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IRISH FARMERS JOURNAL
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Lime – the forgotten fertiliser

Soil and fertiliser for yield improvement

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Introduction

Fertilizer Association of Ireland president PJ Browne

Soil fertility is crucial

The Fertiliser Association of Ireland is a voluntary organisation in existence since 1968 and is made up of members from across the agricultural industry. Its objective is "to promote the efficient use of fertiliser to produce quality food in an economical and environmentally sustainable manner".

We hold two field outings every year, visiting relevant sites in Ireland and abroad. We hold an annual seminar in The Horse and Jockey Hotel every February where we have topical technical papers delivered by guest speakers.

Our 2016 seminar took place on Tuesday of this week. A summary of the presentations along with several other articles are included here in our annual *Irish Farmers Journal* supplement.

We have a very comprehensive website (www.fertilizer-assoc.ie) which contains information on fertilisers and nutrient management, including a catalogue of past seminar papers. The website also hosts an online P and K nutrient calculator for grassland and tillage crops. This calculator is also available to download as a smartphone app.

Last year, we launched the first of our technical bulletins at the Teagasc Soil Fertility Conference in Clonmel in October. This is the first in a series of bulletins that will be published over the coming years to highlight the importance of sustainable soil fertility management and achieving maximum return on investment from nutrient inputs on farms.

Last year saw the dawn of a new era in the dairy sector with the abolition of milk quotas. Gone is the restriction on producing milk, but there are other restrictions and challenges. The ever-swinging milk, grain and beef prices are a major challenge and the amount of available land is a restriction. Never has it been more important to get every drop of available productivity from the land you have from the least amount of inputs. To do this, your soil has to be as close to its optimum fertility as possible and you will go a long way to getting there if you get the basics right.

The Fertiliser Association fully supports the message of soil fertility management developed by Teagasc in recent years. The five-step message is as simple as it is important.

Step 1: Soil test. You can't know what you're dealing with without a basic soil test which will give you your soil pH, P and K levels, or additional nutrients as required.

Step 2: Apply lime. Get your pH as close to 6.3 for grass and 6.5 for cereals by spreading adequate lime. Lime is arguably the most important fertiliser.

Step 3: NPK requirements. Use your test results to plan your fertiliser application rates to achieve top yields and maintain optimum levels of soil P and K. Build fertility and production potential of low-fertility soils. Don't waste money applying excess nutrients on highly fertile fields where lower rates can result in cost savings.

Step 4: Slurry is valuable resource on the farm, but only valuable when applied in the right fields that can put the nutrients in the slurry to the best use.

Step 5: The right fertiliser. There are many different types of fertiliser blends available with different combinations of N, P, K, S and other essential nutrients. Select the right fertiliser based on soil test results and the requirements of each field, and apply at the right rate and time to match your crop requirements. Cost savings are also significant when the right products are chosen. For example, urea can be more economical than CAN if the conditions are suitable.

If in doubt, get advice. There's plenty to be had from Teagasc, any private consultant in your area, or from your local discussion group. If you're not already in a group, consider looking into it.

There will be plenty more challenges and opportunities ahead, but we must be prepared for them. One of the hot topics at the moment is climate change and how the world needs to respond to this challenge. No doubt we will have to play our part and already there is much debate as to how we can do this. There will be measures taken to help reduce our carbon footprint and our greenhouse gas emissions and that may mean changes to the way we farm our land. We as an association embrace the opportunity this brings to improve the sustainability of our farming systems, and contribute to this debate as it unfolds.

We hope you enjoy our supplement, and that the information helps the performance of the soils on your farm.

Managing

John Bailey, AFBI, reports on how sulphur is an essential nutrient but is often ignored

Sulphur (S) is one of at least 16 elements essential for plant growth. It is a major constituent of some amino acids, which are building blocks of proteins. It is also essential for plant functions, including photosynthesis and nodule formation and N fixation in clover.

When grassland becomes S deficient, herbage yield and quality suffer. Sulphur-deficient plants are characteristically small and spindly with younger leaves turning pale green to yellow. Such plants are often similar in appearance to those suffering from nitrogen deficiency.

S deficiency can result in sizeable reductions in grass yield before visible symptoms emerge, and hence farmers may be unaware that the problem exists. Research is highlighting changes to the likelihood and timing of S deficiency problems on grassland soils.

Effects of sulphur on herbage yield

When swards are well supplied with S, more than 80% of N in shoot tissue will be present as protein. When there is not enough S, the proportion may be less than 50%, necessitating the purchase of expensive protein-containing feeds to supplement ruminant diets. Concentrations of sugars in plant shoots also decline under S-deficiency conditions, impairing the digestibility and feeding value of herbage.

Excessive use of S-containing fertilisers on grassland, however, can be detrimental to animal health. High concentrations of sulphur in ruminant diets can inhibit the absorption and utilisation of copper, leading to copper deficiency in both cattle and sheep. Such problems with copper utilisation are particularly likely in areas where soil molybdenum concentrations are also high. Excess S can also depress selenium uptake by herbage and impair animal health. However, neither copper nor selenium deficiencies are likely to be triggered by S fertilisation unless S-enriched fertilisers, eg ammonium sulphate, are used and crop S requirements are appreciably exceeded. But, regardless of the likelihood of copper or selenium deficiencies, S should be applied to optimise pasture growth, since grazing animals can be supplied with trace elements by alternative means, eg via injection or oral supplementation.

Sulphur availability and behaviour

Sulphur is available to plants through mineralisation of organic matter, weathering of S-containing minerals, atmospheric SO_2 deposition, applications of mineral fertiliser and organic manure and direct deposits of livestock excreta by grazing animal. In the last few decades, however, S availability to

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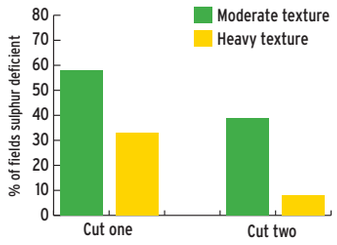
sulphur for grass production

crops has declined in Ireland partly as a result of declining atmospheric deposition, but primarily because of increased usage of fertilisers containing little or no S.

Increases in crop yields have also led to greater removal of S from soils and contributed to the decline in soil S reserves. At the same time, because sulphate is mobile in soil, it has been leached out in land drainage water, with anything up to 50kg S/ha/year lost from intensively managed grassland. Research in Northern Ireland has quantified net S balances in soils since the 1940s and has shown that soil S reserves are declining.

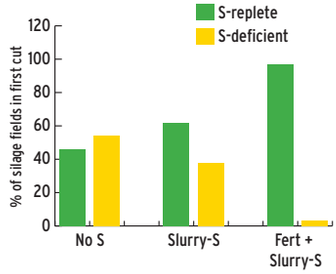
More recent research based on farm survey data has shown that S deficiency is now more widespread across all soil types in Northern Ireland, particularly in the early part of the growing season. Out of 67 dairy farms surveyed each year between 2004 and 2006, 49 farms had silage swards testing as deficient in S at first cut in April/May (Figure 1). While lighter soils with low organic matter levels are generally most prone to S deficiency, S deficient swards are now occurring on all soil types, including heavier textured clay and clay loam soils.

