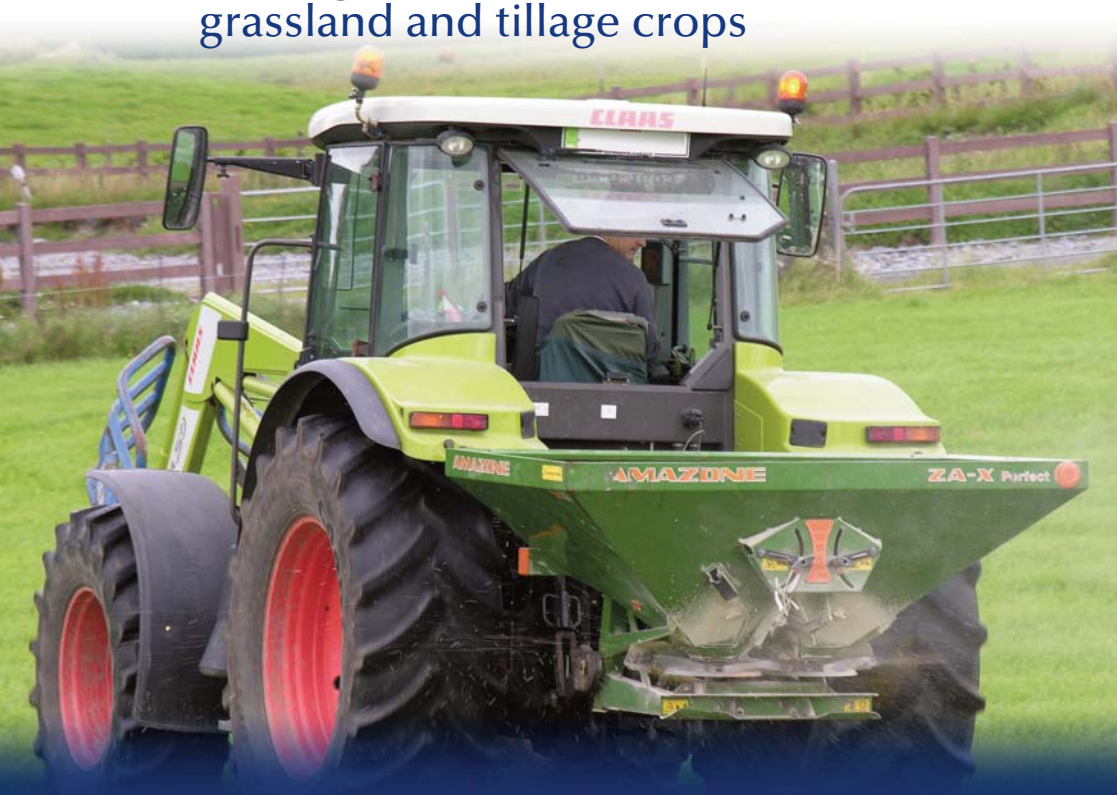
National Soil Fertility Week
'Getting the balance right'

Making best use of fertilizers in grassland and tillage crops



Teagasc, Athenry, Co. Galway, Wednesday 8 Feb
Kildalton College, Piltown, Co. Kilkenny, Thursday 9 Feb
2.00 to 4.30pm.

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Agriculture and Food Development Authority

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National Soil Fertility Week 2012 'Getting the balance right'

Introduction

Teagasc welcomes you today to this event as part of National Soil Fertility week 2012 – "Getting the Balance Right". This campaign is being run by Teagasc in collaboration with the Fertilizer Association of Ireland. The theme of this event and campaign is maximising farm productivity and profitability through efficient use of fertilizers.

