Managing nutrients for Better Returns
The information in this booklet was compiled by Ian Richards, Ecopt and Dr Liz Genever, AHDB Beef & Lamb.

Additional information from ADAS and Creedy Associates.


We are grateful for the support of Catchment Sensitive Farming in developing this guidance.

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Nutrient management can often be forgotten on beef and sheep farms. Yet there is considerable scope to reduce costs and improve output through the wise use of home-produced and bought-in nutrients.

All crops need a good nutrient supply from the soil to grow and thrive. Feeding grass and forage crops properly with manufactured fertilisers or slurries and manures can boost growth. This means bought-in feed requirements can be reduced with potential savings to the business.

The starting place is to test the soil, although only around a third of beef and sheep farmers do so regularly. Yet by measuring and then managing nutrients, producers can optimise their output, while reducing the potential negative impacts of any oversupply.

Minimising losses of nutrients, such as nitrates, nitrous oxide and phosphates through appropriate and accurate fertiliser applications, can create a win:win situation for beef and sheep producers and for the environment.

AHDB funded a review of the eighth edition of the Fertiliser Manual (RB209) and produced the Nutrient Management Guide.

It provided an opportunity for all levy payers to access updated nutrient recommendations, with some of the data coming from the industry.

Dr Liz Genever
AHDB Beef & Lamb
Beef and Sheep Scientist
Soil test results

Taking a representative soil sample, having it tested by a reputable laboratory and acting on the analysis and recommendations, can have long-term benefits for the farming business and the environment.

From the example above, Glebe Field needs lime and some phosphate and potash (see the recommendation below).

<table>
<thead>
<tr>
<th>Field name/Ref/Soil type</th>
<th>Last crop/Next crop</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>MgO</th>
<th>Lime</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLEBE FIELD/12641/12/Heavy</td>
<td>P Pasture/P Pasture</td>
<td>Units/Acre 40</td>
<td>24</td>
<td>0</td>
<td>t/ac 2.4</td>
</tr>
<tr>
<td>Kg/ha 50</td>
<td>30</td>
<td>0</td>
<td>t/ha 6.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See Appendix 3 (page 28) for sources of more information.

More advanced soil tests are available that report more values than the standard pH, phosphate, potash and magnesium test. The advanced tests are more expensive but will go into detail about organic matter, soil type and total and available nutrients. They need additional interpretation and should be used in conjunction with advice from an adviser to get the full benefit.

Soil sampling

It is good practice to soil sample every three to five years. Some environmental schemes dictate frequency. The best time to test soil is between October and March.

Take multiple cores across the field (ideally 25), to a 7.5cm depth in grassland. Avoid unrepresentative areas around feeders or close to hedges. Mix samples thoroughly, bag up 0.5-1kg then send to a soil laboratory. Discuss results of tests with an adviser.
Nutrients for grass and livestock

Like all plants, grass and clover need around a dozen mineral nutrients to live and grow. Only a few of these have to be applied as fertilisers. Breakdown of organic matter, weathering of soil mineral particles and return of manures and plant residues to the soil, can provide most of the nutrients required.

Some nitrogen and sulphur falls in rain and bacteria associated with the clover can fix nitrogen from the air. As the bacteria and clover roots die, this becomes available to the grass.

The capacity of a barrel with unequal staves is limited by the shortest stave. The same principle applies to all nutrients and factors influencing crop growth. Yield is limited by the nutrient in shortest supply.

<table>
<thead>
<tr>
<th>Macro-nutrients (major elements)</th>
<th>Nitrogen</th>
<th>Phosphate</th>
<th>Potash</th>
<th>Sulphur</th>
<th>Calcium</th>
<th>Magnesium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application usually needed for growth</td>
<td>Application of sulphur likely for cutting systems</td>
<td>Applied calcium is not needed except as a liming agent</td>
<td>Magnesium sometimes needed for livestock diet, but does not increase plant yield</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Micro-nutrients (trace elements)</th>
<th>Boron</th>
<th>Cobalt</th>
<th>Copper</th>
<th>Manganese</th>
<th>Molybdenum</th>
<th>Selenium</th>
<th>Sodium</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application very rarely needed for growth</td>
<td>Copper, cobalt, selenium and sodium are sometimes needed for livestock diet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nutrients are imported to the farm in purchased feeds and bedding then reach the soil in manures. The role of fertiliser is to make up the difference between the requirement for a nutrient and its supply from these other sources.
Correcting the pH status of the soil by applying lime is a simple and effective way to increase grassland productivity.

Grass is quite tolerant of low soil pH and the optimum range is 5.5-6.5 on most soils. For grass/clover swards, pH should be 6.2. On peaty soils, pH can be lower, 5.0-5.5 for grass and grass/clover.

If re-seeding, apply lime after ploughing but before final cultivation, so that it mixes into the rooting zone.

If ground conditions permit, apply lime two to three weeks before spring nitrogen application to fields destined for silage.

### Lime choice

The most common liming product is chalk or ground limestone – basically calcium carbonate (CaCO₃). Some forms contain magnesium.

The quality of liming material is based on neutralising value (NV) and reactivity.

**NV** of a liming material is expressed in terms of the percentage of calcium oxide equivalent. 100kg of a liming material with a neutralising value of 50% will have the same neutralising value as 50kg of pure calcium oxide (CaO).

Off-farm wastes, such as paper crumb (NV = 5-10%), lime-treated sewage cake (10-20%), sugar beet waste (22-32%) and green waste compost (up to 5%), can have a liming effect.

Basic slag is a source of lime (NV = 58%) plus a source of phosphate and trace elements. It can be cost-effective, but can contain high levels of iron.

**Reactivity** is the speed of action – which is related to the particle size. Generally the smaller the particle size the larger the surface area and the quicker the action. For example, granular lime contains fine particles which disperse after application so it has a high reactivity (>98%). It can be spread by a fertiliser spreader and is useful when pH needs to be changed rapidly.

### Gypsum

The application of gypsum has limited or no impact on soil pH (depending on the source and feedstock). It can help improve soil condition/workability, particularly on heavy clay soils and where coastal/saline flooding has occurred.

### Table 1: Guidelines for lime application on grass (t/ha)

<table>
<thead>
<tr>
<th>Initial soil pH</th>
<th>Sands and loamy sands</th>
<th>Sandy loams and silt loams</th>
<th>Clay loams and clays</th>
<th>Organic soils</th>
<th>Peaty soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.5</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5.0</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

To calculate from tonnes/ha to tonnes/acre multiply by 0.4046. Apply no more than 7t/ha at one time.

Source: Nutrient Management Guide (RB209)
Phosphate and potash

Phosphate and potash can accumulate on grassland farms. Quite large amounts can be imported in purchased feeds and bedding as well as in fertilisers. Removal in animal sales or wool and losses from the soil tend to be smaller.

The levels of available phosphate and potash are shown as soil Indices that usually only change slowly over the years.

For grassland, target soil Indices are 2 for phosphate and 2 for potash. Where a soil Index is lower than target, the recommended application amount of the nutrient is increased to build up soil reserves, as well as to meet crop requirement. Where the soil Index is above target, recommended application is reduced or omitted to allow the Index to fall slowly. If applications continue and Indices are at target, there is a risk to the environment, especially for phosphate (see page 19).

