Nutrient Management Guide (RB209)

Updated January 2021

Section 3 Grass and forage crops

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Greenhouse Gas Action Plan:
The industry-wide Greenhouse Gas Action Plan (GHGAP) for agriculture focuses on improving resource use efficiency in order to enhance business performance while reducing GHG emissions from farming.

Using the Nutrient Management Guide (RB209)

The Nutrient Management Guide (RB209) helps you make the most of organic materials and balance the benefits of fertiliser use against the costs – both economic and environmental. The guide outlines the value of nutrients and soil, and explains why good nutrient management is about more than just fertilisers. It can save you money as well as help protect the environment.

AHDB first published the Nutrient Management Guide (RB209) in May 2017. Since its publication, recommendations have been revised, with the latest independent research funded by AHDB and its partners. A list of updates is available at **ahdb.org.uk/rb209**

To improve the accessibility and relevance of the recommendations and information, the Nutrient Management Guide (RB209) is published as seven sections that are updated individually.

Further information

The Nutrient Management Guide (RB209) will be updated regularly. Please email your contact details to **comms@ahdb.org.u**k so that we can send you notifications of when they are published.

RB209: Nutrient Management

Download the app for Apple or Android devices to access the current version of the guide. With quick and easy access to videos, information and recommendations, it is practical for use in the field.

Always consider your local conditions and consult a FACTS Qualified Adviser if necessary.

This section provides guidance for grass and forage crops (in situ grazing or ensiling) and should be read in conjunction with Sections 1 and 2. For each crop, recommendations for nitrogen (N), phosphate (P_2O_5) and potash (K_2O) are given in kilograms per hectare (kg/ha). Magnesium (MgO), sulphur (as SO_3) and sodium (as Na_2O) recommendations, also in kg/ha, are given where these nutrients are needed.

Recommendations are given for the rate and timing of nutrient application. The recommendations are based on the nutrient requirements of the crop being grown, while allowing for the nutrients supplied by the soil.

Contents

Introduction

This section provides nutrient recommendations for both grass and forage crops. As with any crop, it is important to match nutrient inputs to the demands of the grass sward or forage crop. Doing this will increase nutrient use efficiency, optimise grassland productivity, prevent loss of excess nutrients to the environment and cut input costs by reducing the need for purchased fertilisers.

For grass and forage crops, there are several factors that affect how efficiently nutrients are used by the plant. Nutrients applied through fertilisers or manures (especially nitrogen) will be used most effectively when there is:

- Good soil structure – compacted or poorly draining soils will hinder plant nutrient uptake and can increase gaseous release of N
- Balanced soil fertility – nutrient efficiency (particularly N) is higher when soils have optimal levels of phosphate, potash, magnesium and sulphur
- A moderate soil temperature – at low temperatures, nutrient uptake by the plant will diminish, leading to a higher risk of leaching
- Sufficient soil moisture – too much moisture will increase the risk of leaching losses, too little will curb plant growth and reduce nutrient uptake
- Optimum soil pH – very low or high soil pH will reduce the amount of nutrients available to the plant. Optimum soil pH for grassland is 6.0 for mineral soils, 5.7 for intermediate organic soils and 5.3 for peaty soils. Aim to raise pH to 0.2 units above the optimum
- Good sward composition – more productive sward species, e.g., perennial rye-grass and timothy, will be more responsive to fertiliser inputs

It is important to plan the amount of grass and forage crop production that needs to be achieved in each field, remembering that nutrient applications may need to be adjusted for seasonal and weather conditions.

Further information

AHDB UK Fertiliser Price Series
ahdb.org.uk/GB-fertiliser-prices

Checklist for decision-making

Before applying fertilisers to grassland or forage crops it is important to:

1. Carry out a soil test (page 8).
2. Understand if the field is within a nitrate vulnerable zone (NVZ) and check the rules for application rates and timing for organic materials and fertilisers.
3. Assess soil structure.
4. Ensure drainage systems are maintained and functioning correctly.
5. Calibrate the fertiliser spreader.
6. Calculate any nutrient available for additions of organic materials (**Section 2: Organic materials**).
7. Consider the environmental risks of fertiliser or organic manure use, e.g. connectivity of water to field to water or proximity of sensitive habitat.
8. Keep good records of organic materials and fertiliser applications across the farm.

Further information

AHDB Field drainage guide
ahdb.org.uk/knowledge-library/field-drainage-guide

Beef and sheep manual 7: Managing nutrients for Better Returns
ahdb.org.uk/knowledge-library/managing-nutrients-for-better-returns

Healthy grassland soils – Four quick steps to assess soil structure
ahdb.org.uk/greatsoils

Think soils
ahdb.org.uk/knowledge-library/thinksoils

Grass and forage requirements

Well-managed grass remains the cheapest feed available to livestock farms. However, to make the most of this resource, it is important to know:

- How much grass the farm is capable of producing
- How much grass must be produced to meet livestock requirements

The recommendations presented in this guide use target dry matter yield to help determine the amount of nutrient required.

Further information

Beef and sheep manual 8: Planning grazing strategies for Better Returns
ahdb.org.uk/knowledge-library/planning-grazing-strategies-for-better-returns

Points to consider

- Nitrogen response occurs in two stages: firstly, nitrogen is taken up rapidly and secondly, dry matter yield increases
- Nitrogen uptake is more rapid than yield increase and is less affected by some adverse conditions, such as short day length. It is necessary, therefore, to distinguish greening of grass (associated with nitrogen uptake) from actual growth

Measuring grass yield

Measuring on-farm grass production in terms of dry matter yield is an essential component of any efficient livestock system. It can also be a useful tool in deciding the target grass dry matter yield which, in turn, will help identify the appropriate nitrogen recommendation. Various methods exist to measure dry matter yield production across a season.

For grazed fields, these include:

- Rising plate meter
- Sward stick
- Cut and weight (quadrat measurements)

For silage fields, cuts can be used to determine grass dry matter yield using trailer-mounted weigh cells, weigh bridges or a small quadrat, or record total weight of bales from the field. It may be necessary to send off subsamples to measure dry matter percentage.

Further information

View videos on how to use plate meters and sward sticks.
ahdb.org.uk/RB209

Calculating target dry matter yield from livestock forage requirement

Aiming to optimise the amount of meat or milk produced from home-grown forages should help reduce the requirement for purchased concentrates and reduce costs of production. To maximise meat and milk production from grass and forage, efficient production and utilisation is needed and it is important to match supply to demand to avoid oversupply of nutrients to crops and poor utilisation.

Further information

Beef and sheep manual 1: Improving pasture for Better Returns
Beef and sheep manual 4: Managing clover for Better Returns
Beef and sheep manual 5: Making grass silage for Better Returns
Beef manual 7: Feeding growing and finishing cattle for Better Returns
Sheep manual 12: Improving ewe nutrition for Better Returns
ahdb.org.uk/knowledge-library

British Grassland Society
britishgrassland.com/page/fact-sheets

Tried & Tested: Feed planning for cattle and sheep
Tried & Tested: Think Manures – a guide to manure managements
nutrientmanagement.org

Sampling for soil pH, phosphorus, potassium and magnesium

Current phosphate, potash and magnesium recommendations are based on achieving and maintaining target soil Indices for each nutrient in the soil throughout the crop rotation. Soil analysis should be done every 3–5 years. The use of soil analysis as a basis for making nutrient decisions and the procedure for taking soil samples is described below.

Taking soil samples for pH, phosphate, potassium and magnesium

Soil sampling must be done accurately to avoid misleading results and expensive mistakes.

- The soil in each field should be sampled every 3–5 years
- Collect samples at the same point in the rotation and well before growing a sensitive crop, e.g. sugar beet
- For arable and forage crops, aim to sample immediately after the harvest of the previous crop
- Do not sample within six months of a lime or fertiliser application (except nitrogen) or six weeks of last organic manure application in autumn and avoid sampling when the soil is very dry
- Do not take samples where muck heaps or feeders have been, in headlands, or in the immediate vicinity of hedges, trees or other unusual features
- The soil sample must be representative of the area sampled. Areas of land known to differ in some important respects (e.g. soil type, previous cropping, applications of manure, fertiliser or lime) should be sampled separately. Small areas known to differ from the majority of a field should be excluded from the sample
- Ideally, the sampled area should be no larger than four hectares
- Clean tools before starting and before sampling a new area
- Walk a ‘W’ pattern across the sampling area, stopping at least 25 times
- At each point, collect a subsample (core) using a gouge corer or screw auger
    - Sample to 7.5 cm depth in long-term grassland fields
    - Sample to 15 cm depth in arable fields, short-term (<5 year) leys or grassland about to be ploughed and re-seeded
- The subsamples should be bulked to form a representative sample and sent to the laboratory for analysis
- Use appropriate packaging (normally available from the laboratory) and label samples clearly, providing as much information about the field and crop as possible

For soils prone to acidity, more frequent testing may be needed than the cycle used for phosphate, potash and magnesium. Since acidity can occur in patches, spot-testing with a soil indicator across the field is often useful. Soil indicator tests can also be useful on soils that contain fragments of free lime, since these can give a misleadingly high pH when analysed following grinding in the laboratory.

PAAG

Professional Agricultural Analysis Group

Most UK laboratories are members of the PAAG that offers farmers and advisers confidence in laboratory analysis.

- Proficiency Tests (often called ring tests) carried out by Wageningen University, guaranteeing that analysis from any member can be trusted **wepal.nl**
- List of UK laboratories **ahdb.org.uk/knowledge-library/soil-testing-companies**
- Sampling guidelines **nutrientmanagement.org/library/sampling**

Classification of soil analysis results into Indices

The laboratory soil analysis results for P, K and Mg (in mg/kg dry soil) can be converted into soil Indices using Table 3.1.

Table 3.1 Classification of soil P, K and Mg analysis results into Indices

Index	Phosphorus (P)	Potassium (K)	Magnesium (Mg)
	Olsen P	Ammonium nitrate extract	
	mg/litre		
0	0–9	0–60	0–25
1	10–15	61–120	26–50
2	16–25	121–180 (2-) 181–240 (2+)	51–100
3	26–45	241–400	101–175
4	46–70	401–600	176–250
5	71–100	601–900	251–350
6	101–140	901–1,500	351–600
7	141–200	1,501–2,400	601–1,000
8	201–280	2,401–3,600	1,001–1,500
9	Over 280	Over 3,600	Over 1,500

Further information

Beef and sheep manual 3: Improving soils for Better Returns
ahdb.org.uk/knowledge-library/improving-soils-for-better-returns

Healthy Grassland Soils
ahdb.org.uk/greatsoils

Grassland recommendations

Phosphate and potash recommendations

The results of a recent soil analysis will be needed to determine the recommended phosphate and potash recommendations. The use of soil analysis as a basis for making nutrient decisions is described on page 10, 11 and 18.

Recommendations are given in the tables as phosphate (P_2O_5) and potash (K_2O). Conversion tables are given on page 35.