Figure 1
Percentages of fields on moderate or heavy textured soils that were S deficient at first and second cuts



It is recommended that at 14kg SO_3/ha should be applied routinely as fertiliser to all silage swards in spring. This moderate dressing of S should not be detrimental to livestock and has the potential to prevent yield losses which can be worth up to €100/ha. Sulphur-containing fertilisers should also be applied routinely for second- and third-cut silage crops on land that has received little or no slurry or where soils are shallow or sandy in texture.

Figure 2
Percentages of silage fields that were S replete or S deficient at first cut



Sulphur from slurry

Previous research suggests that although animal manures contain considerable amounts of S, it is largely unavailable for crop uptake in either short or longer terms. The results of the present survey uphold this conclusion. As shown in Figure 2, 54% of swards receiving no slurry or fertiliser S at first cut were S-deficient. While applying slurry S alone reduced the incidence of S deficiency to 38%, this was still an unacceptably high level of incidence. In contrast, applying both slurry and fertiliser S (and indeed fertiliser S alone) reduced the incidence of S deficiency to almost zero, indicating that slurry alone will be unlikely to overcome S deficiency in the grass.

Rate of sulphur application

Advice based on research work in Ireland has indicated that between 25kg and 50kg S/ha should be applied in spring to maximise grass production on S deficient soils throughout the entire growing season, or 10kg S/ha/cut of silage. The results from the recent farm survey in NI suggest that an application of 14kg S/ha at first cut should prevent swards becoming S deficient on either moderate or heavy-textured soils, but that higher applications could give rise to excessive levels of S in shoot tissue with implications for animal health.

Applying S fertiliser to second-cut crops or for grazing in summer is more likely to be required on lighter soils. Heavier textured soils that have received S in spring are less prone to S deficiency in the summer.

> **Excessive sulphur in ruminant diets can inhibit the absorption and utilisation of copper**

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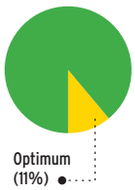
Are Irish soils giving higher crop yields?

Mark Plunkett and **David Wall**, Teagasc, Johnstown Castle, Co Wexford, report on the fertility levels in Irish soils

Over the last 10 years, Teagasc has analysed an average of 38,694 soil samples annually for its farmer clients. Given the geographical spread (all counties) and large numbers of soil-sample data included, the Teagasc soil nutrient data has provided valuable insights into soil fertility trends at a national level. This information has helped to highlight the areas and farm enterprises where action on nutrient management is most required.

In this article, we review soil fertility trends for soil pH and the major nutrients – phosphorus (P) and potassium (K) – emerging from these soil sample results.

Figure 1
Percentage of soils with optimum soil pH, P and K, Index 3 or 4



Overall soil fertility

Overall soil test results for 2015 (Figure 1) indicate that 11% of soil samples have the optimum mix of soil pH, P and K, which is the same as the previous two years. A closer look at this data indicates that soil P and K levels have declined compared with the previous two years, which is of major concern. Soil pH has shown a small improvement, with an increase in the percentage of soils achieving a pH of at least 6.2.

Grassland soils

Trends in pH, P and K levels in grassland soils from 2007 to 2015 are shown in Figure 2.

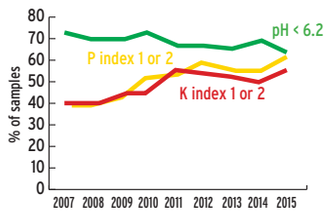
Currently, 64% of grassland soils have a soil pH of below 6.2 (target pH threshold for efficient grassland production). In 2015, the soil data indicates a slight reduction in the percentage of soils with less than a soil pH 5.9. The percentage of soils analysed in the pH range just below the target (ie pH of 5.9 to 6.2) remained stable and soils with a pH above 6.2 increased by 3%.

Since 2010, there has been a trend of decreasing proportions of soil samples with a soil pH below 5.9. This is positive but the pH results continue to indicate that there is a large requirement for lime applications on most grassland farms.

Over the last decade, the percentage of soils with P Index 1 and 2 has increased from 40% in 2007 to 61% in 2015. Between 2009 and 2012, there was a sharp increase from 40% to 59% in the number of soils that are sub-optimal for P (ie Index 1 and 2 combined). This is likely to be connected to the reduced fertiliser P usage in the previous three years from 2007 to 2009.

Between 2012 and 2014, there was an indication of a potential recovery in soil P test levels on grassland farms. However, the most recent soil test results (2015) show a return to 2012 levels of P deficient soils at 61% (ie Index 1 and 2 combined). This indicates that there are insufficient P fertiliser applications annually on Irish grassland farms and that P offtakes are exceeding P inputs, resulting in a further decline in soil P levels.

Figure 2
Grassland soils (2007 to 2015)



These trends in grassland soil P fertility between 2007 and 2015 clearly show that the production potential of our grassland soils is being slowly eroded. The declining soil P fertility trends are serious and, if allowed to continue, pose a serious threat to the expansion of our national livestock sector (dairy and meat output).

Soil K fertility trends somewhat mirror those of soil P. Since 2007, the percentage of soils Index 1 and 2 increased from 40% to 54% up until 2011. Between 2011 and 2015, soil K levels have somewhat stabilised with approximately 54% of soils with sub-optimal K levels (Index 1 and 2). The same is true for soils at Index 3 and 4 where there was a rapid decline between 2007 and 2011 (60% to 46%), followed by stabilisation between 2011 and 2014 (46% of soils). This stabilisation in soil K levels may be due to the better management and targeted use of organic manures (cattle slurry and farmyard manure) on grassland farms.

Tillage soils

Trends in pH, P and K levels in grassland soils from 2007 to 2015 are shown in Figure 3.

On tillage farms, the percentage of soils below the target pH of 6.5 decreased by 6% in 2015. Currently, approximately 45% of tillage soils have a soil pH of at least 6.5. Again, these results indicate that a large percentage (55%) of tillage soils have a lime requirement. Phosphorus fertility trends for tillage soils are similar to those described for grassland. Across tillage soils, there has been a more gradual decline in soil P levels since 2007, with 59% of tillage soils having sub-optimal P levels (Index 1 and 2 combined).

Over this time, there has been a large proportion of tillage soils (currently 36%) at Index 2. There has been a relatively small reduction in the proportion at Index 3 from 26% in 2007 to 21% in 2015, representing a 0.5 percentage point decline per year. The largest changes are in the P Index 1 and 4 category soils where the proportion of high P soils has declined by 9% and the low P soils have

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Overall soil test results for 2015 indicate that 11% of soil samples have the optimum mix of soil pH, P and K, which is the same as the previous two years.

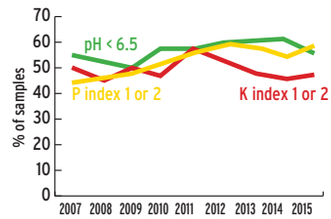
Productivity

Soil fertility is a key driver of the productivity of our farms and where soil fertility continues to decline it erodes farm productivity, profitability and competitive advantage in the marketplace. More attention needs to be placed on soil test results from individual farms.