Dung and urine

Applying manure is a good way to correct low Indices. Phosphate and potash in collected manure and slurry can be returned to the soil quite evenly. Recycling by grazing animals is less effective, as nearly all of the phosphate excreted is in the dung which is concentrated in small areas. Work on dairy farms has shown that at a high stocking rate of three cows/ha, up to 30-50% of the whole pasture area is affected by urine and dung patches every year. This means that a large proportion of the pasture (50-70%) does not benefit from enhanced pasture growth following nutrient returns from animal dung or urine.

Also, dung pats do not have good soil contact so the phosphate they contain is inaccessible to the grass for months. Grazing over many years will raise soil phosphate across the field, but will not reduce the need for applied phosphate in a short-term ley.

Livestock urine contains nitrogen (N) and potash in readily available forms and the patches are much larger. So recycling of potash by grazing cattle is more effective than it is for phosphate.

For nitrogen, the recovery from dung and urine ranges from 9 to 56% for urine and 4 to 27% for dung. Most of the N from urine is available in the first three months while the N from dung can be released over three years.
Nutrient imbalances

Grass cut for silage can remove large amounts of nutrients. Every tonne of grass at 30% dry matter (DM) will remove around 2.1kg of phosphate and 7.2kg of potash. These nutrients will eventually be returned to the soil via manures if used. However, a silage cut can leave the soil with too little readily available potash to support further mowing. So, it is important to replace the potash removed by applying fertiliser or manure.

Clover

Low potash supply can restrict the growth of clover even where there seems to be enough for grass. Correcting low soil potash Indices is even more important if the sward contains grass and clover. Phosphate is also critical for N fixation and clover growth is often limited in low phosphate situations.

Potash and staggers

Excessive potash in the soil can affect magnesium uptake by grass and increase the risk of staggers (hypomagnesaemia) in cattle. Rapidly growing grass will take up potash quickly and in greater quantity than actually needed, interfering with the uptake of magnesium. Large single applications should be avoided on grazed swards. Little and often is better practice.

Magnesium

Magnesium deficiency rarely affects grass and clover growth. In 2014, only 3% of grassland soil samples were at magnesium Index 0 or 1. The concentration of magnesium in herbage however can be a problem for livestock. To avoid staggers, aim for 0.2% magnesium in the DM. Excessive application of potash can reduce magnesium concentration in the grass.

Testing the soil Index can indicate a need for magnesium, but analysing the grass gives results that are better related to livestock requirement.

Liming materials containing magnesium will help raise a low soil magnesium Index.

Magnesium can be applied as a fertiliser, or supplemented feeds can be offered.

Summary

- Use a recognised fertiliser recommendation system such as Nutrient Management Guide (RB209)
- Lime grassland on mineral soils to pH 6.5 and on peaty soils to pH 5.3
- Aim for soil phosphate Index 2 and potash Index 2-
- Apply manures where possible to fields with Indices below target
- Replace potash removed in grass cut for silage
- Avoid large single applications of potash in spring or in fields used for grazing
Sulphur

Sulphur supply
Forty years ago, sulphur (S) supply to grassland was more than adequate. This was due to deposition from the air of sulphur emitted by industry and from sulphur-containing fertilisers like single superphosphate and ammonium sulphate. Supply fell as industry cleaned up its emissions and fertilisers were replaced by more concentrated products. Today, most grassland receives less than 20kg SO₃/ha annually from the air.

Sulphur after cutting
First cut silage benefits from sulphur in the air and from mineralised soil organic matter. Later cuts from the same area are likely to be sulphur deficient and will benefit from an application of sulphate-containing fertilisers at around 40kg SO₃/ha for each cut.

Yield responses are less common in grazed grass. Sulphur deficiency in grass looks very like N deficiency from a distance. But if grass looks yellow after the recommended amount of N has been applied, it is probably deficient in sulphur (see page 13).

A tissue sample needs to be taken to test for deficiency. In grass cut for silage, a concentration of less than 0.25% sulphur, or an N:S ratio greater than 13:1 in the grass dry matter indicates sulphur deficiency.

As well as reducing grass yield, sulphur deficiency affects nitrogen uptake and the formation of protein in grass.

Micronutrients
Copper (Cu), selenium (Se) or cobalt (Co) supply does not affect grass growth, but low concentrations of these elements can cause problems for the livestock eating it.

Copper deficiency in farm animals can occur even where concentrations in the grass seem adequate. On soils high in molybdenum (Mo) – known as ‘teart’ pastures, molybdenum reacts inside the animal so that the copper becomes unavailable. The reaction is promoted by high sulphur in the diet.

Risk seems to be greatest where grass DM concentrations are greater than around 3mg Mo/kg and 0.4% sulphur. Normal applications of sulphur to meet sward requirements are unlikely to significantly increase the risk of copper deficiency on these soils.

Copper, sulphur and cobalt deficiencies are usually corrected by treating animals directly. These nutrients can also be supplied in small amounts in fertilisers. The difference between deficiency and toxicity can be small, so do not over-supplement or apply.

Summary
- Apply a sulphur-containing fertiliser to supply 40kg SO₃/ha for second and third cut silage
- Where copper, selenium or cobalt deficiency occurs in livestock, consider the options of direct treatment of the animals or applying the nutrient in fertiliser. Do not over-supplement or apply
- Remember what is measured in soil analysis is not always available to the growing crop or grazing animal

See Appendix 3 (page 28) for sources of more information on the trace element requirements of livestock.
Crop requirements

To convert ‘kg per ha’ to ‘units per acre’ multiply by 0.8. So 50kg per ha x 0.8 = 40 units per acre.

Grazed grass

<table>
<thead>
<tr>
<th>pH</th>
<th>P Index</th>
<th>K Index</th>
<th>Mg Index</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;6.2</td>
<td>3</td>
<td>2 or &gt;</td>
<td>0-1</td>
<td>No lime required</td>
</tr>
<tr>
<td>6-6.2</td>
<td>2</td>
<td>1</td>
<td>0-1</td>
<td>No requirement</td>
</tr>
<tr>
<td>&lt;6</td>
<td>1</td>
<td>0</td>
<td>0-1</td>
<td>Apply 20kg/ha</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0-1</td>
<td>0-1</td>
<td>Apply 50kg/ha</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>2 or &gt;</td>
<td>0-1</td>
<td>Apply 80kg/ha</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>&lt;2 or &gt;</td>
<td>0-1</td>
<td>If P or K Index is 3 or over, do not apply</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>&lt;2 or &gt;</td>
<td>0-1</td>
<td>Do not apply more than 80-90kg/ha of potash in spring</td>
</tr>
</tbody>
</table>