- Recommendations for soils at target Indices (2 for phosphate and 2- for potash) are maintenance dressings intended to meet crop requirements and maintain soil reserves to prevent depletion of soil fertility
- Recommendations at Indices lower than target include an allowance for building up soil reserves over several years, as well as meeting immediate crop requirement
- All recommendations are given for the midpoint of each Index (midpoint of 2- for potash)
- Herbage or forage analysis can be useful to assess the adequacy of recent phosphate and potash applications and as a basis for adjusting nutrient use for future cuts. Samples uncontaminated with slurry or soil should be taken. Phosphorus (P) deficiency is indicated if the P concentration is below 0.35% P. Potassium (K) deficiency is indicated if the herbage potassium concentration is below 2.5% potasssium (in dry matter) or the nitrogen:potassium ratio of the herbage is above 1:1.3
- In the first season after autumn or spring sowing, deduct the amounts of phosphate and potash applied to the seedbed from the recommendations
- Phosphate and potash applications should be adjusted where yields are likely to be greater or smaller than those shown in the tables in this section. Table 3.2 provides typical values of the phosphate and potash content in crop material per tonne of yield. For example, the offtake for a 10 t cut of 30% DM grass silage would be 21 kg of phosphate and 72 kg of potash

Phosphate and potash in crop material

Table 3.2 Phosphate and potash in crop material

Crop material	Phosphate	Potash
	kg/t of fresh material	
Grass – Fresh grass (15–20% DM)	1.4	4.8
Grass – Silage (25% DM)	1.7	6.0
Grass – Silage (30% DM)	2.1	7.2
Grass – Hay (86% DM)	5.9	18.0
Grass – Haylage (45% DM)	3.2	10.5
Wholecrop cereals	1.8	5.4
Kale	1.2	5.0
Maize: Silage (30% DM)	1.4	4.4
Swedes (roots only)	0.7	2.4
Fodder beet (roots only)	0.7	4.0

The offtake values are based on herbage or forage concentrations of 0.3% phosphorus (P) and 2.0% potassium (K) (on a DM basis). Large datasets of forage analyses show the five-year average (2012–2016) concentrations are 0.33% P and 2.75% K. Offtake values should be adjusted based on actual figures from analyses.

Phosphate and potash for grass silage

Where yields are likely to be greater or smaller than shown in Table 3.3, phosphate and potash applications should be adjusted accordingly (see Table 3.2).

At soil K Indices 2+ or below, extra potash is needed after cutting as follows:

- In one- or two-cut systems, apply an extra 60 kg potash per ha after the last cut or by the autumn. Where grazing follows cutting, this may be applied as an extra 30 kg potash per ha per grazing for up to two grazings
- In three-cut systems, apply an extra 30 kg potash per ha after cutting
- In four-cut systems, no extra potash is needed

Table 3.3 Phosphate and potash recommendations for grass silage

Nutrient	P or K Index				
	0	1	2	3	4 and higher
	kg/ha				
First cut (23 t FW/ha)					
Phosphate[a]	100	70	40M	20	0
Potash[b] – previous autumn	60	30	0	0	0
Potash[b] – spring	80	80	80M (2-) 60 (2+)	30	0
Second cut (15 t FW/ha)					
Phosphate[a]	25	25	25M	0	0
Potash[b]	120	100	90M (2-) 60 (2+)	40	0
Third cut (9 t FW/ha)					
Phosphate[a]	15	15	15M	0	0
Potash[b]	80	80	80M (2-) 40 (2+)	20	0
Fourth cut (7 t FW/ha)					
Phosphate[a]	10	10	10M	0	0
Potash[b]	70	70	70M (2-) 40 (2+)	20	0

a. At soil phosphate Index 2 or above, the whole of the total phosphate requirement may be applied in the spring. At phosphate Index 0 and 1, the phosphate recommendation for the third and fourth cuts may be added to the second cut recommendation and applied in one dressing.

b. To minimise luxury uptake of potash, no more than 80–90 kg potash per ha should be applied in the spring for the first cut. The balance of the recommended rate should be applied in the previous autumn.

The yields are based on wilted silage at 25% dry matter content as removed from the field.

FW = fresh weight. M = maintenance level

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Phosphate and potash for grazing

Table 3.4 Phosphate and potash recommendations for grazed swards

Nutrient	P or K Index			
	0	1	2	3
	kg/ha			
Phosphate[a]	80	50	20	0
Potash[b]	60	30	0	0

a. Phosphate may be applied in several small applications during the season, though there may be a small response if it is all applied in early spring for the first grazing.

b. Potash may either be applied in one application in June or July, or in several small applications during the season. At Index 0, apply 30 kg potash per ha for the first grazing. Where there is a known risk of hypomagnesaemia, application of potash in spring should be avoided.

Point to consider

- Tables contain the total nutrient required, remember to deduct nutrients applied as organic materials (**Section 2: Organic materials**)

Example 3.1

A field with a P Index of 1 and K Index of 1 is having one cut of silage removed.

The recommendations would be 70 kg/ha of phosphate. For potash, 30 kg/ha would be needed as an autumn dressing, 80 kg in the spring and 60 kg after the cut or by the autumn. In the spring, 30 m^3/ha of 6% slurry would supply around 18 kg of phosphate and 69 kg of potash per ha, plus 23 kg of N.

Phosphate and potash for hay

Table 3.5 Phosphate and potash recommendations for hay

Nutrient	P or K Index				
	0	1	2	3	Over 3
	kg/ha				
Phosphate	80	55	30M	0	0
Potash	140	115	90M (2-) 65 (2+)	20[a]	0

a. Potash may be unnecessary in upper half of Index   M = maintenance level

Newly sown swards

In the first season after autumn or spring sowing, deduct the amounts of phosphate and potash applied to the seedbed.

Phosphate and potash recommendations for legume swards

Apply phosphate, potash and magnesium as recommended for pure grass swards. Clover may benefit from a small application of potash at Index 2-, as clover is more responsive to potash than grass.

Example 3.2

Phosphate and potash recommendations for a field with one cut of silage and grazing

The field has a P Index of 1 and a K Index of 1. It would require 70 kg of phosphate for the first cut. It would require 30 kg of potash the previous autumn and 80 kg in the spring. There would be a need for additional potash because of a cut being taken. This can be met by applying 30 kg of potash per ha up to twice during the grazing season.

If the field was only being grazed, it would require 30 kg of potash, which could be applied in June or July or in several small applications during the season.

Sulphur recommendations

Sulphur is an essential nutrient for maximising dry matter yield protein levels in both grazed and conserved grass. Sulphur deficiency is common in grassland, especially in later cuts or where high rates of nitrogen are used.

The symptoms of sulphur deficiency are indicated by a yellowing of the sward. In contrast to nitrogen deficiency, in which the older leaves are most affected, sulphur deficiency can be identified by yellowing of the youngest leaves. Analysis of uncontaminated herbage sampled just before cutting is a useful indicator of deficiency. The information can be used to assess the need for sulphur for future cuts. The critical level is 0.25% total sulphur or an N:S ratio greater than 13:1.

Some soils are more at risk of sulphur deficiency than others. Apply sulphur as mineral fertiliser or livestock manures, to all grass grown on:

- Sandy and shallow soils, e.g. chalk and limestone
- Loamy and coarse silty soils in areas with >200 mm rainfall between November and February
- Clay, fine silty or peat soils in areas with >400 mm rainfall between November and February

On soils at risk of sulphur deficiency, apply:

- Silage – 40 kg SO_3/ha before each cut
- Grazing – 20–30 kg SO_3/ha when up to 100 kg N/ha is applied and an additional 20–30 kg SO_3/ha for each additional 100 kg N/ha applied

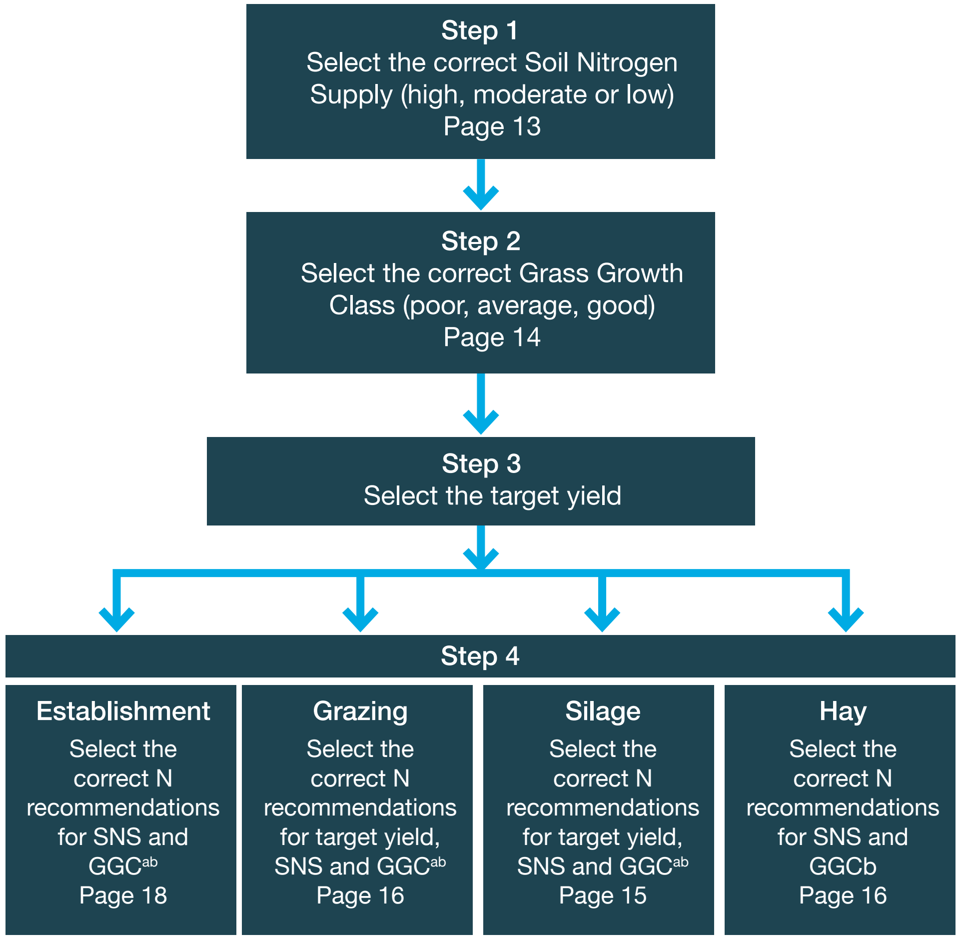
All sulphur recommendations are given as SO_3 and not S; conversion tables (metric–imperial, oxide–element) are given on page 35.

Point to consider

- In drought conditions SO_3 uptake will be limited. Application rates should be reduced or delayed accordingly

Nitrogen recommendations

The nitrogen requirements for grassland can be calculated in four simple steps:



a. For grass-clover swards see page 17.

b. Nutrients applied as organic materials can be subtracted from the recommendations at this stage.

