland recommendations would be helpful.

9. Action points

9.1 Priorities

Nutrient management in the UK is evolving and generally in the right direction. If asked, most farmers and advisers appear to recognize the need to make best use of nutrients but some do not translate this into practice. There are several good reasons for this, including costs, time requirement and lack of information or tools. Three priority areas can be identified where these barriers to progress need to be tackled:

9.2 Grazing livestock farms

Good nutrient management needs to be promoted among grassland farmers (especially lowland and LFA beef and sheep). Benefits of nutrient management need to be explained clearly and available planning tools identified and their use encouraged. Methods might include:

Leaflets: As the number of these farms is large and their geographical distribution is wide, hard-copy leaflets probably represent the best method of communication. Distribution could be through the field staff of PNMG member organizations. Large documents are unlikely to be welcomed and a series of concise, single-issue leaflets might be best. HGCA Topic Sheets and Natural England Technical Information Notes might be suitable models. Examples of issues include calculating a farm-gate phosphate balance, value of soil sampling, nitrogen use for grazed grass (simplified version of recommendations in the Fertiliser Manual), best use of manures, value of spreader calibration. Emphasis would need to be on the economic benefits to the farmer with quantified examples.

Recording system: Adequate records are essential for nutrient management and their lack is the most common NVZ failure. Full nutrient management plans like Tried & Tested might be too daunting but a simpler paper-based nutrient recording system could

be developed based on the field record sheets of Tried & Tested. This would not be a nutrient management plan but would be a step on the way to one. A potential problem would be dilution of Tried & Tested promotion.

9.3 Effective use of organic manures

The potential nutrient value of organic manures needs to be promoted among all farm types. This is not a new issue and progress will not be achieved easily. However, the potential benefits, both economic and environmental, are large. Methods might include:

MANNER-*NPK*: A stand-alone version would be very useful as most of the farms dealing with manures will not use PLANET but some would use the much simpler MANNER-*NPK* (assuming this is indeed similar in input requirements to MANNER).

Guidance on manure sampling and analysis: There is guidance in the Fertiliser Manual but a practical stand-alone guide could be helpful for smaller livestock farms. This could include guidance in interpreting manure analysis reports (for example as one of the single-issue leaflets mentioned above). The Excel tools for converting units (for example, mg/kg dry-matter to kg/tonne fresh material) developed for FACTS might be adapted for wider use.

Guidance on spreader setting: Most guidance (for example that in the Fertiliser Manual) provides the crop available nutrient content from information on the type of manure, soil type and date of application. In practice, the farmer often needs to decide how much manure to apply to achieve a desired rate of nutrient (usually nitrogen) application. Both questions are suited to the type of plastic (for example www.datalizer.com) or cardboard (for example www.create-this.co.uk) slide-rules that have been used in the past for nitrogen recommendations and manure nutrient calculations (Norsk Hydro Fertilizers Nitro-Top Programmer and Hydro Organic Nutrient Calculator)

9.4 Spreader setting and calibration

The benefits of regular calibration and tray-testing of fertilizer and manure spreaders need to be promoted among all farm types. Calibration of fertilizer spreaders (for rate of application) is important for all farms. Tray-testing (for evenness of application) is important mainly in arable farms. Most grazed grass is grown on the linear part of the nitrogen response curve so unevenness of application has no effect on overall yield or risk of nitrate leaching. Calibration and care in bout matching is a requirement for all manure spreaders.

Spreader calibration and tray-testing require knowledge and skill but are boring and time-consuming jobs. Motivation might be improved by demonstrating the yield and financial costs of imprecision in rate and evenness of application. This could be done by updating existing, but old, analyses (for example, Richards 1985). There could be opportunities for joint promotion with the AEA, spreader testing companies and FACTS.

References

AFBI (undated) Technical Notes: *Reducing nitrogen in pig slurry*, *Reducing phosphorus in pig slurry* and *Low Phosphorus diets for dairy cows help the environment and maintain dairy cow performance*. www.afbini.gov.uk/publication-scientific-slurry-technical-notes.pdf

Beegle D B, Carton O T and Bailey J (2000) Nutrient Management Planning: Justification, Theory, Practice. *Journal of Environmental Quality*, **29**, 72-79.

BPEX (undated) Current research and development programmes www.bpex.org/KTRandD/ResearchAndDevelopment/CurrentProjects.aspx

DARD Nutrient management planning. www.ruralni.gov.uk/index/environment/countrysidemanagement/nutrient_management_planning.htm (at www.ruralni.gov.uk, select *Countryside management* then *Nutrient management planning*).