One cut silage = 6 tonnes DM/ha

<table>
<thead>
<tr>
<th>pH</th>
<th>P Index</th>
<th>K Index</th>
<th>Mg Index</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;6.2</td>
<td>3</td>
<td>2 or &gt;</td>
<td>0-1</td>
<td>No lime required</td>
</tr>
<tr>
<td>6-6.2</td>
<td>2</td>
<td>1</td>
<td>0-1</td>
<td>No requirement</td>
</tr>
<tr>
<td>&lt;6</td>
<td>1</td>
<td>0</td>
<td>0-1</td>
<td>Apply 20kg/ha</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0-1</td>
<td>0-1</td>
<td>Apply 40kg/ha</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0-1</td>
<td>0-1</td>
<td>Apply 70kg/ha</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0-1</td>
<td>0-1</td>
<td>Apply 100kg/ha</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0-1</td>
<td>0-1</td>
<td>Apply 30kg/ha in spring + 60kg/ha after cutting</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0-1</td>
<td>0-1</td>
<td>Apply 60kg/ha in spring + 60kg/ha after cutting</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0-1</td>
<td>0-1</td>
<td>Apply 30kg/ha in previous autumn + 80kg/ha in spring</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>2 or &gt;</td>
<td>0-1</td>
<td>Apply 60kg/ha in previous autumn + 80kg/ha in spring</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0-1</td>
<td>0-1</td>
<td>Apply 50-100kg/ha every 3-4 years</td>
</tr>
</tbody>
</table>

If P or K Index is 4 or over, do not apply more than 80-90kg/ha of potash in spring.
If there is no incentive to build up phosphate or potash Indices, for example on rented land, apply just enough to meet crop requirements, i.e., use the recommendation for Index 2.

### Hay

<table>
<thead>
<tr>
<th>pH</th>
<th>P Index</th>
<th>K Index</th>
<th>Mg Index</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;6.2</td>
<td>3 or &gt;</td>
<td>3</td>
<td>2 or &gt;</td>
<td>No lime required</td>
</tr>
<tr>
<td>6-6.2</td>
<td>2</td>
<td>2</td>
<td>2 or &gt;</td>
<td>TARGET – Monitor, may need a small amount</td>
</tr>
<tr>
<td>&lt;6</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>Lime is required – PRIORITY</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

If K Index is 4 or over, do not apply.

### Grass re-seeds

<table>
<thead>
<tr>
<th>pH</th>
<th>P Index</th>
<th>K Index</th>
<th>Mg Index</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;6.2</td>
<td>3</td>
<td>3</td>
<td>2 or &gt;</td>
<td>No lime required</td>
</tr>
<tr>
<td>6-6.2</td>
<td>2</td>
<td>2</td>
<td>2 or &gt;</td>
<td>TARGET – Monitor, may need a small amount</td>
</tr>
<tr>
<td>&lt;6</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>Lime is required – PRIORITY</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

If K Index is 3 or over, do not apply.

The amount applied for establishment should be deducted from the first season requirement.
Nitrogen

Only grow what is needed
Nitrogen is the most important nutrient for grassland because it has such a strong effect on yield.

Very generally, 1kg of N will grow between 10-15kg of grass DM in older swards, but in newer high performing swards (less than ten years old) the response is typically in the range 15-25kg DM; up to 30kg DM per kg N applied.

Swards containing high levels of ryegrass will be more responsive to N than swards containing weed grasses, such as Yorkshire Fog and Creeping Bent.

The response will also depend on the timing, season, soil fertility and moisture.

The Nutrient Management Guide (RB209) approaches nitrogen recommendations by asking producers how much grass they need to produce in terms of grazing and silage or hay production.

Nitrogen recommendations are based on the amount that is required, with factors such as soil nitrogen supply (high, moderate or low) and grass growth class (very poor, poor, average, good or very good) taken into consideration.

Stocking rate and concentrate use is no longer used within the nitrogen recommendations.

It is important to think about the total amount of grass needed to feed the stock. Then use N to boost yield and finally feed concentrates to supplement the grass where necessary. Often the full productive potential of grass is not realised. However there is no point in growing more grass than can be eaten.

Total nitrogen supply
There are several sources of N coming from:

- The breakdown of soil organic matter
- Deposition from the air (usually included with that from soil organic matter as 'soil N')
- Dung and urine deposited by grazing animals
- Applied manures
- Clover
- Fertilisers

These all add up to the total N supply. However only some of this will be readily available to the plants and it is this that controls grass yield.

How much nitrogen is needed?
Beef and sheep producers tend not to use much nitrogen. AHDB Stocktake data suggests the average rate is between 30-60kg N/ha. The price of N has a major influence on practice.

The maximum limit (Nmax) for farms in Nitrate Vulnerable Zones (NVZ) is 300kg N/ha.

The amount needed differs from farm to farm and enterprise to enterprise. Seek advice from a FACTS qualified adviser for recommendations.
after an N application late in the year, but will not necessarily grow much and the full value will not be accrued from the N applied.

Weather conditions usually cause changes to plans for N use during the season. If grass accumulates in grazed areas, cut back on N applications.

Fertiliser nitrogen and clover
Fertiliser N and clover do not always mix well. The N inhibits fixation by the clover and promotes grass growth which can shade out the clover.

Where there is a large amount of clover in the sward, N applied in fertiliser will just substitute for that fixed by the clover and overall grass yield will not change greatly.

Where white clover is vigorous and constitutes 20-30% of the sward DM, fertiliser N requirement can be reduced by 100-150kg N/ha over the season. A sward that typically contains less than 10% white clover by late spring can be treated as a grass-only sward.

Red clover can fix up to 250kg N/ha and needs to be grown with a grass that is capable of capturing as much of this as possible.

Soil N
Soil nitrogen supply (SNS) status cannot easily be measured, but fields can be put into categories depending on their history to estimate SNS (see Table 2).

In grazing situations there is usually no need for bagged N on clover-rich swards, apart from perhaps a little (50kg N/ha) to stimulate grass growth in the spring.

Grass growth during the season
Grass response to N is affected by water supply during the growing season. Where this is ample, less N is needed to achieve a given grass yield.

Grass responds to fertiliser N in two stages. At first it is taken up quite rapidly and the grass greens-up. Then DM yield increases, which happens more slowly.

In rotational grazing or where growing for silage, it is important to allow time after an application of N for the DM response to develop fully. Allow at least one day of growth for every 2.5kg N/ha applied.

Nitrogen uptake is less affected by the amount of daylight than DM growth. So grass will green-up after an N application late in the year, but will not necessarily grow much and the full value will not be accrued from the N applied.

Weather conditions usually cause changes to plans for N use during the season. If grass accumulates in grazed areas, cut back on N applications.

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Table 2: The definitions of soil nitrogen supply (SNS) Status

<table>
<thead>
<tr>
<th>Previous management</th>
<th>Previous nitrogen use (kg N/ha/year)</th>
<th>SNS status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term grass, including grass after one year arable break</td>
<td>More than 250</td>
<td>High</td>
</tr>
<tr>
<td>Long-term grass, including grass after one year arable break, or grass after two years arable (last crop potatoes, oilseed rape, peas or beans, not on light sandy soil)</td>
<td>100-250 or substantial clover content</td>
<td>Medium</td>
</tr>
<tr>
<td>Long-term grass, including grass after one year arable break, or grass after two years arable (last crop cereal, sugar beet, linseed or any crop on light sandy soil)</td>
<td>Up to 100</td>
<td>Low</td>
</tr>
</tbody>
</table>

Soil nitrogen supply (SNS) status cannot easily be measured, but fields can be put into categories depending on their history to estimate SNS (see Table 2).