These national soil test results indicate a large percentage of our grassland and tillage soils would benefit from an application of lime. Correcting soil pH is the primary step towards improving soil P and K availability.

Utilising organic manures and selecting a suitable P to K fertiliser is critical to delivering the required nutrient balance for both productive grassland swards and high-yielding cereal crops.

Figure 3
Tillage soils (2007 to 2015)



increased by 10% – a rate of change in both of these categories of approximately 1% per year.

Between 2007 and 2011, the percentage of tillage soils with low K levels (ie Index 1 and 2) has increased from 50% to 57%. This is related to the reduction in K usage in fertiliser applications during that period from 84,000t to 71,000t. Between 2011 and 2015, the proportion of soils with sub-optimal soil K levels (Index 1 and 2) has decreased from 57% to 47% (slight increase in 2015 on 2014). Soils with K Index 3 levels have increased from 24% in 2007 to 30% in 2015.

There was a rapid decline in the proportion of soil with K Index 4 between 2007 and 2011 from 26% to 17%, respectively. Since 2011, soils with K Index 4 have increased from 17% to 23%.

Overall, in the last five years, soil K on tillage farms has shown a marked improvement and positive trend in terms of the percentage of soils at Index 2 and 3.

Teagasc K advice for cereals was changed (2008) to take account of higher-yielding cereal crops. Fertiliser practice has change at farm level where fertiliser compounds now have altered P to K ratios to improve the supply of K requirements to crops.

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Soil fertility on heavy soils farms

On heavy soils there is the potential to increase annual grass production by 30% where pH, P and K status is optimum.

Ger Courtney of Teagasc outlines the management needed to get best results from heavy soils

There has been a notable decline in soil fertility nationally and the impact is even more serious on heavy soils farms. On heavy soils there is the potential to increase annual grass production by 30% where pH, P and K status is optimum.

Seven dairy farms farming on heavy soil type are participating in a monitoring and development programme and contributing key data on farm performance. The farms are deemed heavy, eg predominately clay mineral soils located in high rainfall areas of the southwest of Ireland

Data over the period 2011-2014 shows that on the heavy farms, grass growth varied from 6.8 tonnes DM/ha in 2012 to 11t DM/ha in both 2014 and 2015.

Changes in soil fertility 2010-2015

It has been firmly established in research that soil pH must be corrected as a first step to overall improvement in soil fertility status.

Farmer participants embarked on a programme of soil fertility improvement in 2010. The low pH was due in part to a trend of low usage of lime nationally with higher nitrogen usage masking the impact of low pH on grass growth.

2013 fertiliser plans showed that on a farm size of 68ha, stocked at 1.8 LU/ha that there was a total lime requirement of 278t. The farms have applied on average 90t ground limestone per annum and the impact on farm pH is shown in Table 1. 2015 average fertiliser costs were 3.3c/l on the heavy soils farms with lime accounting for 0.42c/litre of that cost. A comprehensive soil testing programme took place across all the heavy soils farms in December 2015 and the summary outcome is presented in Table 1.

The drained field on the left and the next field to be drained on the right on the Keane farm in Lisselton, Co. Kerry

Table 1:

Heavy Soils Farms				
N=7	2010	2013	2014	2015
Average Ph	5.6	5.7	5.7	6.1
Phosphorus-P mg/l	5.5	4.9	6.5	5.5
Potassium -K mg/l	115	102	118	99

Average pH has increased from 5.7 to 6.1. All but one of the seven farms showed a pH increase. The farms are continuing to focus on applying further lime in 2016 to bring all paddocks to target pH of 6.3 .No noticeable change in soil trafficability has been observed by the farmers largely due to quantities applied being limited to 2t per acre in any one application

P and K Status

Both P and K status has, disappointingly, declined in 2015.The higher P offtake due to increased cow numbers (+15 cows extra per farm since 2011) and 12% high milk solids production compared to 2014 combined with many paddocks still with pH less than six, which is leading to a continuing lock-up (fixation) of applied phosphorus.

K status is closely linked to P status due to the use of compound fertilisers also the higher leaching impact on K of high rainfall. P and K offtake in product leaving the farm becomes even more significant in a quota free environment. All farms need to be aware of this increasing demand for nutrients as milk production increases. A continuing poor response to additional P applications on low pH paddocks on the heavy clay soils is very evident due to fixation.

Lime and loss through drainage/rainfall losses

Because these farms are located in high rainfall areas lime loss is estimated at up to 625kg/ha/year or a loss through drainage alone of 1.2t/acre in a five-year time frame. In addition, lime is required to counteract acidity from chemical N use and loss in milk/meat means a maintenance requirement of 2t/acre every five years is required on these farms.

In effect, any lime applied in 2011-2014 was only keeping pace with the maintenance requirement and was not having an impact on lifting farm soil pH.

Timing of lime application

Lime can be applied at any time of year when ground conditions are suitable. Outside of the normal application peaks at reseeding and late autumn, monthly lime usage statistics suggest that very little lime is applied in the June period. This coincides with a period on grassland farms that grass is being harvested for silage or taken as surplus quality bales (stubble available) and when ground conditions are good for spreading.

For example, a 33ha milking block stocked at 3.5 cows/ha in May/June can potentially have 33% of the area suitable for lime application in June as grass stubble after silage plus paddocks grazed in the previous week or taken as surplus. This would allow two lorries of lime (40t) be applied without any negative impact on animal intake, etc. The key is to have the lime in the yard in mid-May ready to go when the opportunity arises.

Conclusions

Increased productivity on heavy soils requires a clear management focus on increasing soil fertility in a planned manner. In particular, a renewed campaign of lime application is required on all heavy soils programme farms. Stocking rates must be matched to the grass growth and utilisation capacity of the farm .Based on grass grown of 12.5t DM/ha with all winter feed requirement conserved within the farm (including reserve) a potential stocking rate of 2 LU/ha is achievable.

IN SHORT

- The nature of nutrient behaviour on heavy soils makes it imperative that soil pH is corrected before embarking on high applications of organic/chemical fertilisers.
- A plan is required that sets out a target tonnage of lime to be applied on farm in 2016.
- Ideally spread lime when ground conditions are good over the summer period. June is often a suitable time when little lime is applied nationally.
- A little and often approach works best where high rainfall can lead to excessive losses through drainage and high lime applications can impact on soil trafficability.

For more on fertilisers, see www.farmersjournal.ie

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Pig slurry can save you money this year

GERARD MCCUTCHEON
TEAGASC, OAK PARK

The nutrient content of pig slurry is closely related to the solids or dry matter content. Good manure management on the pig farm will ensure minimal dilution with water. This will result in reduced storage and transport costs for the pig producer and a product with higher solids and nutrient content for the customer farmers. Pig manure that contains 4.3% solids is of reasonable quality. Good-quality pig manure will contain more than 5% solids.

