BEEF AND SHEEP BRP MANUAL 7

Better Returns Programme

Managing nutrients for Better Returns

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Additional information from Creedy Associates.

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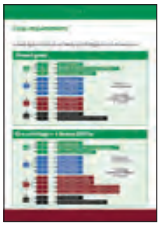
Contents



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.

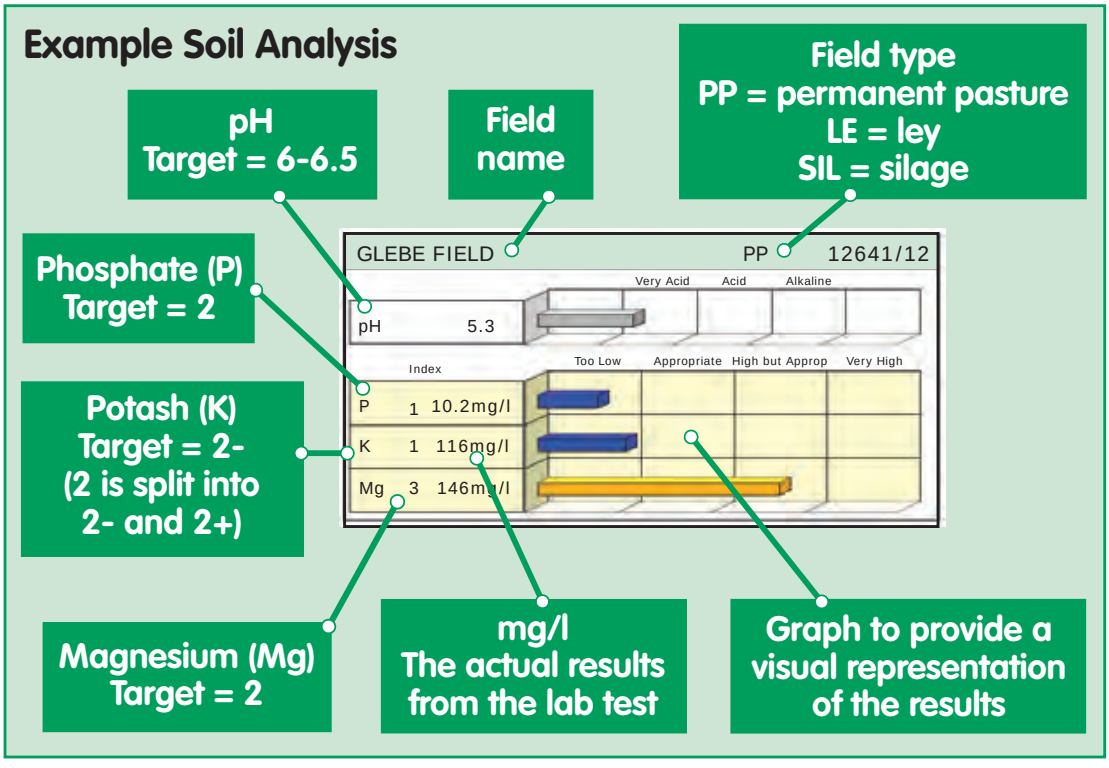
The starting place is to test the soil, although only around a third of beef and sheep farmers do so regularly. Yet by measuring and then managing nutrients, producers can optimise their output, while reducing any potential negative impacts of any oversupply.

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

Dr Liz Genever
EBLEX Livestock 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 P and K (see the recommendation below).

Field name/Ref/Soil type	Last crop/Next crop		P	K	Mg		Lime
GLEBE FIELD/12641/12/Heavy	P Pasture/P Pasture	Units/Acre	40	24	0	t/ac	2.4
		Kg/Ha	50	30	0	t/ha	6.0

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

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.

Primary (major) nutrients	Nitrogen Phosphate Potash	Application usually needed for growth
Secondary (minor) nutrients	Calcium Magnesium Sulphur	Applied calcium is not needed except as a liming agent Magnesium sometimes needed for livestock diet, but does not increase plant yield Application of sulphur needed for silage grass
Micronutrients (trace elements)	Boron Cobalt Copper Manganese Molybdenum Selenium Sodium Zinc	Application very rarely needed for growth Copper, cobalt, selenium and sodium are sometimes needed for livestock diet

Nutrients are imported to the farm in purchased feeds and bedding then reach the soil in manures. The role of fertilisers is to make up the difference between the requirement for a nutrient and its supply from these other sources.