Productive and sustainable farming begins in the soil. Among the functions that soils perform for crop or grass growth is the supply of nutrients to feed the plants. Feeding a crop, whether grass or a tillage crop, is no different to feeding livestock whereby feed is provided based on the condition, production potential and output of the animals. *You wouldn't feed your animals without looking at their condition, therefore why do it to soils?*

Soil fertility management is critical to ensuring that soils have and sustain the capacity to meet the nutrient requirements of grass and crops. Teagasc is promoting **5 simple steps** which can be followed on the farm to help achieve this:

1) Have soil analysis for the whole farm.
2) Apply lime as required to increase soil pH up to target pH for the crop.
3) Aim to have soil test P and K in Index 3 in all fields:
   - Index 4 (high fertility) soils are a resource.... exploit them.
   - Index 1 & 2 soils (low fertility) should be increased to the target fertility level of Index 3.
4) Start by using organic fertilizers as efficiently as possible, then top up with fertilizer as required.
5) Make sure the fertilizer compound is supplying nutrients in the correct balance for the crop, the soil, and to complement other chemical and organic fertilizers being applied.

Today's event will focus on each of these key steps in turn. Fertilizer application will also be discussed, with particular focus on spreader equipment set-up, calibration and maintenance. Fertilizers are too expensive to be spread badly. Having the spreader in good condition is critical to ensure that fertilizer nutrients are applied evenly and accurately.

Representatives from the Fertilizer Association of Ireland are also present and available to discuss and answer questions on fertilizers.

1. Soil Testing

Have soil samples taken for the whole farm. Unless you know what is in the soil, it is impossible to know how much extra it needs. Therefore, by taking soil analysis and putting the results into practice, the fertilizer programme can be tailored to the needs of the soil and the crop. Repeating soil analysis over time is also critical to monitor the effectiveness of the fertilizer strategy.

Taking a sample for standard pH, lime, P and K analysis for every 4 ha of the farm every 5 years will cost approximately €1.25 per hectare per year. This annual cost is equivalent to less than the cost of 1 kg of P in fertilizer.

Having very low soil fertility and not identifying it with soil tests will restrict yields on the farm. For example, research has shown that very low soil phosphorus levels (Index 1) can reduce potential grass production by an average of approximately 1.5 t/ha/yr compared to soils with optimum P fertility (Index 3). At current feed prices, this is potentially worth up to €400 /ha.

Similarly, not identifying soils high in nutrients can result in excess applications that are not required by the crop. For example, applying a standard K application of 120 kg/ha (96 units/acre) to first cut silage would cost approximately €108 /ha based on current prices. If a soil test identified the soil as being high in K (Index 4), there would be potential for substantial fertilizer cost savings.

Soil samples need to be taken correctly in order to get accurate results that fully represent the area being sampled. Taking a sample to a full depth of 10 cm (4 inches) is very important, especially for P in permanent grassland. Avoid soil sampling for at least 3 months after P, K or organic fertilizer application, and for 2 years after lime application.

2. Soil pH and Liming

Apply lime as required to increase soil pH up to target pH for the crop. Maintaining the soil pH at the optimum level will increase the microbiological activity of the soil, and result in better soil nutrient recycling and release. Soil pH is also critical for maximising the availability of nutrients applied in organic and chemical fertilizers.

Soil pH should be the first thing to get right if soil test results show a lime requirement. Lime should be applied to neutralise acidity and raise the pH. For mineral soils, a pH of 6.3 is recommended for grassland, and 6.5 for cereals. Acid soils will result in reduced nutrient release from soil, and poorer response to fertilizers. Apply lime as a priority as per the lime advice.

Over-liming can be an issue in some circumstances, especially in grassland where there is a history of high molybdenum (Mo) in soils. It is advised not to raise the pH above 6.2 in these circumstances, as high Mo can cause copper deficiency in animals. As a general guide, reduce the lime application by 5 t/ha (2 t/acre) where soils are expected to be high in Mo.

It is also important not to apply too much lime in a single application, as it can make some trace elements unavailable. Don't apply more than 7.5 t/ha (3 t/acre) in a single application. Where lime requirements are high, apply the remainder after 2 years. Lime is best applied to grassland at any time of the year when the grass cover is low. Reseeding is a good opportunity to apply lime.

