MAXIMISING ORGANIC PRODUCTION SYSTEMS (MOPS)

# Sustaining **soil health** and **productivity** in **organic horticultural** crop production


An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine


The European Agricultural Fund for Rural Development:
**Europe investing in rural areas**

by William Deasy

***Organic crop production Feed the soil, feed the plant.***

Soil health and fertility management is a crucial task for organic horticulture producers. The focus of this article is the use of organic material inputs by certified organic growers participating in the Maximising Organic Production Systems project. Maximising Organic Production Systems (MOPS) is a European Innovation Partnership (EIP) project that is co-funded by the Department of Agriculture, Food and the Marine and the European Commission.

Optimising soil health is a key principle of organic crop production. Healthy soils are biologically active, have good structure, water retention/infiltration, organic matter and balanced nutrient levels for crop growth and yield. Although soils and soil husbandry vary from farm to farm, organic growers aim to 'feed the soil to feed the plant' by building up, or at least maintaining, soil organic matter and nutrient reserves whilst maximising nutrient recycling, minimising losses to the environment and reducing external inputs. Nutrients and organic matter that are removed from the soil in crops are replaced to prevent deficiencies. In practice, this involves using a balanced crop rotation, including a fertility building stage (e.g. clover/legume-grass) and nutrient retention (e.g. green manures and cover/catch crops), supplemented with organic material inputs (e.g. crop residues, livestock manures, compost) that can be broken down by soil microorganisms to release crop nutrients.

Specialist growers of organic horticultural crops, like vegetables and salads, with few or no livestock to increase and recycle on-farm nutrients, often with several crops in a growing season and protected cropping (polytunnels/glasshouses), have to be particularly skilled at soil and fertility management, crop rotation and making use of external organic material inputs when needed. Organic standards recognise this challenge for horticulture producers and allow the use of defined supplementary organic inputs where required. The emphasis is on sustained and efficient balancing of inputs and off takes of soil organic matter and nutrients to avoid nutrient rundown and losses to the environment. For growers, deciding on exactly which organic material inputs and nutrients are needed depends on a number of factors such as the crops being produced, the type of soil they are growing in and existing nutrient reserves in the soil. Soil assessment, sampling and laboratory analysis provides them with vital information about the composition and nutrient content of their soils that is required to guide such decisions. Plant tissue testing during the growing season can be used to achieve further precision in nutrient management.

The main sources of organic material inputs available to organic horticulture producers, beyond crop residues, green manures and cover/catch crops, include composted livestock manures, compost, anaerobic digestate, soil conditioners/amendments and organic fertilisers, which are the focus of this article. In order to maximise their agronomic benefits and to inform nutrient budgeting, guide application rates and to calculate and compare the financial costs of nutrients; growers obtain information about their quality and composition from standard values, product labels/technical specifications and/or laboratory analysis results. Application rates must depend on the levels of nutrients in the soil that are available to crops. In Ireland, application advice is typically based on the Soil Index System which categorises soil available nutrients into classes (Soil Index 1-4).

***Composted farmyard manure.***
***A valuable source of organic matter and nutrients.***

The MOPS EIP project has provided the participating organic growers with the opportunity to analyse, better understand and make more efficient applications of the organic material inputs that they use for managing their soil health and productivity. This article shares grower practices and knowledge along with laboratory analysis results for livestock manures, organic fertilisers, compost, some waste-derived organic materials and anaerobic digestate. Further information, including about sampling organic materials and interpreting the laboratory analysis report, is available in a technical note compiled for the MOPS EIP project. Information specific to green manures can be read in a separate article on p? reporting on the ongoing MOPS EIP project green manure trial.

## SHARED EXPERIENCE: what some of the growers in the MOPS EIP project say about their soil organic matter and nutrient management practices

### Desmond Thorpe, Thorpe's Organic Farm *https://www.thorpesorganicfarm.ie/*

"We grow organic field vegetables in a rotational system with grassland and oats. We try to maintain soil organic matter by use of long-term green manures (two years), with a mix of chicory, cocksfoot grass and red clover. This has been largely experimental to date. We hope to test this better in practice in the 2021 season. The green manure is mulched a few times in the year and incorporated before planting the vegetable crop. Prior to this we have been rotating the vegetables around the farm usually following grassland. We also use small amounts of well composted farmyard manure, lime and rock phosphate as required. As part of MOPS we do extensive soil testing which helps us address any deficiencies in the soil".