Crop requirement − (**Supply from soil** + **Supply from manures** + **Supply from air** + **Supply from clover**) = **Fertiliser requirement**

Lime

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 6.0-6.5. On peaty soils, pH can be lower, 5.0-5.5 for grass and grass/clover.

For liming, target pH is normally 6.5. This allows for it to drop between soil tests without compromising yield. Ideally test every four to five years. Liming can also have beneficial effects on nutrient availability.

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 ($CaCO_3$). Some forms contain magnesium.

The quality of liming material is based on Total Neutralising Value (TNV) and Reactivity.

TNV is the ability of lime to neutralise acid under laboratory conditions.

Off-farm wastes, such as paper crumb (TNV = 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 (TNV = 58%) plus a source of phosphate and trace elements. It can be cost-effective, but it can contain high levels of iron.

Reactivity is the speed of action – which is related to the particle size. Generally the smaller particle size the larger the surface area and the quicker the action. For example, lime granules have fine particles which are bound together so have high reactivity (>98%). It can be spread by a fertiliser spreader and is useful when pH needs to be changed rapidly.

Guidelines for lime application

pH	Tonnes per ha	Tonnes per acre
6.1-6.4	2	0.8
5.8-6.0	3	1.2
5.6-5.7	4	1.6
5.5	5	2.0
5.3-5.4	6	2.4
5.2 and below	7	2.8

To calculate from tonnes/ha to tonnes/acre multiply by 0.4046.

Apply no more than 7t/ha at one time.

These guidelines are based on material with neutralising value of 54 and fineness of 40% – products with lower neutralising value or coarser will need a heavier dose. This is a simplified version as it has combined recommendations for different soil types. Look at the website (address below) or speak to your contractor for more details.

(Adapted from **www.aglime.org.uk/technical 05.htm**)

Reducing soil pH

It has been suggested that applying gypsum (calcium sulphate) can reduce pH (making a soil of pH 7-8 closer to 6.5). However, various studies suggest that application of gypsum from mined or recycled sources has limited effect on pH, but can help soil condition.

Application of other products containing elemental sulphur can reduce pH as it forms sulphuric acid which reacts with calcium carbonate, but this occurs very slowly. Also using fertilisers containing ammonium will have an acidifying effect.

Phosphate and potash

Phosphate (P) and potash (K) 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 P and K are shown as soil Indices that usually only change slowly over the years.

For grassland, target soil Indices are 2 for P and 2- for K. 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 P (see page 19).

Dung and urine

Applying manure is a good way to correct low Indices. P and K 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 P excreted is in the dung which is concentrated in small areas.

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

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

Cattle and sheep dung is distributed unevenly with poor soil contact

Urine patches cover a larger area and the nutrients are in available forms

Nutrient imbalances

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

Clover

Low K supply can restrict the growth of clover even where there seems to be enough for grass. Correcting low soil K 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 P situations.

Potash and staggers

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

Summary

- Use a recognized fertiliser recommendation system such as Defra Fertiliser Manual (RB209)
- Lime grassland on mineral soils to pH 6.5 and on peaty soils to pH 5.3
- Aim for soil P Index 2 and K Index 2-. Apply manures where possible to fields with Indices below target
- Replace K removed in grass cut for silage
- Avoid large single applications of K in spring or in fields used for grazing

Magnesium

Magnesium deficiency rarely affects grass and clover growth. In 2011, only 3% of grassland soil samples were at Mg Index 0 or 1.

The concentration of Mg in herbage however can be a problem for livestock. To avoid staggers, aim for 0.2% Mg in the DM. Excessive application of K can reduce Mg concentration in the grass.

Magnesium can be applied as a fertiliser (50 -100kg MgO/ha as quicker-acting kieserite or slower calcined magnesite) or supplemented feeds can be offered.

