Consumers and politicians have an interest in food quality and environmental protection and are being more aware of production methods. This booklet aims to provide guidelines on the aspects of food production that relate to the fertility of the soil and the use of nutrients.

It is written to help farmers meet the latest acceptable standards.
Nutrient Management for farmers and the environment

Background

Effective nutrient management is the starting point for all crop and stocking decisions on the farm.

Objective

Before determining fertiliser requirements, it is first necessary to make an overall assessment of the soil type and condition and to identify factors other than nutrient supply that could potentially limit crop growth. Then the objective is to make best use of the nutrients that are already available e.g. from organic manures and soil reserves. Finally, when the fertiliser requirement is determined it must be applied accurately.

Check list

☐ Review each season whether the field/land is capable of sustaining the type of farming to which it is put and is not creating undue pressure on the state of the soil or surrounding environment. Refer to DEFRA Codes of Good Agricultural Practice for the Protection on Soil, Water and Air)

☐ Check that the basic principles of improving and maintaining cultivated soil are being adopted to maintain and where possible improve soil structure and quality. (Refer to DEFRA Code of Good Agricultural Practice for the Protection of Soil and publications of the Soil Management Initiative)

Check soil physical characteristics

☐ Identify soil physical characteristics on a farm map e.g. Soil type, depth, texture noting any potential implications for cultivation and water management

☐ Examine soil to identify any structural problems and rectify. For example, compacted soils inhibit root growth and access to nutrients

☐ Select cultivation methods to limit physical impact on the soil and conserve soil water, for example: consider minimum tillage where appropriate. See guides of the Soil Management Initiative

☐ Know and build-up information on farm maps, the direction of surface and underlying drainage

☐ Assess potential risk and extent of soil erosion and adopt preventive measures if necessary. For example, ploughing across slopes
Nutrient Management for farmers and the environment

Check soil biology

- Maintain well-aerated soils and conserve organic matter which are advantageous to plant growth. Use well-planned rotations to encourage the cycling of nutrients by soil organisms.

Check soil chemistry

The key aspects of soil chemistry should be noted here but are covered specifically for each nutrient in the adjoining parts to this guide.

- Measure or estimate soil nitrogen availability so that the total supply needed can be calculated and matched as closely as possible with crop requirements.
- Analyse phosphorus and potassium and magnesium reserves every 3 to 5 years depending on cropping history/choice and soil type and maintain, build-up or run-down soil indices to recommended levels.
- Make an assessment of likely sulphur response according to crop type and geographical location (Refer to Fertiliser Recommendations RB209) or use plant leaf/herbage samples or deep soil analysis as a guide, and make applications where needed.
- Monitor soil pH every 3-5 years and rectify for the crop rotation with an appropriate liming material.
- Maximise the soil’s ability to retain nutrient supplies by maintaining soil organic matter reserves.

Planning nutrient requirements across the rotation

- Calculate the nutrient requirement of all crops and grass according to soil conditions and yield expectations.
- Calculate the quantity of available nutrients per tonne or m³ of each manure type that is applied.
- Deduct the nutrients added from any manures applied and from soil reserves to give the balance of fertiliser nutrients required.
- Ensure the nutrient value of organic manures is maximised, as far as possible, by applying when manure nitrogen is most available and/or spreadable and apply to fields which would derive the most benefit, (not on clover leys, for example).
- Spread manure evenly so that subsequent fertiliser applications can be accurately matched to organic nutrients already applied.
- Make all nutrient applications at the correct time at the correct rate, (to coincide with crop uptake) in accordance with the DEFRA Codes of Good Agricultural Practice, Water, Air and Soil. (Use tables in RB209).

Using organic manures

- Refer to tables in RB/209, DEFRA/ADAS Farm Management Plans & Manure Management software: “MANNER”.
- Apply evenly at known application rates not exceeding 250kg/ha of total manure nitrogen per year. Note that more stringent restrictions apply in designated Nitrate Vulnerable Zones (Refer to DEFRA Guidelines for Farmers in NVSs and Manure Planning in NVZs).
Using organic manures (continued)

- Calculate application rates by the capacity of the spreader, the number of loads applied per field and the field area.
- Maintain or if necessary improve condition of machinery to a high standard. Set correctly according to working bout widths and calibrate every application.

Achieving optimum soil pH

- Maintain pH within an optimum range according to crop rotation to optimise nutrient availability.
- Refer to tables giving the optimum pH for various grass and crop rotations in RB209 and publications from the Agricultural Lime Association.
- Test soil pH.
- Adjust pH by the use of calculated lime dressings.
- Be aware of neutralising values of different liming materials.
- Ensure that lime is applied in the appropriate part of the rotation, e.g. before sugar beet which responds better to a higher pH, rather than potatoes which require a lower pH for optimum growth.