In grazing situations there is usually no need for bagged N on clover-rich swards, apart from perhaps a little (50kg N/ha) to stimulate grass growth in the spring.

Grass growth during the season
Grass response to N is affected by water supply during the growing season. Where this is ample, less N is needed to achieve a given grass yield.

Grass responds to fertiliser N in two stages. At first it is taken up quite rapidly and the grass greens-up. Then DM yield increases, which happens more slowly.

In rotational grazing or where growing for silage, it is important to allow time after an application of N for the DM response to develop fully. Allow at least one day of growth for every 2.5kg N/ha applied.

Nitrogen uptake is less affected by the amount of daylight than DM growth. So grass will green-up after an N application late in the year, but will not necessarily grow much and the full value will not be accrued from the N applied.

Weather conditions usually cause changes to plans for N use during the season. If grass accumulates in grazed areas, cut back on N applications.

Fertiliser nitrogen and clover
Fertiliser N and clover do not always mix well. The N inhibits fixation by the clover and promotes grass growth which can shade out the clover.

Where there is a large amount of clover in the sward, N applied in fertiliser will just substitute for that fixed by the clover and overall grass yield will not change greatly.

Where white clover is vigorous and constitutes 20-30% of the sward DM, fertiliser N requirement can be reduced by 100-150kg N/ha over the season. A sward that typically contains less than 10% white clover by late spring can be treated as a grass-only sward.

Red clover can fix up to 250kg N/ha and needs to be grown with a grass that is capable of capturing as much of this as possible.
Example of nitrogen requirements (kg N/ha) for a beef enterprise

Assumptions
- Average growth class:
  - Light soils with high summer rainfall (>400mm)
  - Medium soils with 300-400mm of summer rainfall
  - Peaty, silty soils with up to 300mm of rain during the summer
- Yield = 7-9t DM/ha

<table>
<thead>
<tr>
<th>SNS status</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing only</td>
<td>160kg</td>
<td>130kg</td>
<td>100kg</td>
</tr>
<tr>
<td>One cut then grazing</td>
<td>95kg for silage</td>
<td>80kg for silage</td>
<td>65kg for silage</td>
</tr>
<tr>
<td></td>
<td>75kg for grazing</td>
<td>60kg for grazing</td>
<td>45kg for grazing</td>
</tr>
<tr>
<td>Two cuts then grazing</td>
<td>90kg for 1st cut</td>
<td>80kg for 1st cut</td>
<td>70kg for 1st cut</td>
</tr>
<tr>
<td></td>
<td>70kg for 2nd cut</td>
<td>50kg for 2nd cut</td>
<td>30kg for 1st cut</td>
</tr>
<tr>
<td></td>
<td>30kg for grazing</td>
<td>30kg for grazing</td>
<td>30kg for grazing</td>
</tr>
</tbody>
</table>

Notes: Increase total fertiliser nitrogen input by 30kg/ha in a low SNS situation; decrease total fertiliser nitrogen input by 30kg/ha in a high SNS situation.
For high SNS sites, apply 10kg N/ha less for first cut and 20kg N/ha less for second cut. For low SNS sites, apply 10kg N/ha more for first cut and 20kg N/ha more for second cut.
For 1st cut rates over 80kg N/ha, split application: 40kg N/ha in mid-February to early March with the remainder in late March to early April and at least six weeks before cutting.

Example of nitrogen requirements (kg N/ha) for a sheep enterprise

Assumptions
- Average growth class (see above)
- Yield = 7-9t DM/ha

<table>
<thead>
<tr>
<th>SNS status</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing only</td>
<td>160kg</td>
<td>130kg</td>
<td>100kg</td>
</tr>
<tr>
<td>Grazing from Feb, shutting up from April for silage and grazing from July</td>
<td>50kg for grazing (early/mid Feb)</td>
<td>40kg for grazing (early/mid Feb)</td>
<td>30kg for grazing (early/mid Feb)</td>
</tr>
<tr>
<td></td>
<td>100kg for silage</td>
<td>80kg for silage</td>
<td>60kg for silage</td>
</tr>
<tr>
<td></td>
<td>30kg for grazing</td>
<td>30kg for grazing</td>
<td>30kg for grazing</td>
</tr>
<tr>
<td>Grazing from March, shutting up from June for hay and grazing from August</td>
<td>50kg for grazing (early/mid Feb)</td>
<td>40kg for grazing (early/mid Feb)</td>
<td>30kg for grazing (early/mid Feb)</td>
</tr>
<tr>
<td></td>
<td>90kg for hay</td>
<td>70kg for hay</td>
<td>50kg for hay</td>
</tr>
<tr>
<td></td>
<td>30kg for grazing</td>
<td>30kg for grazing</td>
<td>30kg for grazing</td>
</tr>
</tbody>
</table>

These examples have assumed no clover. If red or white clover is present the recommendations need to be reduced.
Nutrient deficiencies

Sometimes a grass crop shows visible symptoms of nutrient deficiency. It can just be disappointing growth and if this is the case it is not possible to identify the problem without carrying out a herbage or soil analysis. If the deficiency is more marked, there can be distinctive signs.

<table>
<thead>
<tr>
<th>Deficiency in</th>
<th>Looks like</th>
<th>Typically occurs</th>
<th>What to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>If severe: yellow older grass leaves</td>
<td>Where soil is poached or waterlogged</td>
<td>Apply nitrogen when soil has dried</td>
</tr>
<tr>
<td>Phosphate</td>
<td>Purple tinge to grass</td>
<td>In spring At phosphate Index 0 or 1</td>
<td>Check soil Index Apply phosphate fertiliser or manure</td>
</tr>
<tr>
<td>Potash</td>
<td>Brown tips to grass Wilted grass Small white spots on clover leaves</td>
<td>In second or third cut growth At potash Index 0 or 1</td>
<td>Check soil Index Apply potash fertiliser or manure</td>
</tr>
<tr>
<td>Sulphur</td>
<td>Yellowish younger grass leaves</td>
<td>In second or third cut growth</td>
<td>Apply sulphur fertiliser for next cut</td>
</tr>
</tbody>
</table>

Analysing some plants can help diagnosis and confirm if the crop will meet the livestock’s dietary needs. Clean samples of the herbage, with no soil contamination, should be cut and sent immediately to a laboratory for testing.

Where there are patches of good and poor growth in a field, take samples from good and poor areas. The comparison of results will be more useful than samples taken just from the poor area.

**Summary**

- Use a nutrient recommendation system, eg Nutrient Management Guide (RB209)
- Develop a nutrient management plan, such as Tried & Tested or PLANET
- Sample soils for pH, phosphate, potash and magnesium every three to five years
- Check the grass through the season for any visible problems
- For diagnosis, take soil or herbage samples from good and poor areas of the field
- Use a FACTS Qualified Adviser for help with nutrient management

See Appendix 3 (page 28) for sources of more information.
Manures as fertilisers

Slurry and manures contain all the nutrients needed by grass and clover, though not necessarily in the ideal ratios for any particular field. They are fertilisers, not wastes and their nutrients are valuable.

Nutrients

Typical available nutrient contents for the common manure types are shown in the table below using values from Nutrient Management Guide (RB209).

