POSITIVE OUTCOME AREAS

- [x] SOIL
- [x] CARBON
- [x] WATER
- [ ] BIODIVERSITY
- [ ] ANIMAL HEALTH & WELFARE
- [ ] SOCIAL

TECHNICAL GUIDE

How changing nutrient management can reduce Scope 3 emissions

Scope 3 emissions largely occur before nutrients reach the farm gate, sitting outside a farmer's direct control and relating to the greenhouse gas (GHG) emissions associated with the manufacture, transport and the use of fertiliser and nutrient products on farm. However, farmers can still strongly influence them through **nutrient planning, demand reduction, soil management and product choice**.

Scope 3 emissions from fertilisers mainly arise from:

- Energy-intensive manufacturing processes (particularly ammonium nitrate)
- Use of fossil-based feedstocks
- Nitrous oxide losses following application
- Transport, packaging and waste
- Poor nutrient targeting or mismanagement

The most effective way to reduce these emissions is to reduce overall nutrient demand first, by improving soil structure, biology and nutrient cycling, and by fully accounting for nutrients already present on farm through legumes, manures and composts. Following that, substituting high carbon inputs with low carbon, recycled or carbon captured fertiliser products can be adopted.

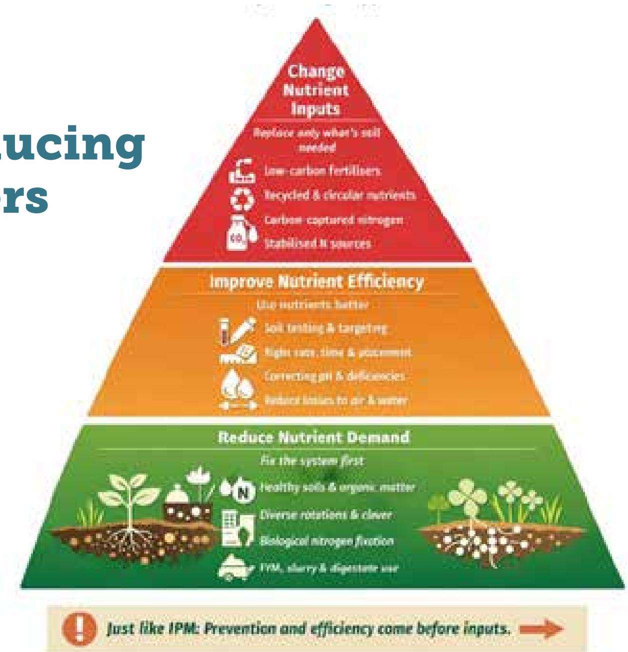
This technical guide sets out how reducing nutrient demand, retaining and recycling nutrients within the system and refining application practices can increase nutrient efficiency, improve soil health and reduce inputs. Lower carbon fertilisers can be used when additional nutrients are needed.

What the science says about reducing Scope 3 emissions from fertilisers

The proof, impacts and evidence

Scientific evidence shows that the largest reductions in fertiliser-related greenhouse gas emissions come from reducing nutrient demand and improving nutrient use efficiency. Mirroring the principles of Integrated Pest Management (IPM), where system design and prevention are prioritised before inputs are used with soil function, biological supply and efficient use forming the base of the "triangle", with fertiliser products at the top.

This diagram, from Nutrient Inputs, illustrates an IPM-style triangle approach.



The proof, impacts and evidence (continued)

University of Cambridge research estimated that global emissions from fertiliser use (synthetic fertilisers and manure) could be reduced by up to 80% by 2050, if technological change is combined with improvements in nutrient management and soil health. Evidence consistently shows that improving soil structure, organic matter and biological activity reduce fertiliser demand by increasing nutrient availability, mineralisation and biological nitrogen fixation. Improved nutrient placement and timing further reduce emissions by lowering losses to air and water.

Life cycle assessment studies show that cleaner fertiliser production pathway's climate benefit is greatest when they replace well targeted nutrient applications, rather than sustaining high nitrogen inputs. Circular fertilisers derived from unavoidable waste streams also support nutrient retention and regional balance when used as part of a whole farm, soil led approach.

Reference: Carbon emissions from fertilisers could be reduced by as much as 80% by 2050 University of Cambridge (2023)

Impact

The most significant impact of reducing Scope 3 emissions from nutrient management comes from lowering overall nutrient demand and improving nutrient use efficiency, rather than from product substitution alone. Improvements in soil structure, organic matter, biological activity and legume performance consistently reduce reliance on purchased fertilisers, lowering emissions across the supply chain.

Research shows that improved soil management and nutrient targeting can substantially reduce nitrogen losses to air and water, particularly nitrous oxide emissions, which dominate fertiliser related climate impacts. These effects are strongly influenced by application rate, timing, placement and soil condition, and often outweigh differences between fertiliser products.