The value of pig manure as a fertiliser depends on how much chemical fertiliser is replaced as well as the cost of the chemical nutrients replaced. The fertiliser value of pig manure at 4.3% solids is €5.85 per m³. This translates into €26.59 per 1,000 gallons. A reasonable rule of thumb is that a thousand gallons of pig slurry is equivalent to a bag of 19:7:20.

The EU Good Agricultural Practice for Protection of Waters Regulations were reviewed in 2014 giving some benefits to farmers using pig slurry. The new statutory instrument (SI 31 of 2014) came into effect on 31 January 2014. A number of requirements in these regulations are summarised briefly below:

- The P requirement for crop growth depends on the stocking rate of the grassland (ie if it is less than 85, between 86 to 130 or between 131kg and 170kg org N/ha/year).
- No "organic fertiliser" may be imported if the stocking rate is above 170 kg/ha.
- If hay or silage is sold off the farm, allowance can now be factored in for extra P required to grow these forage crops.
- The first 300kg of concentrate fed to each grazing livestock unit (ie 85kg organic N) is now discounted in calculating the P from concentrates fed to grazing livestock.
- The availability of P is considered to be only 50% if used on soils with a P index of 1 or 2 as per the Morgans' extractable P test. So if you have low P levels in your soils it is an ideal fertiliser.

In order to save money using pig slurry:

If you use chemical P on your farm it will greatly reduce the volume of pig slurry you may use on your farm. Two field demonstrations run by Teagasc in 2014 showed savings of over €100/ha (ie €40 to €50 saved in fertiliser costs per acre).

It is important that you know the volume of pig slurry you may use in compliance with the "nitrate" regulations to ensure maximum savings in fertiliser costs.

Table 1: Cost per cubic metre of slurry spread with 3,000 gallon slurry tanker, or delivered in the case of a 6,000 gallon truck:

Distance	3,000 gallon slurry tanker (based on a contractor cost of €50/hour)	6,000 gallon truck (based on haulage using a cost of €72/hour)
3 miles or 5 km	€2.57	→→→----------
5 miles or 8km	€3.56	----------
10 miles or 16 km	€6.20	€3.76
15 miles or 24 km	----------	€4.88
20 miles or 32 km	----------	€6

Transport costs

Transport and spreading costs should be included when assessing any savings made if using an organic fertiliser. Research at Moorepark modelled the loading, transport and spreading of slurry in different situations of a standard slurry tanker and using a truck to transport the slurry longer distances. These will vary greatly based upon the distance travelled and the tanker size used to draw the slurry.

Table 1 is a summary of the costs involved in transportation of slurry. There are a number of assumptions factored into this model relating to transport speed with full loads on the outgoing journey and empty tanks on the return journeys.

So it is cost effective based on the model assumptions to have pig slurry delivered and spread on land up to nine miles or 14km away from the pig farm (ie the cost to transport it and spread. Likewise the use of a transport truck to deliver it allows the slurry be brought a greater distance from the pig farm – up to approximately 18 miles.

Advice

Farmers may save money if they use locally available organic fertilisers effectively to grow their crops. You should get your adviser/consultant to do a fertiliser plan to maximise the potential savings for your farm.

The key decision for the farmer is to ensure transport cost are not greater than the nutrient value of €5.85 per cubic metre.

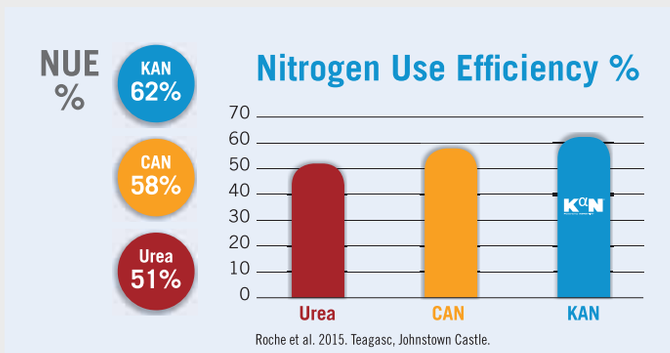
ADVERTISERS ANNOUNCEMENT

NEW NITROGEN KAN FERTILISER TAKING OFF

With tight margins in farming, control of input costs whilst maintaining output is important. Fertiliser is one of the largest input costs for both tillage and livestock farmers. In addition to the cost, some fertilisers have low use efficiency. This means that only a relatively small proportion of what is applied actually gets taken up by the plant. For a number of years it was speculated that the use efficiency of some nitrogen fertilisers could be below 50%. Factors that reduce use efficiency include, leaching, volatilisation, and denitrification.

The fertiliser industry has recently become interested in improving fertiliser use efficiency and a new category of Enhanced Efficiency fertilisers (EEF's) has been created. Because of the large body of trial work done by Teagasc on both traditional and enhanced nitrogen fertilisers recently, farmers have independent and up to date information available to them to help them to make choices.

Usually new products that employ new technology cost more. The good news for farmers is that KAN is cheaper per unit of nitrogen than CAN. It is also more concentrated (46% nitrogen compared with 27% for CAN) so volumes to be transported and spread are less. This helps farmers to save time and costs in spreading.



Roche et al. 2015. Teagasc, Johnstown Castle.

Koch Advanced Nitrogen (KAN) is emerging as the leading EEF in the Irish market and in trials at Teagasc it has been found to:

- Give the same performance as CAN
- Have a higher use efficiency than CAN or urea
- Dramatically reduce emissions of Greenhouse Gases

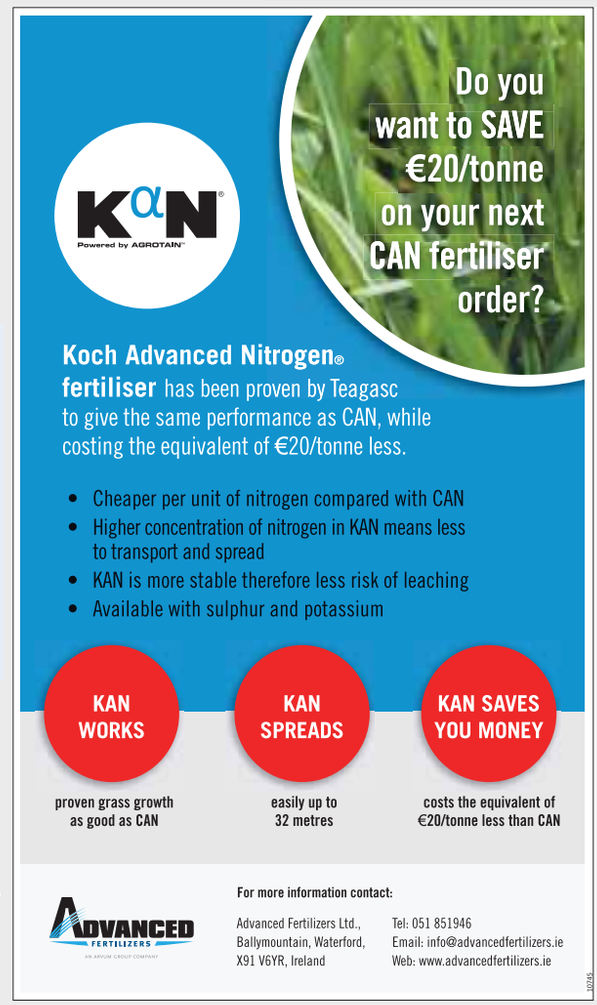
Irish farmers are turning to KAN in increasing numbers and this is what they are saying:

"I tried KAN side by side with CAN but the field with the KAN took off quicker."