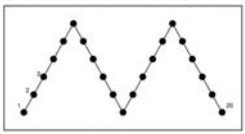
Where soil Magnesium (Mg) levels are low, use a dolomitic limestone (contains Mg) in preference to a calcium (Ca) limestone. In a tillage rotation, apply lime close to the more pH sensitive crops such as beet, peas, beans, or oilseed rape. These crops grow best in pH of approximately 7.0. Potatoes or oats are the most tolerant of more acid conditions, and will grow well at pH 6.0. A pH of 6.5 is recommended for barley, wheat and maize. Lime should be incorporated into the seedbed for tillage crops.

Soil Testing

Cost €€€
@ €25 per sample
4 ha every 5 yrs
= €1.25 /ha/yr
price of < 1 kg of P

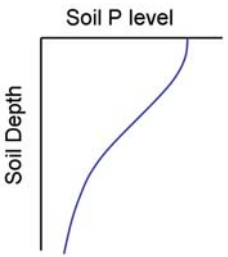
Benefits
e.g. soil P in grassland:
Index 1 vs. Index 3
~ 1.5 t/ha/yr of DM
~ €400 /ha

Sampling
Representative sample



Avoid unusual areas
Wait 3-6 months after fertilizer P/K or slurry
Wait 2 years after Lime
Repeat sampling to monitor changes

Sampling Depth
Critical for P



Soil pH and Lime

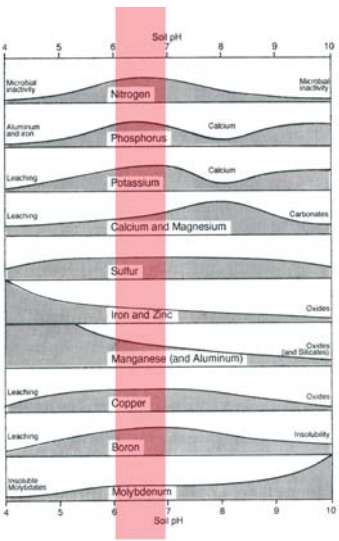
Soil pH - Priority
Soil nutrient release
(up to 50-70 kg/ha of N)
Availability of fertilizers

Optimum soil pH for crops
7.0 Beet, beans, peas, oilseeds
6.5 Cereals and Maize
6.2-6.3 Grassland
6.0 Potatoes

High Molybdenum & Copper

Timing – any time
(low grass cover)

Use Magnesium limestone where soil Magnesium is low



3. Soil fertility levels

The aim of P and K nutrient advice is to maintain all fields at the optimum soil fertility level. The soil test measures the plant available P and K in mg/L of soil. For simplicity, this result can be categorised into a soil Index for each nutrient. The soil Index system divides soils into one of four soil Index levels based on the soil test result. The soil Index indicates the expected response to nutrients applied. For example Index 1 soils are very responsive while Index 4 soils have sufficient soil nutrient reserves and usually do not respond to fresh P and K applications.

Soil Index 3 is considered the optimum Index for production, as it is in this range that the soil fertility level is considered sufficient to feed the crop. Therefore, in order to maintain the soil in this optimum range, the P and K application should replace the P and K removed. At Index 3, P and K advice is based on replacing offtakes in crops. Therefore, the rate applied should depend on the stocking rate and production system (grassland) or the crop yield (tillage and silage crops). This is called the maintenance rate, as the objective is to maintain the soil fertility level by replacing what is removed.

Index 1 and 2 soils are more responsive to applied P and K. These soils have a higher P and K requirement due the fact that the P and K applied should be sufficient to build up soil reserves as well as replacing the P and K removed in product (grain, straw, meat, milk, etc). The aim is to build soil fertility levels from Index 1 and 2 up to Index 3 over a number of years. The rate of soil build up will depend on a number of factors such as soil type, nutrient application rate, and the amount of nutrient removed. Building soil fertility is a long-term process, so application of build up rates in addition to maintenance rates should continue for a number of years after the soil sample is taken.