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

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

Sulphur

Sulphur supply

Forty years ago, sulphur (S) supply to grassland was more than adequate. This was due to deposition from the air of S emitted by industry, and from S-containing fertilisers like single superphosphate and ammonium sulphate.

Supply fell as these fertilisers were replaced by more concentrated products and industry cleaned up its emissions. Today, most grassland receives less than 20kg SO_3/ha annually from the air.

Sulphur after cutting

First cut silage benefits from S 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 SO_3/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 S.

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

As well as reducing grass yield, S 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, Cu reacts inside the animal so that the Mo becomes unavailable. The reaction is promoted by high S in the diet.

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

Copper, S and Co 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

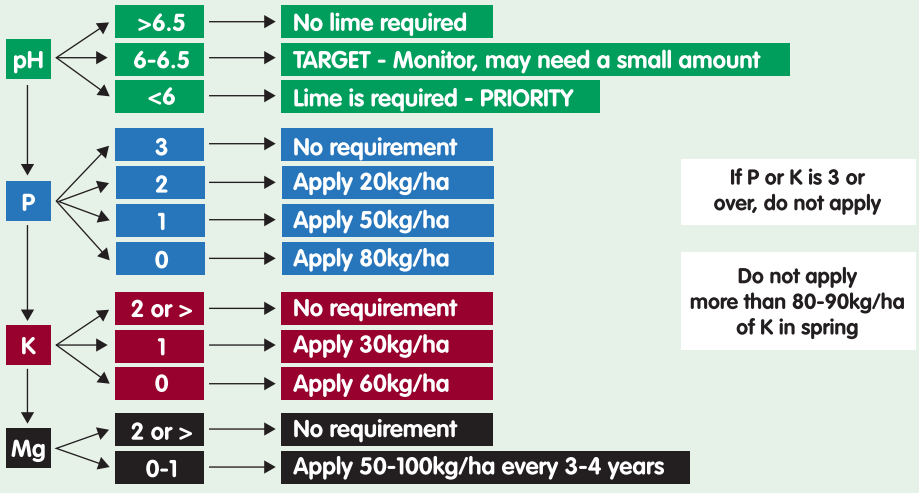
- Apply an S-containing fertiliser to supply 40kg SO_3/ha for second and third cut silage
- Where Cu, Se or Co deficiency occurs in livestock, consider the options of direct treatment of the animals or applying the nutrient in fertiliser. Do not over-supplement or apply
- Remember what is measured in 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.