If soils have a phosphate index of 2 and a potash index of 2+, then total values should be used when calculating the nutrient value of manures.

It is worth getting a sample of manure or slurry analysed, especially if groups are being fed different rations, eg suckler cows vs finishers. It is important that it is representative of the whole heap or lagoon. It is also important to work with the figures for ‘available’ nutrients, ie those that grass plants can access and use, rather than the ‘total’ figures.

Spread it around the farm

Spread manure around the farm, not always on the same few fields. Target manure applications to fields with a low phosphate or potash Index. Try to avoid fields where the phosphate Index is higher than 2, even if the potash Index is low.

When and where?

Applying manure just before a period of rapid grass growth will make best use of the available nutrients. This means early spring or immediately after a cut of silage.

Table 3: Typical crop available nutrient contents in kg/t or kg/m³

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen (N)</th>
<th>Phosphate (P₂O₅)₆</th>
<th>Potash (K₂O)₆</th>
<th>Sulphur (SO₃)₄</th>
<th>Magnesium (MgO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle FYM</td>
<td>0.6ᵃ</td>
<td>1.9</td>
<td>8.5</td>
<td>2.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Sheep FYM</td>
<td>0.7ᵃ</td>
<td>1.9</td>
<td>7.2</td>
<td>3.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Cattle slurry (6% DM)</td>
<td>0.78ᵇ</td>
<td>0.6</td>
<td>2.3</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Pig slurry (4% DM)</td>
<td>1.8ᶜ</td>
<td>0.8</td>
<td>2.0</td>
<td>1.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Poultry manure (40% DM)</td>
<td>5.7ᵇ</td>
<td>7.2</td>
<td>14.0</td>
<td>5.6</td>
<td>4.3</td>
</tr>
</tbody>
</table>

FYM = farmyard manure, DM = dry matter. a = applied in the spring/summer and not incorporated (10% of total). b = applied in the spring/summer and not incorporated (30% of total). c = applied in the spring/summer and not incorporated (50% of total). d = calculated as 60% of total. e = calculated as 90% of total. f = not all sulphur is available to the grass.

When calculating Nmax (maximum N application per crop type in an NVZ), the percentage crop available N for both livestock manures and other organic materials must be used (see NVZ guidance at www.gov.uk).
Do not apply more than 250kg N/ha in manures over a year, or more than 50m³/ha of slurry at any one time. This will minimise the risk of run-off and prevent smothering the regrowth.

If the farm is in an NVZ, do not spread more than 30m³/ha of slurry or 8t/ha of poultry manure in a single application from the end of the organic manures closed period until the end of February.

**Avoid run-off**
Manure should not be applied to frozen, waterlogged and snow covered ground or within 10 metres of surface water or 50 metres of a borehole, well or spring, or on sloping ground.

The risk of disease transmission can be reduced by storing manures for at least one month before application and leaving at least one month after application before grazing.

**Calculating nutrient value**
The nutrient value of manure can be calculated using current prices for fertiliser N, phosphate and potash as in the example below.

### Table 4: Fertiliser examples showing the cost of the nutrient

<table>
<thead>
<tr>
<th>Fertiliser examples</th>
<th>Available nutrients (kg/t)*</th>
<th>Price (£/t)</th>
<th>Cost of nutrient (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium nitrate (34.5% N)</td>
<td>345</td>
<td>250</td>
<td>0.72</td>
</tr>
<tr>
<td>Triple superphosphate – TSP (46% P₂O₅)</td>
<td>460</td>
<td>300</td>
<td>0.65</td>
</tr>
<tr>
<td>Muriate of potash – MOP (60% K₂O)</td>
<td>600</td>
<td>275</td>
<td>0.46</td>
</tr>
</tbody>
</table>

*For example, ammonium nitrate is 34.5% N, so for every 100kg there will be 34.5kg of N available.

### Table 5: Nutrient value in manure

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Cost of nutrient (£)</th>
<th>Cattle FYM nutrient content</th>
<th>Manure value (£/t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>0.72</td>
<td>0.6</td>
<td>0.44</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.65</td>
<td>1.9</td>
<td>1.24</td>
</tr>
<tr>
<td>Potash</td>
<td>0.46</td>
<td>7.2</td>
<td>3.30</td>
</tr>
</tbody>
</table>

**TOTAL**  £4.98

### Sulphur and magnesium
Manures also contain useful amounts of sulphur and magnesium. Availability of sulphur can vary widely from around 15% of total SO₃ for cattle FYM and 35% for slurry applied in the spring.

### Summary
- Treat manures as fertilisers, not wastes
- Use standard tables in Nutrient Management Guide (RB209) or laboratory analysis to estimate the total N, phosphate and potash contents of manures
- Use standard tables in Nutrient Management Guide (RB209) for calculating the crop available N in applied manures (see NVZ guidance at www.gov.uk)
- Target manure applications to fields with low phosphate or potash Indices, but try to avoid fields where the phosphate Index is higher than 2
- Do not apply manures within 10m of a watercourse or 50m of a borehole, well or spring
- Better to use low application rates over a wide area than heavy rates on a few fields
- If farming in an NVZ, comply with the rules for manure storage and application
### Nutrient application examples

#### Grazed grass

<table>
<thead>
<tr>
<th>pH</th>
<th>5.5</th>
<th>4t/ha of lime as clay loam soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>1</td>
<td>50kg/ha of phosphate 109kg of TSP would supply 50kg of phosphate per ha</td>
</tr>
<tr>
<td>K</td>
<td>1</td>
<td>30kg/ha of potash 50kg of MOP would supply 30kg of potash per ha</td>
</tr>
<tr>
<td>Mg</td>
<td>2</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

Alternatively, 170kg of 0-30-20/ha would supply 51kg phosphate per ha and 34kg potash per ha

NB: Manures and slurry have higher potash levels than phosphate, so many may not be suitable for this situation. For example, 10 tonnes of cattle manure per ha would supply 19kg of available phosphate and 72kg of available potash.

6kg of N would also be applied

#### One cut silage

<table>
<thead>
<tr>
<th>pH</th>
<th>5.5</th>
<th>4t/ha of lime as silt loam soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>1</td>
<td>70kg/ha of phosphate 152kg of TSP would supply 70kg of phosphate per ha</td>
</tr>
<tr>
<td>K</td>
<td>1</td>
<td>30kg/ha of potash 50kg of MOP would supply 30kg of potash per ha for the autumn dressing, plus 133kg of MOP in spring would supply 80kg of potash per ha plus 100kg of MOP after the cut or by the autumn would supply 60kg of potash per ha</td>
</tr>
<tr>
<td>Mg</td>
<td>2</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

Alternatively, 30m³/ha (2,700 gallons/acre) of 6% cattle slurry in the spring would supply around 18kg of phosphate and 83kg of potash per ha, which reduces the amount of TSP product used to 113kg/ha and removes the need for a spring dressing of MOP.

THIS IS A SAVING OF AROUND £43/ha.