SNS = Soil Nutrient Supply, GGC = Grass Growth Class

Adjusting nitrogen use throughout the season

Nitrogen requirement and uptake can be heavily influenced by weather conditions, so it is important to continually re-evaluate nitrogen fertiliser requirements throughout the season.

- As nitrogen is more likely to be lost from the soil, aim to target fertiliser timing to meet crop nitrogen demand
- Most nitrogen should be applied in spring or early summer, when sward demand is greatest
- If grass growth is restricted because of drought, reduce the use of N once growth restarts following rain. As a guide, if grass does not grow for two weeks in June or July, the yield will be reduced by about 1 t/DM/ha, leaving 40 kg/ha of unused N in the soil. This should be taken into account in following applications

Assessing the Soil Nitrogen Supply status

The nitrogen recommendations presented in this guide are based on the requirement of the crop, which is adjusted for the amount of nitrogen available from the soil, known as the Soil Nitrogen Supply (SNS).

The method used to assess SNS in grassland systems is different from that used in arable or vegetable cropping systems. Three levels of SNS status are recognised: low, moderate and high. Fields with a low SNS need more additional nitrogen than fields with a moderate or high status.

Nitrogen fertiliser, organic manure use and management history in the last 1–3 years are of most importance for determining the SNS status.

Nitrogen returns

In cattle and sheep systems, around 70% of the nitrogen ingested as conserved grass or feed is excreted. During grazing, this nitrogen is returned to the soil and, in intensive systems, will result in the soil having a moderate or high SNS status.

Likewise, silage fields that receive regular average applications of manure will usually have a moderate or high SNS status. Fields that are regularly cut for silage and receive little or no manure are likely to have a low SNS status. Adjustments upwards to higher rates of nitrogen may be needed for these fields.

The nutrient recommendations take account of past manure applications because these influence assessment of the SNS status of a field. The crop available nitrogen supply from manures applied for the current season's growth (i.e. previous September applications onwards) must be assessed using the information in **Section 2: Organic materials** and deducted from the recommendation.

Table 3.6 Determining the Soil Nitrogen Supply status of grassland

Previous management		Previous nitrogen use (kg/ha/yr)[a]	SNS status
Long-term grass. Includes:		Over 250	High
• Grass reseeded after grass or after one year of arable		100–250 or high clover content	Moderate[b]
• Grass ley in second or later year		Up to 100	Low
First year ley after two or more years of arable with previous crop	Potatoes, oilseed rape, peas or beans, NOT on light sand soil		Moderate[b]
	Cereals, sugar beet, linseed or any crop on a light sand soil		Low

a. Refers to typical fertiliser and available manure nitrogen used per year in the last 2–3 years

b. The nitrogen values in the recommendation tables assume a moderate Soil Nitrogen Supply (SNS) status and so adjustments need to be made for high or low SNS: increase total fertiliser nitrogen input by 30 kg/ha in a low SNS situation; decrease total fertiliser nitrogen input by 30 kg/ha in a high SNS situation.

Increase SNS status by one class if more than 150 kg/ha of total nitrogen has been regularly applied as organic manure for several years. Reduce SNS status by one class if grass was cut for silage and less than 150 kg/ha of total nitrogen as organic manure has been applied on average in previous years.

Assessing Grass Growth Class

Grass Growth Class (GGC) describes the ability of a site to respond to nitrogen depending on soil type and rainfall. The better the GGC, the greater the efficiency of nitrogen use and the greater the dry matter yield response (Figure 3.1).

On good/very good GGC sites, swards dominated by productive grass species typically respond strongly to increasing nitrogen supply, as soil drainage, temperature and water supply are conducive to growth.

On poor/very poor GGC sites, grass responds less well to nitrogen applications because of factors such as poor drainage (i.e. wetness) or cooler temperatures (caused by aspect or altitude). Applying high rates of nitrogen fertiliser to these sites can be costly because of inefficient use and has a high risk of nutrient loss to the environment.

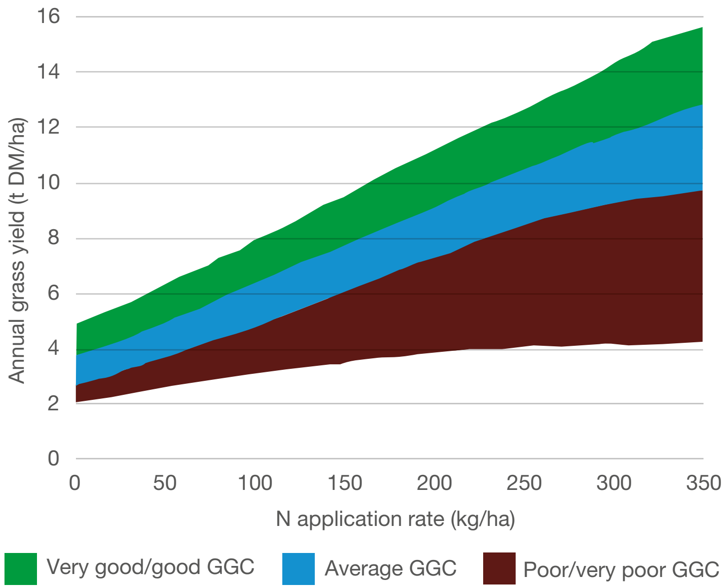


Figure 3.1 Indicative grass dry matter yield by Grass Growth Class (GGC)

Grass swards greater than three years old with minimal clover and low to moderate soil nitrogen supply (SNS).

Similarly, grass growth will be restricted when summer rainfall and the moisture stored in the soil (the soil available water) are inadequate to meet the grass water demand. Although there can be wide variations in summer rainfall between years, Table 3.7 gives an indication of the grass growth potential in an average season, based on the risk of summer drought.

Table 3.7 Determining Grass Growth Class

Soil available water	Soil types[a]	Rainfall[b] (April to September)		
		up to 300 mm	300–400 mm	over 400 mm
Low	Light sand soils, gravels and shallow soils (not over chalk)	Very poor	Poor	Average
Medium	Medium soils, deep clay soils, and shallow soils over chalk	Poor	Average	Good
High	Deep silty soils, peaty soils and soils with groundwater (e.g. river meadows)	Average	Good	Very good

a. See Table 3.13 for soil descriptions.

b. Mean summer rainfall (April to September) is usually about half of annual rainfall.

For sites above 300 m altitude where lower temperatures restrict growth, move down one GGC, e.g. good becomes average.

Nitrogen recommendations for grass silage

Table 3.8 provides nitrogen recommendations for grass silage production for a range of target in-field dry matter yields (t DM/ha).

- The recommendations are applicable to grass swards with low clover content in a very good/good GGC and moderate SNS situation
- Target DM yield will be different for individual farms depending on GGC and livestock requirements
- Good/very good GGC sites with 2–10-year-old swards are likely to achieve target DM yield values at the higher end of the range. New leys with modern varieties may exceed the upper DM yield range by 10–20%
- Poor/very poor GGC sites are likely to achieve DM yield levels towards the lower end of the range in most years

Table 3.8 Nitrogen recommendations for grass silage

Target annual DM yield[a]	N application rate				Total N applied[b]
	First cut	Second cut	Third cut	Fourth cut	
t/ha	kg N/ha				
5–7	70	-	-	-	70
7–9	80	50	-	-	130
9–12	100	75	75[c]	-	250
12–15+	120	90	70[c]	30[c]	310[d]

a. DM yield as harvested in the field for all cuts combined. Does not include spoilage in the clamp. Fresh yield is four times these values if the silage is 25% DM.

b. As manufactured fertiliser and crop available nitrogen from organic materials.

c. If previous growth has been severely restricted by drought, reduce or omit this application.

d. This total N could be applied to a three-cut system (yielding around 15 t DM/ha), with the fourth cut recommendation of 30 kg N/ha being split between the second and third cuts.

In the absence of detailed research for haylage, use similar rates to that for silage, as shown in Table 3.8.

- To adjust for high SNS sites, apply 10 kg N/ha less for first cut, and 20 kg N/ha less for second cut
- To adjust for low SNS sites, apply 10 kg N/ha more for first cut, and 20 kg N/ha more for second cut
- Following early spring grazing, reduce the first cut recommendation by 25 kg/ha
- For first cut rates over 80 kg N/ha, split application: 40 kg N/ha in mid-February to early March, with the remainder in late March to early April and at least six weeks before cutting
- Applications for second and subsequent cuts should be made as soon as possible after the previous cut

Example 3.3

Nitrogen recommendations for a field with one cut of silage and grazing. The target yield is 9–12 t DM/ha and the site has a good GGC and low SNS situation.

The recommendation for the first cut would be 110 kg N/ha, which could be applied as 40 kg in late February and 70 kg in late March.

The field should be available for grazing in June. Soon after the first cut in May, 40 kg N/ha would be applied, followed by two applications of 40 kg N/ha in July and August, allowing for SNS adjustment. A total of 230 kg N/ha would therefore be applied across the season.

Nitrogen recommendations for grazing

Table 3.9 provides N recommendations for grazing for a range of target in-field dry matter yields (t DM/ha).

- The recommendations are applicable to grass swards with low clover content in a very good/good GGC and moderate SNS situation
- Target dry matter yield will be different for individual farms dependent on grass growth class and livestock requirements
- Good/very good GGC sites with 2–10-year-old swards are likely to achieve target dry matter yield values at the higher end of the range. New leys with modern varieties may exceed the upper dry matter yield range by 10–20%
- Poor/very poor GGC sites are likely to achieve dry matter yield levels towards the lower end of the range in most years

Table 3.9 Nitrogen recommendations for grazed swards

Nitrogen application rate per grazing rotation and approximate application date								
Indicative DM yield[a]	Jan/Feb	Mar	Apr	May	Jun	Jul[c]	Aug[c]	Total N applied
t/ha	kg N/ha							
4–5		30						30
5–7		30		20				50
6–8		30		30		20		80
7–9		40		30	30	30		130
9–12		30	30	30	30	30	30	180
10–13	30[b]	40	40	30	30	30	30	230
12–15+	30[b]	40	50	50	40	30	30	270

a. The recommendations take account of nitrogen recycled at grazing.

b. Only applicable to areas with a long grass growing season; the first nitrogen application could be applied as early as mid-to-late January, with the second application in early March.

c. If previous growth has been severely restricted by drought, reduce or omit this application.

Applications of N after August are not usually productive because of the supply of nitrogen from soil organic matter at that time. Check nitrate vulnerable zones (NVZ) rules for guidance on timing.

