Nutrient management on organic cattle farms

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Summary

The aim of organic farming is to maintain good soil fertility primarily by maintaining soil pH in the optimum range (grassland soils pH 6.3 to 6.5) to ensure the availability of major soil nutrients (N, P, K, Ca, Mg & S). This will be the first step to ensuring efficient recycling and utilisation of applied nutrients such as farmyard manure, slurry and or compost. The efficient storage and spreading of farmyard manure, slurry or compost is vital to the success of organic farming. Management of organic farms should ensure regular inputs of manures and a level of microbial and earthworm activity sufficient to breakdown organic matter and ensure the continuous and efficient recycling of nutrients. Shortfalls in nutrients as evidenced in soil sample analysis should be addressed by the application of external sources of certain permitted organic and mineral fertilisers.

Lime

Maintaining soils in the optimal soil pH range facilitates organic matter breakdown and nutrient recycling which is essential for successful organic farming. Many Irish soils are naturally acidic due to our high annual rainfall. Implementing a farm liming programme is the best way of keeping soils at a pH 6.3 to 6.5 based on recent soil analysis.

Soil samples should be taken once every 3 to 5 years to check soil pH levels and plan lime applications based on soil test results and crop requirements. Only apply lime as recommended on the soil test report.

The benefits of correcting a lime deficiency include the following:

- Grassland soils release up to 80kg N/ha once restored to soil pH 6.3.
- Maintaining the correct soil pH is critical for nutrient availability of both soil and applied nutrients.
- Increased survival and productivity of rye grasses & clover.
- Research shows where soil pH was lifted from pH 5.5 to 6.3, grass produced increased by at least an extra 1.0 tonne DM/ha annually.

Recent research from Johnstown Castle clearly shows the importance of lime in relation to the availability of soil P. Figure 1 shows the benefits of liming in unlocking soil P (Lime only bar). This trial shows that by correcting soil pH from 5.2 to 6.4 through the application of 5t/ha of ground limestone, this increased soil P by ~5mg/L. The application of lime for pH correction is the first step to consider when building / improving soil P levels. To maximise the response from applied P during the growing season, maintain soil pH in the optimum range for example grassland pH 6.3 to 6.5 and tillage crops pH 6.5 to 6.8.

Farmyard manure is a very important source of organic matter and nutrients on organic farms
Figure 1: Average change in soil test P (Morgan’s) across 16 soils (av. pH 5.5) treated with lime (5 t/ha of lime), over 12 months in controlled conditions. (Sheil, et al, 2015).

Importance of soil pH on grass production
Correcting soil pH close to the optimum pH, will increase the production of grass annually. Figure 2 shows the grass yield response to lime in grassland over a full growing season. The application of 5t/ha ground limestone (Lime Only Bar) produced ~1.0t/ha of extra grass dry matter compared to the un-limed treatment. The untreated plot had a soil pH 5.2 and the limed plot had a soil pH 6.4 after receiving the 5t/ha of ground limestone.

Figure 2: Relative grass DM yield response in grassland treated with Lime (5 t/ha of lime) over a full growing season (average yield response across two grassland sites.)

Return on Investment (ROI) from ground limestone usage
When the pH of grassland soils are maintained close to the optimum range, increased grass production by at least 1.0t DM/ha/year can be achieved. In addition to P and K release from the soil, N supply worth up to €80 euro may also be achieved, boosting spring and autumn growth in particular. If this extra grass production is utilised by the grazing livestock it has the potential to reduce farm feed bills by at least €181/ha year. One tonne of additional grass production each year over a typical 5 year liming period (5 t/ha lime applied) represents a 7:1 (grass €181/t : lime €25/t) return on investment in lime, not including the potential for reducing fertiliser costs into the future.

In other words, for every €100 investment in lime there will be a return of approximately €700 in extra grass production annually, thus representing a return of €7 for every €1 invested in lime.
Lime advice - ground limestone

