
# FARMING FOR A BETTER FUTURE

## Technologies for Today & Tomorrow

## OPEN DAY

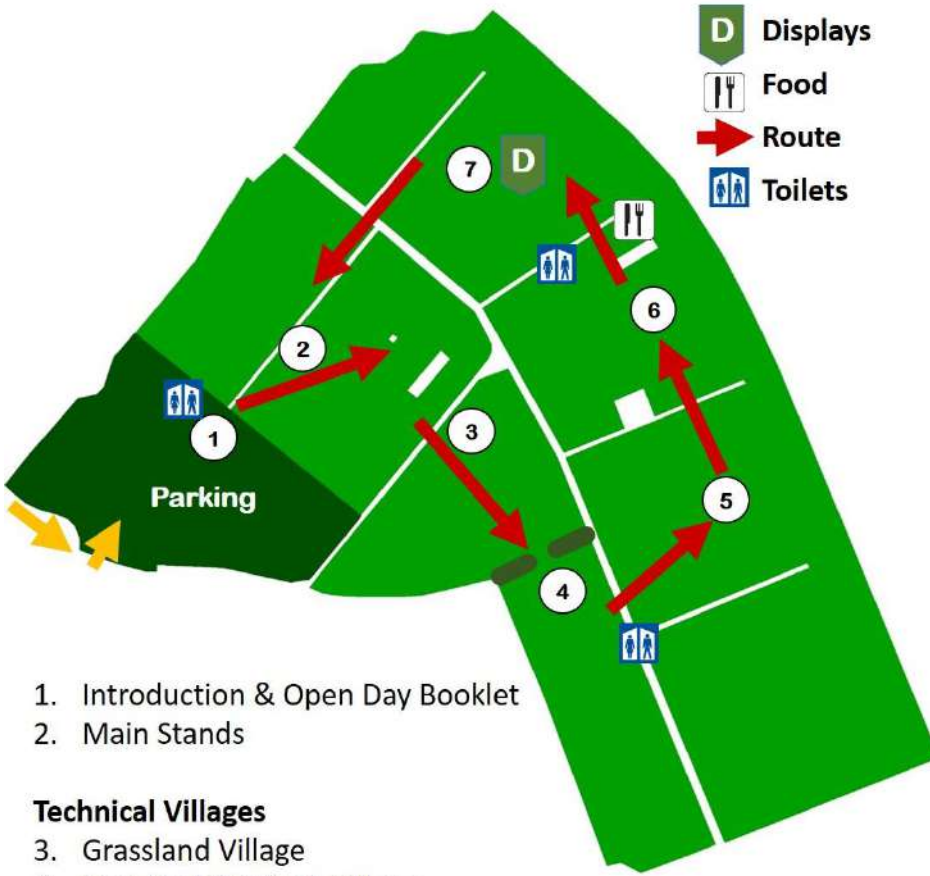
Teagasc, Johnstown Castle
Environment Research Centre

Tuesday, 30 August 2022

Teagasc
Agriculture and Food Development Authority

# FARMING FOR A BETTER FUTURE 2022

*'Technologies for Today & Tomorrow'*

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3. Grassland Village
4. Sustainability Tech Village
5. Livestock Systems Village
6. Advisory, Education & Policy Village
7. Machinery Demo Area (IFJ)

# FARMING FOR A BETTER FUTURE

## ACKNOWLEDGEMENTS

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IRISH FARMERS JOURNAL

## TUESDAY, 30TH AUGUST 2022

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Teagasc, Crops, Environment and Land-use, Johnstown Castle, Wexford, Co. Wexford.

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*To minimise disease risks and accidents, visitors entering and leaving Johnstown Castle Research Centre are asked to:*

Use Footpaths

Do Not Handle Cattle

Do Not Enter Pens or Paddocks containing Cattle

# Thank You

# Farming for a Better Future 2022

## *Foreword*

I am delighted to welcome you to the Johnstown Castle Open Day "Farming for a better future – Technologies for today and tomorrow". The key priority for Teagasc at this point in time is to provide leadership and support for the transformation of our agri-food system to a sustainable food system, which embraces the economic, environmental and social dimensions of sustainability. A sustainable food system must also have innovation at its heart, so technology development and adoption will play a central part of the transformation of the Irish agri-food system. Irish agriculture has shown itself capable of great change and development over many decades. Our grass-based systems of livestock production which dominate Irish agriculture, give us a solid foundation to build on from an environmental sustainability perspective, as well as an animal welfare perspective, and these characteristics coupled with our excellent food quality and our family farming model are what makes Irish produce attractive to discerning consumers all over the world. The next phase of that development will see the industry build on these attributes and in particular, strengthen the environmental aspects of our system, as set out in Food Vision 2030.

Of these issues, climate change has dominated the public discourse in recent months, and in particular the role of agriculture. Sectoral targets have now been set with agriculture's target being a 25% reduction in emissions relative to 2018, and the land use (LULUCF) target will be addressed in 18 months' time. A 25% reduction is a very demanding target. The debate is often framed around a cut to the national herd, but there is an alternative which is the development and deployment of technologies and improvements in our systems of production to reduce emissions. Can we meet all the 25% target

through technology alone? It will be very challenging as the technologies outlined in the 2019 Teagasc MACC are not nearly sufficient. However, we have a very active research programme in this area, and there are a range of additional technologies at various stages in the research pipeline, some which could be deployed soon and others at an early stage of research. You will see most of these technologies that are being researched here at Johnstown Castle, and also at our other research centres, on display today. This includes research to provide more accurate measurements of soil carbon emissions and sequestration to help clarify the LULUCF situation and prepare for carbon farming.

We will also highlight our advisory programmes to support farmers to adopt new technologies and adapt their systems to improve environmental sustainability, such as the Signpost Programme and the ASSAP. Knowledge transfer is obviously key to seeing widespread change at farm level, and this means a very important role for the Teagasc Advisory service in leading this change. In this regard we are very glad to partner with so many other organisations, co-ops and food companies in the delivery of our advisory programmes. I'm also delighted that we have been able to partner with the Irish Farmers Journal for today's event to bring you the live demonstrations of clover establishment and slurry application methods in the machinery area. I hope you very much enjoy the day and find it informative and useful.

**Professor Frank O'Mara**

Director Teagasc

# FARMING FOR A BETTER FUTURE 2022

## *Welcome to Johnstown Castle*

Karl Richards & David Wall

*Teagasc, Soil, Environment and Land use Research Centre, Johnstown Castle, Co Wexford*

On behalf of the staff at the Teagasc, Soil, Environment and Land use Research Centre, Johnstown Castle and other staff involved with today's event, it is a pleasure to welcome you to FARMING FOR A BETTER FUTURE 2022. The theme today is "Technologies for today and tomorrow" which will help farmers maintain productivity while increasing the profitability and environmental sustainability of their family farm businesses. Technologies include multi-species and grass-clover swards, grazing and silage conservation management, sustainable fertiliser technologies and organic manure management, reducing gaseous emissions, protection of water quality, enhancing biodiversity and soil health. Also, winter and spring dairy cow management and nutrition, dairy beef systems, animal health, farm planning and reducing the environmental footprint of grassland production systems. All of these technologies will be essential to increase the competitiveness and sustainability of Irish farms and the agricultural and food sector. These technologies and much more will feature strongly at FARMING FOR A BETTER FUTURE 2022. With many of these technologies, we will also be addressing the high input prices that Irish farmers are currently experiencing and what strategies can be put in place to mitigate their impact on farm profitability. Today's event is comprised of four main 'speaking' stands where the key challenges that are facing Irish farmers and the industry over the coming years will be addressed. These are followed by a series of 'villages' where the key technologies to improve farming sustainability will be shown

throughout the day. We have a number of demonstrations throughout these villages that will be both informative and interactive. You will also have the opportunity to meet with Teagasc 'Signpost Programme' farmers. These farmers are implementing many of the technologies on show today on their farms.

FARMING FOR A BETTER FUTURE 2022 will finish with a live-demonstration arena where three key technologies for reducing the reliance on chemical fertiliser N will be demonstrated. In the demonstration arena the latest machinery for applying slurry, over-sowing clover into existing swards and fertiliser spreader calibration for protected urea products will be shown. In preparation for this event, particular attention has been paid to health and safety, and bio-security arrangements. Please use the footbaths provided, pay attention to the signs erected throughout the circuit and follow the direction of our staff. Visitors are asked to not enter paddocks with cattle, which are 'double-fenced', or pens with cattle in them for both bio-security and safety reasons. Your help and co-operation with these safety measures is greatly appreciated. A major Open Day at our Soils and Environment Research Centre in Johnstown Castle is an opportunity for you, the visitor, to see first-hand the latest research and advice on a wide range of topics that will make your farm more sustainable, both profitably and environmentally, into the future. Again, on behalf of Teagasc and Johnstown Castle staff we hope you have an enjoyable and worthwhile visit, and can take some of what you see here today back to your own farm.

# Challenges and Opportunities for Sustainability on Irish Farms - Technologies for Today and Tomorrow

David Wall and Karl Richards

Teagasc, Crops Environment, and Land-use Research, Johnstown Castle, Co. Wexford

Currently farmers are facing the challenge of economic, social and environmental sustainability with environmental challenges increasing over recent years. The EU Green deal has set targets to halt biodiversity decline, improve water quality, setting targets to reduce fertiliser and pesticide use. Ireland has set very challenging environmental targets such as reducing greenhouse gas and ammonia emissions, improving water quality, reversing the decline in farmland biodiversity. The trends in emissions, water quality and biodiversity continue to decrease or remain static and we urgently need to work together to implement technologies that are known to reverse these trends. Farmers need technologies that allow them to combine economic and environmental sustainability.

## Livestock production systems

Technologies at the systems level are required to reduce emissions per hectare to meet the 25% target by 2030 and climate neutrality by 2050. Continued improvements in grazing management, breeding of efficient animals, reducing the age of slaughter and increasing homegrown feed supplementation will lead to further reductions in emissions. In addition to these proven technologies for improving livestock production systems, newly emerging technologies are being tested for Irish systems such as feed additives for reducing biogenic methane and breeding of lower methane emitting animals in future, hold the potential to reduce emission further over time.

## Greenhouse gas emissions

The 25% greenhouse gas reduction target will be extremely challenging and the recent emissions increases will have to be reversed. Nitrous oxide ($N_2O$) from nitrogen fertiliser, manures and urine accounts for c. 30% of agricultural emissions. The remaining 70% comes from slurry management and directly from the animals. Agricultural soils are a source of emission in the Land use and forestry part of the inventory. Carbon sequestered in our mineral soils is four times lower than the carbon lost from agricultural peat soils.

## Reduce nitrogen fertiliser use

One big challenge is to dramatically reduce reliance on imported, fossil fuel derived fertilisers. There are a range of proven technologies today to reduce this reliance. Optimising soil fertility releases c.70kg N/ha from the soil and reduces fertiliser requirements. Soil fertility is important for clover/multi-species sward establishment and the opportunity to dramatically reduce nitrogen fertiliser use. Use of low emission slurry spreading increases the nitrogen supply in slurry, reducing fertiliser requirements. Where chemical N is used then replacing CAN and urea with protected urea can reduce emissions by over 70%. New research is showing lower emissions when certain low nitrate compound fertilisers are used and that optimal soil fertility can directly reduce emissions by c. 40%.

### Carbon sequestration

Currently carbon sequestration is accounted for in the inventory using default values. New research is underway to produce country specific emission factors for different soil types, land-use, land management practices and water table management of peat soils. This will improve the accuracy of the inventory and quantify a number of technologies to reduce emissions from soils and enhance carbon sequestration. Increasing trees on farms through hedgerow management, on farm forestry and agro-forestry will increase carbon sequestration and is subject to new research. The emerging area of carbon farming is also being researched.

### Water quality

The effect of agriculture on water quality has been subject to large amounts of research over the past 20 years. While Irish water quality is above average within the EU, only 53% of Irish waters are at good or high status and thus rapid improvements are needed to achieve good water quality status by the 2027 target. There are a large number of technologies available for farmers to control nutrient loss from farm yards, hard standings and diffuse losses from fields. Good nutrient management planning is a major corner stone to reducing diffuse nutrient losses. The Agricultural Catchments Programme have greatly improved the science behind water quality and have developed a new critical source area tool for highlighting areas for farmers to address on their farms. The Agricultural Support and Advisory service provides free advice to farmers on appropriate technologies in areas with poor water quality. New technologies have been developed to reduce nutrient and sediment loss to water from farm roadways.

### Biodiversity

The EU biodiversity strategy aims to have at least 10% of agriculture area under high-diversity landscape features by 2027. There are declines in the area of semi-natural habitat, important farmland birds and pollinators. A recent survey of intensively managed farms found that the median wildlife habitat area was 5% (tillage), 6% (intensive beef) and 6.6% (intensive dairying). There are many ways that farmers can actively improve habitats and wildlife on their farms to achieve the 10% target, including a range of technologies from multi-species swards, hedgerow management, field margins and result-based payments for biodiversity. Research of tomorrow is also investigating approaches to quantifying farmland habitats and management plans.

### Summary

There are a large number of proven technologies available to improve environmental sustainability on farms. These are on display through out the open day and have advisers to support farmers on how to adopt these on their farms. Future research is investigating newer technologies to help farmers further improve sustainability. Many of the technologies have multiple benefits and also improve farm profitability. Please identify the technologies that will work on your farm and you could implement over the next year.

## Other resources & online information

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# Technologies for Today and Tomorrow to Reduce Greenhouse Gas and Ammonia Emissions

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## Introduction

Agriculture has been set a challenging sectoral target of reducing greenhouse gas (GHG) emissions by 25% or 5.75 Mt $CO_2$e by 2030. Abatement measures that reduce GHG emissions associated with agriculture, land-use and bioenergy were previously assessed in Teagasc's 2018 Marginal Abatement Cost Curve (MACC). In light of the new targets, this analysis is being revisited and extended to include extra measures currently under research. The ammonia targets also pose considerable challenges, with reductions in emissions from the current 120 kT $NH_3$ to 112 kT $NH_3$ needed by 2030, and further reductions to 107.5 kT $NH_3$ required post 2030. Many of the technologies will reduce both greenhouse gas and ammonia emissions.

In order to reduce on-farm emissions, there are four steps that can be taken.

## Step 1: Reduce Nitrogen (fertiliser and manure) emissions

Nitrous oxide emissions ($N_2O$) have increased by 6% since 1990 but are relatively static compared to 2018. Mineral fertiliser application is the principal source (37%) of $N_2O$ emissions as well as being a key input cost for farmers. In addition urea fertiliser accounts for 12% of ammonia ($NH_3$) emissions that can be readily reduced. Reducing fertiliser use can both reduce GHG and $NH_3$ emissions and improve margins. The main fertiliser reduction strategies are:

1. *Get soil fertility correct*. Moving from pH 5.5 to 6.3 can release between 50 – 70 kg N $ha^{-1}$ per year as well as reducing $N_2O$) emissions per kg N applied.
2. *Use legumes (clover) or multi-species swards*. Clover can fix between 80 – 120 kg N $ha^{-1}$ per year depending on underlying soil fertility and sward management. Multi-species swards also offer extra benefits in terms of drought resistance and cow health. However, care must be taken to ensure adequate dietary roughage (hay or straw) in order to avoid bloat.
1. *Apply slurry using LESS*. Slurry nitrogen fertiliser replacement value can be increased (and ammonia emissions reduced) by between 25% - 50% by using trailing hose (dribble bar) or trailing shoe technology.

   **However, for these measures to work, N fertiliser application must be decreased by the amount of N that each measure saves, otherwise there is little or no GHG saving.**

   If mineral fertiliser must be applied, then switching from either CAN and straight urea to protected urea will directly reduce both GHG and $NH_3$ emissions. New research on low emission compound fertilisers has found that $N_2O$ emissions could be reduced around 40%.

### Step 2: Reduce Enteric and Manure methane and $NH_3$

Methane comprises the majority (70%) of agricultural GHG emissions, which is split between methane from enteric fermentation (87%) and manure methane (13%). While manure methane is the smaller source, it is the easier source to reduce emissions.

1. *Acidification* with hydrochloric acid or ferric/aluminium chlorides to pH < 6 has been shown to reduce both methane and $NH_3$ by 86% and 98%. Ongoing research is quantifying $N_2O$), $NH_3$ and $CH_4$ emissions from landspreading of acidified manure to refine the national inventory. New research is investigating the efficacy of a range of manure additives and acidifying compounds on reducing emissions.
2. *Lower cost alternatives*, such as dairy washings or grass silage effluent (at a 7% inclusion rate) has shown a 50-60% reduction in methane, although reductions in ammonia emissions were much lower (Kavanagh et al. 2021).
3. *Covering external stores.* This measure reduces $NH_3$ emissions by between 40% for floating covers, 60% for flexible covers and 80% for tight lid covers. It can also reduce methane if it is subsequently flared.
4. *Aeration* can also reduce methane by up to 50%. However, $NH_3$ emissions can be significantly increased depending on the aeration system being used.