### Kenneth Keavey, Green Earth Organics *https://www.greenearthorganics.ie/*

"We use organic red clover mix for two years. We mulch the clover, which contributes to enhanced organic matter in the soil. We have experimented with undersowing of crops with subterranean clover also and this has had good results suppressing weeds and holding onto valuable nutrients over winter. We use organic certified pellet manures with a combination of rock dusts to balance any depleted nutrient levels. Annual soil tests allow us to target specific fields with the required supplementation".

### Liam Ryan, Moyleabbey Organic Farm *https://www.moyleabbey.ie/*

"On outdoor crops we do a two-year Italian ryegrass and red clover green manure mix within a five-year crop rotation programme, adding composted farmyard manure and other bought in fertilisers as soil analysis and crop needs dictate. This allows very good soil structure and soil life to develop with follow on crops doing very well and annual weed pressure is usually low after a two-year ley. We also do a green manure cover on bare ground over winter where possible. In tunnel crops, we grow on permanent beds that are not walked on and grow through plastic mulch with bought in fertiliser applied (based on soil tests taken as part of MOPS) and crop needs. This facilitates quick turnaround of crops with minimum tillage required using hand forks and hand rake and low weed pressure with clean crops"

### Nick Cullen, Cullen's Farm *https://www.cullensfarm.ie/*

"We grow organic vegetables in rotation with grassland for grazing sheep. Soil organic matter and fertility are typically supplemented where required using composted poultry manure, rock phosphate and Patentkali®. Soil testing is crucial for monitoring soil health and nutrient status and making accurate decisions on soil management practices, and we are doing comprehensive soil testing as part of MOPS".

### Oliver Kelly, Oliver Kelly Organic Produce

"For year one of my organic crop rotation coming out of grass, I spread decomposed farmyard manure imported onto the farm the previous year from two local suckler farms. Application rates are based on soil analysis results. The farmyard manure is stored in a covered dungstead and turned three or four times during the year. In the first year of the rotation I grow potatoes, and this is followed by root vegetables in the second year. Soil nutrients are supplemented with pelleted manure where needed based on monitoring crop growth along with soil and leaf test results carried out as part of MOPS. In the third year, I plant brassicas with an application of farmyard manure. In year four, I grow legumes with a base dressing of farmyard manure and depending on how crops are growing they may get a top dressing of pelleted manure. In the fifth year of the rotation, the land is returned to grass for two to three years and grazed with sheep".

### Padraig Fahy, Beechlawn Organic Farm *http://beechlawnfarm.org/*

"In order to build up organic matter on our land we put all new land into a two-and-a-half-year rotation with a green manure crop of clover and rye. I source organic farm compost from other organic farms and spread this on the land at approximately four tonnes per acre. I buy in pelleted manures that are made up for salad and root crops. For tunnel crops, well decomposed farmyard manure is applied in winter/spring for the next 12 months production. Soil tests tell us where to supplement with P, K, Mg, B or lime. In early spring, leeks and kale receive a top dressing of high N to boost growth and put colour back in the crop. The wet August this season necessitated top dressing in September/October on some crops as they were under water and roots were saturated. All land for growing summer crops gets a green manure (rye, vetch and black oats) in September. This mops up the excess nutrients and binds the soil structure for the winter. I am managing lands that are in organic production for 20 years, 14 years, nine years and four years, which all require different inputs and soil care".

**Patrick Frankel, Kilbrack Farm**
***https://www.facebook.com/kilbrackorganicfarm/***

"Our fertility is a blend of farmyard manure (70 %) composted with old plant material from our tunnels (10 %) and deciduous leaves that we collect from a long lane running through our organic farm (20 %). We turn it six times and apply the compost each year at a rate based on soil testing results. For our no-dig beds we use 10 wheelbarrows per 100-foot bed depending on the soil analysis. Our plan going forward is to use primarily no-dig systems and tarp areas after compost is added for three to four months to knock back weeds and protect nutrients from leaching"

## LABORATORY ANALYSIS RESULTS

**Livestock manure.** Composition and nutrient content of cattle dungstead/farmyard manure (13 samples) and poultry manure (three samples). For information purposes only.