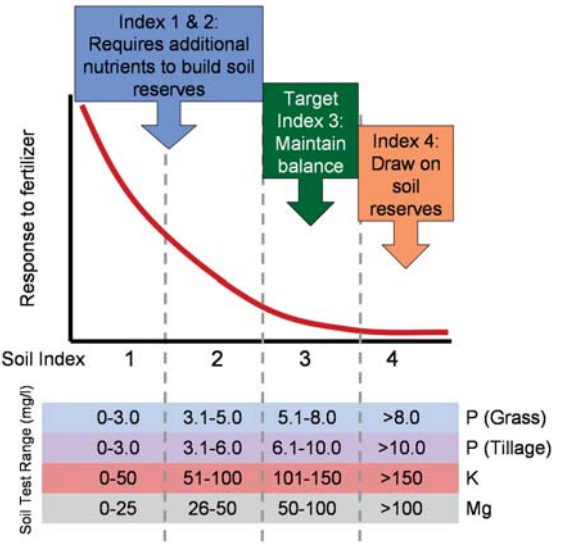
Soils at Index 4 have high fertility and soil reserves will usually supply sufficient P or K to meet crop nutrient requirements throughout the growing season. It is

recommended to omit P or K applications with the exception of certain crops such as potatoes, beet, and some horticultural crops. Where grass and tillage crops are grown on Index 4 soils it is recommended to omit P for a number of years and then re-sample to monitor changes over time. For K it is recommended to omit K applications for one year and then revert back to Index 3 advice in subsequent years. Index 4 soils tend to be fields on the farm that receive frequent dressings of organic manures such as cattle or pig slurry or farm yard manure. These fields offer an opportunity to reduce fertilizer costs and to target other areas of the farm that would benefit from organic manure applications. The speed of P and K decline on Index 4 soils will depend on the soil type, the level of P or K in the soil, and the removals on an annual basis. Regular soil testing is essential to monitor changes.

With high fertilizer prices at present, one may ask should P and K application rates be reduced this year. The P and K advice is based on maintaining soils at Index 3 for optimum productivity. The P and K is applied annually to maintain soil reserves at the correct level of nutrients to ensure optimum yields and effective use of all other inputs, especially N. This is the main reason why one may not see a response to P and K applied annually if the soil reserves are sufficiently high. However, reducing or skipping P or K applications will mean that the nutrients will have to be replaced at some stage if soil fertility is to be maintained. With restrictions in P fertilizer use based on annual allowances, it may not be possible to apply extra in subsequent years.

Soil analysis will identify the low fertility fields which are most deserving of organic manures. These fields will have high nutrient requirements and organic manures are the most cost effective route to controlling costs in these fields. For example, on grassland farms, silage fields will usually have higher high P and K requirements than the grazed areas. Cattle slurry is usually more suitable fertilizer for silage than for grazing, as slurry contains high levels of K which is essential for high yielding grass silage crops. However, this is not always the case, and will depend on the soil results.

Using the Soil Index System



Replacing P / K Offtake (kg/ha) [1 kg/ha = 0.8 units/acre]

Stocking Rate	Dairy	Drystock	Silage
< 1.5 (LU/ha)	10 / 25	7 / 10	1st – 20 / 125 2nd – 10 / 35
1.5 – 2 (LU/ha)	14 / 30	10 / 15	
2 – 2.5 (LU/ha)	19 / 35	13 / 20	
2.5 – 3 (LU/ha)	23 / 40	16 / 25	

1 tonne of concentrate feed per hectare ~ 5 kg of P

Cereals	P & K Removed kg/ha
Spring Barley (7.5 t/ha)	29 / 86
Winter Wheat (10 t/ha)	38 / 98