In terms of reducing enteric methane, ongoing research for tomorrow's technologies is showing that:

1. *Higher Economic Breeding Index* (EBI). Increasing genetic merit via EBI reduces GHG emissions per unit of product by 2% for every 10 euro increase in EBI. There are also some indications that higher EBI cows may have lower associated methane yields.
2. *Feed additives can reduce methane.* Several research trials are currently being conducted into the use of feed additives in bovine and sheep diets. Current data shows that bovines fed 3-NOP as part of a TMR diet exhibit a 30% reduction in methane emissions, while grazing dairy cows fed 3-NOP twice daily (during milking) are exhibiting an 8% reduction. The introduction of seaweed extracts and other products is also being investigated.
3. *Reducing finishing times*. The inventory is being updated and linked to ICBF data to allow a more dynamic counting of animal numbers than relying on June and December numbers. This will allow the benefits of early slaughter in the last decade to be accounted for. As animals are slaughtered earlier, the total amount of methane produced on an annual basis is reduced and could account for up to 0.8 $MtCO_2e\ yr^{-1}$.
4. *Increasing time at pasture* (i.e. reducing the housing period) can also reduce enteric methane as results are showing that the methane emission factor during grazing is reduced from 6.5% to 5.75% of gross energy intake.

### Step 3: Enhance Carbon sequestration and reduce peat emissions

Land–use is currently a source of GHG emissions, but has been excluded from the sectoral targets for 18 months pending a land-use strategy review. However, several measures can assist farmers to lower their total on-farm emissions by enhancing C sequestration or reducing emissions from any peaty soils on their farms.

a. *Afforestation and forestry management*. One hectare of forest sequesters about 7 $tCO_2e$ $yr^{-1}$. Increased afforestation, decreased deforestation and forest management (such as continuous cover) can all contribute to larger carbon removals. While afforestation will contribute little to 2030 targets, (with a linear increase in afforestation to 8,000 ha or 16,000 ha by contributing only 0.2 and 0.23 $MtCO_2e$ $yr^{-1}$), increased rates are crucial for achieving Net Climate Neutrality by 2050. In the short term, forest management, such as reduced forest thinning or delaying clearfell until mean maximum annual increment has been achieved, will achieve larger sequestration rates. New research is beginning on the benefits of agro-forestry where forestry is coupled with grazed grassland strips.

b. *Cropland/Grassland management*. Improved cropland and grassland management can also sequester additional carbon. In the case of croplands, which have low soil carbon levels, this is achieved by increasing inputs of organic matter (from straw, manure or winter green cover). In the case of grasslands, it is achieved by improved fertiliser, lime and grazing management. New research is underway to quantify C sequestration on mineral soils emissions from a range of land-uses and farm management practices.

c. *Hedgerows*. Hedgerows can sequester C in both above/below ground biomass and via increased soil organic carbon. Current estimates have indicated that hawthorn-dominated hedgerows sequester between circa 3.7 t C $ha^{-1}$ $yr^{-1}$, while allowing hedgerows to grow out 1m either side and upward increases sequestration by 1 – 2 t C $ha^{-1}$ $yr^{-1}$ . Planting 20,000km of new hedgerows and increasing height and/or width of 50,000km by 1m could increase sequestration by circa 0.26 $MtCO_2e$ $yr^{-1}$.

d. *Peat soil management*. Altering the water level of organic (peat) soils that have been drained comprises a large emissions saving (0.8Mt $CO_2e$ $yr^{-1}$ for 40,000ha). Unlike forestry, this reduces $CO_2$ emissions that are currently occurring rather than sequestering more C (although this will also occur, but very slowly). Drained peatlands represent a strong $CO_2$ source (circa 20 $tCO_2$ per annum) and account for a national $CO_2$ emission source of 9 million tonnes $CO_2$. New research is refining emissions from peatlands and quantifying the benefits of changing water table height.

e. New research is underway to develop a Teagasc carbon farming decision support tool to assist farmers with reducing emissions and potentially monetising emission reductions and increasing carbon sinks.

### Step 4: Improve energy efficiency and displace fossil fuel

Farms can also reduce emissions by improving on-farm energy efficiency, while they can also contribute to wider energy decarbonisation via the use of biomass for heat substitution or solar PV/biogas/biomethane for electricity or gas power substitution.

*Energy efficiency & Solar PV:* These measures include plate coolers to pre-cool milk, variable speed drives (VSD) on vacuum pumps, solar photovoltaics (PV) and heat recovery systems (additional to pre-cooling). All measures either reduce energy consumption or in the case of solar PV, generate energy. Cumulative GHG emissions reductions during the whole lifetime of each measure were 76.3, 25.5, 17.05 and 57.2 $tCO_2e$ per unit for plate coolers, VSD, heat recovery and solar PV, respectively.

*Wood thinnings/woodchip*. Wood biomass is made up of harvested fuel-wood and sawmill residues for electricity and heat generation and waste wood for heat production. Biomass energy

value of 2.5 MWh per tonne assuming a moisture content of 30%. This can deliver a fossil fuel displacement of 0.7 – 0.8 $MtCO_2e$ from 2022- 2030.

*Biomass/biomethane.* Anaerobic digestion of biomass produced from Irish agriculture (i.e. grass-fed biomass) would produce biogas (55% methane) that could be used directly for heat and electricity generation. In addition, the biogas can be processed to the same standard as natural gas (bio-methane), and injected into the natural gas grid and subsequently used for a range of commercial purposes. Gas Networks Ireland has a target of 1.6 TWh/yr of biomethane production by 2030 which would displace 0.4 Mt $CO_2e\ yr^{-1}$. Research is currently looking at further optimising the AD process for grass and alternative forage feedstocks to improve biogas yields. In addition research is refining the GHG and $NH_3$ emission factors associated with the land-spreading of digestate on soil as a fertiliser replacement.

## Other resources & online information

**Email:** gary.lanigan@teagasc.ie

**Teagasc Website:** https://www.teagasc.ie/media/website/publications/2018/An-Analysis-of-Abatement-Potential-of-Greenhouse-Gas-Emissions-in-Irish-Agriculture-2021-2030.pdf

https://www.teagasc.ie/media/website/publications/2020/$NH_3$-Ammonia-MACC.pdf

# Key Metrics for Efficient Pasture-based Production Systems

Joe Patton[1], Pearse Kelly[2] and David Wall[3]

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## Introduction

Conversion of human-indigestible forage to high quality utilisable protein is the key contribution of ruminant production systems to global human food production. International environmental policy and evolving consumer preferences are placing additional demands on livestock systems. The principal challenges include reducing gaseous emissions and nutrient loss to the environment, minimizing dependency on human-edible feeds, promoting biodiversity, and enhancing animal health and welfare. These sustainability challenges must be met against a backdrop of often low and variable economic margins generated by primary agricultural production. Efficient pasture-based systems, augmented by new and emerging technologies, have the capacity to provide solutions.

## Livestock systems research

The research farm at Johnstown Castle hosts a wide range of pasture-based experimental systems, from autumn and spring-calving dairy herds operating different feed systems, to a range of calf-to-beef models operating at different levels of intensity. Across all systems however, increasing pasture utilised (expressed as tonnes dry matter (DM) per hectare) is a key performance indicator. Numerous analyses have shown that this is the physical performance metric most closely aligned with net farm margins.

## Maximising pasture utilisation

Sward productivity, animal performance and imported feed affect the levels of pasture utilisation achieved on farms. Pasture utilised increases where high animal performance is achieved for lower supplementary feed input, at a stocking rate that is appropriate for annual pasture growth rates. The target is to utilise 10 to 12 tonnes DM per ha for beef and dairy systems while achieving a high level of self-sufficiency for feed energy and protein. The objective of increasing pasture utilisation must be balanced with achieving improved N-use efficiency and reduced N surpluses within each system. Central to this objective is to limit N imports (as inorganic N fertilizer and feed crude protein), while maintaining or increasing productive N offtakes (milk and carcass protein). Clover incorporation into grassland swards and reduced chemical N, low emission slurry spreading, lower crude protein feeds, and optimizing stocking rates, are key management practices.

### Low carbon emission production systems

Addressing carbon emissions from dairy and beef systems is a key priority for the Teagasc research and knowledge transfer programmes, both in terms of improving efficiency per unit product, and mitigating sectoral totals. Management options that are compatible with efficient pasture-based systems include use of NBPT-protected urea instead of CAN fertilizer, earlier age at slaughter, altering sward composition, and selection for robust animal genotypes (EBI). Work on the methane abatement potential of specific dietary additives has shown promise, however, a significant consideration will be the method of supplement delivery in a pasture-feeding context.

## Other resources & online information

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# Supporting Sustainability on the Ground

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## Introduction

Sustainable agriculture can be defined in many ways, but ultimately it seeks to produce food and other outputs, sustain farmers, resources and communities by promoting farming practices and methods that are profitable, environmentally sound and good for communities. Over the last number of years the imperative for farm sustainability improvement has become clear – agriculture needs to reduce its negative impacts on the environment and it needs to begin to deliver positive environmental goods and outputs for society. This is the challenge for all Irish farmers. Some farmers may decide to take on fundamental shifts in their production systems, for example planting a significant area of forestry or changing the management of peat soils and this will have very significant environmental outcomes. However, for the vast majority of farmers achieving the targets that have been set for the industry will be done through incrementally implementing a series of changes on an ongoing basis over the next number of years. Success will depend on implementation across all farms and failure will undoubtedly lead to the implementation of restrictive policies for all farmers

## Why do farmers need to focus on sustainability?

- Firstly it is "The right thing to do"
- Environmental trends are heading in the right direction
- Policy is increasingly focussing on outcomes
- Policy will become more restrictive if outcomes don't improve
- Consumers and the market demands and will pay more for sustainable produce
- For the "team" – all farmers in this together
- €€€ - financial benefit
- Farmers role as proud custodians of the landscape
- Irish farmers can be world leaders

## What sustainability metrics should farmers be looking at?

- Water – river quality of local watercourses (see Maps at catchments.ie)
- N/P balances, N/P use efficiency
- Biodiversity - % of farm allocated to nature (commercial farms), quality of habitats, BMPI (https://www.teagasc.ie/media/website/environment/biodiversity-countryside/Teagasc-Biodiversity-Management-Practice-Assessment-Tool.pdf) participation and scoring in result-based approaches
- GHG – total farm GHGs, GHGs per kg of product, range of farm practices
- Social sustainability – Work/life balance, viability of rural communities
- Economic sustainability – productivity, profitability
- Refer to Teagasc Annual Sustainability Report
- Benchmarking may not always be possible at farm level – a farmer may have to refer to regional/national statistics

## Four steps to improving your farm's sustainability performance

Teagasc recommends a range of "good farming practices" that will enable farmers and growers to reduce gaseous emissions, protect and improve water quality, restore and enhance biodiversity, while also contributing to farm profitability. It is important that each individual farmer understands their farm's sustainability metrics (or numbers), what contributes to those numbers and the opportunities to improve them over time.

1. *Know your farm's sustainability numbers.*
   The starting point for any farmer on the journey to becoming more sustainable is to establish their farm's numbers or current performance. In the past this would have referred to as production-related indicators e.g. yield per cow, average daily gain, kg of beef sold per hectare or profitability related indicators e.g. gross margin per hectare or net profit. But increasingly, farmers will have to understand new indicators, including GHG emissions, ammonia emissions, nutrient balance, nutrient use efficiency, biodiversity score etc. Some of the metrics may depend on more collective action such as river, lake and groundwater quality, the quality of habitats such as uplands and the survival of threatened species. Such indicators are now being made available to farmers through a range of sources.

2. *Identify opportunities to improve your farm's sustainability numbers.*
   There are many opportunities to reduce greenhouse gas emissions, capture carbon, reduce nutrient losses, improve water quality and enhance biodiversity; the potential will depend on the type of farming and your current practices. No two farms are exactly the same; so it follows that the solution will be different for each farm. Technologies and practices which can lead to improved sustainability are listed in the table below. Take the Signpost Sustainability Self-Assessment to identify the opportunities for your farm.

   - Protected urea
   - Lime
   - Correction of soil P and K deficiencies
   - LESS slurry equipment
   - Timing of slurry application
   - Reduced fertiliser N application rates
   - Better grassland management/use of PastureBase
   - Clover
   - Adequate slurry storage
   - Improved herd health
   - Breeding better/ more efficient animals (EBI/ DBI/ CBV/ 4 & 5 star sires)
   - Optimum replacement rate
   - Field margins
   - Buffer strips
   - Side trimming of escaped hedges
   - Retention or planting thorn saplings/ flowering trees

3. *Implement your chosen actions.*
   Teagasc recommends that farmers identify and implement the priority actions on their farm. There are possibly many actions which you could take, but your initial focus should be on those actions which are most suited to your farm and which can have the greatest impact. For example, in terms of reducing GHG emissions, Teagasc has estimated that for intensive grassland farms, switching to protected urea as your source of N fertiliser can have the greatest impact.

4. *Keep records, monitor and review.*
   Record keeping is essential to inform future decision-making, and to allow for the calculation of farm sustainability metrics over time.

## Teagasc supporting farmers to improve sustainability

1. *Signpost Programme*
   The Signpost Programme is a Teagasc-led, whole of industry partnership to support and enable farmers in climate action. While the focus of the programme is to support farmers in reducing greenhouse gas (GHG) emissions, it will also help with advice regarding improving water quality and enhancing biodiversity on Irish farms. Programme partners include farmers, agri-food industry organisations, state organisations, farm organisations and media. You can find out more about the Signpost Programme at www.teagasc.ie/signpost.

   **There are three main pillars to the Signpost Programme.**
   1. Signpost Farms - a network of almost 120 demonstration farms has been established and this network will play two critical roles: (1) be amongst the first to adopt climate mitigation technologies; (2) share their experiences with other farmers through farm walks, events, articles, videos, media etc.

   2. Signpost Advisory campaign – Teagasc proposes to establish a new, targeted advisory service focussed on climate action and sustainability. This new service will provide training opportunities (to enhance farmer knowledge and skills and facilitate farmer-to-farmer learning) and targeted follow-up one-to-one support to farmers, leading to the creation of farm specific action plans. This will augment current advisory activities and will be provided free-of-charge to all participating farmers. Teagasc expects to launch this new service before the end of 2022.

   3. National Agricultural Soil Carbon Observatory (NASCO) – this new on-farm research project aims to deepen the understanding of soil carbon sequestration. The Signpost Farms form an integral part of this Observatory. Agronomic soil samples (to 10cm) have already been taken on the Signpost Farms to establish baseline soil carbon levels, and plans are in place for more detailed soil sampling (to 1m depth). In addition, flux data from long-term eddy covariance towers will provide detailed information on carbon exchange at an ecosystem level; these towers will be located on a subset of the Signpost Farms.

2. *Agricultural Sustainability Support and Advisory Programme (ASSAP)*
   The Agricultural Sustainability, Support and Advisory Programme (ASSAP) was established in a collaborative process between the state and the dairy processing co-ops, to provide an evidence-based approach to reducing agricultural pressures on water quality. The programme, working with the Local Authorities Water Programme (LAWPRO) offers farmer focused advice in 190 priority areas for action (PAAs) and is a critical, integral and parallel part of this collaborative process. The ASSAP programme enables landowners to engage positively in seeking solutions to local problems with the support of a confidential sustainability advisory service focused on water quality improvement. Support from the farming organisations for the programme has been very strong and this is vital in communicating and informing farmers about the ASSAP programme and its key messages.

3. *Agri-environment Scheme Support (ACRES) and Sustainable fertiliser planning*
   Autumn 2022 will see the introduction of a new Agri-environmental scheme; called ACRES. There are two main components to the scheme

   - In eight areas the scheme will operate predominantly as a results-based scheme in high nature value landscapes

- In the rest of the country the scheme will be similar in approach to GLAS with priority access based on priority environmental assets, an element of results-based approach mixed with a range of action-based measures.
  The scheme has set higher targets for outcomes than previous schemes and will incorporate the development of a sustainability plan for each farmer. Teagasc advisers will support clients in the application and implementation of the scheme and in particular in ensuring that the scheme contributes to the achievement of key environmental targets
  Teagasc advisers will also support farmers in meeting the requirements of the new direct payments scheme (BISS) in relation to increasing requirements for cross compliance and for the Eco Schemes.

4. *Discussion groups*
   Discussion groups are increasingly focussed on all elements of sustainability, including profitability, environmental sustainability and social sustainability. Discussion group members gain new skills and expertise in a friendly and open environment, learn from the experiences of other farmers and are supported in trying out new ideas. Teagasc research has identified higher rates of practice adoption and higher farm profit as benefits of group membership. Contact your Teagasc Adviser about joining a group (if you are not a member) or ensure that your group focuses on the sustainability challenge (where you are already a member).

## Summary

In summary, Ireland has a strong international reputation as a supplier of sustainably produced food and drink. However, the Irish agri-food industry, including farmers, is challenged to become even more sustainable over the coming decade. This will require an even greater focus by farmers on caring for the environment and making space for nature, while continuing to produce high quality food and drink. While each farmer will have to identify and implement the best solution for their farm business, a range of possible solutions are known. The Teagasc Advisory Service is ready to help farmers develop tailored solutions for their farm.

And finally, while change is difficult, it is possible. Irish farming has shown previously that it is capable of change. Let's all work together to make the necessary changes. Let's start today.