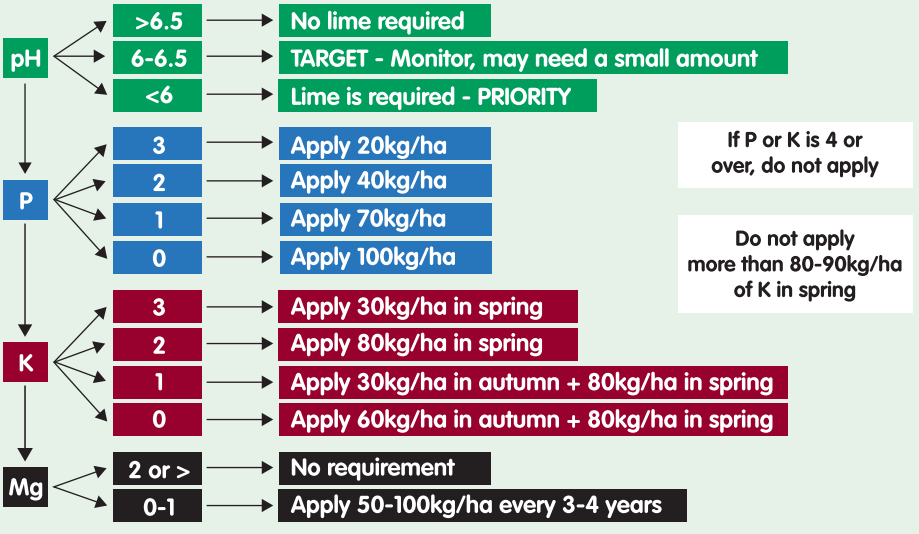
Crop requirements

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

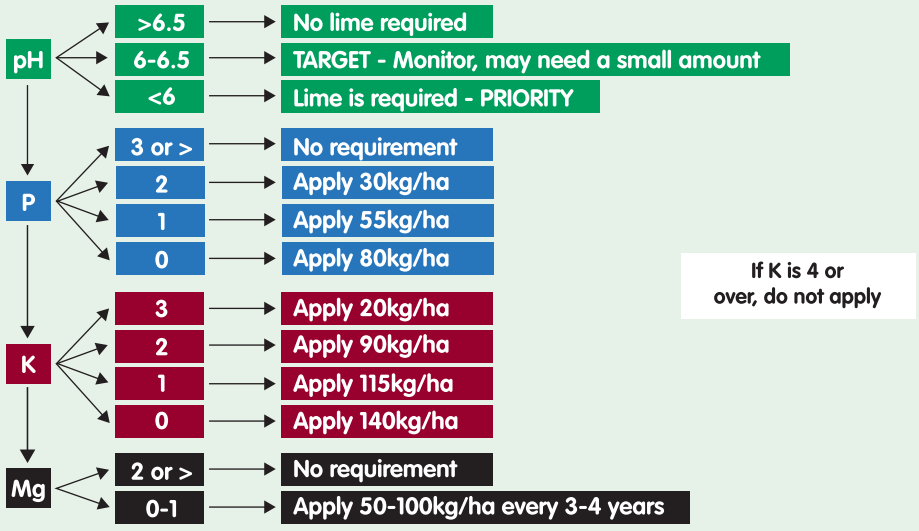


One cut silage = 6 tonnes DM/ha

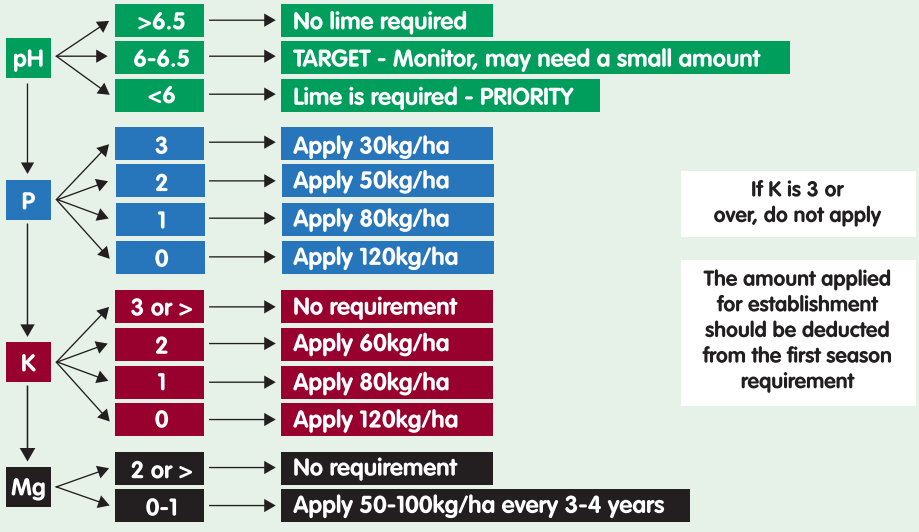


If there is no incentive to build up P or K Indices, for example on rented land, apply just enough to meet crop requirements, ie use the recommendation for Index 2.

Hay



Grass re-seeds



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. So 50kg N will grow an extra 600kg of DM at a 1kg:12kg response.

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

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

Defra's Fertiliser Manual (RB209) approaches nitrogen recommendations by:

- Looking at soil nitrogen supply – high, moderate or low
- Assessing grass growth – very poor, poor, average, good or very good
- Recording concentrate use for beef cattle – tonne per animal per year
- Calculating stocking rate (LU/ha) 1 LU = 650kg cow, 0.6 LU = 390kg growing cattle, 0.17 LU = 1 ewe with lambs
- Deciding whether it is a cutting or grazing system
- Providing nitrogen recommendations to produce enough grass for that system

It is important to think about the total amount of grass needed to feed the stock, and 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 N. EBLEX Business Pointers 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 (NVZs) is 300kg N/ha.