Building Soil Fertility

P: 10-30 kg/ha/yr for each Index (¼ – ½ bag/acre of 16% P)

K: 15-30 kg/ha/yr for each Index (¼ – ½ bag/acre of 50% K)

Index 4

P – reduce/omit until next soil test

K – reduce/omit for 1 year

4. Managing organic manures

Organic fertilizers are a valuable source of N, P and K. Cattle slurry is by far the most common form of organic fertilizer applied in Ireland. Over the last number of years there has been a major drive on Irish farms to improve the utilization of slurry and reduce fertilizer costs. This has been achieved on farm by better facilities for the management of slurry during the winter and more slurry been applied on grassland in early spring when N utilisation is highest.

One of the biggest problems with using slurry within a nutrient management plan is the variability in the dry matter (DM) and nutrient contents. Up to tenfold variation has been found in the DM, and total N P and K contents of different cattle slurry samples. Although factors such as animal type, production system and diet will affect the slurry, the variability is mainly attributable to varying DM content caused by the dilution of slurry with water from dairy parlour washings or rainfall collected on open yards. Where slurry is diluted with water, the nutrient content will be lower. The degree of slurry dilution with water sources can be used as a guide to estimate the nutrient content of slurry. On average, slurry in Ireland is approximately 7% DM. However, the variation in slurries, even between two tanks in the same shed or yard, can be quite considerable.

To make best use of any organic manure it is important to know the actual nutrient content (N, P and K). Laboratory analysis is the most accurate way to determine the dry matter and nutrient content of the slurry. However, the farmer needs to know the nutrient content of the slurry on the day of application. This can be difficult as a representative sample of slurry, usually only obtained after agitation, is needed well in advance of the day of spreading in order to have results back from the laboratory. Since cattle slurry is generally agitated and spread on the same day, the usefulness of laboratory analysis when making decisions about applications is limited. However,

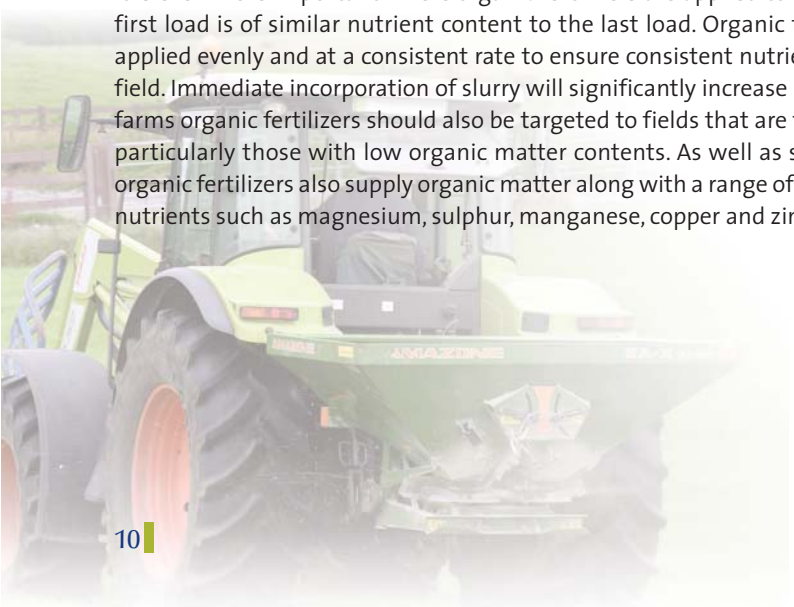
occasional analysis of slurry, even if not every year, can still be a good guide to the nutrient content that one might expect from similar animals on similar diets in the same sheds.

In order to get more rapid information on the day of application, there are a number of on-farm measurement tools to estimate the nutrient content of slurry. The slurry hydrometer is the simplest and most effective on-farm tool which estimates the slurry DM content. Since, the DM content of the slurry is closely related to the N, P and K content of the slurry, this can be a very useful tool to estimate nutrient contents in slurry easily and cheaply on the day of slurry application. This will allow adjustment of slurry application rates based on the slurry nutrient content.