## Other resources & online information

**Email:** tom.odwyer@teagasc.ie; pat.murphy@teagasc.ie

# Grassland Village

## FARMING FOR A BETTER FUTURE

# LIFE - CARBON FARMING

## What is Carbon Farming?

- New type of farming focused on mitigating climate change
  - Reduce and sequester carbon emissions at farm-level
  - 40 projects - 700 farms in 6 countries

## Carbon Farming Project (CFP)

*Establish baseline*

**Carbon Audit**

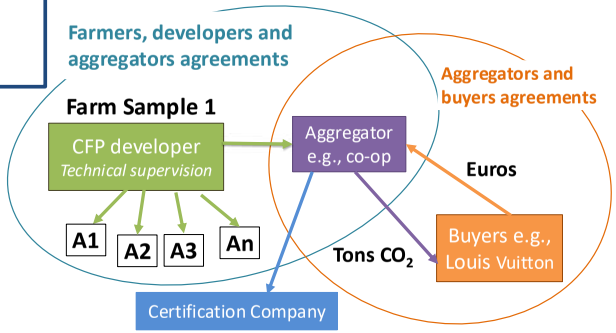
CAP'2ER

*Carbon Action Plan*

Improve farm practices +New tech

Generate Carbon Credits

## Carbon Farming Business Model




## Take home messages

- **Measuring, reporting and verifying carbon reduction key to accessing climate finance**
- **Extra revenue stream worth €6-12k/farm**

# LIFE Carbon Farming: Establishing a Result-based Funding Mechanism to Support Carbon Reductions and Removals in Mixed Crop-livestock Farms

Donal O'Brien[1]; Laurence Shalloo[2]

[1]Teagasc, Johnstown Castle; [2]Teagasc, Moorepark

**Summary:**

- Carbon farming is a new form of agriculture that focuses on increasing carbon capture, i.e. sequestration, and reducing greenhouse gas emissions at farm-level, with the goal of mitigating climate change.
- Many livestock farms can contribute to national and global efforts to curb climate change by 1) adopting proven loss emission technologies, 2) building carbon stocks in soils and vegetation and 3) improving technical efficiency, e.g., increasing the genetic merit of bovines, reducing the delay in age at first calving, reaching slaughter weight earlier etc.
- LIFE Carbon Farming aims to overcome major barriers to the adoption of low carbon practices and technologies in the livestock sector by developing a result-based funding mechanism.
- The European project team aim to create a harmonised process to measure, report and verify emission reductions and removal on farm that can be used to support the sale of carbon credits in private or public markets.
- Currently, 20 carbon-farming projects are being established throughout Ireland, France, Belgium, Germany, Italy and Spain. Actions to mitigate carbon emissions will be implemented on 700 farms, 20-40 of which will be located in Ireland.
- The cost of mitigation actions will be assessed by participants. Project developers will work with aggregators, e.g., agricultural co-operatives to sell verified emission reductions and removals to carbon buyers. Over the course of the project, participants expect to avoid 700,000 tons of $CO_2$ and earn €6.3 million, corresponding to a carbon revenue of €6,000-€12,000 per farm.

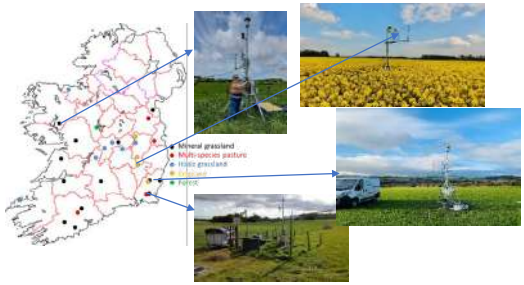
## Other resources & online information

**Twitter:** @LCarbonFarming

**Teagasc Website:** https://www.teagasc.ie/environment/climate-change--air-quality/research/life-carbon-farming/

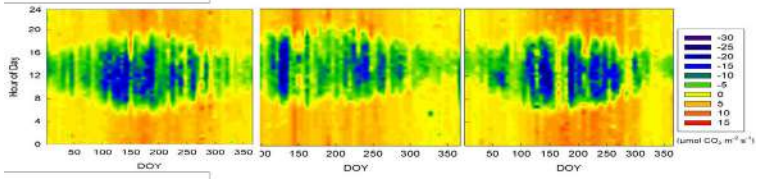
**Email:** donal.mobrien@teagasc.ie

# NASCO – A National Agricultural Soil Carbon Observatory for Ireland




- Peat soils are considered to emit 20 tC per ha per year while grassland on mineral soils are assumed to sequester 0.5 tC per ha per year.
- National values for the impact of management on Carbon emissions and removals from peat and mineral soils are urgently needed.
- The National Agricultural Soil Carbon Observatory is establishing 30 $CO_2$ flux monitoring towers across the country *(see map)* – these measure field scale $CO_2$ uptake and release 10 times per second all year round.
- Soil organic carbon is also measured every 5 years to 1 metre. Soil carbon is also being monitored on the 100+ Signpost Farms.
- The grassland at Johnstown Castle has been sequestering, on average, 3.8 $tCO_2e$ per hectare per year over the past 18 years.

**$CO_2$ Flux measurements at Johnstown Castle**



# NASCO – A National Agricultural Soil Carbon Observatory for Ireland

Gary J. Lanigan, James Rambaud, Macdara O'Neill, Syed Islam, Jack Bishop, Rachael Murphy, Karl G. Richards

Teagasc, Johnstown Castle, Co. Wexford.

**Summary:**

Currently Ireland uses generic values for the amount of carbon sequestered in mineral grassland soils (0.5 $tCO_2$ per hectare per year) and for carbon emitted from peat soils (circa 20 $tCO_2$ per hectare per year). Changes in soil organic carbon (SOC) occur over decades. There is an urgent need to refine the rates of $CO_2$ uptake and release from different agricultural systems for two reasons:

1) Under the National Climate Action Bill, the land-use and forestry sector must reduce emissions by 38%-57% by 2030

2) In order for farmers to gain 'credit' under any Carbon Farming scheme, measured, reported and verified national-specific rates of sequestration or emissions are needed.

The National Agricultural Soil Carbon Observatory, in conjunction with both the Signpost Farm Programme and Agricultural Catchments Programme, will seek to use soil carbon measurements in conjunction with $CO_2$ flux towers and satellite data. This data will be used to verify carbon models which can be used in both inventories and farm calculators. The overall aim of NASCO is as follows:

- Produce verifiable gross C sequestration rates for the grassland and tillage based on soil type and climate that can be utilised in farm C footprinting calculators. Produce Irish-specific $CO_2$ emission factors for histosols and devise alternative uses for re-wetted soils. Produce Irish-specific land management C sequestration factors across the main mineral and organo-mineral soils that are verifiable and can be inputted into national inventories.
- QUANTIFY and VERIFY the impact of farm practices on soil carbon. Use these data to develop strategies that incentivise C sequestration and monetarise the long term curation soil C stocks, such as Carbon Farming, so ensuring that farmers can gain added value for good soil husbandry. Generate robust remote sensing proxies for SOC change. Inform a Land-Use decision support tool that aids in the development of a national Land-Use Strategy.

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/environment/climate-change--air-quality/soil-carbon/

**Email:** gary.lanigan@teagasc.ie

# Agriculture on peat soils

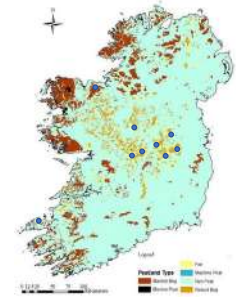


Figure 1. Map of peat soils in Ireland. Circles indicate flux tower sites

Figure 2. Water table manipulation experiment

## The Issue

- There is between 320,000 and 450,000 ha of managed grassland (and some cropland) on peat soils
- National inventories using generic Tier 1 emission factors (Table 1) calculate emissions circa. 9 million tonnes $CO_2e$ per yr This emission is due to drainage lowering the water table and increasing decomposition.

## The Research Questions

- How much farmland is under these soils and what is drainage status?
- How much $CO_2$ are grasslands on different peatland types (fen, raised, blanket bog) emitting?
- What is the impact of nutrient management and water table depth on $CO_2$ and $CH_4$?

## The Approach

- ✓ Using a combination of flux towers and plot scale (lysimeters) to quantify the impact of peatland type on $CO_2e$ emissions.
- ✓ Use this data to validate mathematical models that will predict emissions and the impact of mitigation strategies.

Figure 3. Flux tower at Letterunshin Co. Sligo

Table 1. Tier 1 emission factors for agricultural peatland

| Land use | Emission when Drained | Emission when Re-Wet | Change in Emission |
|---|---|---|---|
| | *Tonnes $CO_2e$ $ha^{-1}*yr^{-1}$* | | |
| Cropland, nutrient poor | 37.6 | 3.1 | 34.5 |
| Cropland, nutrient rich | 37.6 | 9.9 | 27.7 |
| Grassland, nutrient poor Sallow-drained | 23.3 | 3.1 | 20.2 |
| Grassland, nutrient poor Deep-drained | 24.1 | 3.1 | 21.0 |
| Grassland, nutrient rich Shallow-drained | 16.7 | 9.9 | 6.8 |
| Grassland, nutrient rich Deep-drained | 29.2 | 9.9 | 19.3 |

# Agriculture on Peat Soils

Gary J. Lanigan[1], Karl Richards[1], Pat Tuohy[2], James Rambaud[1], Marine Valmier[3], Florence Renou-Wilson[4], Matt Saunders[3], David Wall[1], Owen Fenton[3].

[1]Teagasc, Crops, Environment, and Land-use Research, Johnstown Castle; [2]Teagasc, Moorepark Animal & Grassland Research and Innovation Centre, Fermoy; [3]Trinity College Dublin; [4]University College Dublin

**Summary:**

Ireland has a large amount of grassland on peat soils. While there is some uncertainty as to the total area, it is currently estimated at 350,000 – 420,000 ha. These soils hold tremendous amounts of carbon, with stocks estimated at between 500 and 2000 tC per hectare compared to c. 60-200 tC per hectare on mineral soils. In total, there is over 1 billion tonnes of carbon held in Irish peatland soils. However, when these soils are drained for grassland and cropland use, decomposition is greatly accelerated, resulting in high emissions. Indeed, agricultural land on peat soils is considered to be an emission source of 9 Mt $CO_2$e per annum. The vast bulk of this land was field ditch-drained in the 19th and early 20th century, with more active drainage occurring on 70,000-80,000 ha post 1950. The impact of this drainage on water table height is highly uncertain due to a) the state of the drainage and b) the limited effectiveness of ditch drains to lower the water table across a whole field. As a result, legacy emissions are highly uncertain and likely to be overestimated.

Currently Ireland uses generic (Tier 1) values for the amount of carbon emitted from peat soils. The net value is, on average 20t$CO_2$e $ha^{-1}$ but ranges from 16.8 to 37.6 t$CO_2$e $ha^{-1}$ compared to 2.2 to 8.6 t$CO_2$e $ha^{-1}$ from tillage and dairy farms. Research in Teagasc, in association with university partners is focussed on the following key questions:

- How much $CO_2$ and methane is emitted from grassland and cropland on peat soil?
- Are there emissions differences between fen, raised bog and blanket bog grassland?
- What is the impact of raising the water table and how high does it need to be raised?
- What (if any) are the impacts of fertilisation and nutrient management in general?

In order to address these key questions, a number of research projects are ongoing, based around the National Agricultural Soil Carbon Observatory flux towers as well as plot scale experiments to investigate management impacts.

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/environment/climate-change--air-quality/soil-carbon/

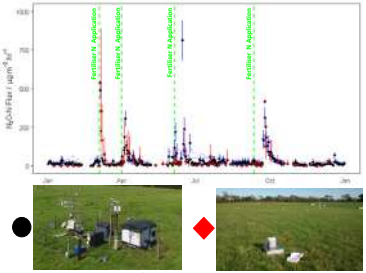
**Email:** gary.lanigan@teagasc.ie

# Sources of Nitrous Oxide ($N_2O$) Emissions from managed grasslands

## Why is measuring GHG emissions important?

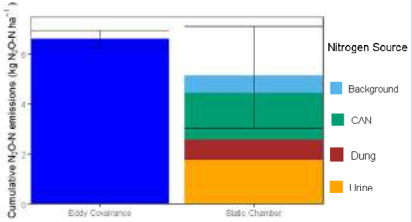
- Measuring GHG emissions can identify low emission practices.
- Quantifying $N_2O$ emissions from grasslands is difficult as these emissions are highly variable over time *(season)* and space *(soil)*.
- Need a robust method for quantifying $N_2O$ with low uncertainty.

### FERTILIZER




- High $N_2O$ fluxes measured by eddy covariance (EC) but not by the static chamber (SC) technique. High frequency & scale of EC measurement compared to SC over small area.

### GRAZING & FERTILIZER




- The EC technique can't tell which source of nitrogen the $N_2O$ emissions are from. The SC technique can disaggregate emission sources
- Approximately 80% of total $N_2O$ emissions were derived from animal excreta and CAN.

## How much $N_2O$ was emitted?

| N source within the grassland soil | Technique | Emissions Kg $N_2O$-N $ha^{-1}$ $yr^{-1}$ |
|---|---|---|
| Fertilizer | EC | 3.35 |
| | SC | 3.13 |
| Fertilizer + Grazing | EC | 6.62 |
| | SC | 5.09 |

$N_2O$ emissions from grazing and fertilizer were approximately twice as high compared to the fertilizer only treatment.

## Take home messages

- EC provides low uncertainty field scale $N_2O$ measurements, while SC can measure $N_2O$ fluxes from different nitrogen sources.
- The N in dung & urine and fertilizer N are important sources of $N_2O$ emissions.
- Combining these techniques can help to identify source specific GHG mitigation strategies for managed grasslands.

# Measuring Nitrous Oxide ($N_2O$) Emissions Using Eddy Covariance (EC) And Static Chambers (SC) From A Managed Grassland

Murphy, R.M.[1,2], Richards, K.G.[2], Krol, D.[2], Gebremichael, A[2], Lopez-Sangil, L.[2], Rambaud, J.[2] Cowan, N.[3] Lanigan G.J.[2] and Saunders, M.[1]

[1]Department of Botany, Trinity College Dublin, Dublin [2], Ireland; [2]Teagasc Johnstown Castle, Wexford, Ireland; [3]UK Centre for Ecology and Hydrology, Bush Estate, Penicuik, Midlothian, UK.

**Summary:**

- Nitrous oxide ($N_2O$) is a potent greenhouse gas with a global warming potential of 265 relative to that of $CO_2$ and with a lifespan of over 100 years.
- $N_2O$ has many abiotic and biotic drivers which vary both in time and space, and thus as a result measuring $N_2O$ from agricultural soils with low uncertainty is still very challenging.
- Static chambers are the most commonly used method to date for measuring soil derived $N_2O$ as the technique is cheap and easy to deploy. Measurements are typically made only once a day and over small areas (< 1 $m^2$) which results in large uncertainties associated with flux measurements.
- The eddy covariance technique has only recently been available for measuring field scale emissions of $N_2O$ through the development and deployment of fast response, high frequency gas analysers. This technique provides continuous measurements of $N_2O$ emissions, at high frequencies of 10 or 20 Hz (i.e. 10 or 20 measurements a second) and over large spatial domains of up to 1 $km^2$. However, within this 1 $km^2$, the eddy covariance technique cannot decipher if a given flux is from a particular nitrogen source i.e., a dung patch, a urine patch, a urine patch that has fertilizer applied to it, etc.
- When we use both methods in tandem, we can overcome their contrasting limitations and provide more insightful quantifications of $N_2O$ from managed pastures that can then be used to both develop more source specific mitigation strategies for $N_2O$ as well as refining the national inventory for $N_2O$ from different nitrogen pools.

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/environment/climate-change--air-quality/soil-carbon/

**Email:** rachael.murphy@teagasc.ie; gary.lanigan@teagasc.ie

https://www.sciencedirect.com/science/article/pii/S0167880921004291

https://www.sciencedirect.com/science/article/pii/S0168192321004299

# Gaseous Emissions Monitoring in the ACP

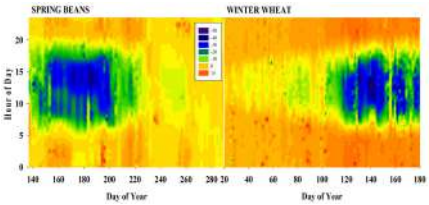
## Changes in soil organic carbon (SOC) over time?

- Establishing $CO_2$ flux monitoring towers to measure the rates of soil carbon sequestration according to soil type & land use

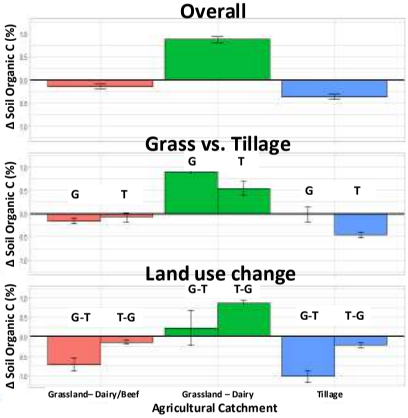
*Funding supported by DAFM (2020-2023)*

### Flux Tower Monitoring

$CO_2$ Flux in the area monitored over time




### SOC Trends over 10 Years




## Take home messages

- ✓ Flux towers monitor ***small*** changes in soil organic carbon quickly compared to soil sampling methods.
- ✓ **-0.14%** and **-0.37% losses** of SOC (0-10 cm) within the Grassland - Dairy/Beef & Tillage catchments, and a **0.87% gain** in SOC in Grassland - Dairy catchment.
- ✓ Potential for drystock systems to increase and/or maintain SOC via organic manure additions.
- ✓ Long term tillage and/or conversion to tillage from grass decreases SOC.