- For high SNS sites, apply 30 kg N/ha less across the season
- For low SNS sites, apply 30 kg N/ha more across the season
- Rates should be adjusted throughout the season according to grass growth, summer rainfall and livestock requirements

Nitrogen recommendations for hay

Table 3.10 Nitrogen recommendations for grass hay production

	Soil Nitrogen Supply		
	Low	Moderate	High
	kg N/ha		
Each hay cut	100	70	40

Point to consider

- Tables contain the total nutrient required, remember to deduct nutrients applied as organic materials (**Section 2: Organic materials**)

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Nitrogen recommendations for grass and clover

Generally, little fertiliser nitrogen is needed on swards with an appreciable clover content. On average, a good grass and clover sward (30–40% of dry matter of clover) will give an annual dry matter yield equivalent to that produced from about 180 kg N/ha applied to a pure grass sward.

It is often difficult to decide how much nitrogen will be supplied because the clover content can be very changeable from year to year and within a given season. The photographs indicate how to estimate clover content and assess nitrogen supply.

These figures should be used as rough guides only because full clover development does not normally take place until late spring onwards.

Lucerne and red clover crops have no requirement for N fertiliser, apart from that needed for establishment in low SNS soils (up to 50 kg N/ha).

For red clover and grass swards, there may be some advantage in applying a small amount of nitrogen (up to 50 kg N/ha) in the early spring if the grass appears to be nitrogen deficient.

Potential nitrogen supply		Percentage cover from clover
180 kg N/ha		20–30% cover
240 kg N/ha		~40% cover
300 kg N/ha		50–60% cover

Grazing grass and clover swards

Applications of fertiliser nitrogen to grass/clover swards should be made with caution because any form of mineral nitrogen inhibits nitrogen fixation by rhizobia in the clover nodules. There is also a risk of the grass responding to the nitrogen and shading out the clover, which can reduce the percentage of clover in the sward.

However, some nitrogen may need to be applied to grass/clover swards to encourage early spring or late autumn growth:

- Apply up to 50 kg N/ha in mid-February to early March if early grass growth is required
- Apply up to 50 kg N/ha in late July or August if autumn grass is required

Establishment

Clover is particularly sensitive to nitrogen application during establishment. No nitrogen should be used during this period.

Cutting grass-clover, red clover or lucerne swards

- Do not apply high levels of nitrogen if a silage crop is taken from a grass/clover sward where the clover content needs to be maintained
- Do not apply any fertiliser nitrogen for red clover or lucerne conservation

Point to consider

- The rate and timing of nitrogen applications in fertiliser and organic materials are subject to limits under nitrate vulnerable zones (NVZ) rules. For further information see **gov.uk**

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Nutrient recommendations for grass establishment

Correct nutrition is important to ensure successful establishment of a new sward. The phosphate, potash and nitrogen recommendations will differ from existing swards. New leys have a greater requirement for phosphate to help with root development and a lower requirement for nitrogen.

Table 3.11 Phosphate and potash recommendations for grass establishment

Nutrient	P or K Index				
	0	1	2	3	4 and higher
	kg/ha				
Phosphate	120	80	50	30	0
Potash	120	80	60 (2-) 40 (2+)	0	0

The amount of phosphate and potash applied for establishment may be deducted from the first season's grazing or silage/hay requirement.

Application of nitrogen

Table 3.12 Nitrogen recommendations for grass establishment

	Soil Nitrogen Supply		
	Low	Moderate	High
	kg N/ha		
Spring sown (April–June)	60	60	60
Summer or Autumn sown (July to mid-October)	30–50[a]	0–30[a]	0
Grass and clover swards	0	0	0

a. Nitrogen is important when rapid grass growth is needed, e.g. when seedbed conditions are suboptimal; or seed is sown late. Nitrogen should not be applied where it will stimulate weed growth (e.g., in weedy stubbles) or seedling competition (e.g., direct-drilled into an existing sward). Be aware of NVZ closed periods.

For spring-sown swards, deduct the amount of nitrogen applied for establishment from the first season's grazing or silage/hay requirement.

Magnesium, sodium and micronutrient recommendations

Magnesium

Grass swards must contain a sufficiently high level of magnesium if the risk of hypomagnesaemia (grass staggers) is to be reduced. At soil magnesium Index 0, apply 50–100 kg magnesium oxide (MgO) per ha every three or four years.

However, the uptake of herbage magnesium decreases as nitrogen and potash increase; consequently, hypomagnesaemia can occur when soil magnesium appears adequate (Index 1). If there is a risk of hypomagnesaemia, 100 kg/ha MgO may be justified to maintain soil magnesium at Index 2. Direct treatment of livestock may also be needed to avoid hypomagnesaemia.

Where liming is also needed, use of magnesian limestone may be most cost-effective (**Section 1: Principles of nutrient management and fertiliser use**).

Magnesium recommendations are given as kg/ha of MgO not as Mg.

Herbage or forage analysis is a useful indicator of the need for additional magnesium and for assessing the risk of hypomagnesaemia. Maintain magnesium concentrations above 0.20% (dry matter basis) and ensure the K:Mg ratio does not exceed 20:1.

Conversion tables are given on page 35.

Further information

Grassland reseeding guide
ahdb.org.uk/knowledge-library/grassland-re-seeding-guide

Sodium

Sodium has no effect on grass growth but a minimum level of 0.15% (dry matter basis) in the diet is essential for livestock health. Research has demonstrated that sodium can improve the palatability of grass and therefore increase dry matter intake.

Herbage or forage analysis is useful to assess the sodium status of grass and its balance with potassium. Where sodium levels are low (below 0.15%) or the K:Na ratio is higher than 20:1, mineral supplements may be required for some classes of stock or a sodium-containing fertiliser may be used.

Apply sodium in fertiliser at 140 kg/ha Na_2O in early spring, either in a single or split application, to improve herbage mineral balances. To improve pasture palatability, apply regular dressings of 10 kg/ha Na_2O throughout the season.

Herbage or forage analysis can be useful to assess nutrient requirements and balances.

- Magnesium (Mg) deficiency is indicated if the Mg concentration is below 0.20% (dry matter basis) or the K:Mg ratio is above 20:1
- Sodium (Na) deficiency is indicated if the Na concentration is below 0.15% (dry matter basis) or the K:Na ratio is above 20:1

Herbage or forage analysis is a useful indicator of the need for additional magnesium and for assessing the risk of hypomagnesaemia. Maintain magnesium concentrations above 0.20% (dry matter basis) and ensure the K:Mg ratio does not exceed 20:1.

The K:Na and K:Mg ratios are key indicators of nutritional quality of forage and reducing the risk of tetany.

Micronutrients (trace elements)

Avoid liming fields above pH 7: this can induce deficiencies of trace elements, such as copper, cobalt and selenium, which can adversely affect livestock growth but not affect grass growth. Too few micronutrients in the overall diet can lead to deficiency in some animals and cobalt deficiency can affect nitrogen fixation by clover.

Aim to only use micronutrient supplementation when a deficiency has been diagnosed. When deficiency does occur, the most effective means of control is usually to treat the animal with the appropriate trace element, although application of cobalt and selenium to grazing pastures can be effective. If deficiencies are identified, consult an accredited feed adviser – preferably one listed in the Feed Adviser Register (FAR) – to decide an appropriate course of action.

More information on the use of lime is given in **Section 1: Principles of nutrient management and fertiliser use**.

Further information

Trace element supplementation of beef cattle and sheep
ahdb.org.uk/knowledge-library/brp-trace-element-supplementation-of-beef-cattle-and-sheep

Potash Development Agency Leaflet 6: Potash, Magnesium & Sodium – Fertilisers for Grass
pda.org.uk/leaflet-type/grass-and-forage

Forage crop recommendations

Calculating Soil Nitrogen Supply (SNS)

Fields vary widely in the amount of nitrogen available to a crop before any fertiliser or manure is applied. This variation must be taken into account to avoid inadequate or excessive applications of nitrogen.

The Soil Nitrogen Supply (SNS) system (Index 0 to 6) indicates the likely extent of this 'background' SNS. Once the Index is identified, it can be used to select the appropriate nitrogen recommendation to achieve optimum yield.

The system used to estimate SNS in cultivated fields is different from the system used in grass fields. The SNS Index for each field used to grow a forage or arable crop can be arrived at either by the:

- Field Assessment Method – an estimation of SNS based on soil type, previous cropping and winter rainfall
- Measurement Method – a soil sample is collected and sent to a laboratory for analysis

The Field Assessment Method is most commonly used by livestock farmers and is described in this section. If you wish to use the Measurement Method it is described in **Section 1: Principles of nutrient management and fertiliser use**.

Field Assessment Method

There are five essential steps to follow to identify the appropriate SNS Index:

Step 1. Identify the soil category for the field.
Step 2. Identify the previous crop.
Step 3. Select the rainfall range for the field.
Step 4. Identify the provisional SNS Index using the appropriate table.
Step 5. Make any necessary adjustments to the SNS Index.

Points to consider

- The Field Assessment Method does not take account of the nitrogen that will become available to a crop from any organic materials applied since harvest of the previous crop. These should be deducted from the fertiliser nitrogen application rates shown in the recommendation tables
- The Measurement Method is not suitable for organic and peaty soils because SNS is very unpredictable (because of the mineralisation of soil organic matter)

Step 1. Identify the soil category for the field

Careful identification of the soil category in each field is very important. The whole soil profile should be assessed to one metre depth for forage crops. Where the soil varies and nitrogen is to be applied uniformly, select the soil type that occupies the largest part of the field.

The soil type can be identified using Figure 3.2, which categorises soils on their ability to supply and retain mineral nitrogen. The initial selection can then be checked using Table 3.13. Carefully assess the soil organic matter content when deciding if the soil is organic (10–20% organic matter for the purposes of this guide) or peaty (more than 20% organic matter). If necessary, seek professional advice on soil type assessments, remembering this will only need to be done once.