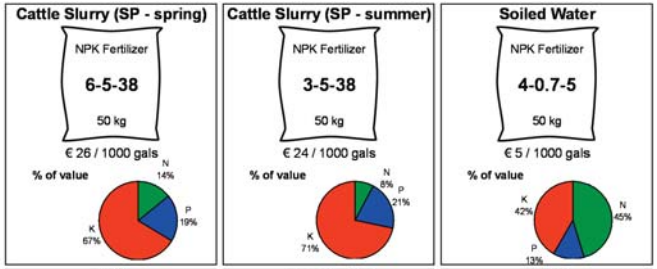
The extent to which slurry can vary in its fertilizer value based on dilution can have a big impact on the nutrient application rate. For example take silage ground receiving 33m^3/ha (3000 gals/acre) of slurry at 7% DM. This will supply 20 kg (16 units) of P and 142 kg (114 units) of K. By comparison, slurry with 4% DM slurry would supply 13 kg (10 units) of P and 83 kg (66 units) of K. Incorrect estimation of nutrient value based on average values can lead to significant under- or over-supply of nutrients. Therefore a tool like the hydrometer that can help estimate nutrient content quickly and cheaply on farm would be beneficial.

Organic fertilizers on tillage crops

It is even more important where organic fertilizers are applied to tillage crops that the first load is of similar nutrient content to the last load. Organic fertilizers need to be applied evenly and at a consistent rate to ensure consistent nutrient supply across the field. Immediate incorporation of slurry will significantly increase N recovery. On tillage farms organic fertilizers should also be targeted to fields that are the longest in tillage, particularly those with low organic matter contents. As well as supplying N, P and K, organic fertilizers also supply organic matter along with a range of secondary and micro nutrients such as magnesium, sulphur, manganese, copper and zinc.



Getting the most out of Organic Fertilizers



Variability & Dilution	DM%	NPK Value (50 kg bag equivalent)
Cattle Slurry	7%	6-5-38
½ slurry; ½ soiled water	4%	5-3-22
Soiled Water	1%	4-0.7-5

Beware of average values

Making Decisions:

1) Where to spread – P & K

2) Application rate

3) When to spread – N

5. Providing a balanced nutrient supply

The final step in the soil fertility management programme is to select a fertilizer that will deliver sufficient N, P and K in a cost effective way. Nutrients need to be applied in the correct balance. Over-supplying one nutrient will be money wasted if the output is being limited by another nutrient that is in short supply. The fertilizer products selected should complement the remaining N, P and K required after soil test results, production potential and earlier organic and chemical fertilizer applications have been accounted for.

On grassland farms, nutrient advice has to be adjusted for the nutrients supplied in slurry and the P coming onto the farm in concentrate feeds. On many intensively stocked livestock farms, chemical P rates allowed are either very low or are not permitted at all. In this case, the main source of P on the farm is cattle slurry. It is therefore critical to target slurry applications to fields with a P requirement.

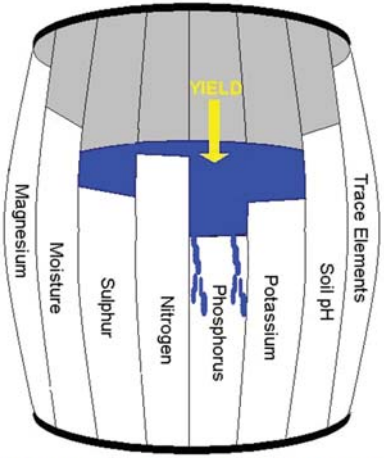
The reduction in P fertilizer application rates has resulted in a reduction in K fertilizer, as P and K application are usually applied together in NPK or PK compounds. This has resulted in an increase in the application of straight N products as the main fertilizer, potentially neglecting the K requirements on the farm. Potassium has a key role in the efficient use of N. Where K is limiting, it will reduce grass yield potential and reduce N efficiency.