# Gaseous Emissions Monitoring in the Agricultural Catchments Programme

Macdara O'Neill; Syed Faiz-Ul Islam; Edward Burgess; Bridget Lynch

Teagasc, Johnstown Castle

**Summary:**

- Eddy covariance flux towers have been established at farms in the Agricultural Catchments Programme (ACP) to measure net carbon dioxide ($CO_2$) exchange for different land uses.
- Flux towers also consist of meteorological sensors (air/soil temperature, soil moisture, radiation, relative humidity) that provide information on the biophysical drivers of $CO_2$ exchange.
- The combined use of flux towers, soil sampling and field management (e.g. slurry, harvest) allows the rate of soil organic carbon (SOC) sequestration to be determined for each farming system.
- Actual rates of SOC sequestration will be compared with the modelled estimates (i.e., 0.5 t C $ha^{-1}$) for mineral grassland soils. Additionally, management, soil type and climatic effects on $CO_2$ fluxes can be investigated across the different catchments.
- Decadal trends in catchment-scale SOC concentrations (0-10 cm depth) at two grassland (Ballycanew and Timoleague) and one cropland (Castledockrell) catchment suggest:
  - The dairy catchment (Timoleague) is gaining SOC (+0.87%) possibly due to higher return of organic manures
  - Long-term tillage and or conversion of grassland to tillage is causing declines in SOC and Castledockrell (-0.37%; 60% tillage) at the Ballycanew (-0.14% 77% grassland)
- Although the topsoil is biologically active, further work is needed to quantify SOC stocks for the soil profile (1 metre)

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/environment/water-quality/agricultural-catchments/agricultural-catchments-week-2022/

**Email:** macdara.oneill@teagasc.ie; syedfaizul.islam@teagasc.ie

# Lowering the Carbon Footprint of Pasture Based Dairy Production

## Solohead Research Farm 2017-2021

| | Control | Clover + NBPT | Clover-Zero |
|---|---|---|---|
| Fertilizer N (kg/ha) | 280 | 96 | 0 |
| Fertilizer N Type | Urea & CAN | NBPT Urea | --- |
| Clover content (%) | 10 | 22 | 30 |
| Slurry Application | Splash plate | Trailing shoe | Trailing shoe |
| Herd EBI (€) | 165 | 165 | 195 |
| Pasture production (t DM/ha) | 15.7 | 15.2 | 15.1 |
| Milk solids (kg/cow) | 496 | 498 | 505 |
| Net Margin (€/ha) | 1483 | 1577 | 1719 |
| **Carbon Footprint (kg/L)** | **0.88** | **0.75** | **0.69** |

- Pasture production on 15 commercial dairy farms to 26 June 2022

| Sward type | Fertiliser N (kg ha) | Pasture (t DM ha) |
|---|---|---|
| Grass only | 111 | 5.95 |
| Grass-Clover | 75 | 5.91 |
| Grass-Clover | 0 | 6.18 |

**Take home messages**

Clover-based system

- Higher profit
- Lower Carbon Footprint

# Lowering the Carbon Footprint of Pasture-based Milk Production

James Humphreys, Daniel Barrett, Marion Sorley and Owen Cashman

Teagasc, Moorepark

**Summary:**

- Dairy farms account for approximately 20% of agricultural land use and approximately 15% of national greenhouse gas emissions.
- The objective was to investigate the potential to lower the carbon footprint of Irish pasture-based dairy production while maintaining productivity and profitability by implementing best practices which include:
  - Inclusion of clover to supply biologically fixed N instead of fertilizer N;
  - Low emission slurry spreading (LESS);
  - NBPT-protected urea as the sole source of fertilizer N;
  - High EBI dairy livestock.
- Relative to the high-input Control the two clover-based systems lowered GHG emissions per ha by 18% for Clover+NBPT and 23% for Clover-Zero.
- Relative to the national average carbon footprint for intensive dairy farms (1.18 kg $CO_2$e q/L) the Clover-Zero system had 40% lower emissions.
- The volume of milk sold was around 2.5% lower from the Clover systems compared with the Control.
- The Clover-based systems improved profitability compared with the Control.
- Similar results are being achieved on the 'Clover Focus Group' commercial dairy farms.
- Adoption of clover instead of fertilizer N, protected urea, where fertilizer N is applied, and low emissions slurry spreading along with higher EBI can substantially lower the carbon footprint of pasture-based milk production while improving profitability.

## Other resources & online information

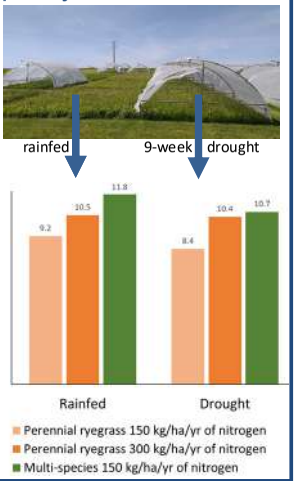
**Email:** james.humphreys@teagasc.ie

# Multi-species mixes – what are the benefits?

Research funded by EU, DAFM & DAERA

## Multi-species mixes – Yield, Fertiliser N, Resilience?

- Multiple tests of multi-species mixtures as a strategy for high yields, drought resistance and forage quality.
- Multi-species mixtures under drought were highest yielding – even compared to ryegrass with twice the level of nitrogen fertiliser.
- Mixtures had highest yield stability, lower nitrous oxide emissions intensity, & lowest weed biomass.
- New research: livestock systems, persistence, fertiliser replacement value; wider environmental benefits (water quality, carbon storage, biodiversity, soil fertility).




## Take home messages

- ✓ Multi-species: consistently higher yields from lower nitrogen fertiliser application
- ✓ Mixtures can mitigate the impact of drought & increase drought resilience
- ✓ Similar (or better) livestock performance on Lower-N Multi Species mixtures compared to Higher-N Grass-only.
- ✓ How low can we go with nitrogen inputs?

# Multi-species Mixes Increase Yield with Less Fertiliser, and Increase Drought Resilience

John Finn[1]; Guylain Grange[1, 2]; Caroline Brophy[2]

[1]Teagasc, Johnstown Castle; [2]Trinity College Dublin

**Summary:**

- Multiple research groups have been testing multi-species grassland mixtures as a strategy for high yields, drought resistance and forage quality. On experimental plots that are harvested, multi-species mixtures consistently deliver higher yields from lower nitrogen application Faced with pressures to reduce greenhouse gases and be more resilient to climate change, multi-species grassland mixtures offer an opportunity to increase sustainable production from intensively managed grasslands. Over the last 20 years, Johnstown Castle research has investigated the effects of mixing species and functional groups of grasses, legumes and herbs with the aim of improving grassland productivity, forage quality and environmental sustainability.
- Multi-species mixtures at 150 kg $ha^{-1}$ $yr^{-1}$ of nitrogen fertiliser under drought were highest yielding – even compared to perennial ryegrass with twice the level of nitrogen fertiliser (300 kg $ha^{-1}$ $yr^{-1}$).
- Multi-species mixtures had highest yield stability, lower emissions intensity of nitrous oxide (a potent greenhouse gas). They also had very low weed biomass – this is important, given that post-emergence herbicide cannot be applied to mixtures of grasses, legumes and herbs. If there is good establishment and no pre-existing weed problem (deal with this before sowing), then weeds are not a problem.
- New research is focusing on livestock performance (dairy, dairy calf to beef, and beef systems), grassland persistence, fertiliser replacement value. Preliminary results from Teagasc and other research show similar (or better) livestock performance on lower N mixtures compared to higher N grass-only swards.
- Although the agronomic performance of mixtures is important, they are likely to have higher performance across other environmental indicators. Teagasc research is also investigating the effects of mixtures on water quality, carbon sequestration, biodiversity and soil fertility within crop rotations.

## Other resources & online information

**Twitter:** @johnfinn310

**Teagasc Website:** www.teagasc.ie/environment/biodiversity--countryside/research/

**Farmland Ecology blog:** https://farmecol.blogspot.com/

**Email:** john.finn@teagasc.ie

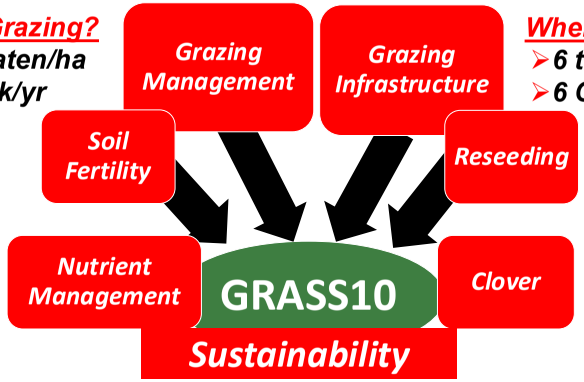
**New Multi4More project from July 2022, funded by DAFM and DAERA**

# Grass10

**To increase the amount grass eaten to 10 T DM/ha in a sustainable way & Achieve 10 Grazings per paddock per year**

**Where is Dairy Grazing?**
- 8 ton Grass DM Eaten/ha
- 7 Grazings per Pdk/yr

**Where is Drystock Grazing?**
- 6 ton Grass DM Eaten/ha
- 6 Grazings per Pdk/yr




**Objectives**
- Increase level of pasture measurement
- Incorporate clover into swards
- Improve nutrient management on farm


Scan QR code to register for weekly Grass10 E-Newsletter

Or visit www.teagasc.ie/grass10

# Grass10 Campaign: Focus of Phase 2 (2021-2024)

John Maher, Micheal O'Leary, John Douglas and Joseph Dunphy

Teagasc, Moorepark Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork

## Grass10 Phase 2 (2021-2024)

Given the success of the Grass10 campaign over the last five years it is critical to maintain this momentum. The Grass10 campaign is now in phase 2 and will continue to focus on increasing grass growth and utilisation of home grown feed on Irish grassland farms. The main focus of the campaign is to ensure the long term sustainability of Irish pasture-based dairy, beef and sheep production systems. The main opportunities to improve the sustainability of our grassland systems are outlined.

***1. Improving the level of grass measurement and management***

Currently, there are over 50 Grass10 grazing courses operating across the country and this model of improving the level of grassland management and measurement locally has worked well. The plan is to further develop this knowledge transfer model to increase farm level adoption of grassland measurement and management using PastureBase Ireland (www.pbi.ie). Every extra day the animal spends at grass reduces greenhouse gas (GHG) & ammonia emissions. Emissions are primarily reduced by animals feeding themselves and spreading their own slurry but also because the animal is eating a superior diet. GHG emissions are further reduced when the animal grazes the right stage of grass growth. Animals that enter the right sward (1300-1500kg DM/ha) will perform better and reduce GHG emissions by 15% compared to a slightly more mature sward (2000 kg DM/ha).

***2. White clover***

There is now an increasing demand to include white clover in grazed pastures due to its ability to biologically fix nitrogen making it available for grass growth and thereby potentially reducing inorganic nitrogen fertiliser use. There are challenges in establishing clover in swards at farm level. Some of the key developments planned in the Grass10 campaign will be to establish 20-25 Clover pilot farms and build a knowledge transfer programme around them, hosting clover workshops in Teagasc Research Centre Farms, and publication of a Clover Management Guide. There are weekly clover updates in the Grass10 Newsletter. Subscribe to the Grass10 newsletter at www.teagasc.ie/grass10 for all grazing and clover tips.

***3. Nutrient management***

Grass requires a continuous and balanced soil nutrient supply to achieve its production potential. Many farms are capable of growing in excess of 12-14 tonnes DM/ha annually. This level of grass production requires reasonable quantities of nutrients such as Nitrogen (N), Phosphorous (P), Potassium (K) and Sulphur (S) supplied at the correct time. The return in grass production from correcting soil fertility is very high. Improving nutrient use efficiency has become a priority due to the ambitious targets to reduce fertiliser use, as outlined in the EU Farm to Fork Strategy (2030). PastureBase Ireland can facilitate the process of improving nutrient use efficiency, along with technologies such as protected urea and low emission slurry spreading (LESS).

Grass10 wishes to acknowledge the support of our industry stakeholders in the Grass10 Campaign.

# PastureBase Ireland (PBI)

## The Latest New Tools

1. Farm Mapping Tool
2. Nitrogen Monthly Planner
3. Nitrogen Use Efficiency/Surplus Calculator
4. Record the level of clover per paddock
5. Forecast & Actual Weather Data

## PastureBase Ireland Usage

| | 2021 | 2020 | 2019 | 2018 | 2017 |
|---|---|---|---|---|---|
| No. of Farms on PBI | 3,871 | 3,558 | 3,528 | 2,701 | 2,401 |
| Total No. of Covers | 79,020 | 66,903 | 52,217 | 35,117 | 33,864 |
| No. Covers per Farm | 20.4 | 18.8 | 14.8 | 13 | 14.1 |
| DM Production (t) | 13.0 | 13.4 | 13.6 | 11.0 | 14.3 |
| Events per paddocks | 7.9 | 8.0 | 8.6 | 7.5 | 7.9 |

## Checklist

- ✓ Measure Weekly
- ✓ Activate Milk Link
- ✓ Record Reseed Events
- ✓ Fertiliser Info Entered
- ✓ Link to Other Farmers

**Join PastureBase Today!**
support@pbi.ie
046-9200965
**Download the app with just a tap!**

## 'PBI Grass' – Offline App

## Take home messages

- More farmers using PBI
- Frequency of measurement has increased per farm
- All farms can grow and utilise more grass

# PastureBase Ireland – A Tool for Every Grassland Farmer

Micheál O'Leary, Anne Geoghegan and Michael O'Donovan

Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork

**Summary:**

- Over 1,000 dairy farms completed 30 farm covers or more in 2021
- Dairy farmers recording farm cover regularly on PBI have grown between 11.1 and 14.4 t DM/ha per year over the last eight years
- Over 100 drystock farms completed 20 farm covers or more in 2021
- Drystock farmers recording farm cover regularly on PBI have grown between 9.2 and 12.7 t DM/ha per year over the last eight years
- Farmers are encouraged start using PBI where there is an array of tools available to benefit their farm business.

PastureBase Ireland (PBI) is an internet-based grassland management programme for all grassland farmers. In operation since 2013, it has gained momentum in recent years due to the development work and offers farmers 'grassland decision support'. It also stores a vast quantity of grassland data from dairy, beef and sheep farmers in a central national database. PastureBase Ireland has an array of tools available in the programme including the grass wedge, spring and autumn rotation planners, feed budget, fertiliser/slurry applications and reseed records.

## Why are farmers using PBI?

The advantages for farmers in using PBI are:

1. Short term: after completing a farm cover the programme displays a grass wedge and calculates the average farm cover, cover per livestock unit, growth rate, etc. This helps farmers in making day-to-day decisions

2. Medium term: when a farmer records 25 – 30 farm covers during the year, PBI calculates the total quantity of grass grown in each paddock (paddock summary report). This gives the farmer the opportunity to investigate underperforming paddocks and helps initiate appropriate corrective action

3. Long term: after a few years using PBI, the farmer will be able to determine how much grass their farm grows in an 'average' year and set the stocking rate accordingly

## New Tools

The development of PBI is constant and over the last number of months there have been an array of new tools made available to farmers. These include; create a map of your farm, categorise your paddocks according to the clover content, share data with other farmers and Agri personal, download a live feed from your milk processor, connect to a local weather station for meteorological data for your farm and many more tools.

## Conclusion

PastureBase Ireland offers the medium for farms to improve grazing management through grassland measurement and better decision making. The application continues to increase and improve the range of tools available to farmers. PastureBase Ireland is available to all grassland farmers. If you wish to sign up or require more information please call our dedicated help centre on 046-9200965 or email support@pbi.ie.

# Soil Testing & Soil Fertility Levels

## 1. Soil Analysis

- Fertiliser Costs: 2 to 4 fold increase.
- Test soils to establish current soil fertility levels in each field.
- Nutrients identified: pH P, K, Mg & micro nut.
- Information for making fertiliser decisions.
- Cost € 1.25/ha

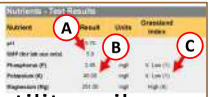
## 2. Taking Soil Samples

- ✓ Area per Soil sample 2 – 4 ha
- ✓ Use a suitable soil corer
- ✓ Sampling depth = top 10 cm of soil
- ✓ Take 20 cores/sample
- ✓ Wait 3 months after P & K applications
- ✓ Leave a gap of two years after lime is applied

**Soil Index, response to fertilisers and soil test range for P & K**

| Soil Index | Response to fertilisers | Fertiliser strategy | P (mg/L) Grassland | P (mg/L) Tillage | K (mg/L) |
|---|---|---|---|---|---|
| 1 | Definite | Build – up + M | 0 – 3.0 | 0 – 3.0 | 0 – 50 |
| 2 | Likely | Build – up + M | 3.1 – 5.0 | 3.1 – 6.0 | 51 – 100 |
| 3 | Unlikely | Maintenance (M) | 5.1 – 8.0 | 6.1 – 10.0 | 101 – 150 |
| 4 | None | None | >8.0 | >10.0 | >150 |

## 3. Acting on Soil Test Results




- Identify fields that require lime.
- Target organic manures to low fertility soils *(soils at Index 1 for P & K)*
- Replace nutrient P & K offtake on soils with good fertility *(soil at Index 3).*
- Ensure that demanding crops *(e.g. silage fields)* receive sufficient nutrient applications.
- Index 4 soils do not require additional fertiliser.