"Spreadability is farmer's biggest fear but KAN is great. We'll use it again next year."

"When we worked out the price of CAN, we were able to make a significant saving by using KAN."

KAN is available from selected merchants. It is available in both 1.5 tonne pallets and 600kg toplift bags. KAN is also available with sulphur.



FERTILIZER ASSOCIATION OF IRELAND

Lime: the forgotten fertiliser

David Wall and **Mark Plunkett,** Teagasc, Johnstown Castle, Wexford look at the role of lime in soil fertility

It is well recognised that regular liming is an essential ingredient for maximising the production potential of our soils

Soil pH status and lime use

The majority of agricultural soils in Ireland are naturally acidic (they have low soil pH). Soil pH is a measure of acidity or alkalinity of a soil and when low (pH <6.0), crops may give reduced yields or fail due to high levels of aluminium (Al) and manganese (Mn) interfering with root growth and nutrient uptake.

On mineral soil types, a target soil pH of 6.3 is recommended for grassland, while slightly higher target soil pH levels are recommended for more sensitive tillage crops such as cereals (pH 6.5) and beet, peas and beans (pH 6.8). Peat soils have lower quantities of Al and Mn present and therefore the target soil pH required is also lower at about 5.5.

It is well recognised that regular liming is an essential ingredient for maximising the production potential of our soils. Grassland soils which are maintained at the optimum soil pH have the potential to release up to 80kg/ha of nitrogen (N) from soil organic matter reserves, which is worth about €80/ha annually.

Mineral soils in the optimum pH range 6.3-6.5 will be more efficient at supplying phosphorus (P) and potash (K) from both stored reserves in the soil and freshly applied fertiliser and manure inputs for plant uptake.

Over the last two decades, there has been small progress in relation to correcting soil pH on Irish farms and currently approximately two thirds (65%) of soils have sub-optimal soil pH levels (ie soil pH less than 6.3). This is not surprising given that the average lime usage over this period is approximately half of what it was in the 1970s and early 1980s.

With the majority of farmed soils at low soil pH status, the under-application of lime is likely costing farmers dearly in terms of crop nutrition and yield and quality. The application of lime is often influenced by factors such as cashflow and weather conditions. Based on soil test results and lime use statistics over the last three decades, there are clear indications that lime is the forgotten fertiliser on the majority of Irish farms.

Soil testing and lime advice - what should you do?

The approach to managing soil pH by applying lime should be tailored to the individual situation on the farm. Firstly, all soils should be tested on a regular basis (once every three to five years) to monitor soil pH levels in addition to P and K levels. This will provide a reliable basis for calculating the rate of lime required to suit the soil types on your farm.

It is also important to select the correct type of lime (ie instance calcium (Ca) v magnesium (Mg). Where soil magnesium levels are low (<50ppm), applying magnesium limestone to correct both soil pH and Mg levels is most efficient. Knowing the lime requirement for each field on the farm is a good starting point for planning and organising what and where lime applications are needed.

Liming strategies - which scenario does your farm fall into?

Three possible scenarios that you may identify on your farm following the receipt of soil test results are discussed as follows.

1. Maintenance lime applications for the farm: Soil testing on a regular basis and liming as per soil test report is the best approach to maintaining soil pH levels and realising the long-term benefits. In this situation, a smaller quantity of lime maybe required on a regular basis depending on the farming system.

Lime can applied at any time of the year to maintain optimum soil pH. For example, lime can be applied at sowing time on tillage farms or when grass covers are low (eg post-silage harvest) on grassland farms. It is good practice to apply lime to 20% of the farm annually. This strategy has many benefits, firstly spreading the cost of lime over a five-year period.

For example, the annual liming costs for a 100-acre farm where 20% of the area (20 acres) requires a maintenance lime application of 2t/ac once every five-year period is just €10/ac/year (total €1,000 per year) across the whole farm.

This represents a relatively small annual lime cost for the farm using ground limestone costing €25/t; alternatively, applying granulated lime on an annual basis is also appropriate and effective in such maintenance situations where soil pH is relatively close to target.

On farms with high molybdenum (Mo) soils, liming to increase soil pH levels on just 20% of the farm annually reduces the potential for acute copper deficiency in grazing animals arising

Fertilising for profit on grassland farms >>12

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- Drive your Tillage Yields
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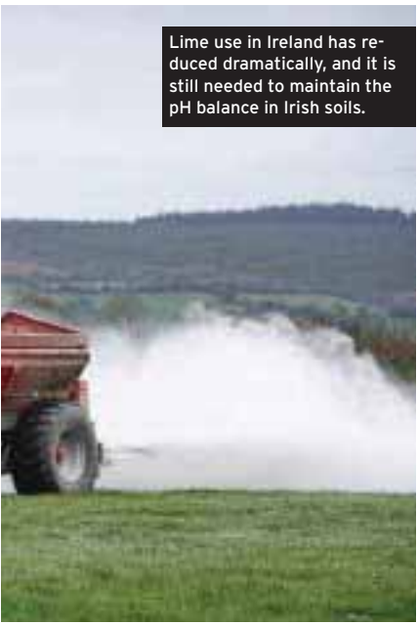

Lime use in Ireland has reduced dramatically, and it is still needed to maintain the pH balance in Irish soils.

from high Mo levels (related to high soil pH) in grass across the entire farm.

2. Proportion of the farm requiring lime: If soil test results indicate that a proportion (eg 50%) of the farm requires lime correct soil pH levels, then a targeted approach is required where a lime plan is developed for these low pH fields based on soil results. Where large quantities of lime are required, it is recommended not to exceed 3t/ac in a single application.

Planning is required to have the quantity of liming material delivered and spread at the appropriate time and when soil conditions are most suitable. For example, lime might be applied after first-cut silage, during reseeding of grassland or late summer to early autumn when grazing rotations are longer and when soils are more trafficable. In tillage situations, applying lime to ploughed soils after rolling/pressing and working into the seedbed during crop establishment is best. Alternatively, applying to stubble fields after harvest time may allow more flexibility in some situations.

In this example, our 100-acre farm requires 4t/ac of lime on 50% of the area. This situation will require additional cashflow in certain years to cover the cost of lime. Where >3 t/ac lime is required, it is recommended to split the application rate (ie 2t/ac now and the reminder in year three). The cost of lime is now spread over a three- to four-year period with an initial whole-farm cost of €25/ac in the year one and the remaining €25/ac in year three. Most importantly, lime should also be applied on a maintenance approach for the remainder of the farm to ensure that soil pH levels do not slip. The old adage of prevention being better than a cure, or at least less damaging on the pocket, applied here too.