Life cycle assessments indicate that low emission fertilisers substitutions can reduce manufacturing-related emissions, depending on production pathway and energy source but whole farm greenhouse gas reductions are typically modest unless total nitrogen inputs also decline.

At farm scale, studies suggest 5–15% reductions in overall greenhouse gas emissions are achievable where lower emission fertilisers are combined with improved soil health, effective legume management and better utilisation of organic manures. In this context, low carbon fertilisers function as a supporting tool, reinforcing system level change rather than driving it.

Whole farm system

Reducing Scope 3 emissions from nutrient management is most effective when it forms part of a whole farm approach that prioritises soil function, nutrient efficiency and circularity. Low carbon fertilisers are an important enabling tool, but they are not the starting point. The most durable emissions reductions come from first improving soil health and reducing overall nutrient demand by improving soil structure and biology, building organic matter, and maximising biological nitrogen fixation through legumes, herbal leys, manures and composts. Then refining how nutrients are applied and retained within the system by applying at the right rate, in the right place and at the right time minimises losses and maximises uptake. Finally, replace high emission inputs with lower embedded emission alternatives, such as recycled or carbon captured nutrient products, where additional nutrients are still required.

Low carbon nutrient technologies align well with organic and agroecological systems because they often use unavoidable waste streams as feedstocks. When combined with rotational grazing, composting and reduced tillage, they support progress towards a more closed loop, resilient nutrient system.

Clover does not automatically fix nitrogen.
Effective nitrogen fixation depends on adequate molybdenum, calcium and correct soil pH to support nodulation and enzyme activity.

Timescales

Short term (year 1) Low carbon fertilisers can deliver immediate carbon savings, as embedded emissions are lower from the point of use. However long term benefits depend on wider management decisions, particularly nutrient planning, application timing and soil condition. Changes in behaviour and product choice work together, and the full benefits of a whole-farm approach develop over time.

Medium term (2–3 years) benefits often include reduced reliance on purchased fertiliser as legumes, organic matter and soil biology contribute a greater share of nitrogen supply. Crop performance and quality become more consistent, and the carbon footprint of produce continues to fall as nutrient cycling improves.

Long term (5+ years) outcomes include sustained reductions in Scope 3 emissions across supply chains, higher soil carbon, improved rotational resilience and reduced dependence on synthetic fertilisers. Progress is typically strongest where low-carbon fertilisers support, rather than replace, legumes, composts, reduced tillage and effective residue management.

How do I make sure changing my nutrient management to reduce Scope 3 emissions will work for me?

Start by understanding and reducing your underlying nutrient demand, which is strongly influenced by soil health. Chemical health begins with soil testing to establish baseline acidity (pH), phosphorus (P), potassium (K) and available nitrogen, identifying where nutrients are already sufficient or locked up. Correcting pH and balancing indices improve nutrient availability and reduces the need for additional inputs.

Biological health underpins nutrient cycling. Active soil biology, supported by organic matter, legumes and diverse rotations can significantly reduce reliance on purchased nitrogen, increasing nitrogen supply through biological fixation and mineralisation. Physical health is equally important, good soil structure and drainage improve rooting depth, infiltration and nutrient uptake, reducing losses.

Manures, slurries and digestates should be accounted for in the nutrient plan, as their contribution is often underestimated. Finally, refine application behaviour by adjusting timing, calibrating rates and managing rainfall risk to maximise nutrient use efficiency.

Pitfalls to avoid include undervaluing legumes and farmyard manure (FYM) and assuming new products will behave like standard ammonium nitrate. If unsure, trial changes on 20–25% of the farm area before wider adoption.

Measuring and monitoring

Monitoring is essential for understanding nutrient use efficiency and carbon impacts, and for distinguishing the effects of management change from product choice.

Once changes are introduced, monitoring should focus on how nutrients are used and retained, not just total inputs. Track crop response, yield and nitrogen use efficiency, and record application timing and weather conditions, as these strongly influence losses. Sap analysis is a useful tool to assess crop need rather than depending on soil analysis which may not account for naturally available nutrients. Field observations of soil structure, infiltration, rooting depth and worm activity help assess improvements in physical and biological function. Year on year tracking of Scope 3 emissions supports evaluation of whole farm progress.

While immediate carbon savings can result from lower embedded emissions and improved placement, effective monitoring allows application rates to be refined, costs justified and benefits clearly demonstrated to customers, auditors and supply chains.