The amount needed differs from farm to farm and enterprise to enterprise. Seek advice from a FACTS qualified advisor for precise recommendations.

Previous management	Previous nitrogen use (kg N/ha/year)	SNS status
Long term grass including grass after one year arable break	More than 250	High
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)	100-250 or substantial clover content	Medium
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)	Up to 100	Low

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 the table above).

Remember to deduct the contribution of N from clover. In grazing situations there is usually no need for bagged N on clover-rich swards, apart from perhaps a little (50kg N) 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 is likely to be reduced by 100-150kg N/ha over the season. A sward containing less than 10% white clover as DM can be treated as grass on its own.

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
- Concentrate use = 200kg/animal/year
- 1.2 livestock units/ha
- **Yield = 9.2t DM/ha**

SNS Status	Low	Moderate	High
Grazing only	120kg	90kg	60kg
One cut then grazing	128kg for silage 72kg for grazing	116kg for silage 54kg for grazing	104kg for silage 36kg for grazing
Two cuts then grazing	128kg for 1st cut 112kg for 2nd cut 30kg for grazing	116kg for 1st cut 102kg for 2nd cut 23kg for grazing	104kg for 1st cut 91kg for 2nd cut 15kg for grazing

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

Assumptions

- Average growth class (see above)
- 1.5 livestock units/ha
- **Yield = 9.3t DM/ha**

SNS Status	Low	Moderate	High
Grazing only	200kg	170kg	140kg
Grazing then one cut of hay then grazing	80kg for grazing (early/mid Feb) 100kg for hay 50kg for grazing	68kg for grazing (early/mid Feb) 70kg for hay 43kg for grazing	56kg for grazing (early/mid Feb) 40kg for hay 35kg for grazing
Grazing then one cut of silage then grazing	80kg for grazing (early/mid Feb) 116kg for silage 50kg for grazing	68kg for grazing (early/mid Feb) 105kg for silage 43kg for grazing	56kg for grazing (early/mid Feb) 95kg for silage 35kg for grazing

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. This can be just disappointing growth. 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.

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

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 Defra's Fertiliser Manual (RB209)
- Develop a nutrient management plan such as Tried & Tested or PLANET
- Sample soils for pH, P, K and Mg 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 FYM 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 Defra's Fertiliser Manual (RB209).

It is worth getting a sample of manure or slurry analysed, especially if groups are being fed different rations, eg sucklers 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.

	Typical crop available nutrient contents in kg/t or kg/m³				
	Nitrogen (N)	Phosphate (P_2O_5)[d]	Potash (K_2O)[e]	Sulphur (SO_3)	Magnesium (MgO)
Cattle FYM	0.6[a]	1.9	7.2	2.4	1.8
Sheep FYM	0.7[a]	1.9	7.2	3.0	1.6
Cattle slurry (6% DM)	0.78[b]	0.6	2.9	0.7	0.6
Pig slurry (4% DM)	1.7[c]	0.9	2.2	1.0	0.7
Broiler litter	9.0[b]	15.0	16.2	8.0	4.4

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.

When calculating Nmax (maximum N application per crop in an NVZ), the percentage crop available N figure must be used (shown in Table 8 of NVZ Guidance Leaflet 3), and not the figures published in Defra's Fertiliser Manual.

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 P or K Index. Try to avoid fields where the P Index is higher than 2, even if the K 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 late winter or early spring, and immediately after a cut of silage.

Do not apply more than 250kg N/ha in manures over a year, or more than 50m^3/ha of slurry at any one time. This will minimise the risk of run-off and prevent smothering the regrowth.

Avoid run-off

Manure should not be applied 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, P and K as in the example below.