DARD (2007) Guidance booklet for Northern Ireland farmers on the requirements of the Nitrates Action Programme (Northern Ireland) Regulations 2006 and the Phosphorus (Use in Agriculture) (Northern Ireland) Regulations 2006. www.ni-environment.gov.uk/dard-nitratesguidance.pdf.

Defra (2005) Manure Nutrient Evaluation Routine (MANNER-*NPK*) Final report, project KT0105.

Defra (2008) ECSFDI Evaluation Report, May 2008. www.defra.gov.uk/foodfarm/landmanage/water/csf/monitoring.htm.

Defra (2009a) Protecting our Water, Soil and Air. A Code of Good Agricultural Practice for farmers, growers and land managers. www.defra.gov.uk/foodfarm/landmanage/cogap/documents/cogap090202.pdf.

Defra (2009b) Agriculture in the United Kingdom, 2009. www.defra.gov.uk/evidence/statistics/foodfarm/general/auk/latest/documents/AUK-2009.pdf.

Defra (2009c) Guidance for Farmers in Nitrate Vulnerable Zones. www.defra.gov.uk/environment/quality/water/waterquality/diffuse/nitrate/help-for-farmers.htm.

Defra (2009) Evaluation of Cross Compliance. www.defra.gov.uk/corporate/consult/gaec/adas-evaluation-xc.pdf

Defra (2010a) GB Animal feed statistical notice – June 2010. www.defra.gov.uk/evidence/statistics/foodfarm/food/animalfeed/documents/mcompspn.pdf.

Defra (2010b) Farm Practices Survey. www.defra.gov.uk/evidence/statistics/foodfarm/enviro/farmpractice/

Defra (2010c) British Survey of Fertiliser Practice. www.defra.gov.uk/evidence/statistics/foodfarm/enviro/fertiliserpractice/index.htm

RPA (2010) 2009 Inspection statistics

www.rpa.gov.uk/rpa/index.nsf/293a8949ec0ba26d80256f65003bc4f7/8a2b5628f5ca537d802576f5004ce208!OpenDocument.

Richards I R (1985) Effects of inaccurate fertilizer spreading on crop yield and quality in the UK, *Proceedings of the Fertilizer Society, No. 240*.

SAC (2009) Technical Notes. www.sac.ac.uk/consulting/services/c-e/crops/publications/technotes/.

Scottish Government (2008) Guidelines for farmers in nitrate vulnerable zones. www.scotland.gov.uk/Publications/2008/12/12134339/0.

SEPA BMP 5:Nutrient management plan. http://apps.sepa.org.uk/bmp/ShowPractice.aspx?bmpNumber=5 (at www.sepa.org.uk, select *Land* then *Agriculture* then *Diffuse pollution* then *Best Management Practices* then *Planning and management*).

Welsh Assembly Government, Tir Cynnal: Resource Management Plan, Soil nutrient management plan. http://cymru.gov.uk/depc/publications/environmentandcountryside/farmingandcountryside/farmingschemeinformation/agri-env/tircynnal/soilnutrientmanagementplan/soilnutrientmanagementplane.pdf;jsessionid=jxh9M7Spkkr5JYlgzRpQyvQzvS7PX2Q0dLrcyZY20k3psnpCmnMP!-2005468515?lang=en&ts=3
(at http://cymru.gov.uk, select *Environment and countryside* then *Farming and countryside* then *Farming and scheme information* then *Agri-environment schemes* then *Tir Cynnal* then *Documents*).

Welsh Assembly Government (2009) Nitrate Vulnerable Zones in Wales. Guidance for Farmers. http://wales.gov.uk/docs/desh/policy/091201nvzworkbooken.pdf .

Withers P J A, Edwards A C and Foy R H (2001) Phosphorus cycling in UK agriculture and implications for phosphorus loss from soil. *Soil Use and Management*, **17**, 139-149.

EM2 Nutrient management plan

A nutrient management plan should take into account all sources of nutrient supply as well as soil nutrient status and the influence of soil type, rainfall and irrigation. The plan should follow a recognised fertiliser recommendation system (see appendix 1 for suggested guidance) and should be prepared in conjunction with a FACTS (Fertiliser Advisers Certification and Training Scheme) qualified person. A nutrient management plan must be documented and include the following steps:

- Maintain an up-to-date soil analysis. Soils must be analysed for pH, P, K, and Mg every three to five years, depending on the cropping system. Use the results to adjust inputs of lime and phosphate, potash and magnesium nutrients.
- Assess the nutrient requirement of the crop using a recognised fertiliser recommendation system.
- Assess the nutrient supply from organic manures (see appendix 2 for suggested guidance).
- Calculate the need for fertiliser nutrients by deducting the contribution from organic manures from the crop nutrient requirement.
- Spread organic manures and fertilisers as accurately and uniformly as possible. Equipment should be in good working order and recently calibrated.
- Keep clear field records of cropping, organic manure and fertiliser applications. This will aid future decisions on nutrient management and demonstrate the practical outcome of the plan.
- Update the plan at the start of each cropping year.