| | kg/t fresh weight | | | | | |
|---|---|---|---|---|---|---|
| | Cattle dungstead/farmyard manure | | | Poultry manure | | |
| **Parameter** | **Mean** | **Min.** | **Max.** | | | |
| Total Nitrogen (N) | 7.63 | 4.0 | 17.9 | 11.47 | 11.73 | 6.13 |
| Ammonium Nitrogen ($NH_4^+$) | 0.9 | 0.32 | 2.29 | - | 5.72 | - |
| Nitrate Nitrogen ($NO_3^-$) | 0.26 | 0.01 | 1.19 | - | 3.06 | - |
| Phosphorus (P) | 1.53 | 0.71 | 2.58 | 11.15 | 12.7 | 7.01 |
| Potassium (K) | 9.42 | 3.73 | 37.03 | 8.17 | 18.25 | 9.43 |
| Calcium (Ca) | 8.09 | 1.81 | 19.02 | 10.56 | 92.09 | 12.82 |
| Magnesium (Mg) | 1.59 | 0.48 | 3.38 | 4.93 | 5.15 | 3.56 |
| Sulphur (S) | 1.15 | 0.26 | 2.13 | 2.24 | 3.65 | 1.6 |
| Iron (Fe) | 2.07 | 0.78 | 4.92 | 0.99 | - | 11.73 |
| Manganese (Mn) | 0.2 | 0.08 | 0.3 | 0.39 | - | 1.45 |
| Boron (B) | 0.01 | 0.003 | 0.01 | 0.02 | - | 0.01 |
| Zinc (Zn) | 0.05 | 0.01 | 0.17 | 0.31 | 0.23 | 0.19 |
| Copper (Cu) | 0.01 | 0.003 | 0.04 | 0.05 | 0.05 | 0.03 |
| Molybdenum (Mo) | 0.001 | 0.0004 | 0.002 | 0.003 | - | 0.002 |
| Sodium (Na) | 1.25 | 0.54 | 2.45 | 1.75 | - | 1.56 |
| Dry Matter (DM) | 287.45 | 146.7 | 505.7 | 295 | 460 | 487 |
| pH | 8.57 | 7.0 | 9.9 | - | 7.4 | - |
| Carbon: Nitrogen (C: N) ratio | 14.6 | 12.4 | 16.8 | - | 7.5 | - |

**Organic fertiliser.** Composition and nutrient content of some professional granular/pelleted organic fertiliser (two samples). For information purposes only.

| **Parameter** | **% nutrient DM basis** | |
|---|---|---|
| Total Nitrogen (N) | 7.15 | 5.38 |
| Ammonium Nitrogen ($NH_4^+$) | 1.65 | 0.82 |
| Nitrate Nitrogen ($NO_3^-$) | 0.31 | 0.03 |
| Phosphorus (P) | 1.69 | 1.001 |
| Potassium (K) | 1.27 | 1.93 |
| Calcium (Ca) | 1.11 | 0.87 |
| Magnesium (Mg) | 0.59 | 0.65 |
| Sulphur (S) | 0.74 | 0.72 |
| Zinc (Zn) | 0.01 | 0.01 |
| Copper (Cu) | 0.001 | 0.001 |
| Dry Matter | 91.3 | 90.1 |
| pH | 5.9 | 6.0 |
| C: N ratio | - | 6.9 |

**Compost.** Composition and nutrient content of professional composts (one sample of peat-free seed compost, two peat-based seed compost and one peat-free compost). For information purposes only.

| | kg/t fresh weight | | | |
|---|---|---|---|---|
| **Parameter** | **Seed compost (peat-free)** | **Seed compost (peat-based)** | | **Compost (peat-free)** |
| Total Nitrogen (N) | 3.93 | 4.24 | 4.28 | 10.16 |
| Ammonium Nitrogen ($NH_4^+$) | - | - | - | 0.73 |
| Nitrate Nitrogen ($NO_3^-$) | - | - | - | 0.01 |
| Phosphorus (P) | 0.34 | 0.26 | 0.29 | 1.68 |
| Potassium (K) | 2.02 | 0.85 | 1.06 | 5.59 |
| Calcium (Ca) | 3.53 | 5.74 | 63.99 | 26.82 |
| Magnesium (Mg) | 0.63 | 0.92 | 0.88 | 2.2 |
| Sulphur (S) | 0.39 | 0.68 | 0.62 | 1.17 |
| Iron (Fe) | 3.28 | 1.31 | 1.45 | - |
| Manganese (Mn) | 0.07 | 0.05 | 0.05 | - |
| Boron (B) | 0.01 | 0.004 | 0.004 | - |
| Zinc (Zn) | 0.02 | 0.02 | 0.02 | 0.14 |
| Copper (Cu) | 0.01 | 0.01 | 0.01 | 0.03 |
| Molybdenum (Mo) | 0.001 | 0.002 | 0.002 | - |
| Sodium (Na) | 0.33 | 0.14 | 0.17 | - |
| Dry Matter | 353 | 333 | 376 | 647.2 |
| pH | 6.3 | 6.2 | 6.9 | 8.3 |