Achieving an accurate fertiliser application

Refer to FMA leaflet: Fertiliser Spreaders – choosing, using and maintaining

- Use a good quality product with a well-maintained fertiliser spreader.
- Service and maintain all fertiliser spreaders and sprayers.
- Aim to achieve even application with a variation of less than 10% which will limit the risk of crop losses incurred due to uneven spreading.
- Ensure correct settings and calibration and recalibrate even when different application rates of the same product are used.
- Check the application rate (the flow onto the distribution mechanism) using a rate calibration kit, normally supplied with the machine.
- Check the pattern of fertiliser spread using calibration trays; at least for each type and also for each brand of fertiliser. Checks are also necessary after equipment has been serviced or parts replaced or when adapting the machine for headland applications.
- Contact spreader/sprayer manufacturer if unsure about settings for a particular product.
- Avoid spreading fertiliser in windy conditions.
- Ensure operators are properly trained.
An easy to complete set of forms on managing soil nutrients and fertiliser inputs

These can be used and submitted by growers as documentary evidence of practice for meeting the requirements of farm assurance schemes.

These forms are designed to provide a check-list, which is compatible with the detail of the more substantial publications on managing soil and fertilisers (see list attached) and is also in line with the principles of integrated farm management and good agricultural practice. This is a practical tool in so far as it can be submitted, when completed, as documentary evidence towards meeting the requirements of crop assurance schemes.

The document reflects a consensus of the advice from the fertiliser industry, the Department for the Environment Food and Rural Affairs, Linking Environment And Farming and others. It is also written in accordance with the standards of the Fertiliser Advisers Certification and Training Scheme.

After consideration of the points in this document, growers should be able to improve the efficiency of nutrient use on farm and still achieve optimum crop yields and limit losses to the environment. These combined objectives can be achieved by making sure that all the nutrient inputs and outputs in the farming system are accounted for. This is sometimes called a nutrient budget.

This document takes the user through a logical thought process beginning with the general principles of integrated nutrient management followed by separate and specific sections on nitrogen, phosphorus, potash, sulphur and other nutrients.
**Reference list**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
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<tbody>
<tr>
<td>DEFRA, Fertiliser Recommendations for Agricultural and Horticultural Crops, (RB209), 7th edition</td>
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**Contacts**

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<tr>
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<tr>
<td>Agricultural Lime Association</td>
<td>ALA, tel: 0207 730 8194 <a href="http://www.aglime.org.uk">www.aglime.org.uk</a></td>
</tr>
<tr>
<td>The Scottish Executive Environment and Rural Affairs Department</td>
<td>SEERAD, tel: 0131 244 6023 <a href="http://www.scotland.gov.uk">www.scotland.gov.uk</a></td>
</tr>
<tr>
<td>Department of Agriculture and Rural Development</td>
<td>DARD, tel: 028 7776 8075 <a href="http://www.dardni.gov.uk">www.dardni.gov.uk</a></td>
</tr>
<tr>
<td>Environment Agency</td>
<td>Tel: 01454 624400 <a href="http://www.environment-agency.gov.uk">www.environment-agency.gov.uk</a></td>
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<td>Environment Agency (Wales)</td>
<td>Tel: 029 2077 0088 <a href="http://www.environment-agency.gov.uk">www.environment-agency.gov.uk</a></td>
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<tr>
<td>Environment and Heritage Service, N Ireland</td>
<td>Tel: 01232 546570 <a href="http://www.ehmsni.gov.uk">www.ehmsni.gov.uk</a></td>
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<td>Scottish Environment Protection Agency</td>
<td>SEPA, tel: 01786 457700 <a href="http://www.sepa.org.uk">www.sepa.org.uk</a></td>
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<td>Fertiliser Manufacturers Association</td>
<td>FMA, tel: 01780 781360 <a href="http://www.fma.org.uk">www.fma.org.uk</a></td>
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<td>Farming And Wildlife Advisory Group</td>
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<td>Potash Development Association</td>
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</table>
Background

Nitrogen is the nutrient with the greatest influence on crop yield and quality through effects on chlorophyll and protein production. It is of primary importance environmentally as well as economically.

Objective

To assess the extra balance of fertiliser nitrogen required taking into account the reservoirs of nitrogen in the soil and any nitrogen supplied from organic manures. This is calculated as follows:

\[
\text{Fertiliser nitrogen} = \text{crop type requirements} - \text{available soil nitrogen} - \text{manure nitrogen}
\]

Crop requirement

Refer to tables in *Fertiliser Recommendations* (RB209) and:

- Adjust values according to crop/grassland type, crop potential and quality targets and reappraise these according to actual crop performance.

Soil nitrogen supply

- Assess available nitrogen using RB209 book values based on soil type, rainfall and cropping history or from measurements taken from soil samples in spring (and autumn for historic data).

Manure available nitrogen

- Assess nitrogen supply from manures by using RB209 book values and or measurement and accounting for the method of application, timing method of incorporation.