23kg of N would also be applied
**Hay**

<table>
<thead>
<tr>
<th>pH</th>
<th>5.5</th>
<th>4t/ha of lime as silt loam soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>P Index</td>
<td>1</td>
<td>55kg/ha of phosphate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120kg of TSP would supply 55kg of phosphate per ha</td>
</tr>
<tr>
<td>K Index</td>
<td>1</td>
<td>115kg/ha of potash</td>
</tr>
<tr>
<td></td>
<td></td>
<td>192kg of MOP would supply 115kg of potash per ha</td>
</tr>
<tr>
<td>Mg Index</td>
<td>2</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

Alternatively, 30m³/ha (2,700 gallons/acre) of 4% pig slurry would supply around 27kg of phosphate and 66kg of potash per ha, which reduces the amount of TSP product to 61kg/ha and the amount of MOP product to 82kg/ha.

**Grass re-seeds**

<table>
<thead>
<tr>
<th>pH</th>
<th>5.8</th>
<th>3t/ha of lime, if not already corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>P Index</td>
<td>1</td>
<td>80kg/ha of phosphate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>174kg of TSP would supply 80kg of phosphate of ha</td>
</tr>
<tr>
<td>K Index</td>
<td>1</td>
<td>80kg/ha of potash</td>
</tr>
<tr>
<td></td>
<td></td>
<td>133kg of MOP would supply 80kg of potash of ha</td>
</tr>
<tr>
<td>Mg Index</td>
<td>2</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

Alternatively, 10 tonnes of cattle FYM/ha would supply around 19kg of phosphate and 72kg of potash per ha, which reduces the amount of TSP product to 132kg/ha and removes the need for the MOP product.

**Index**

**P**

**Mg**

**K**

51kg of N would also be applied

6kg of N would also be applied
Minimising nutrient losses

Nutrients can be lost from the soil to water and in the case of N, to the air. Losses of N and phosphate can cause environmental problems, so any potential losses need addressing. Problems like these have not been associated with potash and sulphur. Losses are greater when nutrients applied exceed crop requirements or applications are made in high risk situations or in poor soil conditions.

Nitrate leaching
Nitrogen in nitrate form can be leached or washed out of soil and end up in ponds, streams, rivers, lakes or aquifers affecting water quality and sensitive habitats. The European Union (EU) limit of 50mg nitrate/litre, originally introduced for drinking water, now applies to surface and ground waters. In surface waters nitrate can also contribute to eutrophication (nutrient enrichment) and the excessive algal growth and oxygen depletion this causes, which damages aquatic wildlife.

NVZ have been designated where nitrate concentrations are high or increasing, or where waters are, or may become eutrophic.

Ammonia
Ammonia emissions have significant implications for human health and contribute to acid rain. It can lead to unwanted inputs of N to soils and vegetation that can badly impact sensitive sites.

The storage and application of livestock manures is a significant source of ammonia emissions from agriculture.

Between 10% and 80% of the readily available N in slurry can be lost during and after application.

So there is an economic as well as environmental reason for trying to retain as much as possible.

Most of the loss occurs in the first few hours after application, so injection by trailing shoe equipment or, where possible, rapid incorporation, will minimise losses.

Nitrogen oxide
Where the soil is anaerobic (oxygen starved), nitrate can be converted by micro-organisms to nitrous oxide, which is a potent greenhouse gas.

Poaching, poor drainage or waterlogging can make soil anaerobic and will increase N loss.
**Phosphate in water**
If phosphate reaches surface water, even in very small amounts, it can promote excessive algal growth and blanket weed in ponds (eutrophication). The water can then become depleted of oxygen when the algae or weeds die and decompose. Phosphate is naturally low in freshwater, so that is why even small amounts can cause problems.

Phosphate does not leach from soil except at very high Indices. However, it does move across the soil surface and through drains attached to soil particles or in manure that has not been incorporated.

**Minimise phosphate loss**
- Allow any soils with high phosphate Indices to fall to the target 2
- Avoid manure application close to surface water or when rainfall is expected
- Inject or, where possible, carry out rapid incorporation of manures

**Table 6: Summary of the issues with nutrient losses**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Why?</th>
<th>What to do?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate leaching or run-off</td>
<td>Breach of EU 50mg/l water limit</td>
<td>Match fertiliser manure application rate and timing to crop needs and observe spreading controls</td>
</tr>
<tr>
<td></td>
<td>Eutrophication of ponds, lakes, rivers and estuaries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Affects biodiversity in water bodies</td>
<td></td>
</tr>
<tr>
<td>Ammonia volatilisation</td>
<td>Public health</td>
<td>Inject slurry or use trailing shoe equipment</td>
</tr>
<tr>
<td></td>
<td>Acid rain</td>
<td>Incorporate slurry on bare land within 24 hours, preferably within six hours</td>
</tr>
<tr>
<td></td>
<td>Enrichment of natural soils and vegetation</td>
<td></td>
</tr>
<tr>
<td>Nitrous oxide emission</td>
<td>Greenhouse gas – climate change</td>
<td>Match fertiliser and manure applications to grass need</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoid poaching</td>
</tr>
<tr>
<td>Phosphate run-off</td>
<td>Eutrophication of ponds, lakes, rivers and estuaries</td>
<td>Use soil phosphate Index for fertiliser and manure decisions</td>
</tr>
<tr>
<td></td>
<td>Affects biodiversity in water bodies</td>
<td>Do not apply manure within 10m of surface water or manufactured fertiliser within 2m of the centre of a watercourse or field ditch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoid manure application to wet or sloping land or if rainfall is expected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoid poaching</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoid soil run-off and erosion (maintain good soil structure and condition)</td>
</tr>
</tbody>
</table>
Accurate spreading

All the work put into deciding which fertilisers or manures to use and how much to apply will be wasted if spreading is inaccurate.

There are two kinds of inaccuracy:

• Wrong rate of application
• Uneven spreading

The inaccuracies above affect grass yield and quality and can increase nutrient losses to water or air.

Before spring use, check the condition of fertiliser and manure spreaders and replace worn parts. The cost in time and money will be recovered during the year through more accurate spreading and less waste.

Fertiliser spreaders

Applying 25kg N/ha less than required can reduce first cut yield by 0.25-0.75t DM/ha. Applying more than required will increase fertiliser cost unnecessarily. Spreader manufacturers provide advice on calibration for accurate application.

Unevenness of spreading fertiliser N is shown as a coefficient of variation (CV) measured in a tray test. For perfectly even spreading, the CV is 0%. Visibly uneven growth can occur where the CV is greater than 20%.

A properly maintained, set-up and operated fertiliser spreader should achieve a CV of 10-15%. However, values of 30% are often found when spreaders are tested. The loss of yield due to uneven spreading is small, up to a CV of 10% but then increases sharply.

Tray tests of fertiliser spreaders can be done on the farm. The cost of professional testing can usually be recovered by improved effectiveness of the fertilisers used.
Summary

- Check fertiliser and manure spreaders before use in spring
- Calibrate manure spreaders before use
- Calibrate fertiliser spreaders for rate of application in spring and whenever the product being spread changes
- Tray test fertiliser spreaders for evenness of application in spring. Aim for a CV of 10-15%

Manure spreaders

Manure spreaders can be calibrated by weighing empty and full, then spreading a full load over a known area at a known forward speed. This speed can then be adjusted to get the required rate of application. When spreading, check that the bout width allows even application. Typically, the ideal bout width is half the spreading width for broadcast spreaders.