Fertiliser examples	Available nutrients (kg/t)* [A]	Price (£/t) [B]	Cost of nutrient (£) [B/A]
Ammonium nitrate (34.5% N)	345	350	1.01
Triple Super Phosphate – TSP (46% P_2O_5)	460	500	1.09
Muriate of potash (60% K_2O)	600	400	0.67

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

Nutrient	Cost of nutrient (£) [C]	Cattle FYM nutrient content [D]	Manure value (£/t) [CxD]
N	1.01	0.6	0.61
P	1.09	1.9	2.07
K	0.67	7.2	4.82
		TOTAL	**£7.50**

Sulphur and magnesium

Manures also contain useful amounts of S and Mg. Availability of the S can vary widely from around 50% in fresh slurry to 5% in manure that has been stored over winter.

Summary

- Treat manures as fertilisers, not wastes
- Use standard tables in Defra's Fertiliser Manual or laboratory analysis to estimate the total N, P_2O_5 and K_2O contents of manures
- Use standard tables in Defra's Fertiliser Manual for calculating the crop available N in applied manures but use Table 8 in NVZ Guidance Leaflet 3 when calculating Nmax
- Target manure applications to fields with low P or K Indices, but try to avoid fields where the P Index is higher than 2
- Do not apply manures within 10m of a watercourse or 50m of a borehole, well or spring used for human consumption
- 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

Nutrient application examples

Grazed grass

pH	5.8	3t/ha lime
P	1	50kg/ha — 109kg of TSP (46% P) would supply 50kg of P/ha
K	1	30kg/ha — 50kg of MOP (60% K) would supply 30kg of K/ha
Mg	2	No requirement

Alternatively, 170kg of 0-30-20/ha would supply 51kg P/ha and 34kg K/ha

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

6kg of N would be applied too

One cut silage

pH	5.8	3t/ha lime
P	1	70kg/ha — 152kg of TSP (46% P) would supply 70kg of P/ha
K	1	30kg/ha + 80kg — 50kg of MOP (60% K) would supply 30kg of K/ha for the autumn dressing, plus 133kg of MOP in spring
Mg	2	No requirement

Alternatively, 30m^3/ha (2700 gallons/acre) of 6% cattle slurry in the spring would supply around 18kg of P and 83kg of K, which removes the need for the spring dressing of MOP and reduces the TSP amount to 113kg/ha.

THIS IS A SAVING OF AROUND £67/ha.

23kg of N would be applied too

TSP = Triple Super Phosphate (45-46% P_2O_5)
MOP = Muriate of potash (60% K_2O)

Hay

pH	5.8	3t/ha lime, if not already corrected
P	1	55kg/ha 120kg of TSP (46% P) would supply 55kg of P/ha
K	1	115kg/ha 192kg of MOP (60% K) would supply 115kg of K/ha
Mg	2	No requirement

Alternatively, 30m³/ha (2700 gallons/acre) of 4% pig slurry would supply around 27kg of P and 66kg of K, which reduces the TSP amount to 61kg/ha and the MOP amount to 82kg/ha.

THIS IS A SAVING OF AROUND £67/ha.

51kg of N would be applied too

Re-seed

pH	5.8	3t/ha lime, if not already corrected
P	1	55kg/ha 109kg of TSP (46% P) would supply 50kg of P/ha
K	1	80kg/ha 133kg of MOP (60% K) would supply 80kg of K/ha
Mg	2	No requirement

Alternatively, 10 tonnes of cattle FYM/ha would supply around 19kg of P and 72kg of K, which removes the need for MOP and reduces the TSP amount to 67kg/ha.

THIS IS A SAVING OF AROUND £61/ha.

6kg of N would be applied too

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 P can cause environmental problems, so any potential losses need addressing. Problems like these have not been associated with K or S. 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 rivers, lakes or aquifers. The EC limit of 50mg nitrate/litre, originally introduced for drinking water, now applies to surface waters and aquifers. In surface waters nitrate also can contribute to eutrophication (nutrient enrichment) and the excessive algal growth and oxygen depletion this causes, which damages aquatic wildlife.

Ammonia

Nitrogen also can be lost to the air as ammonia, N gas and nitrous oxide. Ammonia contributes to acid rain and to unwanted N input to natural soils and vegetation.