IN SHORT

- Soil testing on regular basis to monitor pH.
- Maintenance lime application can cost as little as €10/acre on a 100-acre farm.
- Good planning is required for lime application.

3. The whole farm requires lime: Where soil test results show that the whole farm has sub-optimal soil pH, a different approach will be required. Low soil pH will be a major limiting factor to the productivity of the entire farm. Therefore, if grass or crop production is required across the whole farm (ie where there is a reasonably high stocking rate on grassland farms) it may be important to focus on the whole farm to increase performance rather than a proportion of the farm.

Firstly, it will be important to examine the costs involved and budget accordingly to spread the cost of the lime. The strategy is to apply 33-50% of the recommended lime across the whole farm. For example, where the recommended rate of lime is 3t/ac, apply 1.5t/ac now and apply the balance in year three. This will allow the opportunity to capitalise on the benefits of liming including increased N, P and K availability to enhance grass and crop production across the entire farm area.

This scenario will incur a higher annual lime costs in the initial years. The typical cost of lime (applied at 1.5t/ac) in this situation will be €38/ac in year one and €38/ac in year three.

The main difficulty with this scenario is selecting suitable times throughout the year to apply lime in order achieve coverage of the whole farm. This can be done in a staged approach over the year by selecting smaller proportions of the area (eg treating silage ground, and some of the grazing area in spring and in autumn, etc).

In this scenario, every opportunity should be taken to improve soil pH levels by applying lime when soil and land management conditions allow.

The old adage of prevention being better than a cure, or at least less damaging on the pocket, applied here

FERTILIZER ASSOCIATION OF IRELAND

Soil and fertiliser for tillage yield improvement

Lack of soil maintenance is a significant productivity constraint. **Andy Doyle** reports

The gap between potential yield and the actual achievement is clear and indicates that something is missing in our production systems that is holding back progress with yields

The yield plateau has long been established in both the scientific and traditional practice of farming. The drive towards intensification moulded farmers' attitudes towards simplicity and specialisation. This led to increased scale, continuous tillage and flat or decreased productivity over time.

This has become increasingly apparent over the past 15 years as our average winter wheat yields were going backwards and spring barley was just about holding still. Only an exceptional year bucked this trend in our national average yields (see Figures 1 and 2). The gap between potential yield and the actual achievement is clear and indicates that something is missing in our production systems that is holding back progress with yields.

The ever-increasing cost base that lay behind this period of flat yield performance was an additional problem and the two together acted to usurp margins and profit in the sector.

Soil: The three-legged stool

It has long been said that a healthy soil is like a three-legged stool (Figure 3). When all three legs are in place, they give the soil a solid foundation on which to produce big healthy crops. When any one is missing or damaged, yield potential is reduced and the cost of delivering that potential can be increased. A healthy soil needs all three legs functioning.

A healthy soil is a sustainable entity where all three legs are interlinked to help supply all of the requirements for plant growth. An active biological system helps to restructure soil. Well-structured soils can more easily support root and plant growth.

Well-structured soils allow enhanced water and air percolation which enables a healthier plant root system to support higher crop yields. Healthy soils contain more organic matter and humus to help supply more of the crop's needs at critical times and often have lower need for applied fertilisers. Healthy soils drain better but still hold more moisture for times of need.

A healthy soil is also likely to be more resilient against compression damage because of its naturally spongier texture. This does not mean that it cannot be damaged but it should mean that it will recover more quickly, primarily as a result of the active biological system it contains.

A balanced biological system is also likely to improve the availability of the nutrients in the soil but that does not lessen the need to have soil in a good state of fertility. Soil fertility is not just about the actual amount of nutrient present in the soil – it is much more about the amount that is available for plant growth and when it is available. Two soil characteristics are very important for this process – soil acidity or alkalinity, as measured by pH, and humus content.

Nutrient availability

Lime is the most basic and yet the most critical element of fertility. If soil pH is not close to optimum, then the availability of major nutrients is reduced. The anti-acidity elements in lime reduce the ions which drive acidity and thus prevent them from binding with the important plant nutrients. This helps their availability for plant growth. Lime also helps the activity of the whole biological system by optimising soil pH.

Recent Teagasc work has clearly highlighted the link between soil pH, lime and P availability. A similar outcome is likely with soil humus. Humus is an efficient carrier and delivery system for plant nutrients, making them more available to plant roots. So when humus is generated in the soil, more of the soil nutrient pool will be readily available to plant roots to support growth. Keeping soil organic matter and humus maintained is essential for nutrient availability.

Requirements and off-takes

It is important to remember that years such as 2015 with very high yields will take more nutrients out of fields, which is worth considering when coming back with fertiliser programmes in subsequent years.

Soil testing

Soil testing is another area worthy of debate and possibly a lot more science. Many new variants are being brought to the market by commercial interests and we need to know if these have anything additional to offer, or not. The sampling of soil is another and separate issue.

There is increasing evidence, based on relatively limited experience, that larger fields which have been uniformly managed for a number of decades are now showing quite variable fertility levels.

Understanding the causes of fertility variability is important because they can mean a reduction in potential productivity in some areas and/or a waste of applied nutrient in others. Soil samples taken across fields have hidden situations where soil P levels have varied from 3 mg/litre to over 50 mg/l

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Cavallo Ercole Stainless Steel Twin Disc Salt Spreader
Stainless steel hopper, spinning discs, spreading vanes, Road lights fitted, PVC Cover supplied, Galvanised sub frame which is then powder painted for double protection against residual salt by products, 16 cwt capacity


Cavallo Zeus Stainless Steel Fertilizer Spreader
Basic model 18cwt with stainless steel extensions available to increase capacity to 1.5 tons or 2 tons, Stainless steel spinning discs, vanes and vibratinfg pans, Filtering grids, PVC Covers are optional extras, Hydraulic shut off on either side as standard, Protection bars fitted

in the same field which had uniform husbandry for decades. The same variability has been found with regard to pH and lime requirement.

So does this mean that we should consider grid sampling or soil conductivity testing, or is there some better way to unravel this variability? Growers need research to advise on the most appropriate ways to tackle this problem.

Figure 3
The stool of productivity

Figure 1
Winter wheat

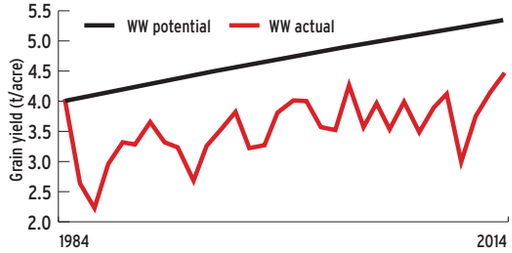
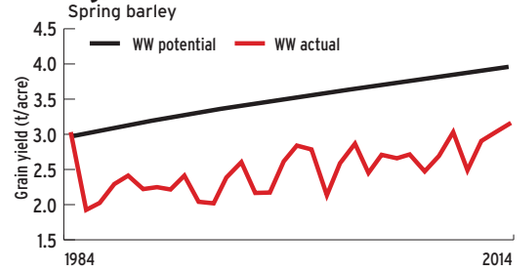


Figure 2
Spring barley



Nutrition for crop protection

Another aspect of soil fertility/health that deserves more serious consideration is the potential impact that it can have for crop protection. Growers are very aware of the continuously increasing requirement for chemical use in crop production and this comes with a cost. While fungicides, herbicides and many other inputs leave a return in their own right, when the total production cost is not rewarded with margin, then we must look towards a different model.