A variable amount of N is lost to the air during manure spreading. Losses will be minimised by keeping trajectories low and where possible using trailing shoe or injection equipment for slurry. Work rate can be lower with these full width spreaders, but nutrients will be applied more accurately. When applying manures to land before a re-seed, aim to incorporate within 24 hours to reduce losses.
Manufactured fertilisers

With so many types of manufactured fertilisers the right choice depends on suitability and price. There are straights that contain one nutrient, for example ammonium nitrate (N), triple superphosphate (TSP) or muriate of potash (MOP).

Di-ammonium phosphate (DAP) and mono-ammonium phosphate (MAP) are often called straights, but strictly speaking are compounds. Compound fertilisers contain more than one nutrient (for example, 20-10-10) and can be blends of straights or complex fertilisers, in which every particle has the same nutrient content.

Ammonium nitrate
Straight N is usually ammonium nitrate or urea. Ammonium nitrate is less susceptible to loss of N compared to urea after application, but as it is an oxidising agent it has special storage requirements. There must be a hazard warning sign at the farm entrance if more than 25t of ammonium nitrate is stored and an oxidising agent sign on the store. The local fire brigade and the Health and Safety Executive must be informed of its presence.

Ammonium nitrate should not be stored with combustible materials or carbon sources, including urea. It should only be bought from a member of the Fertiliser Industry Assurance Scheme (FIAS).

There is a 'Five Point Plan' for the storage of all fertilisers on farms which can be downloaded for free (see page 28). Fertilisers should be stored securely and any losses reported promptly to the police. They should also be stored at least 10m from any watercourse and 50m from a borehole.

Urea
Urea can be cheaper than ammonium nitrate on a unit of N basis, but some N can be lost as ammonia after application. Urea has a higher N content than ammonium nitrate (46% against 34.5%), but has a lower bulk density, so a spreader hopper will contain the same amount of N with both materials.

Phosphates
Straights and compound fertilisers are suitable as phosphate fertilisers for grassland. When using a compound, choose one that has the most suitable ratio of N, phosphate or potash for the crop’s needs.

There are some water-insoluble phosphate fertilisers that are suitable for grassland, especially where soil pH is lower than 6.0. Rock phosphate is effective in acidic soils. The availability of phosphate from ashed poultry manure is less affected by soil pH.

These products are especially useful for raising a low phosphate Index. The slag that comes from
the steel making industry contains around 1.5% phosphate, much less than traditional basic slag which contains 12-15% phosphate. It is however also a liming agent.

**Potash**
Muriate of potash (MOP) is the main source of potash for grass and is used as a straight or in compounds. At the rates recommended, the chloride will not cause any problems. It is easily leached from the soil so does not accumulate.

**Sulphur**
Ammonium sulphate or the N/S compounds available are good sources of sulphur. Gypsum (calcium sulphate) is less soluble but is suitable if applied in spring. Pelleted elemental sulphur is slower acting and more suited to autumn application.

**Summary**
- Buy the right product for the job in hand
- Compare prices of different products
- Follow the Five Point Plan for fertiliser storage
- Buy fertiliser from a FIAS registered supplier
## Rules and regulations – Nitrate Vulnerable Zones (NVZ)

### Summary of NVZ rules for grassland (always check Defra’s website for current NVZ Guidance)

<table>
<thead>
<tr>
<th>Rule Type</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nmax</strong></td>
<td>Maximum N application per crop = 300kg N/ha/year. Extra 40kg N/ha if grass is cut at least three times in year. Includes manufactured fertiliser N, crop available N from livestock manures and other organic manures</td>
</tr>
<tr>
<td><strong>Field organic manure N limit</strong></td>
<td>250kg N/ha in any 12 month period per field. Includes total N in all organic manures</td>
</tr>
<tr>
<td><strong>Livestock manure N farm limit</strong></td>
<td>170kg N/ha in calendar year across the farm. Includes all total N produced by livestock (must use standard tables). Derogation to 250kg N/ha has been available for farms with &gt;80% grass</td>
</tr>
<tr>
<td><strong>Closed periods (no spreading of organic manures with high available nitrogen content, eg slurry, poultry manure, or digestate)</strong></td>
<td>Manufactured fertiliser N: 15 September – 15 January. Organic manure N: 1 September – 31 December on shallow and sandy soils. 15 October – 31 January (all other soils)</td>
</tr>
<tr>
<td><strong>No spread areas</strong></td>
<td>Not if soil is waterlogged, flooded, snow covered or frozen more than 12 hours in previous 24. Manufactured fertiliser N: 2m from surface water. Organic manures: 10m from surface water, 50m from borehole, well or spring and 6m from surface water where precision spreading equipment is used</td>
</tr>
</tbody>
</table>

In winter, check expected compliance with Nmax, the livestock manure N farm limit and the organic manure N field limit. In autumn, check again that the limits are not breached.

### Summary of NVZ rules for manures (always check the NVZ Guidance)

<table>
<thead>
<tr>
<th>Rule Type</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage capacity</td>
<td>Five months for cattle slurry. Includes any rain or wash water entering the store</td>
</tr>
<tr>
<td>Construction standards</td>
<td>New or substantially altered storage must comply with Silage, Slurry and Agricultural Fuel Oil (SSAFO) Regulations. Environment Agency must be notified at least 14 days before construction or reconstruction begins</td>
</tr>
<tr>
<td>FYM storage</td>
<td>On impermeable base with run-off containment, in roofed building or in temporary field heap</td>
</tr>
<tr>
<td>Temporary field heaps</td>
<td>Field heaps must occupy as small a surface area as is practically required to support the heap and prevent it from collapsing. They must not be sited within 10m of surface water (30m if the land is steeply sloping), 50m of spring, well or borehole, on land that might flood or become waterlogged, on same site for &gt;12 months. Leave at least two years before return to site. Mark site on risk map</td>
</tr>
<tr>
<td>Risk map</td>
<td>Must show fields and areas, surface waters, boreholes, springs, wells, areas of sandy or shallow soils, slope &gt;12 degrees, land within 10m of water or 50m of spring, well or borehole, land drains and field manure heaps</td>
</tr>
<tr>
<td>Spreading equipment</td>
<td>Must be low trajectory (&lt;4m from ground)</td>
</tr>
</tbody>
</table>
Keeping records
Keeping records helps retain knowledge and experience of previous operations and to comply with Cross Compliance and NVZ rules.

Records can be kept on paper or on computer. There are systems to help with both.

The Tried & Tested paper-based Nutrient Management Plan includes farm and field record sheets that are straightforward to complete. The PLANET computer program keeps records as well as providing nutrient use recommendations. Both of these include records and calculations required under NVZ rules.