A nutrient management plan completed for other schemes (such as a farm assurance scheme or LEAF) will count as a nutrient management plan under this option, providing it includes all the steps described above.

Appendix 2 Current nutrient management plan in SEPA BMP guidance (http://apps.sepa.org.uk/bmp/ShowPractice.aspx?bmpNumber=5)

BMP 5: Nutrient management plan

Background

Nutrients are imported onto farms, in the form of inorganic fertiliser, animal feed and imported manure and exported in crop and livestock products. Calculated nutrient input-output balances indicate that many farms have an annual surplus of N and P (for example of calculations see Frost et al, 2002). The size of annual surplus can vary widely, but is generally greatest on intensive livestock farms (eg dairy, pig and poultry) and least on arable farms. The result of this relationship between nutrient surplus and farm type has resulted in a broad geographical distribution to the increase in soil N and P status, being greatest in the intensive dairy areas of the west as well as more localised surpluses associated with individual poultry and pig operations.

Description

A Nutrient Management Plan is a systematic way of considering all nutrient uses on a farm in order to achieve a closer balance between nutrient inputs and outputs. Nutrient balances can be calculated for the whole farm (farm gate) or individual fields. Closer balances between inputs and outputs can reduce nutrient surpluses and help to minimise losses. A key factor in the development of a Nutrient Management Plan relates to the efficient utilisation of nutrients contained in animal waste materials (dung and urine). Nutrient additions in the form of organic manures require to be compensated by reduced use of inorganic fertilisers. Outline nutrient plans and help to develop them are given in The 4 point plan and PEPFAA Code (2005). Nutrient planning is a requirement for farms situated within Nitrate Vulnerable Zones. A computer based (farm/field) recommendation system is available (see Planet or EMA) and is under continual development and refinement (note caution may be required when applying recommendations to Scottish Farms). Insufficient land area for receiving livestock waste is also an issue for some farms (see BMP 26). A second important feature of a nutrient management plan is matching nutrient supply with crop demand in order to minimise the potential for leaching of excess nutrients, particularly N. However, assessing the appropriate rate of N for any given crop is difficult due to uncertainties in climatic factors such as temperature and rainfall; above average rainfall years usually result in greater leaching of N. Since a substantial component of N leaching occurs during the autumn after crop harvest, especially when land is ploughed, a key objective of a nutrient management plan is to minimise the quantity of nutrients remaining in the soil after harvest, whilst maintaining crop yield. A range of information is available to help predict soil nitrogen contents prior to fertiliser application (see ref 186) and/or the computerised recommendation scheme (Planet). Sampling soil shortly before nitrogen application can be particularly useful where large dressings of organic manures have been applied in the autumn or early winter and it is not clear what nitrogen residues remain in the spring (see BMP 94). For P and K it is, generally, possible to achieve a good balance of inputs versus the sum of off-takes plus any deliberate excess in inputs to raise the soil nutrient status, it is more difficult for N because of the various chemical forms and transformation processes. Optimum agronomic and environmental conditions are achieved when nutrients are used at recommended application rates. Regular soil analysis and nutrient budgets can help to optimise nutrient availability. Calculate the likely nutrient off take in the harvested part of the crop about to be sown and match fertiliser applications to expected yields and soil nutrient status. For soils having an adequate soil P status, maintenance P applications should be applied. It is particularly important to include the P content of any manure which will be applied to the land.

Appendix 3 Nutrient management plan of the Downs and Harbours Clean Water Partnership
(www.cleanwaterpartnership.co.uk/section4_2.html)

Nutrient Management Plans

A Nutrient Management Plan is a systematic way of considering all nutrient uses on a farm in order to achieve a closer balance between nutrient inputs and outputs. Nutrient balances can be calculated for the whole farm (farm gate) or individual fields. Closer balances between inputs and outputs can reduce nutrient surpluses and help to minimise losses.