- Leave at least 3 months between liming & silage harvest.
- Wait 7 days after applying slurry before applying lime.
- Leave 3 months between applying lime first and slurry application after.
- Lime can be applied at any time of the year, however, mid-summer and autumn are ideal as soils are dryer and firm. In addition, there are increased spreading opportunities post silage and grazing and there is less interference with slurry or FYM applications.
- A 3-5 year liming plan for the farm should be developed to address the fields that urgently require pH correction and those that will need maintenance lime applications in future years. As part of this liming plan, all lime applied to achieve the target soil pH should be based on the soil test report (lime requirement (t/ha)).
- On heavier and organic soils, there is often hesitance to applying lime for fear of “softening the sod” or increased poaching (due to rapid break down of soil organic matter). On these soils, it is best to apply lower application rates of lime (<5 t/ha) on a more regular basis to control soil acidity to avoid “softening the soil”.
- Ground limestone (calcium limestone) is the most suitable liming material where soil pH is low and a large quantity of lime is required to increase the soil pH to the target range.
- Apply Magnesium (Mg) lime (dolomitic limestone) where soil Mg levels are low (Index 1 or 2) to replenish soil Mg reserves.
- Don’t exceed 7.5t/ha in a single application. Where the lime requirement is large (>7.5 t/ha [3 t/ac]) split the lime application (i.e. apply 50% now and the balance in year 3).
- On high molybdenum (Mo) soils, maintain soil pH <6.2 to prevent negative effects on copper (Cu) uptake in ruminant animals.
- On high Mo soils, only lime a proportion of the farm each year (e.g. 20% of the farm annually) to reduce the risk of an acute copper deficiency in grazing animals arising from high Mo levels (related to high soil pH) in grass across the entire farm.
- Magnesium lime is slower to increase soil pH and therefore maybe more suitable on high Mo soils to reduce the incidence of copper deficiency.

Granulated limes

- Granulated lime is composed of fine lime (i.e. <0.10 mm sieve) and therefore is very reactive (i.e. ~ 100% will react within the year of application).
- Treat granulated liming products like a fertiliser in that they should be applied annually.
- Where soil pH is close to the target level, granulated lime could be considered as a maintenance type liming product.
- The rate of application from maintenance will depend on the level of lime loss and acid production (i.e. from manure applications) annually, e.g. lime utilization and loss will typically range from 450 to 900 kg/ha per year.
- The industry recommends to apply granulated lime at a rate of ~1:3 (compared to ground limestone). This would equate to a granulated lime application of 150 to 300kg/ha to replace lime utilization, loss and acid production referred to above.
- Consider costs over the 3-5 year period when considering granulated limes.

For further information on Lime grassland advice refer to:
Phosphorus and potassium efficiency from animal manures

The efficiency of phosphorus (P) and potassium (K) uptake from animal manure applications is largely not affected by application timing or method. However, application of P and K in quantities that are in excess of the levels that crops require represents poor utilisation of a valuable asset on the farm.

This is particularly the case where slurry or farmyard manure (FYM) is applied to fields that have no P or K requirement (i.e. land with soil P or K levels at Index 4). Historically, slurry has often been applied in fields that were more convenient to the farmyard and slurry storage tanks to minimise slurry spreading costs.

However, as fertiliser prices increase, so too does the economic value of the nutrients in slurry and FYM. The value of the N, P and K content in 1,000 gallons of cattle slurry (7% DM) or 1 tonne of FYM is approximately €20 and €9 respectively at present. If this slurry or FYM is applied to a field with no P or K requirement, then this potential saving will not be realised. To make best use of P and K in organic manures check soil test results and target manures to fields with the largest demand during the growing season. “For example” cattle slurry is an excellent source of K and is ideal for replenishing fields with low soil K levels.

Table 1: Target P and K levels in organic grassland soils

<table>
<thead>
<tr>
<th>Target Index</th>
<th>Phosphorus (P)</th>
<th>Potassium (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morgan’s Level (mg/l)</td>
<td>Grassland 5.1 to 8.0 mg/L</td>
<td>Grassland 101-150 mg/L</td>
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<tr>
<td></td>
<td>Tillage 6.1 – 10 mg/L</td>
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</tbody>
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Note: - Additional P and K applications will be required at soil Index 1 and 2 to build soil fertility levels to the target Index 3. Further information available at https://www.teagasc.ie/crops/soil--soil-fertility

Nitrogen efficiency from animal manures

As discussed in other parts of this booklet, the over-riding source of nitrogen (N) on productive organic farms is from leguminous (nitrogen fixing) plants such as white and red clover. However, animal manures are another significant source of N. The efficiency of N utilisation will depend to a large extent on the weather conditions at the time of application. Farmyard manure contains low levels of N in a form that is immediately available to plants. The N contained in FYM normally requires a period of time in order to break down and become available. Autumn application is often favoured for this reason so that a proportion of the N becomes available to plants in the following spring.
Unlike FYM, slurry contains a significant amount of N that is immediately available for plant uptake. However, this N can also be lost to the air. Losses of N to the air from slurry application are higher when weather conditions are warm and dry. Cool, overcast or misty conditions at the time of application will result in reduced N losses and improved N efficiency. Consequently, spring application is generally recommended rather than summer application. For example, 1,000 gallons of cattle slurry (7% DM) contains approximately 6.5 units of N when applied in spring. However, the same slurry applied in summer is only worth approximately 3 units of N.