All NVZ records must be kept for five years. For nutrient management purposes, useful records include:

Farm
- Area of grass and of any other forage crops
- Livestock numbers (for stocking rate)
- Purchased feeds (for dependence on grass)
- Dates of calibration and tray testing of fertiliser and manure spreaders
- Risk map for manure application

Field
- SNS status (low, moderate, high) and results of soil analysis
- Date of re-seeding
- Amounts and dates of fertiliser and manure applications
- Nutrient contents of fertilisers and manures applied
- Method of manure application
- Notes on grass growth and any visible nutrient deficiencies
- Amount of silage or hay produced if cut (loads, bales or tonnes)

Summary
- Use a recognised fertiliser recommendation system such as Nutrient Management Guide (RB209)
- Take account of requirements of the stock. Do not use fertiliser N to grow more grass or forage than needed
- Before calculating how much fertiliser N to apply, consider other sources: soil, clover, deposition by grazing animals or spread organic manures. Take account of field history – permanent pasture is likely to have more soil N than a short term ley or field that is always cut. Check the soil nitrogen supply (SNS) status
- Use standard tables for the crop available nitrogen contributed by any manures applied and deduct this from fertiliser requirement
- If clover is important, restrict fertiliser to no more than 100-150kg N/ha over the season
- If grass accumulates in grazed areas, cut back on fertiliser N for a while
- Comply with rules for N use if in an NVZ

See Appendix 3 (page 28) for sources of more information.
Appendix 1
Applying manures to grassland – a visual guide

25t/ha or 10t/acre =
N = 15kg\(^\uparrow\)
Phosphate = 48kg\(^\uparrow\)
Potash = 180kg\(^\uparrow\)
Value\(^*\) = £124.80

50t/ha or 20t/acre =
N = 30kg\(^\uparrow\)
Phosphate = 96kg\(^\uparrow\)
Potash = 360kg\(^\uparrow\)
Value\(^*\) = £249.60

Source: ThinkManures (www.nutrientmanagement.org). \(^\uparrow\)Available nutrients supplied, based on cattle farmyard manure with 10% N availability (RB209.) \(^*\)Based on bagged fertiliser prices – 1kg of N = £0.72, 1kg of Phosphate = £0.65, 1kg of Potash = £0.46.
Appendix 2
Applying slurry to grassland – a visual guide

Source: ThinkManures (www.nutrientmanagement.org). ^Available nutrients supplied, based on 6% DM cattle slurry with 25% N availability (RB209). *Based on bagged fertiliser prices – 1kg of N = £0.72, 1kg of Phosphate = £0.65, 1kg of Potash = £0.46.
Appendix 3

Sources of information

AHDB
The Nutrient Management Guide (RB209) which includes nitrogen recommendations and standard tables of nutrient contents of manures with information on sampling FYM and slurry, can be downloaded free at www.ahdb.org.uk

AHDB Beef & Lamb
Beef and Sheep Better Returns Programme (BRP) Manual 3 – Improving soils for Better Returns has more information on interpreting soil test results. Call 024 7647 8834 for a free copy or download at beefandlamb.ahdb.org.uk

Read more about the trace element requirements of livestock in BRP Plus+ document Trace element supplementation of beef cattle and sheep – available to download at beefandlamb.ahdb.org.uk – follow the links under BRP literature

AIC
Information on calibrating and tray testing fertiliser spreaders is in Fertiliser Spreaders: Choosing, Maintaining & Using published by AIC, which can be downloaded at www.nutrientmanagement.org/fertiliser-spreader-manual/

Information on the Fertiliser Industry Assurance Scheme (FIAS) is at the AIC website www.agindustries.org.uk

Defra
Find NVZ guidance and information, including standard values for crop availability of manure nitrogen that must be used when calculating Nmax at www.gov.uk/guidance/nutrient-management-nitrate-vulnerable-zones


FACTS
Information on training for nutrient management planning is available at www.factsinfo.org.uk/facts/home.eb

Health and Safety Executive (HSE)
The HSE booklet Storing and Handling Ammonium Nitrate can be downloaded at www.hse.gov.uk/pubns/indg230.pdf

NaCTSO
The Five Point Plan for Fertiliser Security, drawn up by the National Counter Terrorism Security Office (NaCTSO) is at www.gov.uk/government/publications/secure-your-fertiliser/secure-your-fertiliser

Natural England
Catchment Sensitive Farming advisers can help farm businesses by providing free training, advice and grants to farmers in priority catchments to reduce water pollution. To find out if you are in a CSF area go to www.naturalengland.org.uk/csf

Tried & Tested
The paper-based Tried & Tested Nutrient Management Plan is available free at www.nutrientmanagement.org.

There is also a list of the main UK agricultural laboratories offering soil testing, and two useful booklets – Think Manures and Managing Livestock Manures Booklet 2: Making better use of manure on grassland

There is information on calibrating manure spreaders in Managing Livestock Manures Booklet 3: Spreading systems for Slurries and Solid Manures, at www.nutrientmanagement.org
Appendix 4

Conversion factors

<table>
<thead>
<tr>
<th>Metric to Imperial</th>
<th>Imperial to Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 tonne/ha</td>
<td>0.4 tons/acre</td>
</tr>
<tr>
<td>100kg/ha</td>
<td>80 units/acre</td>
</tr>
<tr>
<td>1m³</td>
<td>220 gallons</td>
</tr>
<tr>
<td>1m³/ha</td>
<td>90 gallons/acre</td>
</tr>
<tr>
<td>1kg/1m³</td>
<td>9 units/1000 gallons</td>
</tr>
<tr>
<td>1kg</td>
<td>2 units</td>
</tr>
</tbody>
</table>

$$\frac{50\text{kg/ha of phosphate required}}{\text{TSP (with 46% phosphate)}} = \frac{50}{46} = 109\text{kg of Triple superphosphate (TSP) needed}$$

To calculate rate of nutrient supplied by specified application rate of fertiliser product, multiply by the analysis %, eg

$$\begin{align*}
100\text{kg/ha of 20-10-10} & = \frac{100 \times 20}{100} = 20\text{kg N applied} \\
& \text{For phosphate} = \frac{100 \times 10}{100} = 10\text{kg phosphate applied} \\
& \text{For potash} = \frac{100 \times 10}{100} = 10\text{kg potash applied}
\end{align*}$$

To convert units/acre to kg/ha (for nutrients), multiply by 1.25, eg

$$160\text{ units/acre} \times 1.25 = 200\text{kg/ha}$$

To convert kg/ha to units/acre (for nutrients), multiply by 0.8, eg

$$200\text{kg/ha} \times 0.8 = 160\text{ units/acre}$$

To convert bags*/acre to kg/ha (for product), multiply by 125, eg

$$2\text{ bags/acre of Ammonium nitrate} \times 125 = 250\text{kg/ha of Ammonium nitrate}$$

* Refers to defunct hundredweight bags (cwt = 50kg)

Source: Nutrient Management Guide (RB209), Fieldfare Training
Other BRP publications available

**Joint Beef and Sheep BRP**
- Manual 1 – Improving pasture for Better Returns
- Manual 2 – Improved costings for Better Returns
- Manual 3 – Improving soils for Better Returns
- Manual 4 – Managing clover for Better Returns
- Manual 5 – Making grass silage for Better Returns
- Manual 6 – Using brassicas for Better Returns
- Manual 7 – Managing nutrients for Better Returns
- Manual 8 – Planning grazing strategies for Better Returns
- Manual 9 – Minimising carcase losses for Better Returns
- Manual 10 – Growing and feeding maize silage for Better Returns

See the AHDB Beef & Lamb website [beefandlamb.ahdb.org.uk](http://beefandlamb.ahdb.org.uk) for the full list of Better Returns Programme publications for beef and sheep producers.