When choosing a fertilizer product for grassland, consider the ratio of P and K required based on the stocking rate and system. Grazing systems typically require P and K in the ratio of between 1:2 and 1:4. By contrast, silage has a P and K requirement closer to 1:6. Therefore, the P:K ratio in the fertilizer should reflect the requirements of the field. This ratio will change depending on the soil Index, concentrate feed usage, or where slurry is applied. It may also be appropriate to use a straight K or NK product where P is not required. Similarly, a straight P or NP product should be used where no K is required.

Other nutrients aside from N P and K also play a critical role in plant nutrition and in nutrient supply. Applications of nutrients such as sulphur (S), magnesium (Mg) and trace elements are also required in certain circumstances. Requirements tend to be more localised, usually related to the parent material from which soils are formed. Magnesium is usually applied as Mg limestone. Foliar applications are also available. Response to S application is more likely on light textured soils with low organic matter. A number of fertilizer compounds are available that contain S.

On tillage farms the yield potential of cereal crops have increased significantly over the last 25 years resulting in higher P and K requirements. Therefore it is critical to select a fertilizer that will deliver the correct balance of P and K for the crop being grown. This is essential to maximise crop yield potential and secondly to prevent the decline of soil fertility levels.

Getting the Balance Right



Choosing fertilizer products

1) Supply correct P : K balance
   - Soil test results – P & K Index – Maintenance, Build-up
   - Range of Index combinations
2) P & K already supplied
   - Slurry / FYM
   - P in conc. feeds (5 kg/t on average)
3) Consider NP / NK / straight products
4) Correct application rate to meet requirements
5) Sulphur, Magnesium, Trace Elements

"Select fertilizers to complement soil and crop nutrient requirements to maximise productivity"

6. Spreading it correctly

The task of the fertilizer spreader is to apply the correct quantity of fertilizer in the field in a manner that allows it be accessed by the growing plant. The design of spreader, its setting; and the type and condition of the fertilizer will affect how well this is achieved. While applying the correct total application rate onto the field or crop is important, it is also critical to apply the required rate evenly to the crop.

Many operators rarely if ever accurately calibrate their fertilizer spreader. Last year's setting is relied on, and modified if it becomes obvious that it is inaccurate. Fertilizer is rarely a constant product with blended material often varying in physical nature from year to year, if not from batch to batch. This can impact on flow rate resulting in application errors. Frequently, the operator checks the application rate by estimating the number of loads spread on given areas and adjusting the rate setting between fields or paddocks. This can result in significant errors even though the overall rate may appear correct. A farmer spreading 40 ha in 5 fields may spread the first field at a rate 20% below what is required; adjust the rate and spread the next field at 15% more than required; the third field at 5% more than required and the last two at the correct rate. Overall the rate appears correct but 40% of the area has been spread at rates well outside those required. Proper calibration can reduce these errors.

The application will be determined by 1) knowing the flow rate of fertilizer through the spreader at different settings; 2) knowing the true forward speed of the tractor; and 3) driving to an accurate bout width. For all spreaders, the first step is to consult the instruction book and/or the manufacturer's website to access the manufacturer's best information about fertilizer flow rate and settings, and to determine the appropriate calibration procedure for the spreader. Many manufacturers build up a database of fertilizer flow rates from either full spreading tests or accurate measurement of the fertilizers characteristics that influence flow rate (density, size distribution, granule strength and shape of the particles). These settings can be accessed from the instruction book or increasingly through the manufacturer's web sites. 'Flow' bags are also available from some manufacturers which allow the operator quickly assess the flow rate of fertilizer. The manufacturer's settings may or may not be accurate as there may not be a correct match with a known fertilizer and slight variations in individual machines and in weather conditions will impact on the required setting.