# Soil Testing and Soil Fertility Levels

Mark Plunkett, David Wall

Teagasc, Johnstown Castle

**Summary:**

- A standard soil test will provide major nutrient analysis such as soil pH, Lime Requirement, P & K for a cost of €1.23/ha/year
- Test soils regularly to establish / monitor soil fertility levels
- With current fertiliser costs, up-to-date soil analysis will be vital in making key fertiliser decisions and controlling costs
- For reliable soil test results ensure soil samples are taken at the correct time of the year and by a trained professional
- Take a soil sample every 2 to 4 ha
- Sample the top 10cm of soil
- Take a minimum of 20 soil cores
- Ensure 3 to 6 months between soil sampling and the last application of P or K
- Leave 2 years between liming and soil sampling
- Up-to-date soil test results are the first step to preparing a farm fertiliser plan
- The farm fertiliser plan will provide field specific advice to utilise all applied nutrients as efficiently as possible

## Other resources & online information

**Soil Sampling Factsheet -** https://www.teagasc.ie/crops/soil--soil-fertility/soils-nutrients-and-fertiliser-factsheets/

**Teagasc Website:** https://www.teagasc.ie/crops/soil--soil-fertility/

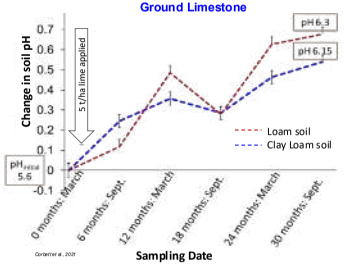
**Email:** mark.plunkett@teagasc.ie; david.wall@teagasc.ie

# Liming Agricultural Soils - achieving multiple benefits

## What is the acidity levels in your soils?

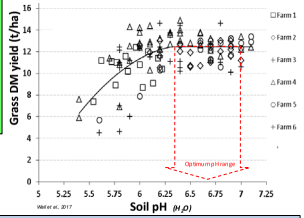
**Lime planning – The first step to good soil fertility!**
- Check lime recommendations as per soil tests
  *Target grassland pH: 6.3-8.8 mineral soils, 5.5-5.8 peat soils*
- Plan farm lime applications
  *What field, What lime type, What rate*
- Long-term investment – spread €ost over years

Fast & effective control of soil acidity with Ground Limestone



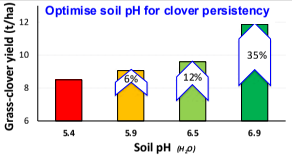

**Soil pH affects nutrient availability & plant roots**
- Soil P & K availability severely limited at pH < 6.0
- Increased soil N supply up to 80 kg/ha at pH >6.3
- Clover (legumes) very sensitive to soil acidity!

Correct soil pH to increase grass yield potential



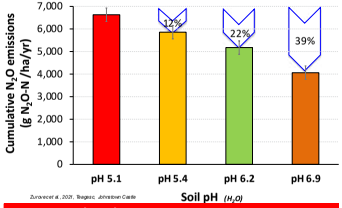

**Timing of Lime Applications**
Utilize all opportunities to lime!
- ✓ Once soils dry out and are trafficable
- ✓ After grazing out paddocks
- ✓ After silage harvest
- ✓ At reseeding time
- ✓ Late summer on heavy textured soils

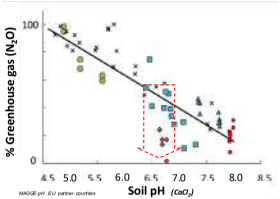
Optimise soil pH for clover persistency




**Optimal soil pH is important for all soil processes!**
- Reduces greenhouse gas emissions
- Improves nitrogen use efficiency
- European project (MAGGE-pH) evaluated the link between pH and greenhouse gas emissions

Increasing soil pH also reduces nitrous oxide ($N_2O$) emissions




**Benefits of Liming**
- ✓ Liming increases soil productivity
- ✓ Improves the soil habitat for soil biology
- ✓ Increases crop production potential
- ✓ Increases N-P-K-S nutrient use efficiency
- ✓ Reduces N fertiliser requirements and overall fertiliser costs for the farm

**Take home messages**
- ✓ Use your soil test results to identify field with low soil pH (i.e. high acidity levels)
- ✓ Use all opportunities to apply the lime needed over the growing season
- ✓ Apply lime prior to reseeding and target higher pH levels (> 6.8) for clover swards

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

FACCE ERA-GAS

MAGGE-pH

# Liming Agricultural Soils Delivers Many Benefits

Mark Plunkett, David Wall

Teagasc, Johnstown Castle

**Summary:**

- Correcting soil's pH is the first step to good soil fertility
- Apply lime as recommended on recent soil analysis
- Plan lime application annually and aim to maintain soil pH's once every 5 years based on soil analysis
- Aim for a soil pH 6.3 to 6.5 on mineral soils
- Aim for a soil pH 5.5 to 5.8 on peat soils
- Maintaining soil pH in the optimum ranges will increase the availability of major soil nutrients such as N & P
- Mineral soils with the correct soil pH will release up to 80 kg N/ha/year
- Optimal soil pH increases N efficiency and reduces GHG production
- Correct soil pH increases grass dry matter production by up to 1.5t/ha annually
- For clover sward productivity aim for a soil pH 6.5 to 6.8
- Lime can be applied at any time of the year providing soil and weather conditions are suitable
- Ground limestone gives cost effective long term control of soil acidity
- Lime offers a return on investment of €6 to 10 for €1 invested in ground limestone

## Other resources & online information

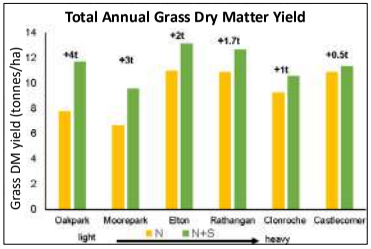
**Liming Factsheet -** https://www.teagasc.ie/crops/soil--soil-fertility/soils-nutrients-and-fertiliser-factsheets/

**Teagasc Website:** https://www.teagasc.ie/crops/soil--soil-fertility/

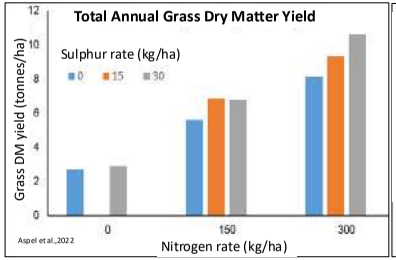
**Email:** mark.plunkett@teagasc.ie; david.wall@teagasc.ie

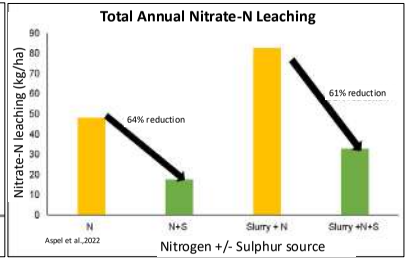
# Sulphur Nutrition for Grassland

## When & where is Sulphur fertiliser required?








Aspel C., Murphy, P., Mcloughlin, M., and Forrestal, P. (2022) Sulfur fertilisation strategy affects grass yield, nitrogen uptake, and nitrate leaching: A field lysimeter study.

## Take home messages

- Sulphur (S) can increase yields.
- Large soil variability: 4%-51% increase observed (0.5 to 4 t DM /ha grass).
- S increases nitrogen (N) use efficiency
- Potential to decrease N leaching on free draining soils.
- The optimum S rate increases with higher N inputs. Largest response to S fertiliser between March - June.
- S is often needed where slurry is used.
- Up to 20 kg/ha S fertiliser per cut is recommended for silage swards.

# Sulphur Nutrition for Grassland: Increased Yield, Nitrogen Uptake and Reduced Nitrogen Leaching

Claire Aspel[1, 2], Paul Murphy[2], Patrick Forrestal[1]

[1]Teagasc, Soils, Environment and Land Use Dept., Johnstown Castle, Co. Wexford

[2]School of Agriculture and Food Science, University College Dublin, Dublin

**Summary:**

- Sulphur (S) fertiliser can significantly increase grass yields (up to 4 tonnes DM increase was observed on a highly responsive soil).
- Response to S differs across soils. On S heavier soil an extra 500 kg/ha DM was observed.
- Sulphur fertiliser increases grass nitrogen uptake and nitrogen use efficiency (NUE)
- The largest responses to S fertilisation were observed for applications between March and June.
- Sulphur can potentially reduce nitrate leaching on free draining soils (up to 30.6 kg/ha nitrate-N reduction was observed). Sulphur fertilisation also kept concentrations below the maximum allowable concentration.
- Nitrogen rate affects the sulphur rate. The optimum sulphur rate increases with the higher nitrogen fertiliser application.
- Chemical sulphur fertiliser is also needed with slurry applications as S present in cattle slurry is not sufficient to meet grass sulphur demand.

## Other resources & online information

**Teagasc website:** https://www.teagasc.ie/publications/2020/importance-of-sulphur-s-for-grass--crop-production.php

**Teagasc website:** https://www.teagasc.ie/media/website/crops/soil-and-soil-fertility/The-Role-of-Sulphur-in-Crop-Production.pdf

**Research article:** https://onlinelibrary.wiley.com/doi/full/10.1002/jpln.202100133

**Email:** claire.aspel@teagasc.ie; patrick.forrestal@teagasc.ie

# NMP Online Maps

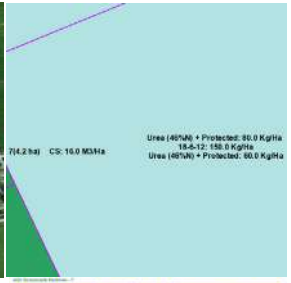
P Map

K Map

pH Map

Lime Requirement Map

Fert Map




Overall Fertility Status

pH > 6.2, P & K Index 3 or 4


| | Ha's | % |
|---|---|---|
| Yes | 7.10 | 10% |
| No | 30.85 | 81% |

Lime

Soil pH > 6.2


| pH | Ha's | % |
|---|---|---|
| <5.5 | 5.20 | 14% |
| 5.5-5.9 | 6.05 | 16% |
| 5.9-6.2 | 19.70 | 52% |
| 6.2-6.5 | 0.00 | 0% |
| >6.5 | 7.10 | 19% |

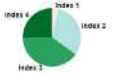
Phosphorus

P Index


| Index | Ha's | % |
|---|---|---|
| 1 | 5.45 | 14% |
| 2 | 7.84 | 21% |
| 3 | 17.68 | 46% |
| 4 | 7.10 | 19% |

Potassium

K Index




| Index | Ha's | % |
|---|---|---|
| 1 | 1.30 | 3% |
| 2 | 11.99 | 31% |
| 3 | 15.15 | 40% |
| 4 | 9.71 | 25% |

| Soil P Ranges (mg/l) | | |
|---|---|---|
| Soil P Index | Grassland crops | Other crops |
| 1 | 0.0 - 3.0 | 0.0 - 3.0 |
| 2 | 3.1 - 5.0 | 3.1 - 6.0 |
| 3 | 5.1 - 8.0 | 6.1 - 10 |
| 4 | Above 8.0 | Above 10.0 |

| Soil K Ranges (mg/l) | | |
|---|---|---|
| Soil K Index | Mineral Soil | Peat * |
| 1 | 0- 50 | 0-100 |
| 2 | 51- 100 | 101-175 |
| 3 | 101- 150 | 176-250 |
| 4 | Above 150 | Above 250 |

# NMP Online - Your Soil Fertility Plan Made Simple

Pádraig Foley[1]; Pat Murphy[1]; Tim Hyde[2]

[1]Teagasc, Johnstown Castle; [2]Teagasc, Athenry

**Summary:**

NMP Online is a tool that can help you get your soil fertility to a place where your farm can perform to its optimum. Start with these three steps:

- Step one is taking your soil sample – a soil sample on a 4ha field will last 4 years and this is €1.23/ha or 50 cent/acre.
- Step two is getting these soil samples into NMP Online with the help of your advisor.
- Step three is the key to success – implementing your nutrient management plan to get the best return on investment from slurry, FYM, bag fertiliser and lime.

Working with your advisor, NMP Online can deliver you the following:

- A fertiliser plan
  - Split by split
  - Based on the soil fertility of each field
- A lime plan for the farm
  - Targeting fields where lime will have the best impact
  - Spreading the investment
- Making the best use of slurry and FYM
  - Target the fields that need it
  - At the right time of year

The following are the questions that you should ask your advisor:

- Can you give me a lime requirements map?
- Can you give me a colour coded map outlining the P & K indices on my farm?
- Can you prepare a fertiliser plan for me?
- Should I have my agitated slurry analysed?

## Other resources & online information

**Twitter:** @TeagascEnviron

**Teagasc Website:** https://www.teagasc.ie/environment/soil/nmp/

**Google Teagasc NMP Online video for a summary of what NMP Online can do for you.**

**Email:** padraig.foley@teagasc.ie; pat.murphy@teagasc.ie

# Cattle Slurry Application Methods

**Nitrogen (N)**
- N lost as ammonia gas to air.
- Time of application – slurry N efficiency is highest in spring
- Weather conditions critical.
- Application techniques - LESS

**Phosphorus (P) & Potassium (K)**
- Valuable nutrient source
- No losses of P & K to air
- Availability (Index 1&2 =50%, Index 3 =100%)
- More precise app.


| Cattle Slurry N Value at 33m³/ha (3,000gals/ac) | Splash Plate | Trailing Shoe | Direct Injection |
|---|---|---|---|
| |   |   |   |
| N Recovery % | 30% | 40% | 50% |
| Available N /ha | 23kg | 33kg | 40kg |
| N Value[2022] (€/ha) | €76 | €109 | €132 |

**Benefits of Low Emission Technology**
- More slurry N retained to grow grass & More evenly applied slurry nutrients (N, P, K S)
- Reduced farm fertiliser N €osts
- Less grass contamination & Less odour
- Key technology to help meet the National GHG and Ammonia Emission reduction targets

# Using Cattle Slurry Efficiently – Application Methods

Mark Plunkett

Teagasc, Johnstown Castle

**Summary:**

- The typical value of good quality cattle slurry applied in spring time by LESS has an is equivalent N - P - K value of 9-5-32
- Analyse organic manures to determine actual nutrient values (N, P & K) & dry matter percentage (DM%)
- Apply cattle slurry based on recent soil analysis
- Cattle slurry is a valuable source of potassium (K)
- Apply cattle slurry to grass silage fields to recycle nutrients and maintain soil fertility levels
- Apply cattle slurry in spring to maximise N recovery
- Apply with LESS technology (Trailing shoe/Band spreader) to reduce ammonia N losses during application
- Apply slurry under suitable weather conditions to maximise N recovery – cool, calm and moist conditions improves N utilization
- Aim to empty slurry tanks well in advance of winter to maximise farm slurry storage

## Other resources & online information

**Organic Manure Factsheet -** https://www.teagasc.ie/media/website/crops/soil-and-soil-fertility/3.-Organic-Manure.pdf

**Teagasc Website:** https://www.teagasc.ie/crops/soil--soil-fertility/

**Email**: mark.plunkett@teagasc.ie

# Slurry Acidification & Amendments

Funding support by:
An Roinn Talmhaiochta, Bia agus Mara
Department of Agriculture, Food and the Marine
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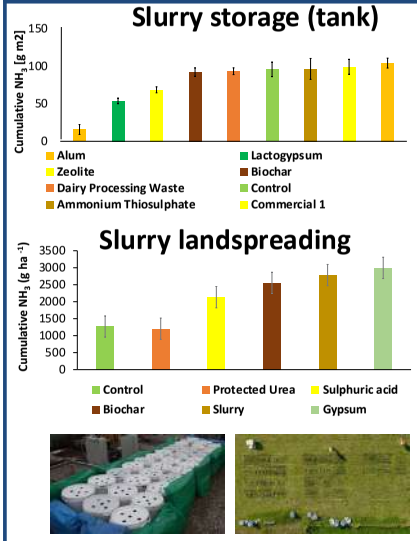
## How Effective are Slurry Additives at Reducing Gaseous Emissions?




| Amendment | Impact on gaseous losses / Efficacy | | | |
|---|---|---|---|---|
| | Ammonia | Methane | Nitrous oxide | Mode of action |
| In storage | | | | |
| Alum | 82% ↓ | 96% ↓ | N/A | Reduce slurry pH |
| Ferric chloride | 96% ↓ | 98% ↓ | N/A | Reduce slurry pH |
| Acetic acid | 73% ↓ | 94% ↓ | N/A | Reduce slurry pH |
| Sulphuric acid | 85% ↓ | 95% ↓ | N/A | Reduce slurry pH |
| Sugar beet molasses | ~65% ↓ | ~80% ↑ | N/A | Reduce slurry pH |
| Apple pulp | ~50% ↓ | ~30% ↑ | N/A | Reduce slurry pH |
| Grass silage effluent | ~40% ↓ | ~60% ↓ | N/A | Reduce slurry pH |
| Spent brewer's grain | ~25% ↓ | ~150% ↑ | N/A | Reduce slurry pH |
| Commercial A | - | - | N/A | Microbial |
| Commercial B | - | - | N/A | Microbial |
| Commercial C | - | - | N/A | Microbial |
| Commercial D | - | 10% ↓ | N/A | Reduce slurry pH |
| GEBTech treatment | 28%↑ | 31%↓ | 85%↓ | Chemical reaction |
| landspreading | | | | |
| Alum | 92% ↓ | - | 202% ↑ | Reduce slurry pH |
| Ferric chloride | 54% ↓ | 99% ↓ | 154% ↑ | Reduce slurry pH |
| Polyaluminium chloride | 65% ↓ | 121 ↓ | 29% ↓ | Reduce slurry pH |
| Biochar | 77% ↓ | - | 62% ↓ | Adsorb ammonium |
| Gypsum | 8% ↑ | N/A | N/A | Reduce slurry pH |
| Sulphuric acid | 23% ↓ | N/A | N/A | Reduce slurry pH |
| Biochar | 8% ↓ | N/A | N/A | Adsorbs ammonium |
| GEBTech treatment | 2%↓ | 88%↓ | 36%↑ | Chemical reaction |

## Take home messages

- Slurry acidification is very effective at reducing emissions but requires H&S considerations.
- Other additives that absorb slurry N *e.g. biochar* can offer smaller reductions.
- Large variability between the effectiveness of additives for reducing emissions & potential trade-offs.
- Prior to purchase, consider scientific backing of any slurry additive formulation.