Alternative application methods such as bandspring, trailing shoe or shallow injection will increase the N efficiency from slurry applications. For example, the trailing shoe will increase N recovery by 3 units/1,000 gals. However, the main advantage of adopting such methods is by way of reducing the grass contamination from slurry application. This may facilitate more slurry being applied in between grazing rotations and, on silage ground during Spring when conditions permit rather than onto bare swards following silage harvesting in summer.

**Importation of fertilisers**

Organic fertilisers are a nutrient source and should be regarded as a supplement to, and not a replacement for nutrient recycling within the farm. They should be used only to replace the nutrients that are removed by the farming system or when soil fertility has been inadvertently compromised by harvesting silage from the same area each year.

Some common examples of imported organic manures/materials permitted according to organic standards.

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*Farmyard manure (FYM) is a good source of nitrogen (N) and potassium (K) on organic farms.*
include to the following:

- Cattle slurry from both organic and non-organic farms including non-organic derogation farmers (>170 kg N/ha) with a normal grass-based outdoor system.
- Free-range and organic poultry manure.
- Dairy processing sludge from certain dairy processors (consult with an Organic Certification Body for a list of certified processors).
- Horse manure from organic or non-organic farms.
- Straw (conventional is permitted), sawdust (un-treated) and wood chips for bedding of animals or supplement to existing manures.

A number of caveats exist regarding the importation of such manures onto organic farms:

- Manures imported onto an organic holding must come from a system of extensive husbandry and manures from factory farming origin are not permitted. vis a vis imported organic manures from zero-grazing of cattle, sheep, pigs and horses, all poultry systems with the exception of organic and free range and commercial piggeries where pigs are permanently housed.
- A composting period of 3 months is generally required for organic manures that originate from non-organic sources.
- Mushroom compost made from materials which come from ineligible material including poultry manure not from a free-range or organic enterprise are not permitted.

Also, certain types of mineral fertilisers can be used (Table 2). Examples of such products include, ground rock phosphate, sulphate of potash and basic slag. The performance of some of these fertilizers is different to that of conventional fertilizers. For instance, ground rock phosphate works best in more acidic soils (pH <6.5) and may become inert above pH 7.0. Also, both ground rock phosphate and basic slag release P slower compared to conventional fertilizers eg. superphosphate. In all cases the Organic Standards should be consulted to ensure that the product is permitted for use.

Table 2: Sources of mineral fertilizers on organic farms

<table>
<thead>
<tr>
<th>Phosphorus (P)</th>
<th>Ground Rock Phosphate (typically 11% P) works best in soils at &lt;pH 6.5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium (K)</td>
<td>A. Potassium sulphate (also known as SOP or sulphate of potash)</td>
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<tr>
<td></td>
<td>i. 41% K</td>
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<td></td>
<td>ii. 18% S</td>
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<td></td>
<td>B. Potassium sulphate with magnesium and sulphur: (e.g., Patentkali®)</td>
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<tr>
<td></td>
<td>i. 26% K</td>
</tr>
<tr>
<td></td>
<td>ii. 6% Mg</td>
</tr>
<tr>
<td></td>
<td>iii. 17% S</td>
</tr>
<tr>
<td></td>
<td>C. Potassium sulphate with sodium and sulphur (e.g., Magnesia-Kainit®)</td>
</tr>
<tr>
<td></td>
<td>i. 9% K</td>
</tr>
<tr>
<td></td>
<td>ii. 3% Mg</td>
</tr>
<tr>
<td></td>
<td>iii. 20% Na</td>
</tr>
<tr>
<td></td>
<td>iv. 4% S</td>
</tr>
<tr>
<td>Other fertilisers</td>
<td>A. Basic Steelworks slag (variable content, check with supplier). Contains some P, K, and other trace elements.</td>
</tr>
<tr>
<td></td>
<td>B. Seaweed fertilisers - potassium (K) and other trace elements.</td>
</tr>
</tbody>
</table>

Note: In all cases the Organic Standards should be consulted to ensure that the product is permitted for use.