Nutrient management plans can be a highly cost-effective management practice, since long-term use of nutrient management plans has demonstrated economic benefits and higher profitability to farmers. Savings are highly dependent on the amount of "over-fertilisation" taking place prior to a nutrient management plan being written.

A good NMP can help you to:

- Make the most of the nutrients in your soil
- Avoid wasting money on overuse of fertilisers
- Increase the quality and yield of crops
- Unlock the value of nutrients contained in slurry and manure
- Reduce the risk of pollution
- Nutrient Management Plans are a requirement of the Nitrate Vulnerable Zone (NVZ) Regulations

Nutrient management plan

- **A nutrient management plan will help you to make the most efficientuse of inorganic fertilisers and maximise the use of nutrients containedin any organic manures that you apply.**
- **If you use organic manures, you should combine this plan with a manuremanagement plan.**

A nutrient management plan will help you decide upon lime and fertilizer use, taking account of all sources of nutrient supply, as well as soil nutrient status, and the influence of soil type and rainfall.
Following the plan will minimise the risk of pollution resulting from the over-application of nutrients.

In Nitrate Vulnerable Zones you must comply with the mandatory rules, and only apply manufactured nitrogen fertilisers and organic manures according to crop requirement and at certain times. You must keep records that enable the Environment Agency to check what you have applied (reference 24). This is currently a cross compliance requirement.

Good practice

147. If you have already produced a nutrient management plan you may wish to check it is clearly set out and includes the steps in the following paragraphs. The "Tried and Tested" plan will meet all the advice and criteria set out below (reference 55).

148. Soils should be analysed for pH, P, K, and Mg every three to five years, depending on the cropping system. Use the results to adjust inputs of lime and phosphate, potash and magnesium nutrients.

149. Assess the nutrient requirement of the crop using a recognised fertilizer recommendation system (e.g. RB209 or PLANET). If you receive professional advice on your plan, ensure that you use a current FACTS (Fertiliser Advisers Certification and Training Scheme) qualified person.

150. Assess the nutrient supply from organic manure. Consider if a laboratory or on-farm analysis is necessary. Make sure you obtain representative samples of manure for analysis. You may need to thoroughly mix the contents of slurry stores.

151. Calculate the need for fertiliser nutrients by deducting the contribution from organic manures from the crop nutrient requirement.

152. Keep clear and accurate field records of your cropping and of all applications of fertilisers, livestock manures and organic manures. This will help future decisions on nutrient management and demonstrate the practical outcome of the plan.