Codes of Practice for conserving Nitrogen on farm

Minimise nitrate leaching by:

- Applying nitrogen when crop/grass is most actively growing
- Ensuring accurate application according to growth stage and weather
- Avoiding periods when heavy rain might be expected or when land is waterlogged or frozen
- Creating autumn crop cover
- Weighing up the benefits of minimum tillage, which reduces nitrogen mineralisation in the soil (cultivation affects nitrogen release)
- Complying with the rules affecting Nitrate Vulnerable Zones (Refer to specific guidelines from DEFRA).

Reduce ammonia emissions by:

- Incorporating manures into the soil, preferably by ploughing soon after spreading
- Applying slurries with an injector or band spreader rather than splash-plate
Background

Phosphorus is important in root development, the ripening process and particularly in the formation of the plant’s sugars and carbohydrates. An adequate supply of phosphorus is essential in the early stages of a plant’s life and for early maturity. The declaration of phosphorus in fertilisers is as phosphate (P₂O₅).

Objective

The key to managing soil phosphate status is to balance crop/grass off-takes with applications and to manage soil reserves effectively. Regular soil analysis will demonstrate if strategies to build, maintain or run-down soil reserves are effective.

Crop requirement

Refer to FMA leaflet: Responsible Phosphate Management and the PDA leaflet: Phosphate and Potash Removal by Crops and RB209

- Use the results of soil analysis, aiming for soil index 2 as the optimum target for arable and forage crops and grass and a target of soil index 3 for vegetable crops. Adjust phosphate applications according to replacement needs.
- Establish the target soil phosphate (P₂O₅) index for the rotation
- Establish whether there is a need to build up, maintain or run down the soil phosphate level
- If the soil index for P₂O₅ is at the target level (index 2) the application rate should be sufficient to replace the nutrients removed and retain reserves at index 2. (Note that replacement applications will not be sufficient on all soil types).
- If the soil is below the target level the application rate should replace the nutrients removed in the previous crop and build soil reserves to index 2
- If the soil is above index 2 the P₂O₅ applications should be less than removal to run-down soil reserves
- If the soil is at index 4 or above P₂O₅ applications are not necessary (for most crops)
- In the case of potatoes assess the requirement for fresh fertiliser applications according to expected response
- Deduct contributions of P₂O₅ from previous fertiliser and manure applications

Conserving Phosphate on farm

- Minimise surface run-off from recently spread manures avoiding applications to frozen, waterlogged soils or steep slopes
- Avoid consequences of soil erosion which can carry phosphate to water by taking necessary preventative measures to reduce soil movement
- Avoid loss of phosphate in water draining from the soil by not building-up soil levels above 2 for intensive grassland and 3 for arable cropping

Approved by the:
Background

Potassium is associated with the regulation of water within the plant. It is particularly important in plants that store large amounts of sugar and starch e.g. potatoes. It is also vital for the root nodule bacteria on legumes and is closely associated with the uptake on nitrogen. The declaration of potassium in fertilisers is as potash (K₂O).

Objective

The key to managing soil potash status is to balance crop/grass off-takes with applications and to manage soil reserves effectively. Regular soil analysis will demonstrate if strategies to build, maintain or run-down soil reserves are effective.

Crop requirement

Refer to the PDA leaflet: Phosphate and Potash Removal by Crops and Fertiliser Recommendations (RB209)

- Use the results of soil analysis to determine if strategies to build, maintain or run-down soil reserves are required and adjust potash applications according to replacement needs
- Establish the target soil potash index for the rotation which must be set for the crop with the highest demand
- If the soil index for potash is at the target level the application rate should be sufficient to replace the nutrients removed in the previous crop
- Establish the necessity for fresh potash application(s) according to probability for response
- Allow for contributions of potash from previous fertiliser and manure applications

Conserving potash (potassium) on farm

- Avoid applying any potash source (fertiliser, slurry or manure) to waterlogged, frozen or very dry and highly cracked soil
- Avoid trying to maintain light sand soils above index 1. Instead it is more economic to fertilise little and often to suit crop uptake
- Allow for the release of potash from the reserves of certain clay types. Be aware that some can release around 50kg/ha of potash per year which should be allowed for in calculating additional requirements

Approved by the:
Background

Sulphur is an integral part of proteins and so deficiency results in poor growth and quality. Large reductions in emissions from industry had lead to many light to medium textured soils becoming deficient in sulphur and unable to support optimum crop performance. Certain soils are inherently low in other nutrients such as magnesium, selenium and manganese. These are important for optimal plant and animal performance. The declaration of sulphur in fertilisers is as sulphate (SO$_3$).

Objective

To account for soil sulphur and other minerals and trace elements to avoid deficiencies leading to sub-optimal crop and animal performance and health.

Assessing crop requirements

- Assess the risk of sulphur deficiency by referring to Fertiliser Recommendations (RB209) or results of plant analysis
- Assess the need for sulphur after deducting the contribution from animal manure and soil reserves from crop requirement
- Apply an appropriate level of sulphur to the crop if there is a risk of sulphur deficiency by referring to Fertiliser Recommendations (RB209)
- Assess the risk of other nutrient deficiencies and correct, if appropriate.