There is a growing belief that a more balanced supply of a big range of nutrients is likely to produce a plant that is more resistant or tolerant to a range of problems. We often hear mention of the importance of zinc or manganese in this regard but a healthy soil may be supplying many other substances that help plants fight initial infection, or to cope better in the presence of disease.

Having a fertile soil which can supply nutrients on a gradual basis, especially during the early part of the growing season, may well have a knock-on effect in terms of how a programme might be redesigned. Likewise, biological activity in the soil is itself a series of complex chemical process and who knows what these chemicals are doing, either in a positive or negative context. It is possible that some of these compounds may have a growth promotion effect or even a useful fungicidal effect.

Soil potential sets yield potential

Thirty years ago, we were able to raise more eyebrows with the level of yield reports from individual fields. Thirty years later we are trying to reproduce the yield levels of 30 years ago, despite the significant genetic improvements that have taken place in the interim. The harvest of 2015 rocked our perspective of yield potential and it is time to shift the expectation of what our tillage soils are capable of.

Lack of long-term investment in soil fertility in conacre land brings the viability of this into question in many cases. There are many growers in Ireland who could be better off with less ground if this land could produce the genetic potential of the varieties we plant on a land base with healthier soil.

> **If we want to have a viable future in tillage we must maximise the yield and returns from the acres we grow**

In conclusion

Our soils are our greatest asset. We cannot grow an acre of crop without an acre and we cannot grow a profitable acre without a good acre. If we want to have a viable future in tillage we must maximise the yield and returns from the acres we grow. Having a healthy soil is not an option in this regard – it is essential.

"If you look after your soil it will look after you." Think soil – think potential.

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Fertilising for profit on grassland farms

Christy Watson and **Fiona Doolan,** Teagasc, outline good grassland management to increase overall farm profitability

Table 1: Trends in key performance indicators (KPIs) for store bulls and heifers on Farm Case Study A corresponding with improved soil fertility and grassland management over the same period.

	2013	2014	2015	Change in 2015 vs. 2014
Store bulls spec				
Days on farm	477	457	435	- 22
Sale weight (kg/hd)	440	451	476	+ 25
Change in sale value				+ €1,400
Heifers				
Days on farm	636	634	634	No change
Carcase weight (kg/hd)	N/A	312	329	+ 17
Change in sale value				+ €1,200

Table 2: Key performance indicators (KPIs) for Farm Case Study B.

	2012	2013	2014	Change in 2015 vs. 2013
Area farmed (ha)	49.44	37.48	37.33	- 12.11 (- 24%)
Stocking rate U/ha)	1.38	1.54	1.76	+ 0.38 (+ 28%)
Fertiliser cost (€/ha)	€115	€118	€127	+ €12 (+ 10%)
Purchased concentrate (€/ha)	€65	€50	€54	- €11 (- 17%)
Gross output (€/ha)	€773	€782	€1,036	+ €263 (+ 34%)
Gross margin (€/ha)	€411	€414	€637	+ €226 (+ 55%)
Carcase weight (kg/hd)	N/A	312	329	+ 17
Change in sale value				+ €1,200

Applying the right amounts of N, P, K, and lime with properly calibrated spreading equipment is critical.

> A twin-track approach was taken to address the problems present

The following two case studies of drystock farms in Co Kildare demonstrate how optimising land area, stocking rate and soil fertility have proven worthwhile for improving farm profitability.

Case Study A

The first of two case studies is a 60ha drystock farm with small tillage enterprise. There are 40 single-suckling cows. Heifers finished and bulls are sold as stores. There are also 200 ewes, lambing in mid-March. This farm is pretty typical of many farms in that over the last 10 to 15 years, soil fertility has declined to a critical level, leading to a reduction in farm output and productivity. Stocking rate was pretty constant over the last five years at 2LU/ha, but this did not truly reflect the emerging problem.

The soil P and K Indices were poor (74% of the farm is in Index 1 and 2 for P and 79% of the farm is in Index 2 for K). The soils were also acidic, with only 12% of the farm tested optimal for pH. The result of this soil fertility problem was a shortage of grass even in good growing seasons. This of course impacted negatively on the livestock enterprises, compromising output and reducing farm income.

The farm was exiting the REPS scheme in 2011 and this prompted a review of the whole farm system as the income from the REPS scheme had to be replaced.

A twin-track approach was taken to address the problems present. Firstly, a programme to address the soil fertility issue began in 2011 when lime was applied to the most deficient fields. The expenditure on fertiliser increased by 68% from 2010 to 2014. The impact of improved soil nutrition was really evident when a new paddock system was put in place in 2014. Some of the key benefits to the beef system of the investment in fertiliser/lime and paddock grazing are outlined in Table 1.

Compared with 2014: store bulls have been sold 22 days earlier weighing 25 kg heavier; and heifers have gained an extra 17kg liveweight. The combined increase in sale value for cattle in only one year is €2,600. All other livestock on the farm have shown similar increases in productivity.

Despite the annual fertiliser expenditure increasing by 68% over the five years 2010 to 2015, the Teagasc Profit Monitor shows the farm gross output increased from €54,313 in 2010 to €72,398 in 2014, resulting in an increase in gross margin of 30% over that same period. The investment in additional fertiliser/lime to address soil fertility along with paddock fencing is paying off very quickly in additional farm income.

The financial benefits of improving farm performance will continue to increase over the coming years. The farm is poised to increase stocking rate and the genetic potential of the breeding stock is being targeted.

Surplus inputs of P and K are being applied to increase soil Indices. However, the picture for N is not so good, with only 70% of the recommended N being applied. Nitrogen is the fuel for grass growth. This is a similar pattern we observe as advisers on farms where N is overlooked in many cases within the whole P and K debate. This is often true of lime as well. There is very little point in increasing soil P and K indices and then not driving output with appropriate levels of N.

Huge gains in productivity can be achieved on this and many other farms when good soil and grassland management is combined with well-bred livestock. The target for this farm is to increase the kgs of beef produced per livestock unit to 363kg/LU and increase lambs weaned per ewe to the ram to 1.5 without additional concentrate use.

Case Study B

The second case study a suckler-to-weanling farm with 40 single-suckling cows. The farm comprises heavy soils merging into peaty soils at bottom of farm. Much of the farm suffers from impeded drainage.

Similar to the first farm, poor grass supply was restricting farm stocking rate, output and income. This farmer was also exiting the REPS scheme and needed to replace the annual REPS payment through more commercial farming activity.