The main source of ammonia is livestock manure during storage and especially application, including the urine deposited by grazing animals. Loss tends to be greater from slurry systems than from FYM.

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 gas and nitrous oxide

Where the soil is anaerobic (oxygen starved), nitrate can be converted by micro-organisms to harmless N gas and to small amounts of nitrous oxide, a potent greenhouse gas. Poaching, poor drainage or water-logging can make soil anaerobic and will increase N loss.

Poaching promotes loss of N by de-nitrification, and of P by soil erosion

Phosphate in water

If phosphate reaches surface water, even in very small amounts, it can promote excessive algal growth and blanket weed in ponds. The water can then become depleted of oxygen when the algae or weeds die and decompose. Phosphate is generally 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 in soil particles or in manure that has not been incorporated.

Minimise P loss

- Allow any high soil P 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

Eutrophication and algal growth caused by the movement of P to water

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

NB: Some of the ELS options are designed to help address these problems

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 three kinds of inaccuracy:

- Wrong rate of application
- Uneven spreading
- Timing – in relation to closed periods and when plants cannot make use of the nutrients applied, eg too cold, wet or dry

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 0.25t 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% in practice. 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, and the cost of professional testing can usually be recovered by improved effectiveness of the fertilisers used.

Manure spreaders

Manure spreaders can be calibrated by weighing empty and full, and then spreading a full load over a known area at a known forward speed. Forward 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 FYM to land before a re-seed aim to incorporate within 24 hours to reduce losses.

Summary

- Check fertiliser and manure spreaders before use in spring
- 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%
- Calibrate manure spreaders before use

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. These 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 HSE 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 'Ten 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

Triple superphosphate and compound fertilisers are suitable as P fertilisers for grassland. When using a compound, choose one that has the most suitable ratio of N, P or K for the crop's needs.

There are some water-insoluble P 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 P from ashed poultry manure is less affected by soil pH.

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

Potash

Muriate of potash (MOP) is the main source of K 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 S. Gypsum (calcium sulphate) is less soluble but is suitable if applied in spring. Pelleted elemental S 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 Ten Point Plan for fertiliser storage
- Buy fertiliser from a FIAS registered supplier

Rules and regulations – Nitrate Vulnerable Zones (NVZs)

Summary of NVZ rules for grassland (always check the NVZ Guidance Leaflets)	
Nmax	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 and crop available N (must use standard %) in livestock manures
Field organic manure N limit	250kg N/ha in any 12 month period per field. Includes total N in all organic manures
Livestock manure N farm limit	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 >80% grass
Closed periods (no spreading of organic manures with high available nitrogen content, eg slurry, poultry manure, or fertilisers)	Manufactured fertiliser N: 15 September – 15 January. Organic manure N: 1 September – 31 December (sandy or shallow soils). 15 October – 15 January (all other soils)
No spread areas	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

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 Leaflets)	
Storage capacity	Five months for cattle slurry. Includes any rain or wash water entering the store
Construction standards	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 store is used
FYM storage	On impermeable base with run-off containment, in roofed building or in temporary field heap
Temporary field heaps	FYM must be stackable and not give rise to free drainage from within heap. Not sited within 10m of water or land drain, 50m of spring, well or borehole, on land that might flood or become waterlogged, on same site for >12 months. Leave at least two years before return to site. Mark site on risk map
Risk map	Must show fields and areas, surface waters, boreholes, springs, wells, areas of sandy or shallow soils, slope >12 degrees, land within 10m of water or 50m of spring, well or borehole, land drains, field FYM heaps
Spreading equipment	Must be low trajectory (<4m from ground)

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.