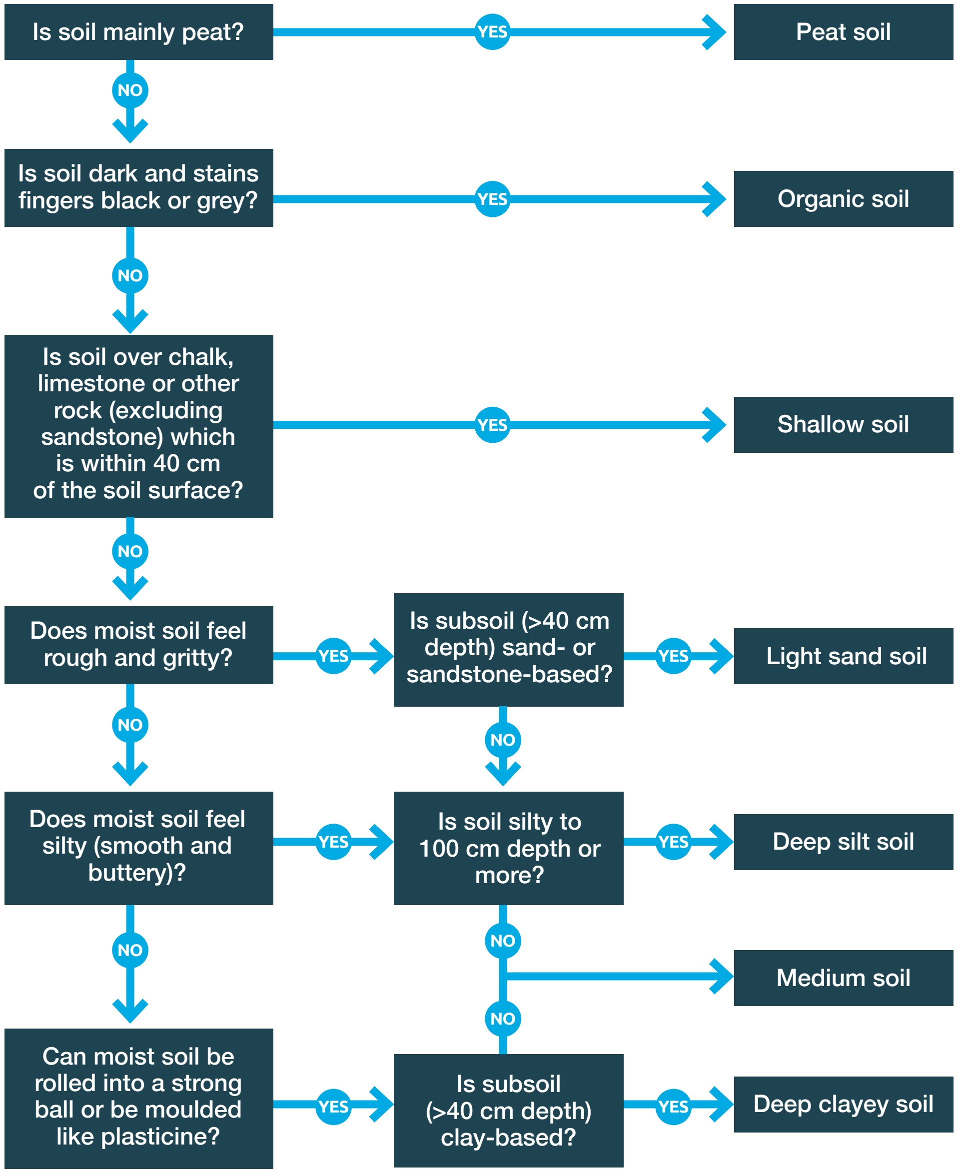

Figure 3.2 Soil category assessment

Table 3.13 Soil category assessment

Soil category	Description of soil types within category	Properties
Light sand soils	Soils that are sand, loamy sand or sandy loam to 40 cm depth and are sand or loamy sand between 40–80 cm, or over sandstone rock.	Soils in this category have poor water-holding capacity and retain little nitrogen.
Shallow soils	Soils over impermeable subsoils and those where the parent rock (chalk, limestone or other rock) is within 40 cm of the soil surface. Sandy soils developed over sandstone rock should be regarded as light sand soils.	Soils in this category are less able to retain or supply nitrogen at depth.
Medium soils	Mostly medium-textured mineral soils that do not fall into any other soil category. These include sandy loams over clay deep loams and silty or clayey topsoils that have sandy or loamy subsoils.	Soils in this category have moderate ability to retain nitrogen and allow average rooting depth.
Deep clayey soils	Soils with predominantly sandy clay loam, silty clay loam, clay loam, sandy clay, silty clay or clay topsoil overlying clay subsoil to more than 40 cm depth. Deep clayey soils normally need artificial field drainage.	Soils in this category are able to retain more nitrogen than lighter soils.
Deep silty soils	Soils of sandy silt loam, silt loam or silty clay loam textures to 100 cm depth or more. Silt soils formed on marine alluvium, warp soils (river alluvium) and brickearth soils are in this category. Silty clays of low fertility should be regarded as other mineral soils.	Soils in this category are able to retain more nitrogen than lighter soils and allow rooting to greater depth.
Organic soils	Soils that are predominantly mineral but with between 10–20% organic matter to depth. These can be distinguished by darker colouring that stains the fingers black or grey.	Soils in this category are able to retain more nitrogen than lighter soils and have higher nitrogen mineralisation potential.
Peat soils	Soils that contain more than 20% organic matter derived from sedge or similar peat material.	Soils in this category have very high nitrogen mineralisation potential.

Step 2. Identify the previous crop

Usually, this is straightforward but sometimes clarification may be needed.

High residual nitrogen vegetables (‘high N vegetables’) are leafy, nitrogen-rich brassica crops such as calabrese, Brussels sprouts and some crops of cauliflower, in which significant amounts of crop debris are returned to the soil, especially in rotations where an earlier brassica crop has been grown within the previous 12 months. To be available for crop uptake, this organic nitrogen must have had time to mineralise, but the nitrate produced must not have been at risk to loss by leaching.

Medium residual nitrogen vegetables (‘medium N vegetables’) are crops such as lettuce, leeks and long-season brassicas such as Dutch white cabbage, in which a moderate amount of crop debris is returned to the soil.

Low residual nitrogen vegetables (‘low N vegetables’) are crops such as carrots, onions, radish, swedes or turnips, in which the amount of crop residue is relatively small.

Step 3. Select the rainfall range for the field

The appropriate rainfall category should be identified, based on either annual rainfall or excess winter rainfall. Ideally, an estimate of excess winter rainfall is required because this is closely related to drainage by which nitrate is lost through leaching. Figure 3.3 shows long-term (1981–2010) average excess winter rainfall, which, in an average year, can be used to select the rainfall category (Table 3.14).

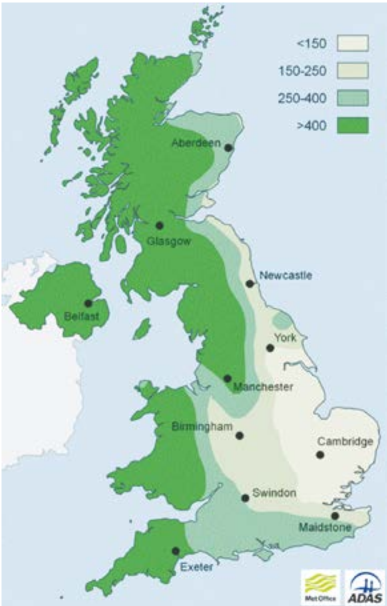

Figure 3.3 Excess winter rainfall (mm)

Table 3.14 Rainfall categories

Rainfall category	Excess winter rainfall	Annual rainfall
	mm	
Low	Less than 150	Less than 600
Moderate	150–250	600–700
High	250 or more	700 or more

Step 4. Identify the provisional SNS Index

Tables 3.15 (low rainfall), 3.16 (moderate rainfall) and 3.17 (high rainfall) should be used where the field has not been in grass within the past three years. Take account of the footnotes to the tables.

Higher than typical Indices can occur where there has been a history of grassland or frequent applications of organic materials. The Measurement Method is recommended in these situations (**Section 4: Arable crops**).

If grass has been grown in the previous three years, also look at Table 3.18. Select the higher of the Index levels based on the last crop grown (from Table 3.15, 3.16 or 3.17 and that based on the grass history (from Table 3.18).

Table 3.15 SNS Indices for low rainfall (500–600 mm annual rainfall, up to 150 mm excess winter rainfall) – based on the last crop grown

Previous crop	Soil category					
	Light sand soils or shallow soils over sandstone	Medium soils or shallow soils not over sandstone	Deep clayey soils	Deep silty soils	Organic soils	Peat soils
Beans	1	2	3	3	All crops in SNS Index 3, 4, 5 or 6. Consult a FACTS Qualified Adviser.	All crops in SNS Index 4, 5 or 6. Consult a FACTS Qualified Adviser.
Cereals	0	1	2	2		
Forage crops (cut)	0	1	2	2		
Oilseed rape	1	2	3	3		
Peas	1	2	3	3		
Potatoes	1	2	3	3		
Sugar beet	1	1	2	2		
Uncropped land	1	2	3	3		
Vegetables (low N)[a]	0	1	2	2		
Vegetables (medium N)[a]	1	3	3[b]	3[b]		
Vegetables (high N)[a]	2	4[b]	4[b]	4[b]		

a. Index may need to be increased by up to 1 where significantly larger amounts of leafy residues are incorporated (Step 5). Where there is uncertainty, soil sampling for soil mineral nitrogen (SMN) may be appropriate.

b. Refer to Step 2.

Table 3.16 SNS Indices for moderate rainfall (600–700 mm annual rainfall, or 150–250 mm excess winter rainfall) – based on the last crop grown

Previous crop	Soil category					
	Light sand soils or shallow soils over sandstone	Medium soils or shallow soils not over sandstone	Deep clayey soils	Deep silty soils	Organic soils	Peat soils
Beans	1	2	2	3	All crops in SNS Index 3, 4, 5 or 6. Consult a FACTS Qualified Adviser.	All crops in SNS Index 4, 5 or 6. Consult a FACTS Qualified Adviser.
Cereals	0	1	1	1		
Forage crops (cut)	0	1	1	1		
Oilseed rape	0	2	2	2		
Peas	1	2	2	3		
Potatoes	0	2	2	2		
Sugar beet	0	1	1	1		
Uncropped land	1	2	2	2		
Vegetables (low N)[a]	0	1	1	1		
Vegetables (medium N)[a]	0	2	3	3		
Vegetables (high N)[a]	1	3	4	4		

a. Refer to Step 2.

Table 3.17 SNS Indices for high rainfall (over 700 mm annual rainfall, or over 250 mm excess winter rainfall) – based on the last crop grown

Previous crop	Soil category					
	Light sand soils or shallow soils over sandstone	Medium soils or shallow soils not over sandstone	Deep clayey soils	Deep silty soils	Organic soils	Peat soils
Beans	0	1	2	2	All crops in SNS Index 3, 4, 5 or 6. Consult a FACTS Qualified Adviser.	All crops in SNS Index 4, 5 or 6. Consult a FACTS Qualified Adviser.
Cereals	0	1	1	1		
Forage crops (cut)	0	1	1	1		
Oilseed rape	0	1	1	2		
Peas	0	1	2	2		
Potatoes	0	1	1	2		
Sugar beet	0	1	1	1		
Uncropped land	0	1	1	2		
Vegetables (low N)[a]	0	1	1	1		
Vegetables (medium N)[a]	0	1	1	2		
Vegetables (high N)[a]	1[b]	2	2	3		

a. Index may need to be lowered by 1 where residues incorporated in the autumn and not followed immediately by an autumn-sown crop.

b. Refer to Step 2.