# Acidification and Amendments for Slurry Treatment – Impacts on Emissions

[1]Dominika Krol; [1]Maxwell Owusu-Twum; [1]George Gleasure; [2]Shaun Connolly

[1]Teagasc, Johnstown Castle; [2]NUI, Galway

**Summary:**

- Slurry storage and land spreading are both important sources of ammonia and greenhouse gas emissions (methane and nitrous oxide) into the atmosphere. Storage of manures produce 10.6% of agricultural GHG emissions, with a further 4% associated with land spreading. Simultaneously, these activities are also responsible for 79% of ammonia.
- Slurry amendments, sometimes also called additives, can mitigate these emissions by affecting manure characteristics. Most commonly known amendments are acidifiers that use chemical mode of action (e.g., acids reducing slurry pH). Other, less studied modes of action, are biological (e.g., microbial additives modifying microbial processes) or physical (e.g., biochar adsorbing nitrogen onto its surface).
- Research to date shows very good reduction of ammonia and GHG emissions from acidifiers and lesser reductions from biochar.
- There is large variability in how effective various additives are relative to mitigating emissions during slurry storage and land spreading.
- Slurry acidification uses hazardous materials and needs careful consideration and specialist installation in order to adhere to health and safety standards.

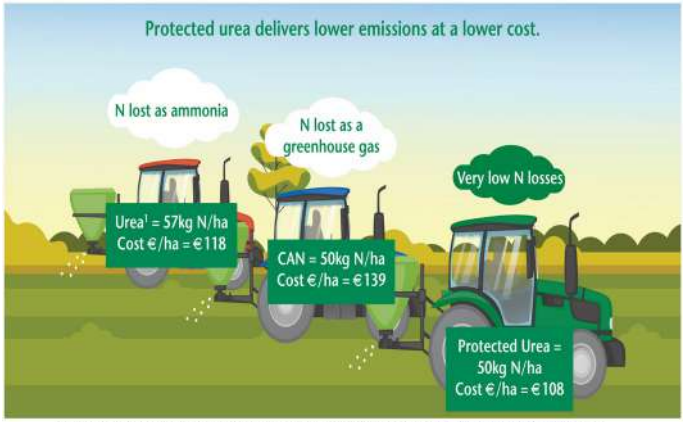
## Other resources & online information

**Email:** dominika.krol@teagasc.ie

# Protected Urea

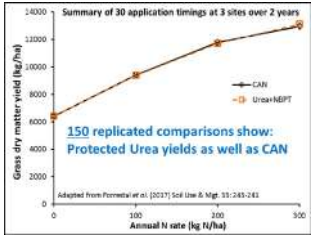
Funding support by
An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

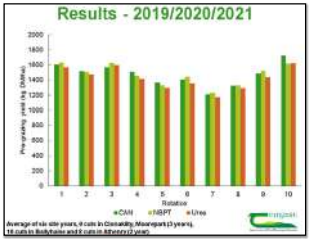
Protected urea reduces ammonia-N loss
⇒N is reliably retained to grow grass
ask for NBPT, 2-NPT or NBPT+NPPT


[1]. Urea must be applied at a 12% higher spreading rate due to higher N losses. Note: Cost per tonne: urea = €950/t; protected urea = €1,000/t; and, CAN = €750/t.

**Teagasc cutting & grazing trials show protected urea is reliable for yield**




**Take home messages**

- ☑ Protected urea is cheaper than CAN
- ☑ Protected urea can be spread throughout the growing season & is reliable for yield
- ☑ Lower greenhouse gas loss than CAN
- ☑ Lower ammonia-N loss than urea

# Protected Urea: Reduce Emissions, Maintain Yield and Save Money

Patrick Forrestal[1]; Áine Murry[2]; Niharika Rahman[1]; Brian McCarthy[2]; Fiona Brennan[1]; Aoife Duff[1]; Siobhan Kavanagh[3]; Mark Plunkett[1]; Gary Lanigan[1]; Karl Richards[1]

[1]Teagasc, Soils, Environment and Land Use Dept., Johnstown Castle, Co. Wexford
[2]Teagasc, Grassland Dept., Moorepark, Co. Cork.
[3]Teagasc Signpost Programme

**Summary:**

- Protected urea has become significantly cheaper than CAN per kg or unit of N making it relatively a very cost effective fertiliser N choice.
- Ask for products protected with the urease inhibitors NBPT, NBPT+NPPT or 2-NPT.
- Teagasc cutting and grazing trials over the past 10 years have shown protected urea yields as well as CAN across a range of conditions and soils.
- Choosing protected urea in place of CAN in grasslands will reduce greenhouse gas emissions and agriculture will get credit for the reduced emissions
- Choosing protected urea in place of standard urea will reduce ammonia gas losses retaining N to grow crops and opening the potential for cost savings by reduction of the protected urea rate vs the urea rate.
- Residues not found in milk following testing of a dairy herd grazing pastures receiving all their N using protected urea.
- In-season testing of grass samples from the Teagasc long-term protected urea plots at Johnstown Castle did not detect any residues of the urease inhibitor on grass.
- Testing of soils from the long-term protected urea plots revealed that the inhibitor used on protected urea had no impact on the diversity or quantity of soil micro-organisms compared to when CAN fertiliser was used

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/crops/soil--soil-fertility/protected-urea/

**Nutrient tips to save money and reduce emissions on your farm: Signpost Webinar** https://www.youtube.com/watch?v=w_XcCkgsx-k

**Teagasc Signpost Programme:** https://www.teagasc.ie/environment/climate-change--air-quality/signpost-programme/

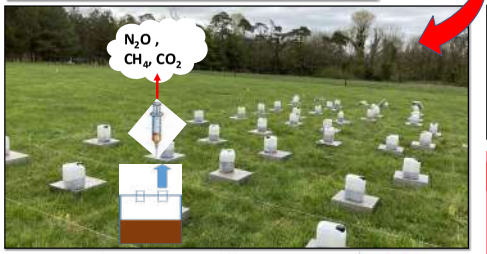
**Why use protected urea in 2022:** https://www.teagasc.ie/environment/climate-change--air-quality/signpost-programme/videos/

# Developing $N_2O$ Emission Factors

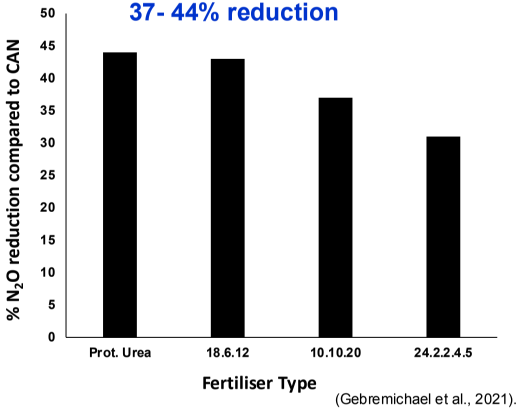
- **Task:** Quantifying $N_2O$ emissions from a range of compound fertilisers with varying nitrate to ammonium/urea ratios.
- **Goal:** to generate EFs which can be included in the National Inventory Report and will allow for mitigation measures specific to Irish conditions


Rate = 40 kg N $ha^{-1}$

| Compound | Nitrate:Ammonium |
|---|---|
| 10.10.20 | 0.05 |
| 18.6.12 | 0.53 |
| 24.2.2.4.5 | 0.79 |




Compounds with the lowest nitrate ($NO_3$) to ammonium ($NH_4$) ratios gave the lowest emissions!




(Gebremichael et al., 2021).

## Take home message

☑Moving from $NO_3$ to $NH_4$ based compound fertiliser has the potential to reduce emissions while maintaining yield. Offers a 'win-win' scenario.

# Developing $N_2O$ Emission Factors for a Range of Compound Fertilisers

O'Neill, R. M.; Richards, K. G.; Lanigan, G. J.; Krol, D. J.

Teagasc, Johnstown Castle

**Summary:**

**Effect of compound fertilisers on $N_2O$ emissions**

- Straight nitrogen fertiliser sales account for ~50% and ~55% of the total nitrogen fertiliser sales in the ROI and NI respectively (compound nitrogen fertilisers contain a blend of nitrogen with other nutrients such as potassium, phosphorous and sulphur).
- Compound fertiliser nitrogen has different nitrate to ammonium ratios ranging 0.05 for 10:10:20, 0.53 for 18:6:12 and 0.8 for 27:2.5:5.
- We hypothesise that, similar to the protected urea research, $N_2O$ emissions will be higher from these high nitrate containing compound fertilisers.
- A preliminary field trial in 2020 (Gebremichael et al., 2021), showed a significant 40% reduction in $N_2O$ emissions from the lower nitrate to ammonium ratio compound fertilisers compared to CAN. Compound fertilisers have an important role, that will continue in the future, in providing balanced (N, P, K, S, etc.) grass nutrition, allowing for multiple nutrient application in a single pass. Therefore, it is important to quantify emission factors associated with their use and advise on optimal nutrient management strategies that can reduce such emissions.
- $N_2O$ emissions are currently being quantified on moderately well drained soils (Johnstown Castle)
- $N_2O$ emissions are being measured from 9 fertiliser treatments applied to grassland soils in 5 equal splits (40 kg N $ha^{-1}$ $split^{-1}$) to simulate a typical grazed grassland. Fertiliser treatments: zero N control, 6 different compound fertilisers, CAN and protected urea. Treatments are established in a randomised block design with 5 replicate plots.
- $N_2O$ emissions are being measured using the static chamber technique. One 40 cm square stainless steel chamber will be located on each of the 5 replicate plots for each fertiliser treatment (Krol et al. 2020). Headspace samples are taken from the chambers just prior to each N application, then are sampled four times a week for the first two weeks, then twice a week in the following two weeks, then once weekly until the next application. Gas samples are then transferred to evacuated gas-tight vials, and analysed in the laboratory by gas chromatography, using an electron-capture detector.
- The experiment will be conducted over 2 full years and emission factors generated for each fertiliser type.

## Other resources & online information

**Twitter:** @macc_lab

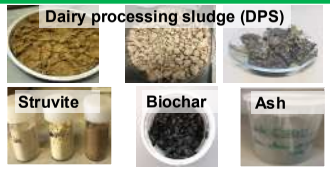
**Instagram:** teagascjc; **Email:** rosie.oneill@teagasc.ie; karl.richards@teagasc.ie

# Bio-Based Fertiliser Alternatives

## What are bio-based fertilisers?

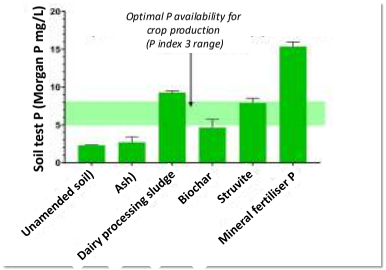
- Wastes and by-products contain valuable nutrient sources (e.g. P&K) that could by recycled and re-used by agriculture.
- Bio–based fertilisers contain nutrients that have been recovered from a range of by-products and waste streams.
- Evaluation of fertiliser nutrient equivalence value of bio-based fertilisers is being conducted at Johnstown Castle.

## What sources were evaluated?




## Bio-based fertiliser P compared to Mineral fertiliser P?

**Soil P availability from different fertilisers**




**P fertiliser equivalence value for spring wheat**

Fertiliser equivalence value compared agronomic performance of bio-based fertilisers to Mineral one.

| Bio-based fertilisers | P fertiliser equivalence value (%) |
|---|---|
| Dairy processing sludge | 30% to 80% |
| Biochar | -10% to 20% |
| Struvite | 80% to 90% |
| Ash | -150% |

## Take home messages

- ✓Some bio-based fertilisers display comparable P availability to mineral P fertilisers and are good alternatives.
- ✓Soil P build-up is slower for bio-based fertilisers compared to mineral P.
- ✓Dairy P. Sludge & Struvite showed high P fertiliser equivalence value compared to mineral P fertilisers, while some showed lower value (Ash & Biochar).

# Bio-Based Fertilisers - Alternatives to Chemical Fertilisers

Owen Fenton[1]; Karen Daly[1]; Olha Khomenko[1,2]; Wenxuan Shi[1,3], Patrick Forrestal[1], Elizabeth O'Carroll[1], Cathal Redmond[1]

[1]Teagasc, Johnstown Castle; [2]University of Limerick; [3]NUI Galway

**Summary:**

- Alternatives to conventional mineral fertilisers are needed to reduce the current reliance on imported chemical fertilizers.
- To accelerate the transition towards sustainable agricultural systems, the Farm to Fork Strategy under the EU Green Deal targets a reduction in fertiliser usage by 20% and recommends the use of recycled organic wastes as a source of nutrients in soils.
- Johnstown Castle is set up to investigate the ability of bio-based fertilisers to increase the plant available P and the mineral fertiliser equivalence value of certain bio-based fertilisers.
- New alternatives to mineral/chemical fertilisers are being examined: cattle slurry, poultry manure, dairy processing sludge & derived materials such as struvite, biochar and ash (called STRUBIAS).
- Some bio-based fertilisers display comparable plant available P to mineral fertilizers.
- The available P build-up in soils amended with bio-based fertilisers is slower than with chemical fertilisers, and, therefore, application rates and times may need to be adjusted to maximize P uptake.
- Some bio-based fertilisers show high P fertiliser equivalence value compared to mineral P fertilisers (dairy processing sludge, struvite), while some have low P fertiliser equivalence value (ash, biochar).

## Other resources & online information

**Twitter:** @etnREFLOW; @forrestalpj; @ofenton; @karendaly053

**Websites:** https://etn-reflow.eu/; https://www.nutri2cycle.eu/

Teagasc Website: https://www.teagasc.ie/environment/johnstown/;

https://www.teagasc.ie/media/website/publications/2020/TResearch_Autumn2020_p12-13(ReducingNutrientLoss).pdf

**Email:** owen.fenton@teagasc.ie; karen.daly@teagasc.ie; patrick.forrestal@teagasc.ie; elizabeth.ocarroll@teagasc.ie; wenxuan.shi@teagasc.ie; olha.khomenko@teagasc.ie

# Environment Village

## FARMING FOR A BETTER FUTURE

# Biodiversity on Farmland

## Hedgerow Management

- Is the height of all your internal hedges at least 1.5m above ground level (or above hedge bank if present)?
- Is there a flowering thorn tree in every hedge?


## Layout of farming platform

- Is your average field size less than 5 ha?


## Field Margin Management

- Do you always retain at least 1.5m uncultivated margins when cultivating?
- Do you avoid spraying within your field margins (except for spot spraying noxious weeds)?


## Watercourse management

- Are all watercourse banks on your farm fenced?
- Is there a fenced margin over 1.5m on all watercourses?
- Do you prevent livestock drinking access to all watercourses?

# Teagasc Biodiversity Management Practices Self-Assessment Tool: Linear Habitats

Catherine Keena[1] and Jim Kinsella[2]

[1] Teagasc, Kildalton, Piltown, Co Kilkenny
[2]University College Dublin, School of Agriculture and Food Science, Belfield, Dublin [4].

**Summary:**

The Teagasc Biodiversity Management Practices Self-Assessment Tool supports appropriate management of linear habitats to deliver biodiversity side-by-side with productive agriculture. Important elements are hedges, farming platform structure, field margins and watercourses.

- Biodiversity management practices undertaken by farmers are a key element of farm sustainability.
- There is a need to include biodiversity management in the assessment of farm sustainability.
- An innovative, affordable, repeatable and rapid assessment tool developed to support best practice for biodiversity combined four key elements of intensively management livestock farms (Figure 1).
- Farmer engagement is key and research showed a need for more effective training.

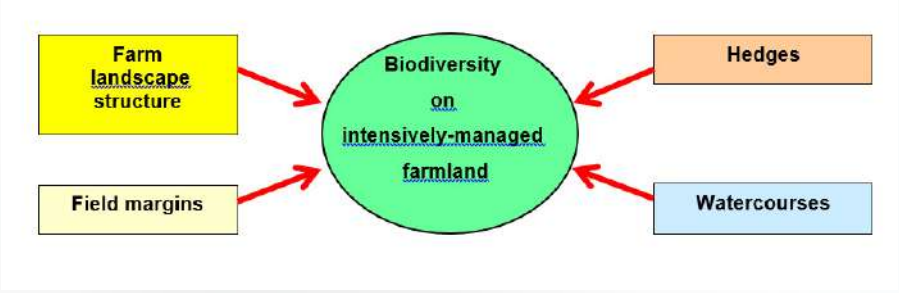



*Figure 1. Diagrammatic representation of the characteristics of farms that combine to reflect biodiversity on intensively managed Irish farmlands*

### Farmed landscape structure

Agricultural landscapes can be viewed as a mosaic of habitats. Average field size has the strongest overall effect on biodiversity on intensively managed farmland. Farmland with smaller field sizes have higher biodiversity. Linear habitats are networks or corridors for nature across the countryside. Under the Environment Impact Assessment (Agriculture) Regulations, permission must be sought from the Department of Agriculture Food and the Marine where hedge removal will result in a field size over 5 hectares. Farmed landscape with average field size less than 5 hectares provides networks for nature and corridors of movement for birds, bats, bees and butterflies to move through the countryside.