In NVZs, records of N use and manure storage must be kept for at least 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 recognized fertiliser recommendation system such as Defra's Fertiliser Manual (RB209)
- Take account of requirements of the stock. Do not use fertiliser N to grow more herbage than needed
- Before deciding how much fertiliser N to apply, consider other sources: soil, clover and deposition by grazing animals. 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 muck to grassland – a visual guide

25t/ha or 10t/acre
= N = 15kg P = 48kg
K = 180kg^
Value* = £188.07

50t/ha or 20t/acre
= N = 30kg P = 96kg
K = 360kg^
Value* = £376.14

Source: ThinkManures (www.nutrientmanagement.org). ^Available nutrients supplied, based on cattle farmyard manure with 10% N availability (RB209.) *Based on bagged fertiliser prices – 1kg of N = £1.01, 1kg of P = £1.09, 1kg of K = 67p

Appendix 2

Applying slurry to grassland – a visual guide

→ 25m³/ha or
2225 gallons/acre
= N = 16kg P = 15kg
K = 73kg^
Value* = £81.42

→ 50m³/ha or
4500 gallons/acre
= N = 32kg P = 30kg
K = 146kg^
Value* = £162.84

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 = £1.01, 1kg of P = £1.09, 1kg of K = 67p

Appendix 3

Sources of information

ADAS

PLANET (Planning Land Applications of Nutrients for Efficiency and the Environment) is a nutrient management computer program that can be downloaded free or ordered on a DVD at **www.planet4farmers.co.uk**

Manner NPK can be used to calculate nutrients in applied manures and slurries – download free from **www.planet4farmers.co.uk**

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/Library-publications/Library-publications/**

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

EBLEX Better Returns Programme

Beef and Sheep BRP Manual 3 – *Improving soils for Better Returns* has more information on interpreting soil test results. Call **0870 241 8829** for a free copy or download at **www.eblex.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 view online at **www.eblex.org.uk** – follow the links under BRP literature

DEFRA

The *Fertiliser Manual* (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.defra.gov.uk/publications/2011/03/25/fertiliser-manual-rb209/** or a hardcopy can be ordered at **www.tsoshop.co.uk**

Find NVZ guidance and information, including standard values for crop availability of manure nitrogen that must be used when calculating Nmax at **www.defra.gov.uk/food-farm/land-manage/nitrates-watercourses/nitrates/**. The requirements for records in NVZs are outlined in the Guidance Leaflets

The Defra code of good agricultural practice *Protecting our Water, Soil and Air: a Code of Good Agricultural Practice for farmers, growers and land managers* is at **www.defra.gov.uk/publications/2011/06/16/pb13558-cogap/**

FACTS

Information on the Fertiliser Advisers Certification and Training Scheme (FACTS) is at **www.basis-reg.com**

HSE

The HSE booklet *Storing and Handling Ammonium Nitrate* can be downloaded at **www.hse.gov.uk/pubns/indg230.pdf**

NaCTSO

The *Ten Point Plan for Fertiliser Security*, drawn up by the National Counter Terrorism Security Office (NaCTSO) is at **www.secureyourfertiliser.gov.uk/10points.htm**

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*, again at **www.nutrientmanagement.org**

Appendix 4

Conversion factors

Metric to Imperial

1 tonne/ha	=	0.4 tons/acre
100kg/ha	=	80 units/acre
1m³	=	220 gallons
1m³/ha	=	90 gallons/acre
1kg/1m³	=	9 units/1000 gallons
1kg	=	2 units

Imperial to Metric

1 ton/acre	=	2.5 tonnes/ha
100 units/acre	=	125kg/ha
1 bag/acre	=	125kg/ha
1000 gallons	=	4.5m³
1000 gallons/acre	=	11m³/ha
1 unit	=	0.5kg

To calculate rate of fertiliser product needed to provide a specified rate of nutrient required, divide by the analysis %, eg

$$\frac{\text{50kg/ha of phosphate required}}{\text{TSP (with 46\% phosphate)}} = \frac{50}{46} \times 100 = \text{109kg of TSP needed}$$

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

100kg/ha of 20-10-10	For N	= 100 x 20/100	=	20kg N applied
	For P	= 100 x 10/100	=	10kg P applied
	For K	= 100 x 10/100	=	10kg K applied

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

160 units/acre x 1.25 = 200kg/ha

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

200kg/ha x 0.8 = 160 units/acre

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

2 bags/acre of AN x 125 = 250kg/ha of AN

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

Source: Fertiliser Manual, 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

See the EBLEX website for the full list of Better Returns Programme publications for beef and sheep producers.

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