Table 3.18 SNS Indices following ploughing out of grass leys

	SNS Index		
Light sands or shallow soils over sandstone – all rainfall areas	**Year 1**	**Year 2**	**Year 3**
All leys with 2 or more cuts annually receiving little or no manure 1–2 year leys, low N 1–2 year leys, 1 or more cuts 3–5 year leys, low N, 1 or more cuts	0	0	0
1–2 year leys, high N, grazed 3–5 year leys, low N, grazed 3–5 year leys, high N, 1 cut then grazed	1	2	1
3–5 year leys, high N, grazed	3	2	1
Other medium soils and shallow soils – not over sandstone – all rainfall areas			
All leys with 2 or more cuts annually receiving little or no manure 1–2 year leys, low N 1–2 year leys, 1 or more cuts 3–5 year leys, low N, 1 or more cuts	1	1	1
1–2 year leys, high N, grazed 3–5 year leys, low N, grazed 3–5 year leys, high N, 1 cut then grazed	2	2	1
3–5 year leys, high N, grazed	3	3	2
Deep clayey soils and deep silty soils in low rainfall areas (500–600 mm annual rainfall)			
All leys with 2 or more cuts annually receiving little or no manure 1–2 year leys, low N 1–2 year leys, 1 or more cuts 3–5 year leys, low N, 1 or more cuts	2	2	2
1–2 year leys, high N, grazed 3–5 year leys, low N, grazed 3–5 year leys, high N, 1 cut then grazed	3	3	2
3–5 year leys, high N, grazed	5	4	3
Deep clayey soils and deep silty soils in moderate (600–700 mm annual rainfall) or high (over 700 mm annual rainfall) rainfall areas			
All leys with 2 or more cuts annually receiving little or no manure 1–2 year leys, low N 1–2 year leys, 1 or more cuts 3–5 year leys, low N, 1 or more cuts	1	1	1
1–2 year leys, high N, grazed 3–5 year leys, low N, grazed 3–5 year leys, high N, 1 cut then grazed	3	2	1
3–5 year leys, high N, grazed	4	3	2

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The Indices shown in Table 3.18 assume that little or no organic materials have been applied. Where silage fields have received the organic manures produced by livestock that have eaten the silage and the manure has been applied in spring, they should be regarded as containing nitrogen residues equivalent to a previous grazing history.

'Low N' grassland means average annual inputs of less than 250 kg N/ha in fertiliser plus crop available nitrogen in organic materials used in the last two years, or swards with little clover.

'High N' grassland means average annual applications of more than 250 kg N/ha in the last two years, clover-rich swards or lucerne.

Step 5. Make any necessary adjustments to the SNS Index

When using the field assessment method, it is not necessary to estimate the amount of nitrogen taken up by the crop over winter. This is already taken into account in the tables.

Manure history: Where regular applications of organic manures have been made to previous crops in the rotation, increase the Index value by one or two levels, depending on manure type, application rate and frequency of application. The nitrogen contribution from manures applied after harvest of the previous crop should not be considered when deciding the SNS Index. This contribution should be deducted from the recommended nitrogen application rate using the information in **Section 2: Organic materials**.

Fertiliser residues from previous crop: The Index assessments assume that the previous crop grew normally and that it received the recommended rate of nitrogen applied as fertiliser and/or organic manures. The Index should be increased if there is reason to believe nitrogen residues are likely to be greater than normal and these residues will not be lost by leaching. This could occur where a cover crop was sown in autumn and grew well over winter. Similarly the Index may need to be adjusted downwards if there is reason to believe nitrogen residues will be smaller than usual.

Example 3.4

Maize is to be sown following overwintered barley stubbles after a long-term arable rotation with limited use of organic manures. The soil is a light sand in a high rainfall area.

Using Table 3.17, the SNS Index would be 0. Using Table 3.19, the nitrogen recommendation would be 150 kg N/ha.

Example 3.5

Winter wheat is to be sown following a three-year pure grass ley, which has been managed in the last two years using 280 kg N/ha/year as fertiliser plus crop available nitrogen in manure. Slurry has been applied in early spring each year before taking one cut of silage followed by grazing.

The soil is a medium soil in a moderate rainfall area.

The previous grass management is classed as 'high N'. Using Table 3.18 for medium soils, select the category '3–5 year leys, high N, grazed', which gives an SNS Index of 3 in year one. Regular applications of slurry in previous years could increase the SNS Index by one level, but account should be taken of the application rate and N content of the slurry.

Phosphate, potash and magnesium recommendations

The results of a recent soil analysis are needed to determine phosphate, potash and magnesium recommendations. The use of soil analysis as a basis for making nutrient decisions is described in **Section 1: Principles of nutrient management and fertiliser use**.

Recommendations are given in the tables as phosphate (P_2O_5) and potash (K_2O). Conversion tables are given on page 35.

- Recommendations at target Indices (2 for phosphate and 2- for potash) are maintenance dressings intended to meet crop requirements and maintain soil reserves to prevent depletion of soil fertility
- Recommendations at Indices lower than target include an allowance for building up soil reserves over several years (typically 10–15 years to raise one Soil Index) as well as meeting immediate crop requirement
- All recommendations are given for the mid-point of each Index (midpoint of 2- for potash). Where the soil analysis value is close to the range of an adjacent Index, the recommendation may be reduced or increased
- Recommendations are based on a typical yield. Adjustments can be made for higher or lower yields by estimating crop offtake using Table 3.2

Further information

Wheat Growth Guide
ahdb.org.uk/wheatgg

AHDB Beef & Lamb Cereals Directory
ahdb.org.uk/knowledge-library/the-cereals-directory-2

Forage maize – nitrogen, phosphate and potash

Table 3.19 Nitrogen, phosphate and potash recommendations for forage maize

Nutrient	SNS, P or K Index				
	0	1	2	3	4 and higher
	kg N/ha				
Nitrogen	150	100	50	20	0
Phosphate[a]	115	85	55	20	0
Potash[a]	235	205	175 (2-) 145 (2+)	110	0

a. Estimates based on a 40 t/ha fresh weight yield. Use Table 3.2 to adjust for higher or lower yields.

Evidence is being gathered by the Maize Growers Association (MGA) that forage maize could respond to higher levels of nitrogen. Currently there is not enough data to justify changing the recommendations but it is area of further work. Discuss with a FACTS Qualified Adviser and use MGA's nitrogen predictor form.

- To encourage rapid early growth, all of the phosphate requirement and up to 10–15 kg/ha of the nitrogen requirement may be placed below the seed at drilling. The remainder of the nitrogen requirement should be top-dressed as soon as the crop has emerged. Potash should be applied before seedbed preparation and thoroughly worked in
- Where sugar beet or potatoes do not feature in the rotation, magnesium fertiliser is only justified at Soil Index 0 when 50–100 kg MgO/ha should be applied every three or four years

Wholecrop cereals - nitrogen

Wholecrop wheat, winter sown – nitrogen

Nitrogen recommendations for wholecrop wheat are the same as wheat grown for grain with no adjustments made to account for harvest date. Fermented wholecrop is generally cut at soft dough stage (GS85), with high dry matter wholecrop cut closer to fully ripe (GS87–89).

Table 3.20 Nitrogen for winter sown wholecrop wheat

Soil category	SNS Index						
	0	1	2	3	4	5	6
	kg N/ha						
Light sand soils	180	150	120	90	60	0-60	0–40
Shallow soils	280[a]	240[a]	210	180	140	80	0–40
Medium soils	250[a]	220	190	160	120	60	0–40
Deep clay soils	250[a]	220	190	160	120	60	0–40
Deep silty soils	240[a]	210	170	130	100	40	0–40
Organic soils				120	80	40–80	0–40
Peat						0–60	

a. The N recommendation exceeds the N max limit of 220 kg for winter-sown wheat. The N max limit is calculated for the whole of the area of a crop type grown on farm and not for individual fields. For more details see **gov.uk/nitrate-vulnerable-zones**

Timing of application

There is no requirement for seedbed nitrogen. Depending on the total nitrogen requirement and crop development, it will often be appropriate to apply nitrogen at the following timings:

- Less than 120 kg N/ha: Apply all the recommended amount as a single dressing by early stem extension, but not before early April
- 120 kg N/ha or more: Apply about 40 kg N/ha between mid-February and mid-March, except where:
  - There is a low risk of take-all, and
  - Shoot numbers are very high. Well-tillered crops do not need nitrogen at this stage. Crops with too many tillers will be prone to lodging and higher disease levels

The balance of the application should be applied in one or two dressings during early stem extension. Where more than 120 kg N/ha remains to be applied, half should be applied at the start of stem extension (not before April) and half at least two weeks later (not after early May).

Don't forget

- Tables contain the total nutrient required – remember to deduct nutrients applied as organic materials (**Section 2: Organic materials**)

Wholecrop wheat, spring sown – nitrogen

Table 3.21 Nitrogen for spring-sown wholecrop wheat

Soil category	SNS Index						
	0	1	2	3	4	5	6
	kg N/ha						
Light sand soils	160	130	100	70	40	0–40	0
All other mineral soils	210[a]	180	150	120	70	40	0–40
Organic soils				120	70	40	0–40
Peaty soils						0–40	

a. The N recommendation exceeds the N max limit of 180 kg for spring-sown wheat. The N max limit is calculated for the whole of the area of a crop type grown on farm and not for individual fields. For more details see **gov.uk/nitrate-vulnerable-zones**

Timing of application

For crops drilled before March, apply nitrogen at early stem extension but not before early April or after early May. For amounts greater than 70 kg N/ha, apply the first 40 kg N/ha of the total in the seedbed except on light sand soils. On these soils apply 40 kg N/ha at the 3-leaf stage but not before March.

For late-drilled crops, all the nitrogen can be applied in the seedbed, except on light sand soils, where amounts greater than 70 kg N/ha should be split with 40 kg N/ha in the seedbed and the remainder by the three-leaf stage.

Wholecrop barley, winter sown – nitrogen

Table 3.22 Nitrogen for winter-sown wholecrop barley

Soil category	SNS Index						
	0	1	2	3	4	5	6
	kg N/ha						
Light sand soils	170	140	110	80	60	0–40	0
Shallow soils	220[a]	190	150	120	60	20–60	0–20
Medium and deep clay soils	190[a]	170	140	110	60	20–60	0–20
Deep fertile silty soils	170	150	120	80	40	0–30	0
Organic soils				110	60	0–40	0
Peaty soils						0–40	

a. The N recommendation exceeds the N max limit of 180 kg for winter-sown barley. The N max limit is calculated for the whole of the area of a crop type grown on farm and not for individual fields. For more details see**gov.uk/nitrate-vulnerable-zones**

Timing of application

There is no requirement for seedbed nitrogen. Depending on the total nitrogen requirement and crop development, it will often be appropriate to apply nitrogen at the following timings:

- Less than 100 kg N/ha: Apply this amount as a single dressing by early stem extension (GS30–31)
- Between 100 and 200 kg N/ha: Split the dressing with 50% during late tillering in mid-February/early March and 50% at GS30–31
- 200 kg N/ha or more: Apply three splits with 40% during late tillering in mid-February/early March, 40% at GS30–31 and 20% at GS32

These recommendations assume appropriate measures are taken to control lodging (e.g. choice of variety, use of plant growth regulator). Reduce the recommendation by 25 kg N/ha if the lodging risk is high.