### Hedges

Two key types prevalent (Figure 2):

1) Escaped (never-topped) hedge or treeline. Do NOT top, side trim only

2) Topped hedges – aim to grow to at least 1.5 m and retain a thorn tree in every hedge.

*Figure 2. Do not top an 'Escaped hedge' and do not let a 'Topped hedge' escape.*

The bigger and bulkier a hedge is the better. Hedge height over 1.5 m provides suitable nest sites for birds away from the base where foxes can reach them, and the top away from birds such as magpies or birds of prey. Flowering hedges provide flowers for bees and fruit and seeds for birds and small mammals. Escaped hedges flower freely with the biodiversity value in their canopy. Topped hedges with a dense base provide great cover at ground level for mammals as well as nest sites. Routine annual cutting means that there are few flowers or food on the body of Topped hedges. Existing Topped hedges could be greatly improved by selecting individual or clumps of thorn trees within the hedge and allowing their development into mature trees. The practice of retaining an occasional new thorn tree every year provides a diversity of tree heights. Songbirds use smaller developing trees which are a metre or so above the body of a hedge as 'songposts'.

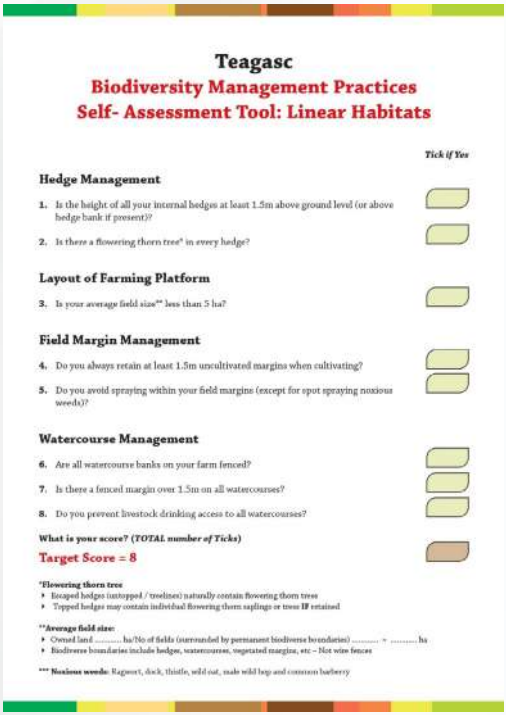
## Field margins

Field margins are a rough grass habitat, which is absent from a lot of intensively managed farmland in Ireland. Uncultivated and unsprayed field margins allows the rough grass margin to continue undisturbed, protecting the soil biodiversity. Their presence allows grasses and wildflowers to flower and seed, providing habitat for associated invertebrates, birds and small mammals. Birds such as linnet feed on grass seed. There is a high biodiversity value in native plants growing wild naturally. Wildflowers growing wild in unimproved field margins undisturbed and unfertilised for millennia are not to be confused or equated with sowing unregulated packets of flower seed.

We need to maintain our native species of flora and fauna, which have been here for thousands of years and are in tune with each other with regards timing of flowering and other growth stages. Some are inconspicuous – in other words, they may not be 'showy' or attractive to humans. Actions to protect our declining biodiversity must be evidence-based and directed by science, rather than individual preferences. It cannot be about actions that make the landscape attractive to humans, those that are easiest, or about focusing on one species at the expense of others.

## Watercourses

All watercourses are important for biodiversity, including small watercourses and drains, which are important in their own right, and important for their influence on larger watercourses. Fenced watercourse banks preventing siltation from eroded banks allow natural bankside vegetation to flourish. Watercourse margins provide further protection for watercourses and allows space for native wildflowers and grasses to grow, providing habitat for associated fauna. Prevention of livestock drinking access to watercourses prevents siltation of watercourses, and protects the habitat for instream biodiversity



**Teagasc**

**Biodiversity Management Practices**

**Self- Assessment Tool: Linear Habitats**

*Tick if Yes*

**Hedge Management**

1. Is the height of all your internal hedges at least 1.5m above ground level (or above hedge bank if present)?
2. Is there a flowering thorn tree* in every hedge?

**Layout of Farming Platform**

3. Is your average field size** less than 5 ha?

**Field Margin Management**

4. Do you always retain at least 1.5m uncultivated margins when cultivating?
5. Do you avoid spraying within your field margins (except for spot spraying noxious weeds)?

**Watercourse Management**

6. Are all watercourse banks on your farm fenced?
7. Is there a fenced margin over 1.5m on all watercourses?
8. Do you prevent livestock drinking access to all watercourses?

**What is your score? (*TOTAL number of Ticks*)**

**Target Score = 8**

***Flowering thorn tree**
- Escaped hedges (untopped / treelines) naturally contain flowering thorn trees
- Topped hedges may contain individual flowering thorn saplings or trees **IF** retained

****Average field size:**
- Owned land ..... ha/No of fields (surrounded by permanent biodiverse boundaries) ..... = ..... ha
- Biodiverse boundaries include hedges, watercourses, vegetated margins, etc – Not wire fences

***** Noxious weeds**: Ragwort, dock, thistle, wild oat, male wild hop and common barberry

## Conclusion

Linear habitats comprising hedges, field margins and watercourses are valuable habitats for biodiversity within the farming platform, alongside land managed for agricultural production. Best practice biodiversity management practices on these linear habitats are important.

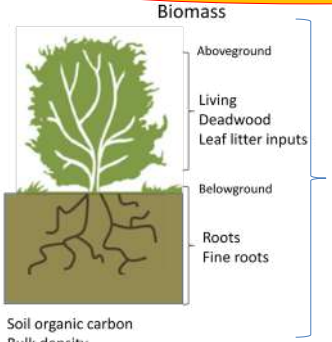
# Hedgerows – carbon and biodiversity

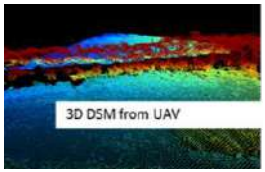
## The benefits?

- Hedgerows can provide important benefits in agricultural landscapes for climate and biodiversity.
- To include hedgerows in inventory reporting a method to assess carbon stock changes over time is required.

## Assessing carbon stocks in hedgerows

In-field and remote measurements




Build 3D Digital surface model using remote technology and develop biomass algorithms to calculate biomass stock changes

## Results

- Relationships between remote and direct measurements established and equations generated → can be used to assess carbon stock changes of biomass between two time steps.
- Carbon concentration of dry biomass was consistent across all pools measured (living, dead above and below ground).
- Mean aboveground and belowground biomass stocks of 58 t C / ha and 10 t C / ha respectively.
- Wider and higher hedges have the greatest capacity to sequester C whilst also benefitting biodiversity.
- Over-trimming limits biomass sequestration accumulation and biodiversity value.

## Take home messages – Management Matters!

✓ Less intensively managed hedgerows have a higher biodiversity value and they sequester more carbon in the biomass pool when compared to highly managed narrow hedgerows.

PROJECT PARTERS

FUNDERS

# Farm Carbon – Hedgerow Management for Carbon & Biodiversity

Lilian O'Sullivan[1], Gary Lanigan[1], Daire Ó hUallacháin[1], Shiva RahimiTana[1], Mark Ward[1], Ian Kavanagh[1], Kevin Black[2]

[1]Teagasc, Johnstown Castle, Co. Wexford. [2] Forest Environment Research and Services (FERS), Navan, Co. Meath

**Summary:**

Hedgerows are linear landscape features composed of shrubs and trees. Landscape features such as hedgerows can play an important role in enhancing carbon sinks. In Ireland, hedgerows are a prominent part of the agricultural landscape. Research has estimated a hedgerow length of ~689,000 km, representing ~ 4% of the land area (Green et al., 2019). To include hedgerows into national inventory reporting a mechanism to assess carbon stock changes over time is required. Internationally, few studies have related aerial imagery to ground-truthed biomass measurements and related changes in biomass to hedgerow management. In the Farm Carbon project, we took direct measurements to develop relationships between measured hedgerow biomass and 3-D digital elevation model (DEM) data (remotely captured using drones).

**Results:**

- Relationships between remote and direct measurements were established. The equations generated can be used to assess carbon stock changes of biomass between time steps, required for inventory reporting.
- Carbon concentration of dry biomass was consistent across all pools (living, dead above and below ground) measured.
- Mean aboveground and belowground biomass stocks of 58 $tC.ha^{-1}$ and 10 $tC.ha^{-1}$ respectively, are similar to studies in other countries.
- Further research is needed to establish more robust root/shoot ratios for belowground root biomass with management impact requiring further investigation.
- Irregular less intensively managed hedgerows contained significantly higher amounts of aboveground biomass compared to intensively managed hedgerows.
- Management regime had a strong effect on carbon stock changes and highlighted a small net emission source for pilot study over the survey period.

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/environment/climate-change--air-quality/research/farm-carbon--------/

**Email:** lilian.osullivan@teagasc.ie

**Twitter:** @farm_carbon

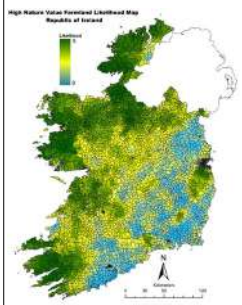
**Reference:** Green, S., Matin, S., Gharechelou, S., Calkwell, F., Black, K., (2019), BRIAR: Biomass Retrieval in Ireland Using Active Remote Sensing (2014-CCRP-MS.17), Report 305 prepared for the EPA by Teagasc.

# Paying Farmers for Enhancing Biodiversity

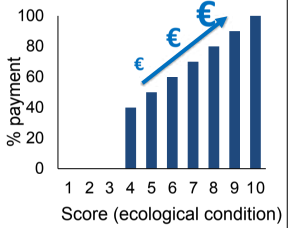
## Main Points

- **National Biodiversity Emergency** declared
- **85%** of habitats in unfavourable condition
- **Huge potential** in High Nature Value (HNV) farmland

**HNV**: Areas where low intensity agricultural practices contribute high levels of biodiversity



- 33% of agricultural area is HNV
- 50% of HNV farmland is in uplands
- HNV farms have many high diversity areas
- Threats: abandonment and intensification




**Performance-related payments** reward farmers for enhancing the quality of nature on their land

## Funding

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

HNV FARMLAND & FORESTRY
FARMFORBIO

FARM ECOS
Farming and Natural Resources: Measures for Ecological Sustainability

## Take home messages

- In general, the amount of high diversity areas on HNV farms surpasses the EU 10% target
- Priority to enhance the quality of these features to support more biodiversity
- Performance-related payments can help farmers to achieve this goal

*O'Rourke, E. and Finn, J.A. 2020. Farming for Nature: the Role of Results-Based Payments. Teagasc and NPWS.*

*Images: James Moran*

# Paying Farmers for Enhancing Biodiversity

Stephanie Maher[1], John Finn[1], Daire Ó hUallacháin[2]

[1]Teagasc, Johnstown Castle; [2]Teagasc Moorepark

**Summary:**

- A National Biodiversity Emergency has been declared in Ireland, with 85% of habitats in unfavourable condition
- High Nature Value (HNV) farms are farms where low intensity agricultural practices support high levels of biodiversity. These farms have huge potential to help address the biodiversity crisis
- In general, the amount of high diversity areas on HNV farmland far surpasses the EU target of 10%, therefore attention should be focussed on enhancing the quality of these nature-rich areas
- Performance-related or "results-based" payments pay farmers for the quality of habitats on their land, with payments increasing in line with increasing quality
- These payments could help support farmers to improve biodiversity on their land, particularly in areas of high nature value

## Other resources & online information

**Email:** stephanie.maher@teagasc.ie

# Maintaining and Improving Farmland Biodiversity


## Policy Perspective

- *Farm to Fork* aims for 10% of agricultural area under high-diversity landscape features.
- *CAP Strategic Plan* aims for >4% landscape features, rising to 10% (Ecoscheme).

## Retain

- Retain a diversity of habitats.
- Different habitats deliver different ecosystem benefits.
  - Buffer strips: water, carbon and biodiversity.
  - Hedgerows: biodiversity, carbon, agronomic.

## Enhance

- Biodiversity is dependent on habitat ***quantity*** and ***quality***.
- Enhancing the quality of the habitat enhances the functioning.
  - Reduced cutting improves hedgerow quality, benefitting biodiversity & carbon storage.

## Create

- Creation and targeting of new habitats enhances biodiversity.
  - Newly created habitats should not replace existing habitats.

# Maintaining and Improving Farmland Biodiversity

Daire Ó hUallacháin, John Finn, Stephanie Maher

Environment and Land-use Programme, Teagasc, Johnstown Castle, Wexford

**Summary:**

- Wildlife habitats such as hedgerows, field margins, ponds, wetlands, and woodlands, commonly occur on Irish farms. These habitats are vital to biodiversity, but they also provide important benefits (ecosystem services) to agricultural systems, including nutrient cycling in soil, flood prevention, regulation of pests and diseases, pollination and carbon storage.
- Policy agendas are focusing more on sustainable management of agricultural land, recognising the need to increase production (to cope with increasing food demands), without compromising the environment and ecosystem services. The Farm to Fork Strategy recommended that 10% of agricultural areas should be under high-diversity landscape features. More recently, the draft Common Agricultural Policy (CAP) Strategic Plan requires that 4% of agricultural area should be landscape features, with incentives (under Ecoschemes) for those who exceed this 4% threshold. It is estimated that natural and semi-natural habitats constitute over 6-7% of farm area on intensive farming systems and are substantially higher on more extensive farming systems.
- The retention of existing habitats is vitally important, as they typically deliver greater ecological benefits compared to newly created habitats. Thus, in the first instance, farmers should aim to retain, and optimise the ecological quality of existing farmland habitats, before establishing new biodiversity or carbon initiatives. Whilst existing habitats should be protected from intensive agricultural management, some semi-natural habitats benefit from reduced farm management, e.g. light grazing of extensive grasslands prevents the area from scrubbing over. More frequently occurring habitats such as hedgerows also benefit from a reduction in management. Revising cutting practices to ensure a tall hedgerow structure, with flowering trees, provides multiple environmental benefits. Avoiding fertiliser, slurry and herbicide application along field and watercourse margins will enhance the benefits for biodiversity and help improve water quality.
- Where there is a lack of existing habitats on a farm, new measures can be designed and targeted to provide multiple benefits for biodiversity, water quality and carbon storage. Targeted smarter buffer zones can ensure that the right measure is implemented in the right place.
- All farmers can help protect the quantity and quality of wildlife habitats. Effective implementation of such measures can play an important role in the reversal of biodiversity decline and ensure the continued delivery of crucial ecosystem services. In addition, such approaches can offer significant marketing opportunities to Irish farmers and retailers in terms of capitalising on Ireland's reputation for sustainable production systems.

## Other resources & online information

**Email:** daire.ohuallachain@teagasc.ie

# SOIL HEALTH

**What is soil health?**

Soil health can be defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals & humans *(USDA, 2020)*

## SOILS - THE LOWDOWN.....

### EU 2030 TARGETS

**EU MISSION IN SOIL HEALTH & FOOD TARGETS:**

- ✓ 75% OF SOILS HEALTHY BY 2030
- ✓ 50% DEGRADED LAND RESTORED
- ✓ CONSERVE SOIL ORGANIC CARBON STOCKS
- ✓ NO NET SEALING
- ✓ REDUCE POLLUTION (inc. reduced fertiliser use)
- ✓ PREVENT EROSION (30-50%)
- ✓ IMPROVE SOIL HABITAT/BIODIVERSITY (20-40%)

### ACTIONS

- ❑ SUPPORT CLIMATE-SMART & SUSTAINABLE SOIL MANAGEMENT PRACTICES.
- ❑ DEVELOP & FOSTER TOOLS TO AID FARMERS WITH SUSTAINABLE FOOD PRODUCTION.
- ❑ IDENTIFY SOIL MANAGEMENT PRACTICES THAT SUSTAIN BIODIVERSITY & SOIL FUNCTIONS.
- ❑ DEMONSTRATE BEST PRACTICE THROUGH A NETWORK OF LIVING LABS.