**Anaerobic digestate.** Composition and nutrient content of anaerobic digestate (two samples of whole digestate and one sample of separated fibre digestate). For information purposes only.

| **Parameter** | **kg/m³ fresh weight Whole (slurry) digestate** | **kg/t fresh weight Whole digestate** | **kg/t fresh weight Separated fibre digestate** |
|---|---|---|---|
| Total Nitrogen (N) | 10.05 | 25.01 | 7.02 |
| Ammonium Nitrogen ($NH_4^+$) | 8.75 | 1.79 | 2.3 |
| Nitrate Nitrogen ($NO_3^-$) | 0.02 | - | - |
| Phosphorus (P) | 1.45 | 23.44 | 2.23 |
| Potassium (K) | 4.94 | 21.36 | 4.88 |
| Calcium (Ca) | 2.02 | - | - |
| Magnesium (Mg) | 0.52 | 7.45 | 0.84 |
| Sulphur (S) | 0.83 | 7.48 | 1.8 |
| Zinc (Zn) | 0.044 | 0.224 | 0.093 |
| Copper (Cu) | 0.013 | 0.039 | 0.021 |
| Dry Matter | 79.9 | 890 | 315 |
| pH | 8.9 | 6.9 | 8.6 |

**Waste-derived organic material.** Composition and nutrient content of waste-derived spent mushroom compost (two samples) and corn husk (one sample). For information purposes only.

| | kg/t fresh weight | | |
|---|---|---|---|
| **Parameter** | **Spent mushroom compost** | | **Corn husk** |
| Total Nitrogen (N) | 8.44 | 5.31 | 8.37 |
| Ammonium Nitrogen ($NH_4^+$) | 1.71 | - | 0.59 |
| Nitrate Nitrogen ($NO_3^-$) | 0.01 | - | <0.1 |
| Phosphorus (P) | 1.98 | 2.03 | 1.01 |
| Potassium (K) | 12.06 | 5.49 | 5.6 |
| Calcium (Ca) | 32.65 | 20.58 | 4.89 |
| Magnesium (Mg) | 2.2 | 1.17 | 1.01 |
| Sulphur (S) | 12.12 | 2.27 | 0.72 |
| Iron (Fe) | 1.1 | - | - |
| Manganese (Mn) | 0.09 | - | - |
| Boron (B) | 0.01 | - | - |
| Zinc (Zn) | 0.1 | 0.05 | 0.03 |
| Copper (Cu) | 0.02 | 0.01 | <0.01 |
| Molybdenum (Mo) | 0.001 | - | - |
| Sodium (Na) | 2.54 | - | - |
| Dry Matter | 360.7 | 299 | 558 |
| pH | 6.5 | - | 6.3 |

## SUMMARY

- Organic material inputs are a valuable source of organic matter and nutrients for optimising soil health, fertility and crop roductivity.
- The composition and nutrient content of organic materials can vary significantly.
- Sampling and laboratory analysis can be used to accurately determine the composition and nutrient value of organic materials.
- It is important to apply the correct amounts of organic material inputs at the right times and at the right rates in suitable conditions. Soil analysis results must form the basis for recommendations on nutrient application rates.
- The total amount of livestock manure, as set out in the Organic Food and Farming Standards in Ireland, shall not exceed 170 kg of nitrogen per year/hectare of agricultural area used.
- Organic materials can be a source of environmental and pathogenic contamination if not handled, stored and applied properly. It is important to ensure that their use complies with the organic standards, national and EU legislation.

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