Calibration procedures

Static calibration involves measuring the output of fertilizer over time. Procedures differ with different machines. Some require the discs to be removed, while others need the vanes to be taken off and a fertilizer collection apparatus to be placed around the disc.

The flow of fertilizer is then checked at the required setting by weighing the output of a timed run and comparing this with the manufacturer's values and if necessary developing a new setting chart for that fertilizer.

The second part of the calibration procedure is to ensure you have an accurate forward speed indicator. Electronic tractor speed indicators can usually be checked and calibrated (necessary for different wheel sizes) - again consult the instruction book. Remember unless you have a radar speed measurement system, wheel slip can make a huge difference to real forward speed. Travelling on ploughed ground for example could result in a difference of up to 20% in real speed compared to indicated speed resulting in a similar error in fertilizer application rate.

Finally accurate bout marking is essential to getting the rate right. GPS tracking systems avoid the huge errors that can occur if you rely on guessing the right distance in a grass field. Manual marking of the field can be accurate but operators should measure their stepped distances to get markers down at the correct width. Tramlines can be out by 5%.

Spreading Fertilizer Correctly

Preparing for work
- Instruction book
- Attaching and setting up on the tractor
- Maintenance
- Health and Safety

Calibration – use calibration charts and spreader manufacturers fertilizer flow-rate database on their internet websites
Application rate is affected by:
- Forward speed
- Regulator setting
- Bout width
- Fertilizer type and quality
- Agitator action, flow rate

Type and condition of fertilizer
- Density
- Granule size range, strength, shape
- Blends, batches
- Storage

Spreading accuracy
- Fertilizer type and condition
- Spreader setting, PTO speed, granule speed
- Tray tests, CV
- Boundary spreading
- Driver skill, GPS tracking, on-board weighing systems
- Weather – wind and rain

Timing of P and K

K can be applied all year round. There is no restriction on K application in autumn, provided it is applied as straight K. N and P applications are not permitted in autumn after 15 September. However, this restriction does not apply for straight K. High application rates should be avoided in spring to reduce the risk of high K reducing Mg uptake, which can result in grass tetany in livestock. It is advised not to apply more than 90 kg/ha (72 units/acre) of K in spring. Apply the reminder in the autumn where high rates are required.

P can be applied either in early spring, or during the summer or early autumn (before 15 September). Where annual P application rates are low, little and often application in low rates during the spring and summer may be the best approach. This is because P content in grass tends to be lowest at these times. Low P products such as 27-2.5-5 and 24-2.5-10 are suitable for this purpose.

Summary

Soil testing is the starting point to managing soil fertility. Knowledge of the nutrient status of each field on the farm is essential to making appropriate and cost effective decisions on fertilizer applications and organic fertilizer distribution around the farm. Soil pH is the first thing to get right. The efficiency of all other nutrient inputs will depend on it. Aim to maintain a soil pH of 6.3 for grassland and pH 6.5 for tillage crop rotations to maximise the availability and utilisation of applied N, P and K.

Soil fertility needs be managed on a long term basis with the aim to maintain soils at P and K Index 3 for optimum production. It is very worthwhile to compare soil test results from the same fields over time. This will provide a sound basis for tailoring a fertilizer plan for the soils on your farm. It will also help identify fields that need extra nutrients in the form of slurry or FYM which is a cost effective way of replenishing soil fertility levels. Soil fertility changes very slowly over time so a small annual investment in lime, P and K will pay dividends in the future.

Having equipment calibrated and set up to apply fertilizer as evenly and accurately as possible is the final critical step to a successful fertilizer strategy. After investing heavily in products, it is important to allow them to work by applying them correctly.

Suppliers of Slurry Hydrometers

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2.00 to 4.30pm.

NDP
National Development Plan 2007 - 2013

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Agriculture and Food Development Authority

Further information:

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