Soil fertility was above average on this farm, with 55% of the farm testing optimal for P and K, with all fields satisfactory for lime. Approximately one quarter of the farm was Index 2 for P, with the rest of the farm equally divided between Index 3 and 4. Soil K levels were good in general, with only 18% of the farm with very low levels in Index 1, but with 16% in target Index 3 and 66% in Index 4.

Initially temporary paddocks/divisions were made using reels of electrified fencing. After observing the increase in grass supply and resultant improvement in livestock output, the farmer became a firm advocate of paddock grazing. Paddock size is appropriate to the numbers of grazing livestock to ensure they are grazed out within two days. The progress to date has been spectacular, bearing in mind that farming practice has only changed over the last three years.

The change in some of the key performance indicators on the farm as a result of the change in grazing practice is shown in Table 2. In 2013, almost 12ha of rented land was dropped without any negative impact on farm output or increase in fertiliser use. The usage of purchased concentrate feed also reduced. Gross output has increased by 34% in the period from 2012 to 2014. More importantly, gross margin has increased by almost 55%. Gross margin can be described as the return on farming activity, it is critical that we demonstrate in financial terms the improvement in farm profitability from focusing on improved grassland management.

The dramatic on-farm improvements made over the last three years could well be unsustainable in the long run if soil fertility levels decline. The farm will be soil-tested in the coming weeks and an updated soil nutrient plan is to be prepared in advance of any fertiliser purchases. Our well-managed soils like our livestock will also respond to good nutrition.

This example clearly outlines the type of farm income progress that can be made on many lowly stocked farms by replacing non-essential rented land with good soil and grassland management.

Fertilising for profit: key tools

1. Soil samples
Having information on soil fertility levels is absolutely essential as a starting point for a plan.

2. Nutrient management plan
A plan identifies the exact steps needed to be taken to correct soil fertility. Priorities are established as to where sometimes scarce resources are to be deployed to improve farm efficiency and profitability.

3. Measurement
More on farm measurements need to be taken to demonstrate progress, (silage yield measurement; grass growth rates; grazing days; animal growth rates; suckler cow fertility and ewe weaning rate).

4. Profitability
Profit Monitor completed, the case for investing in fertiliser and lime needs to be made on the basis of a potential improvement in farm income.

5. Best practice
Applying the right amounts of N, P, K, and lime with properly calibrated spreading equipment is critical.

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Farm Safety

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Safety tips for using fertiliser

Teagasc health and safety officer **Dr John McNamara** looks at the action that can be taken to prevent injury

In 2015, 18 people lost their lives in farm accidents. This represents tragedy for the farm families affected. While it represents a 40% reduction on the 30 farm deaths in 2014, the situation is far from satisfactory. One death or serious injury is one too many. Let us all resolve to take practical action throughout 2016 to prevent injury.

Keeping tractors and machines in check is the key to preventing many fatal accidents.

Image courtesy of Yara

ABOVE: Lifting bags puts a strain on your back. Remember to lift the right way, with your legs – not your back.

Image courtesy of Yara

ABOVE RIGHT: Use a knife with a long handle to cut the bag. Never walk under a suspended load.

When using small fertiliser bags, proper manual handling techniques should be used to prevent injury.

Bulk fertiliser spreading is an option for farmers. It frees up time but may require more management to ensure it is done correctly.

Accident causes

Getting crushed by a moving vehicle or machine and entanglement was the main cause of farm deaths, accounting for 39% of the total. A number of crush deaths were associated with tractors rolling away in farmyards or when handling baled silage. Falls from heights and animal incidents were each associated with 22% of deaths with slurry, collapsing objects and entrapment making up the remaining fatalities. About 2,500 serious injury-causing accidents occur on farms each year.

Behaviour is the key to safety

When fertiliser is being spread, there is a lot of tractor movement around the farmyard. Keeping tractors and machines in check is the key to preventing many fatal accidents. This is done by adopting safe behaviours. The principle precautions with a farm vehicle are as follows:

➲ Stop the engine and leave the fuel-control in the shut-off position and remove the key.
➲ Apply the hand brake securely.
➲ Park on level ground, where possible.
➲ Use wheel stops, if necessary, to prevent a vehicle from rolling from its parked position.
➲ As vehicles vary in operating procedures, always follow the manufacturer's operating manual.

Good farmyard layout

A good farmyard layout allows delivery and storage of fertiliser and adequate space for vehicles to turn. When fertiliser is being stored and spread at a location which is away from the farmyard, thought should be given to how the fertiliser is stored and filled into the spreader.

Keeping fertiliser spills to a minimum cuts the risk of slipping or falling. Some fertiliser products are inherently slippery while others are oil-based or absorb moisture, so they can get slippery when spilled.

Bystanders

Loading up fertiliser requires concentration.

The safety of bystanders, particularly children and older farmers, should be given priority.

The majority of childhood and older farmer farm deaths are due to tractor and machinery movement in farmyards.

Spreading on sloping ground

Fertiliser-spreading on sloping ground needs particular attention due to the risk of tractor overturn. Driver competence and experience is crucial for this task. The following points should be considered:

➲ Your alternative land-use options for steep slopes.
➲ Make sure that you are familiar with the slope by walking it before driving it. Slopes that are very wet or dry ground on which rain has fallen are particularly dangerous. Drive up and down a slope, not across.
➲ Make sure that the tractor is in good mechanical condition, and preferably use a four-wheel drive tractor.
➲ Select the right gear before approaching the slope. Avoid gear changes on slopes.
➲ Keep as much weight uphill as possible and use front-end weights.
➲ Use wide turning circles and turn uphill if driving across a slope for access.

Choosing between bulk or bags

The options of bulk spreading and half-tonne bags are now widely available. Gone are the days when 50kg bags were the only option regarding handling fertiliser. Also, the level of mechanisation on farms gives more options than in the past.

The bulk option takes the "weight off your shoulders" and also frees up work time for important farm management tasks. There are many excellent contractors available to spread bulk, but having good communications and management skills is essential if fertiliser needs to be spread in your absence.

Big bags

The following safety controls have been devised for big bags generally, but always follow any instructions given for individual products.

➲ Always beware of overhead electrical cables.
➲ Before lifting, check that lifting loops are not worn or cut. The forks or hooks being used should be smooth.
➲ Bags should not be pulled along the ground.
➲ Bags should not be allowed to swing against handling equipment or be left suspended for any length of time.
➲ When cutting the big bag, never stand under it or cut the bottom of the bag.
➲ When emptying, suspend the bag over the spreader and cut an "X" on the side of the bag 15cm above the base, with a long-handled knife.

Small bags

Small bags require lifting. Set up the fertiliser on a trailer which is at waist height, if possible. This prevents lifting from ground level and reduces the strain caused. If lifting a bag, stand the bag upright, adopt a shoulder-wide "boxer" stance with your feet firmly on the ground. Bend your knees and keep your back straight, while lifting with your thigh muscles.

It is vital to keep the bag close to your body and grip it firmly. Point in the direction of the fertiliser spreader and never twist your spine by having your back to the spreader. Ideally, training should be undertaken and alternatives should be considered to minimise lifting strain.