Wholecrop barley, spring sown – nitrogen

Table 3.23 Nitrogen for spring-sown wholecrop barley

Soil category	SNS Index						
	0	1	2	3	4	5	6
	kg N/ha						
Light sand soils	140	110	70	50	0–40	0	0
Other mineral soils	160[a]	140	110	70	30	0–30	0
Organic soils				70	30	0–30	0
Peaty soils						0–30	

a. The N recommendation exceeds the N max limit of 150 kg for spring-sown barley. The N max limit is calculated for the whole of the area of a crop type grown on farm and not for individual fields. For more details see **gov.uk/nitrate-vulnerable-zones**

Research has shown that the economically optimal rate of N fertiliser increases with yield, assuming all limiting factors are managed. Where previous experience of growing spring barley indicates that grain yields above 5.5 t/ha can be realistically expected, the recommended rate should be increased by 10 kg N/ha for each 0.5 t/ha additional yield, up to a maximum yield of 10 t/ha. Similarly, for low-yielding crops, the recommended rate should be reduced by 10 kg N/ha for each 0.5 t/ha reduction in expected yield.

Timing of application

For crops drilled before March, apply nitrogen at early stem extension but not before early April or after early May. For amounts greater than 70 kg N/ha, apply 40 kg N/ha of the total in the seedbed, except on light sand soils. On these soils apply 40 kg N/ha at the three-leaf stage, but not before March.

For late-drilled crops, all the nitrogen can be applied in the seedbed, except on light sand soils, where amounts greater than 70 kg N/ha should be split with 40 kg N/ha in the seedbed and the remainder by the three-leaf stage.

Forage triticale, winter sown – nitrogen

The nitrogen requirements of triticale are the same as those of wheat in most situations. However, forage triticale is generally harvested earlier than winter wheat or triticale grown for grain; typically at early milky development (GS71; mid–end June). Nitrogen recommendations are therefore 50 kg N/ha lower than for winter wheat grown for grain.

Triticale has a greater lodging risk than wheat, so less nitrogen may be required in situations of high lodging risk.

Table 3.24 Nitrogen for winter-sown forage triticale

Soil category	SNS Index						
	0	1	2	3	4	5	6
	kg N/ha						
Light sand soils	130	100	70	40	0–30	0	0
Shallow soils	230	190	160	130	90	30	0
Medium soils	200	170	140	110	70	0–30	0
Deep clay soils	200	170	140	110	70	0–30	0
Deep silty soils	190	160	120	80	50	0–30	0
Organic soils				70	30	0–30	0
Peaty soils						0–30	

Timing of application

There is no requirement for seedbed nitrogen. Depending on the total nitrogen requirement and crop development, it will often be appropriate to apply nitrogen at the following timings:

- Less than 120 kg N/ha: Apply all the recommended amount as a single dressing by early stem extension but not before early April
- 120kg N/ha or more: Apply about 40 kg N/ha between mid-February and mid-March, except where there is a low risk of take-all and shoot numbers are very high. Well-tillered crops do not need nitrogen at this stage. Crops with too many tillers will be prone to lodging and higher disease levels

The balance of the application should be applied in one or two dressings during early stem extension. Where more than 120 kg N/ha remains to be applied, half should be applied at the start of stem extension (not before April), and half at least two weeks later (not after early May).

Oats and rye, winter sown – nitrogen

Table 3.25 Nitrogen for winter-sown oats and rye

Soil category	SNS Index						
	0	1	2	3	4	5	6
	kg N/ha						
Oats							
Light sand soils	150	110	80	20–60	0–40	0	0
All other mineral soils	190	160	130	100	70	0–40	0
Organic soils				100	70	0–40	0
Peaty soils						0–40	
Rye							
Light sand soils	110	70	20–50	0–20	0	0	
All other mineral soils	150	120	90	60	30	0–20	
Organic soils				60	30	0–20	
Peaty soils						0–20	

Timing of application

Depending on the total nitrogen requirement and crop development, it will often be appropriate to apply nitrogen at the following timings:

- Less than 100 kg N/ha: Apply as a single dressing by early stem extension, but not before late March
- 100 kg N/ha or more: Split the dressing with 40 kg N/ha in mid-February early-March and:
  - If the remaining nitrogen is less than 100 kg N/ha then apply the rest by early stem extension, but not before late March
  - If the remaining nitrogen is 100 kg N/ha or more then apply in two dressings: half at early stem extension (not before late March) and half at least two weeks later

These recommendations assume appropriate measures are taken to control lodging (e.g. choice of variety, use of plant growth regulator). Reduce the recommended rate by 40 kg N/ha for oats or 25 kg N/ha for rye if lodging risk is high.

Wholecrop silage from bi-crops

Crops, such as cereals and legumes, are grown together as specialist wholecrop silages. It is difficult to provide recommendations for the variety of crops that are being used by the industry, so it is best to assess the proportion of each crop within the mix and use the relevant tables, alongside knowledge of SNS Index, to produce an appropriate recommendation.

Wholecrop cereals grown for silage with legumes (e.g. peas, beans, vetch or lupins) do not require any nitrogen, but will benefit from sulphur, phosphate, potash and magnesium, as for cereals grown as a single crop.

Oats, rye and triticale, spring sown – nitrogen

Table 3.26 Nitrogen for spring sown oats, rye and triticale

Soil category	SNS Index						
	0	1	2	3	4	5	6
	kg N/ha						
Light sand soils	90	60	30	0–30	0	0	0
All other mineral soils	140	110	70	40	0–30	0	0
Organic soils				40	0–30	0	0
Peaty soils						0	

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Wholecrop cereals – phosphate, potash, magnesium and sulphur

All wholecrop cereals – phosphate and potash

Table 3.27 Phosphate and potash for all wholecrop cereals

Nutrient	P or K Index				
	0	1	2	3	4 and higher
	kg/ha				
Expected yield 30 t FW/ha					
Phosphate	115	85	55	0	0
Potash	220	190	160	100	0

The amounts of phosphate and potash are appropriate to the fresh weight yield shown. Table 3.2 can be used to calculate offtake if wholecrop yields are known to be different, for example a spring-sown crop yielding 25 t FW/ha.

At Index 2, phosphate and potash can be applied when convenient during the year but, at Index 0 and 1, they should be applied and worked into the seedbed. To avoid damage to germinating seedlings, do not use more than 150 kg/ha of nitrogen plus potash on sandy soils.

All wholecrop cereals – magnesium

At Mg Index 0, magnesium fertiliser should be applied every 3–4 years at 50–100 kg MgO/ha.

All wholecrop cereals – sulphur

Not all cereal crops will respond to sulphur. Use Table 3.28 to assess the risk of deficiency. Where deficiency has been recognised or is expected, apply 25–50 kg/ha SO_3 as a sulphate-containing fertiliser in early spring, before the start of stem extension.

Table 3.28 Sulphur deficiency risk

Soil texture	Winter rainfall (Nov–Feb)		
	Low (<175 mm)	Medium (175–375 mm)	High (>375 mm)
Sandy	High		
Loamy and coarse silty	Low	High	
Clay, fine silty or peaty	Low		High

Example 3.6

Wholecrop winter wheat is to be sown on land at P and K Index 0. The crop is expected to yield 30 t FW/ha.

Offtake for a wholecrop cereal is 1.8 kg P_2O_5/t and 5.4 K_2O/t (Table 3.2). The recommendations at Index 0 would be 114 kg P_2O_5/ha and 222 kg K_2O/ha. Both these values are arrived at by (expected yield, i.e. 30 x offtake) + 60 to build up the Soil Index over 10–15 years (Table 1.6, Section 1).

Swedes, turnips, fodder beet, rape and kale

Table 3.29 Nitrogen, phosphate and potash for forage swedes, turnips, fodder beet, rape and kale

Nutrient	SNS, P or K Index						
	0	1	2	3	4	5	6
	kg/ha						
Forage swedes and turnips (65 t/ha roots lifted)							
Nitrogen	100	80	60	40	0–40	0	0
Phosphate	105	75	45	0	0	0	0
Potash	215	185	155 (2-) 125 (2+)	80	0	0	0
Fodder beet (85 t/ha roots lifted)							
Nitrogen	130	120	110	90	60	0–40	0
Phosphate	120	90	60	0	0	0	0
Potash	400	370	340 (2-) 310 (2+)	190*	0	0	0
Forage rape, swedes and stubble turnips (grazed)							
Nitrogen	100[a]	80[a]	60	40	0–40	0	0
Phosphate	85	55	25	0	0	0	0
Potash	110	80	50 (2-) 20 (2+)	0	0	0	0
Kale (grazed)							
Nitrogen	130	120	110	90	60	0–40	0
Phosphate	80	50	20	0	0	0	0
Potash	200	170	140 (2-) 70 (2+)	70	0	0	0

Recommendations are based on typical yields. Adjustments can be made for higher or lower yields by estimating crop offtake using Table 3.2.
The recommendations for grazed crops are assuming that all the manures are returned. For hybrid brassicas, use the recommendations for forage rape, swedes or stubble turnips.

a. Forage rape and stubble turnips, apply no more than 75 kg N/ha at Index 0 or 1. Further reductions may be made if the soil is moist and has been cultivated.

Phosphate and potash

Phosphate and potash need only be applied to the seedbed at Index 0 or 1. In crops where roots are removed (forage swedes, turnips and fodder beet) and the tops are also carted off, potash applications may need to be increased by up to 150 kg/ha.

Magnesium

Where sugar beet or potatoes do not feature in the rotation, magnesium fertiliser is only justified at Soil Index 0, where 50–100 kg MgO/ha should be applied every three or four years. The exception is fodder beet, which should be treated as sugar beet with a Mg recommendation at Index 1 (**Section 4: Arable crops**).

Sodium

For fodder beet, sodium is recommended on all soils except Fen silts and peats. Apply 400 kg/ha of agricultural salt (200 kg Na_2O /ha) well before drilling. If sodium is recommended but not applied, increase potash by 100 kg K_2O/ha.

Boron

A boron application may be needed. Soil and plant analysis are useful guides to assess the need for boron.

Sulphur

Soils at risk of deficiency require 25 kg SO_3/ha (Table 3.28).

Point to consider

- Tables contain the total nutrient required – remember to deduct nutrients applied as organic materials (**Section 2: Organic materials**)

Rye-grass grown for seed

Phosphate and potash

Phosphate and potash can be applied at any convenient time, except at Index 0 and 1 when the dressing should be applied in the spring of the harvest year.

Table 3.30 Nitrogen, phosphate and potash for rye-grass grown for seed

Soil category	SNS, P or K Index						
	0	1	2	3	4	5	6 and higher
	kg N/ha						
Nitrogen							
Light sand soils	160	110	60	0–40	0	0	0
All other mineral soils		160	110	60	0–40	0	0
Organic soils				60	0–40	0	0
Peaty soils						0–40	
Phosphate							
All soils	90	60	30	0	0	0	0
Potash							
All soils	150	120	90 (2-) 60 (2+)	0	0	0	0

Requirements are based on a seed and hay yield of 5 t/ha. If the hay is chopped and returned, much less phosphate and potash is required.