153. Update the plan at the start of each cropping year.

Appendix 5 Overall nutrient application rates, England, Scotland and Wales

Fig A3a Overall N application rate Great Britain

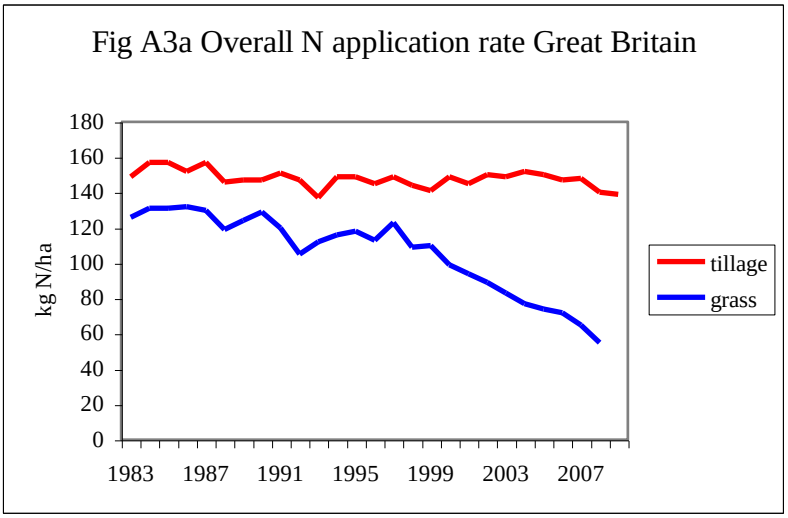


Fig A3b Overall P_2O_5 application rate Great Britain

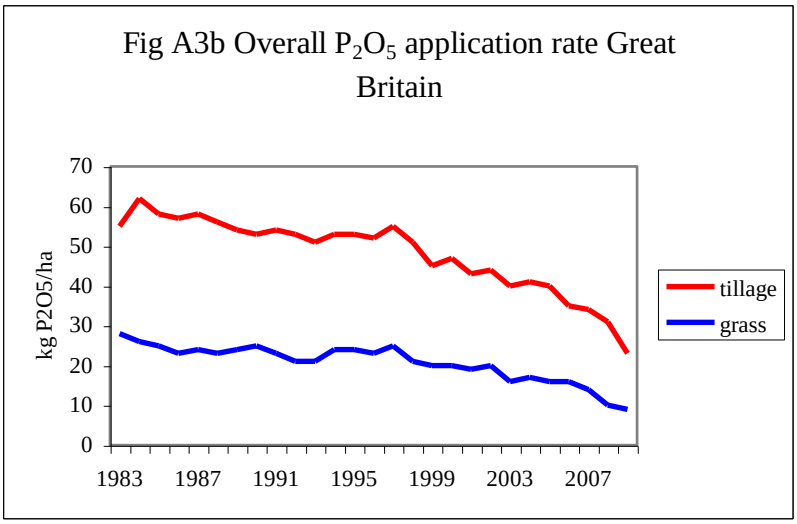
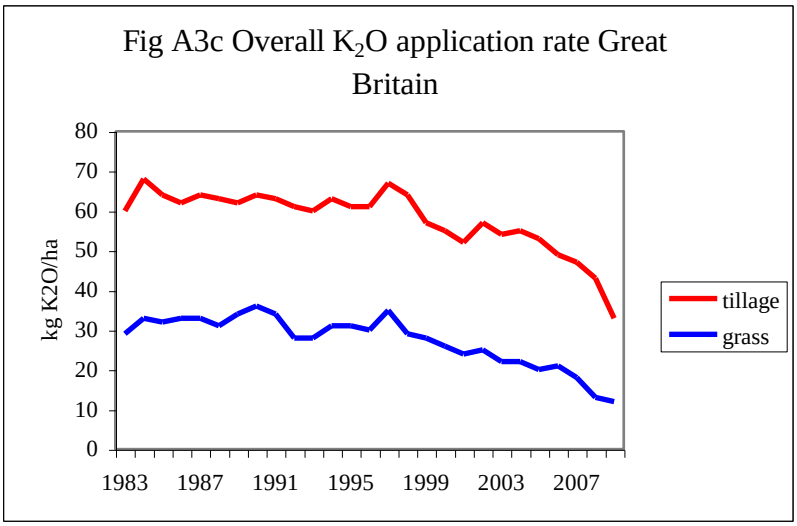


Fig A3c Overall K_2O application rate Great Britain



Appendix 6 Nitrogen and phosphorus in feed raw materials 2009/2010

	000t	% N	% P	000t N	000t P_2O_5
Wheat	2805	1.79	0.30	50.2	19.3
Barley	872.6	1.69	0.34	14.7	6.8
Oats	92.2	1.62	0.30	1.5	0.6
Whole and flaked maize	113.3	1.37	0.27	1.6	0.7
Rice bran extractions	15.3	2.14	1.51	0.3	0.5
Maize gluten feed	53.2	3.03	0.88	1.6	1.1
Wheat feed by-product	846.5	2.41	1.03	20.4	20.0
Other cereal by-products	166.2	2.00	1.00	3.3	3.8
Distillery by-products	250.2	0.92	0.12	2.3	0.7
Whole oilseeds	57.3	3.16	0.72	1.8	0.9
Oilseed rape cake and meal	790.4	5.42	1.05	42.8	19.0
Soya cake and meal	1086.3	7.92	0.76	86.0	18.9
Sunflower cake and meal	300.8	5.07	1.06	15.3	7.3
Other oilseed cake and meal	472.4	3.31	0.63	15.6	6.8
Field beans	105.8	4.00	0.43	4.2	1.0
Field peas	31.4	3.58	0.52	1.1	0.4
Dried sugar beet pulp	247.9	1.58	0.13	3.9	0.7
Molasses	255.8	0.90	0.08	2.3	0.5
Citrus and other fruit pulp	76.8	0.94	0.09	0.7	0.2
All meal (fish poultry etc)	124.8	10.50	2.75	13.1	7.9
Minerals	425.7	0.00	0.50	0.0	4.9
Oil and fat	179.8	0.00	0.00	0.0	0.0
Protein concentrates	14.6	15.00	0.00	2.2	0.0
Other materials	237.9	2.00	0.50	4.8	2.7
Confectionery by-products	178.9	2.50	0.35	4.5	1.4
Total raw materials	9801.4			294.4	126.2

Sources: Defra (2010) and Ewing (1997)

Whilst the production of this publication was part-funded by The England Catchment Sensitive Farming Delivery Initiative (ECSFDI), the content does not necessarily reflect the agreed policy of Natural England, Environment Agency or Defra.