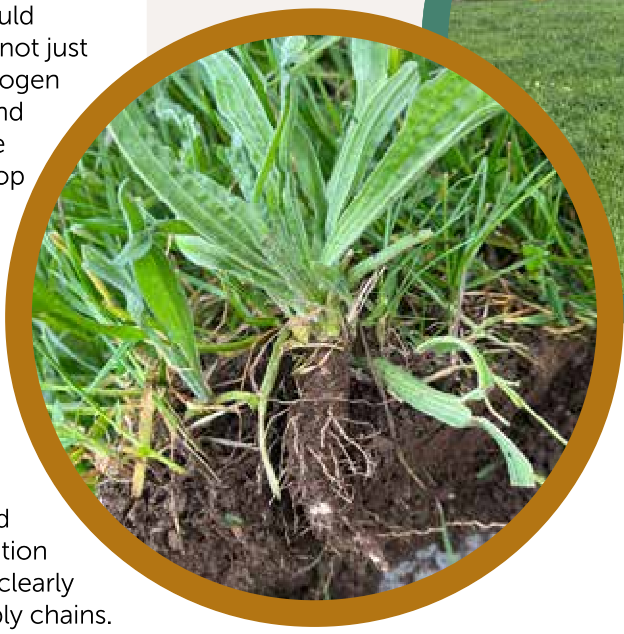
CASE STUDY

Chris and Bella Mossman, Nant y Bach Farm

Nant y Bach Farm transitioned from a conventional dairy system to a regenerative, lower input approach beginning in 2018 following repeated Bovine TB outbreaks and ongoing livestock health challenges. The aim was to improve resilience and profitability while reducing reliance on costly external inputs linked to high Scope 3 emissions.

Central to the transition has been a focus on improving grassland, moving from monoculture ryegrass to diverse multi-species swards for both grazing and silage. This has improved soil structure, root depth diversity and drought resilience while supporting productive pasture growth. Soil health has been prioritised through reduced tillage, targeted slurry application using trailing shoe technology and the development of a foliar nitrogen strategy.

As a result, synthetic nitrogen inputs have fallen significantly from 300 kg/ha historically to 80 kg/ha in 2025, with a target of 50 kg/ha. Participation in an Innovate UK trial investigating biological inputs has further supported improvements in nitrogen use efficiency. Despite lower inputs, the farm continues to target 12 t dry matter/ha, demonstrating that resilient grassland systems can maintain productivity while reducing reliance on fossil-fuel-derived fertilisers.



Efficient nitrogen use supports productive swards, stronger root systems and a lower carbon

Financial and environmental considerations

Reducing Scope 3 emissions with nutrient management involves both short term considerations and longer term economic and environmental gains. The starting point is not fertiliser substitution but understanding and reducing overall nutrient demand through improved soil health, nutrient planning and better use of on-farm resources. These changes often deliver cost savings, regardless of fertiliser type.

Where additional nutrients are still required, lower emission fertiliser products including carbon-captured nitrogen, recycled nitrogen and phosphate fertilisers, organic mineral blends and stabilised alternatives to conventional ammonium nitrate may involve different cost structures. Prices vary by product and supplier, but when assessed per kilogram of available nutrient and adjusted for nutrient use efficiency, many are comparable with conventional fertilisers. In practice, cost effectiveness depends on application rate, timing and system context rather than product price alone.

Environmental improvements arise primarily from lower total nitrogen use and reduced losses, supported by soil-led management. Benefits may include lower embedded emissions, reduced nitrous oxide risk through improved timing and stabilisation, and gradual improvements in soil physical and biological function. Higher organic matter inputs can improve infiltration, aggregation and resilience to weather extremes, while better integration of legumes, composts, manures and digestate strengthens on farm nutrient cycling and reduces reliance on imported inputs.

Upfront considerations may include slightly higher prices per tonne for some lower emission products, additional soil testing in year one to establish baseline nutrient and carbon status, and a short calibration period to match application equipment to new materials. Some recycled or organic-mineral fertilisers have lower nutrient concentrations, resulting in higher application volumes; this can improve spread pattern, reduce scorch risk and support soil biology, but may affect logistics. Where liquid fertilisers are introduced, minor changes to storage, handling or metering may be required, though these are typically modest and quickly integrated.

Savings tend to accrue through multiple, reinforcing mechanisms. Improved nutrient use efficiency can allow reductions in application rates over time, lowering input costs without compromising yield. Better targeting reduces waste from leaching and volatilisation, while improved soil structure can reduce cultivation intensity, fuel use and remedial fieldwork. Recycled phosphate products reduce exposure to global fertiliser markets, particularly in mixed systems with effective use of FYM or slurry.

Taken together, farms that combine soil-led nutrient management with targeted use of lower emission fertilisers often see improved financial resilience, reduced exposure to price volatility and better alignment with emerging supply chain climate requirements. Returns on investment typically develop over two to three cropping seasons, particularly where legume management and whole farm nutrient planning are well established.

Organic growers: Always check nutrient inputs are approved for organic use. Refer to the Soil Association Inputs Directory or speak to your certification officer before application.

Soil Association

Soil Association advice and support

Contact our Farming and Land Use Team
Speak to a farming advisor: 0117 314 5100
General enquiries: 0300 330 0100
Email: producer.support@soilassociation.org
Find out more:
www.soilassociation.org/guides-for-whole-farm-planning