Nitrogen

Nitrogen rates are for crops for which there is a low risk of crop lodging – either because of field characteristics or where amenity varieties are grown. A lower nitrogen rate will be appropriate for crops with a higher risk of lodging. Higher rates may be needed in the second cropping year or where amenity varieties are grown.

Depending on the total nitrogen requirement and crop development, it will often be appropriate to apply nitrogen at the following timings:

- Less than 100 kg N/ha: Apply the whole application in early April
- 100 kg N/ha or more: Apply 40 kg N/ha in early-mid March and the balance of the application in early April

Where a crop of Italian rye-grass seed is to be grown following a silage crop, apply 60 kg N/ha immediately following the silage crop.

Example 3.7

Fodder beet is to be sown on land at P and K Index 1. The crop is expected to yield 85 t/ha (roots lifted).

Offtake for fodder beet is 0.7 kg P_2O_5/t and 4.0 K_2O/t (Table 3.2). The recommendations at Index 1 would be 90 kg P_2O_5/ha and 370 kg K_2O/ha. Both these values are arrived at by (expected yield, i.e. 85 x offtake) + 30 to build up the Soil Index over 10–15 years (Table 1.6, Section 1).

Conversion tables

Metric to imperial

1 tonne/ha	0.4 tons/acre
100 kg/ha	80 units/acre
1 kg/tonne	2 units/ton
10 cm	4 inches
1 m^3	220 gallons
1 m^3/ha	90 gallons/acre
1 kg/m^3	9 units/1,000 gallons
1 kg	2 units

Note: a ‘unit’ is 1% of 1 hundredweight, or 1.12 lbs.

Imperial to metric

1 ton/acre	2.5 tonnes/ha
100 units/acre	125 kg/ha
1 unit/ton	0.5 kg/tonne
1 inch	2.5 cm
1,000 gallons	4.5 m^3
1,000 gallons/acre	11 m^3/ha
1 unit	0.5 kg

Element to oxide

P to P_2O_5	Multiply by 2.291
K to K_2O	Multiply by 1.205
Mg to MgO	Multiply by 1.658
S to SO_3	Multiply by 2.500
Na to Na_2O	Multiply by 1.348
Na to salt	Multiply by 2.542

Oxide to element

P_2O_5 to P	Multiply by 0.436
K_2O to K	Multiply by 0.830
MgO to Mg	Multiply by 0.603
SO_3 to S	Multiply by 0.400
Na_2O to Na	Multiply by 0.742
Salt to Na	Multiply by 0.393

Fluid fertiliser

kg/tonne (w/w basis) to kg/m^3	Multiply by specific gravity (w/v basis)

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Analysis of fertilisers and liming materials

The materials listed below are used individually and some are used as components of compound or multi-nutrient fertilisers. The chemical and physical forms of nutrient sources, as well as growing conditions, can influence the effectiveness of fertilisers. A FACTS Qualified Adviser can give advice on appropriate forms for different soil and crop conditions.

The reactivity, or fineness of grinding, of liming materials determines their speed of action. However, the amount of lime needed is determined mainly by its neutralising value.

Nitrogen fertilisers	Typical % nutrient content
Ammonium nitrate	33.5–34.5% N
Liquid nitrogen solutions	18–30% N (w/w)
Calcium ammonium nitrate (CAN)	26–28% N
Ammonium sulphate	21% N, 60% SO_3
Urea	46% N
Urea + urease inhibitor	46% N + NBPT
Urea + nitrification inhibitor	46% N + DCD
Calcium nitrate	15.5% N, 26% CaO

Phosphate fertilisers	
Single superphosphate (SSP)	18–21% P_2O_5, typically 30% SO_3
Triple superphosphate (TSP)	45–46% P_2O_5
Di-ammonium phosphate (DAP)	18% N, 46% P_2O_5
Mono-ammonium phosphate (MAP)	12% N, 52% P_2O_5
Rock phosphate (e.g. Gafsa)	27–33% P_2O_5

Potash, magnesium and sodium fertilisers	
Muriate of potash (MOP)	60% K_2O
Sulphate of potash (SOP)	50% K_2O, 45% SO_3
Potassium nitrate	13% N, 45% K_2O
Kainit	11% K_2O, 5% MgO, 26% Na_2O, 10% SO_3
Sylvinite	Minimum 16% K_2O, typically 32% Na_2O
Kieserite (magnesium sulphate)	25% MgO, 50% SO_3
Calcined magnesite	Typically 80% MgO
Epsom salts (magnesium sulphate)	16% MgO, 33% SO_3
Agricultural salt	50% Na_2O

Sulphur fertilisers	
Ammonium sulphate	21% N, 60% SO_3
Epsom salts (magnesium sulphate)	16% MgO, 33% SO_3
Elemental sulphur	Typically 200–225% SO_3 (80–90% S)
Quarried gypsum (calcium sulphate)	40% SO_3
Polyhalite (e.g. Polysulphate)	Minimum 48% SO_3, 14% K_2O, 6% MgO, 17% CaO.

Liming materials	Neutralising Value (NV)
Ground chalk or limestone	50–55
Magnesian limestone	50–55, over 15% MgO
Hydrated lime	c.70
Burnt lime	c.80
Sugar beet lime	22–32 + typically 7–10 kg P_2O_5, 5–7 kg MgO, 3–5 kg SO_3/tonne

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Glossary

Available (nutrient)	Form of a nutrient that can be taken up by a crop immediately or within a short period so acting as an effective source of that nutrient for the crop.
Clay	Finely divided inorganic crystalline particles in soils, less than 0.002 mm in diameter.
Content	Commonly used instead of the more accurate ‘concentration’ to describe nutrients in fertiliser or organic manure. For example, 6 kg N/t often is described as the nitrogen content of a manure.
Cover crop	A crop sown primarily for the purpose of taking up nitrogen from the soil and which is not harvested. Also called green manure.
Crop-available nitrogen	The total nitrogen content of organic manure that is available for crop uptake in the growing season in which it is spread on land.
Crop nitrogen requirement	The amount of crop-available nitrogen that must be applied to achieve the economically optimum yield.
Economic optimum	Rate of nitrogen application that achieves the greatest (nitrogen rate) economic return from a crop, taking account of crop value and nitrogen cost.
FACTS	UK national certification scheme for advisers on crop nutrition and nutrient management. Membership renewable annually. A FACTS Qualified Adviser has a certificate and an identity card.
Farmyard manure (FYM)	Livestock excreta that is mixed with straw bedding material that can be stacked in a heap without slumping.
Fertiliser	See Manufactured fertiliser.
Fluid fertiliser	Pumpable fertiliser in which nutrients are dissolved in water (solutions) or held partly as very finely divided particles in suspension (suspensions).
Grassland	Land on which the vegetation consists predominantly of grass species.
Grass Growth Class (GGC)	Ability of a site to respond to nitrogen fertiliser application depending soil type and rainfall.
Leaching	Process by which soluble materials such as nitrate or sulphate are removed from the soil by drainage water passing through it.
Ley	Temporary grass, usually ploughed up one to five years (sometimes longer) after sowing.
Lime requirement	Amount of standard limestone needed in tonnes/ha to increase soil pH from the measured value to a higher specified value (often 6.5 for arable crops). Can be determined by a laboratory test or inferred from soil pH.

Liquid fertiliser	See Fluid fertiliser.
Livestock manure	Dung and urine excreted by livestock or a mixture of litter, dung and urine excreted by livestock, even in processed organic form. Includes FYM, slurry, poultry litter, poultry manure, separated manures and granular or pelletised manures.
Maintenance application	Amount of phosphate or potash that must be applied to replace the amount removed from a field at harvest (including that in any straw, tops or haulm removed).
Major nutrient	Nitrogen, phosphorus and potassium, which are needed in relatively large amounts by crops.
Manufactured fertiliser	Any fertiliser that is manufactured by an industrial process. Includes conventional straight and NPK products (solid or fluid), organo-mineral fertilisers, rock phosphates, slags, ashed poultry manure and liming materials that contain nutrients.
Manure	See Livestock manure and Organic manure.
Micronutrient	Boron, copper, iron, manganese, molybdenum, zinc, which are needed in very small amounts by crops (see also Major nutrient). Cobalt and selenium are taken up in small amounts by crops and are needed in human and livestock diets.
Mineral nitrogen	Nitrogen in ammonium (NH_4) and nitrate (NO_3) forms.
Mineralisation	Microbial breakdown of organic matter in the soil, releasing nutrients in crop-available, inorganic forms.
Neutralising value (NV)	Percentage calcium oxide (CaO) equivalent in a material. 100 kg of a material with a neutralising value of 52% will have the same neutralising value as 52 kg of pure CaO. NV is determined by a laboratory test.
Nitrate vulnerable zones (NVZs)	Areas designated by Defra as being at risk from agricultural nitrate pollution.
Offtake	Amount of a nutrient contained in the harvested crop (including straw, tops or haulm) and removed from the field. Usually applied to phosphate and potash.
Olsen P	Concentration of available P in soil, determined by a standard method (developed by Olsen) involving extraction with sodium bicarbonate solution at pH 8.5. The main method used in the England, Wales and Northern Ireland and the basis for the Soil Index for P.
Organic manure	Any bulky organic nitrogen source of livestock, human or plant origin, including livestock manures.

Organic soil	Soil containing between 10% and 20% organic matter (in this guide). Elsewhere, sometimes refers to soils with between 6% and 20% organic matter.
Peaty soil (peat)	Soil containing more than 20% organic matter.
Poultry manure	Excreta produced by poultry, including bedding material that is mixed with excreta, but excluding duck manure, with a readily available nitrogen content of 30% or less.
Sand	Soil mineral particles larger than 0.05 mm.
Silt	Soil mineral particles in the 0.002–0.05 mm diameter range.
Slurry	Excreta of livestock (other than poultry), including any bedding, rainwater and washings mixed with it, which can be pumped or discharged by gravity. The liquid fraction of separated slurry is also defined as slurry.
SNS Index	Soil Nitrogen Supply expressed in seven bands or Indices, each associated with a range in kg N/ha.
Soil Index (P, K or Mg)	Concentration of available P, K or Mg, as determined by standard analytical methods, expressed in bands or Indices.
Soil Nitrogen Supply (SNS)	The amount of nitrogen (kg N/ha) in the soil that becomes available for uptake by the crop in the growing season, taking account of nitrogen losses.
Soil texture	Description based on the proportions of sand, silt and clay in the soil.
Soil type	Description based on soil texture, depth, chalk content and organic matter content.
Trace element	See Micronutrient.

Produced for you by:

AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

W ahdb.org.uk
@The_AHDB

For specific AHDB Nutrient Management Guide (RB209) enquiries:
T 024 7647 8784
E nutrient.management@ahdb.org.uk

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