## MEASURING SOIL HEALTH - INDICATORS

**MAIN FUNCTIONS THAT OUR SOILS PERFORM:**

- PP = primary productivity (food production),
- WP = water purification and regulation (draining & storing water),
- CS = carbon sequestration & climate regulation
- BIO = supporting biodiversity (soil as a habitat for flora & fauna)
- NC = nutrient cycling (storing & recycling different nutrient sources)

**WHAT ARE THE KEY PHYSICAL, CHEMICAL AND BIOLOGICAL SOIL HEALTH INDICATORS?**

| KEY INDICATORS | SCALE SUITABILITY | | | MEASUREMENT FEASIBILITY | | | RELEVANCE TO SOIL FUNCTION DELIVERY | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | SOIL PEDON / BIOTA | FIELD | LANDSCAPE | LOGISTIC | EXTRAPOLATION POTENTIAL | SENSITIVITY | PP | WP | CS | BIO | NC |
| **PHYSICAL** | | | | | | | | | | | |
| SOIL TEXTURE | ✓ | | | | ✓ | ✓ | HIGH | LOW | HIGH | LOW | LOW |
| SOIL STRUCTURE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | HIGH | HIGH | HIGH | HIGH | HIGH |
| BULK DENSITY | ✓ | ✓ | | | ✓ | ✓ | HIGH | HIGH | HIGH | LOW | LOW |
| HYDRAULIC CONDUCTIVITY | | ✓ | ✓ | ✓ | ✓ | ✓ | HIGH | HIGH | HIGH | LOW | LOW |
| **CHEMICAL** | | | | | | | | | | | |
| pH | ✓ | ✓ | | ✓ | ✓ | ✓ | HIGH | HIGH | HIGH | HIGH | HIGH |
| MACRO/ MICRO NUTRIENTS | ✓ | ✓ | | ✓ | ✓ | ✓ | HIGH | LOW | HIGH | LOW | HIGH |
| SOIL ORGANIC MATTER | ✓ | ✓ | | ✓ | ✓ | ✓ | HIGH | LOW | HIGH | HIGH | HIGH |
| SOIL CARBON FRACTIONS | ✓ | ✓ | | | ✓ | ✓ | HIGH | LOW | HIGH | HIGH | HIGH |
| **BIOLOGICAL** | | | | | | | | | | | |
| EARTHWORM ABUNDANCE | ✓ | | | | | ✓ | LOW | LOW | HIGH | HIGH | HIGH |
| MICROBIAL BIOMASS | ✓ | ✓ | | ✓ | ✓ | ✓ | HIGH | HIGH | HIGH | HIGH | HIGH |
| ROOTING TYPE, DEPTH & ABUNDANCE | ✓ | | | ✓ | ✓ | ✓ | HIGH | HIGH | HIGH | HIGH | HIGH |
| BOTANICAL COMPOSITION | | ✓ | ✓ | ✓ | ✓ | ✓ | HIGH | HIGH | HIGH | HIGH | HIGH |
| BACTERIAL & FUNGAL COMMUNITIES | ✓ | | | | | ✓ | LOW | LOW | HIGH | HIGH | HIGH |
| ENZYME ACTIVITY | ✓ | | | | ✓ | ✓ | LOW | LOW | HIGH | HIGH | HIGH |

## ARE IRISH SOILS HEALTHY?

*Irish soils are "relatively"* healthy BUT....

- Sub-optimal soil fertility (poor nutrient balance) status is common. However recent improvements in pH status on farms.
- Some soils more susceptible to effects of weather (e.g. soil erosion) and management (poaching & loss of biodiversity)
- Poorly drained soils - prone to compaction, less resilient to machinery & animal trafficking. Reduced drainage & waterlogging
- High capacity to store organic matter and more biodiverse under low-moderate management intensity.
- Well drained soils – more resilient against compaction, high productive capacity but risks for water quality (N leaching) and loss of organic matter exist.

# Soil Health – Soils for the Future

Giulia Bondi, David Wall, Lilian O'Sullivan

Teagasc, Johnstown Castle, Co. Wexford

**Summary:**

Soil health can been defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals and humans. Soil is a precious resource that supports the production of food, feed and fibre that underpins agricultural enterprises. Soil also provides other essential services critical to sustain life on the planet including nutrient cycling; carbon sequestration and climate regulation; water purification and as a habitat for biodiversity. Sustainable soil management is critical to sustain soil health and to guarantee the provision of these services into the future. Farmers play a pivotal role in managing soil functioning by applying inorganic or/and organic fertilisers to build up nutrient supply for production. The challenge in Ireland is that soils are highly variable and while the soil types and environment on farm is fixed, management must be adapted to the production capacity and context specific conditions in-field. In 2020, the EU Mission on Soil Health and Food has outlined a series of targets for soil health. The soil quality assessment research (SQUARE) project established a baseline of key soil heath indicators and their explanatory power for soil functioning.

- EU Mission in the area of soil health and food has defined targets to be achieved by 2030.
- Soil health key indicators and their evaluation of explanatory power for soil functioning is outlined categorised into physical, chemical and biological indicators.
- Soil structure, pH, microbial biomass, rooting type, depth and abundance, and botanical composition showed the highest relevance to the delivery of all soil functions.
- Irish soils are relatively healthy but weaknesses exist.
- Practices across grassland farms showed to be standardised but more intensively managed sites were at a higher risk.
- Well drained soils = more resilient to compaction, high productive capacity with optimum nutrients but at a greater risk for water quality and loss of organic matter.
- Poor drained soils = more prone to structural compaction, less resilient especially at high trafficking, high capacity to sequester carbon and more biodiverse under a low/moderate management system.
- Teagasc researchers are part of the European Joint Programme on soil (EJP Soil) to develop knowledge and tools to support soil health through sustainable soil management.

## Other resources & online information

**Websites:** https://ejpsoil.eu/

**Teagasc Website:** https://www.teagasc.ie/environment/soil/research/square/

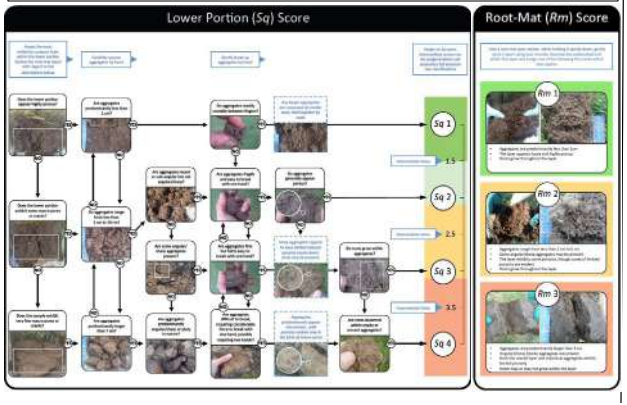
**Email:** giulia.bondi@teagasc.ie, david.wall@teagasc.ie, lilian.osullivan@teagasc.ie

# Assessing Soil Compaction and Soil Quality

## Have you soil compaction problems on you farm?

- Poor grass growth in certain parts of fields?
- Poor drainage and surface water ponding?

**GrassVESS: visual method to assess soil structure**




## What are the key indicators of soil structural quality?

- What forms of soil aggregates are present?
- Can plant roots & water move through the soil?


## Take home messages

**Physical quality**

- Know your soil type
- Understand limits for soil trafficability?
- Minimize compaction

**Chemical quality**

- Correct balance of nutrients/fert. inputs
  - ✓ Right - product,
  - ✓ Right - place,
  - ✓ Right - rate,
  - ✓ Right - time

**Biological quality**

- Feed the soil regularly!
- Org Manure inputs?
- Grass sward diversity?

**Is soil specific management needed?**

# Assessing Soil Compaction and Soil Quality

Giulia Bondi[1]; Cathal Somers[2]; Owen Fenton[1], David Wall[1]

[1]Teagasc, Johnstown Castle; [2] Teagasc, Advisory Office, Mullinavat

**Summary:**

- Soil quality is the soil's ability to provide a range of different services through its capacity to perform soil functions under changing management and climatic conditions.
- Soil structure is a measure of soil quality that can be easily assessed by using cheap, quick and user-friendly methodologies.
- Visual soil assessment techniques allocate an objective score based on manually breaking down a sample of soil by hand to assess specific soil features.
- GrassVESS: key features of soil structural quality are colour, aggregate size, shape and strength, pore structure, the presence of roots at different levels etc.
- This tool can be used by farmers and practitioners to check the quality status of their land.

**Prevention is better than cure:**

- Get to know your soil is key. Determine whether your management is having a negative impact and know where the problems are located within fields/paddocks.
- Avoid machinery and livestock traffic on wet soils. Soil structure is weaker when wet and prone to damage.
- Maintaining nutrient balance is key to soil stability and resilience. SOM helps form soil aggregates by gluing soil particles together helping it to resist compaction.
- Soil biology, including plant roots, are key to structural resilience. When soil structure is damaged, it is the action of soil organisms and roots which helps repair the damage by breaking up compacted layers.

## Other resources & online information

**Some related outputs are available in the SQUARE webpage:** https://www.teagasc.ie/environment/soil/research/square/support-material/

**The Soil Structure ABC:** https://www.teagasc.ie/media/website/environment/soil/The-soil-structure-ABC.-A-practical-guide-to-managing-soil-structure.pdf

**Email:** giulia.bondi@teagasc.ie; david.wall@teagasc.ie; cathal.somers@teagasc.ie; owen.fenton@tegasc.ie

# SOIL COMPACTION – Protecting soil structural quality

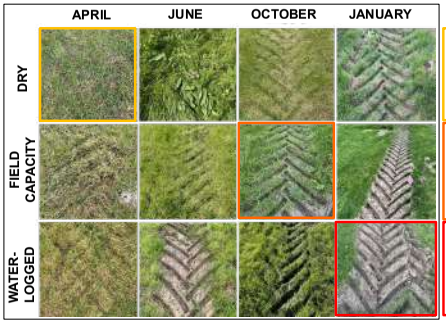
## When is it suitable to travel with heavy machinery on soils?

- Soil compaction on intensive managed temperate grassland soils is a major threat to soil health, nutrient efficiency and grass yield.
- Machinery trafficking of wet soils results in higher risk of soil structural damage.
- Identification of suitable soil moisture conditions for safe field operations will inform better management decisions to prevent soil compaction from occurring.

## SLURRY APPLICATION FIELDWORK SCHEDULE


| Compaction events | |
|---|---|
| **April** | 1st silage cut closure |
| **June** | After 1st silage cut harvest |
| **October** | Before slurry spreading open period |
| **January** | Begin of slurry spreading opening |

## ASSESSING LEVELS OF COMPACTION




Compaction at the soil surface. Will naturally correct itself.

Compaction within the top soil(0-20cm). Can be corrected

Soil structure is destroyed at depth & needs re-development

## Take home messages

- ✓ With soil compaction – *"protection better than cure"*
- ✓ Avoid trafficking soils that are saturated *>35 % MC*
- ✓ Highest risk of long-term compaction in early spring (Jan-Mar).
- ✓ Leave 4-5 days for soils to dry out after rainfall in early spring and autumn
- ✓ Leave 2-3 days for soils to dry-out after heavy rainfall in late spring and early autumn.

# Finding a Suitable Soil Moisture Range for Safe Field Operations in Grassland

Emanuela Lepore, Giulia Bondi, Owen Fenton, David Wall

Teagasc, Johnstown Castle

**Summary:**

Soil compaction is one of the most serious threats to soil productivity

- Increasing bulk density
- Decreasing number and dimension of pore space
- Decreasing rhizosphere development, etc.

Water content at time of trafficking impacts the level of compaction. About 33 Mha of the European agricultural lands are severely compacted due to increased weight of modern agricultural machinery and traffic in wet conditions. Soil moisture content is a good indicator of soil vulnerability to compaction. However, it is challenging to predict field moisture content accurately, thus hampering pasture management decisions in short to medium timescales.

Heavy machinery and cultivation equipment can cause smearing if soils are wet. This effectively creates a cemented or sealed layer which restricts water, air and roots. The deeper this happens the more difficult it is to remedy. Most of compaction by trafficking happens in the first 0-20 cm; however, for example, ploughing in wet conditions may cause smearing at the bottom of the plough furrow creating a "pan" at 20 to 25 cm depth.

The identification of a threshold range of soil moisture content for safe field operations can improve management decision in short and medium timescales and prevent compaction. Few tips to avoid compaction:

- Trafficking close to a rainfall event makes the soil prone to irreversible compaction.
- Field traffic is safe from irreversible compaction when it occurs 1 or 2 days after a rainfall event, depending on the rainfall intensity.
- Soil moisture ranging from 36 to 42% can be considered as the limit to avoid loss of soil structure during field operations.

## Other resources & online information

**The Soil Structure ABC:** https://www.teagasc.ie/media/website/environment/soil/The-soil-structure-ABC.-A-practical-guide-to-managing-soil-structure.pdf

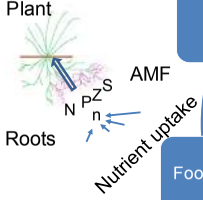
**Email:** emanuela.lepore@teagasc.ie; giulia.bondi@teagasc.ie; david.wall@teagasc.ie; owen.fenton@teagasc.ie

# SOIL BIODIVERSITY – The soil's engine

## Soil Biology is essential for agricultural productivity and ecosystem health

A healthy soil is a disease suppressive soil

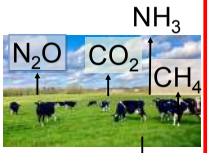
Visual assessment techniques are useful for assessing the soil habitat




Soil microbes including mycorrhizae are important for nutrient, vitamin and plant hormone provision

**Benefits**

- Protection from pests and diseases
- Carbon Storage
- Reduced environmental losses
- Improve Plant Resilience
- Food Quality
- Nutrient provision




## Funding

eagasc
An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine
MARIE CURIE ACTIONS
European Commission
Horizon 2020
European Union funding for Research & Innovation

## Key Messages for Improving Soil Biological Health

1. Assess soil health – visual assessment
2. Avoid physical damage of soil
3. Diversify your crops
4. Return organic matter to soils & diversify carbon inputs
5. Maintain a balanced fertility and pH

# Soil Biodiversity - Benefits and Strategies to Improve Soil Biodiversity

Fiona Brennan[1]; Aoife M. Duff[1]; Natalie J. Oram[1]; Israel Ikoyi[2]; Kerry Ryan[1]; Yahaya Jebril Amanor[1]; Aaron Fox[1]; Arne Schwelm[1]; Katie Martin[2]; Aisling Moffat[3]; Sorcha Kelly[1]; Meritxell Grau Butinyac[1]; Rose Edwin[4]

[1]Teagasc, Johnstown Castle; [2] University College Dublin; [3]Teagasc, Oakpark; [4]Teagasc Moorepark

**Summary:**

- Soil physical health is essential for soil biological health. Visual assessment techniques including assessment of soil colour, structure and plant rooting patterns provide useful information about the health of the soil habitat. Soil physical health assessments can be carried out using GrassVESS (grassland) or double spade method (tillage) techniques, and this can be done in tandem with observation or counting larger organisms such as earthworms.
- Physical damage to soil can be minimised by keeping soil vegetated, and avoiding machinery or animal traffic when soil conditions are unsuitable. Reduced tillage practices can also be beneficial for soil organisms that are particularly sensitive to them for e.g. earthworms.
- Diversifying crops, and thus creating a variety of habitats belowground, through implementation of practices such as crop rotation, cover crops, intercropping and mixed species swards (MSS) can mitigate soil erosion and biodiversity loss. Cropping systems such as MSS further help with drought resilience and enable reduction of N fertilisation, which is beneficial for soil biodiversity.
- Organic matter is hugely important to the physical, chemical and biological health of soil. Tillage soils or soils that are subject to continuous silage production can see a decline in organic matter quantity or quality over prolonged periods, if organic matter is not returned. Application of organic manures and slurries, incorporating crop residues, diversifying your crop, crop rotations, grassland swards and always having a living root in the ground can all play a role in ensuring that the organic matter in your soil will support diverse soil biological communities.
- Optimising your soil fertility with the use of soil tests and liming to the correct pH for your system will ensure that only necessary fertilisers are used, thereby reducing the impact of fertiliser on the soil biodiversity and allowing the organisms to work optimally for the farmer. Fertiliser type matters - protected urea has shown to have no impact on the overall soil microbial community compared to CAN and Urea, allowing farmers to maximise nutrient use efficiency while protecting the soil biodiversity.

## Other resources & online information

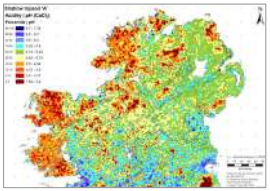
**Twitter:** @Soilmicrobio; @SOILGUARD_H2020, @MASTER_IA_H2020

**Teagasc Website:** https://www.teagasc.ie/contact/staff-directory/b/fiona-brennan/

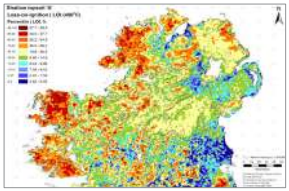
# Mapping Soil Health Indicators

## What soil chemical health indicators have been mapped?

9,921 samples on a 4km$^2$ grid *(or 1km$^2$ in Dublin and Galway)* have been used to map of soil fertility indicators in the northern half of Ireland

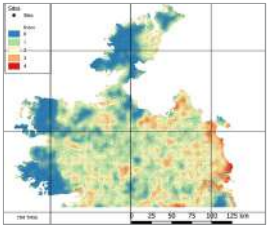


- pH ranges from 2.6 – 7.7
- 18% of samples have an optimum pH value

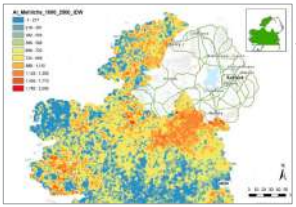


- LOI is a measure of soil % organic matter
- %OM ranges from 0.6-99%

Soil P index



- 40% of samples are in low in P (index 1&2)
- 12% of samples are at the target P index (index 3)
- 10% of soils have a high P concentration (index 4)



- Some soils are very high in Al High and will bind any P fertiliser added to the soil


## Funding

- This work is being jointly supported by Geological Survey Ireland and Teagasc (Terra Soil Collaborative Agreement 2018).


## Take home messages

- ✓ pH and %OM are simple soil tests and key soil health indicators which regulate potential nutrient availability
- ✓ Low soil pH and high soil Al concentration will lead to increased P fixation to the soil surface making it difficult to build-up plant available P

# Mapping Soil Health Indicators

Rebecca Hall[1], Felipe Bachion de Santana[1], Margaret Browne[2], Mairéad M. Fitzimmons[2] Vincent Gallagher[2], , Eric C. Grunsky[2], Victoria Lowe[2], Karen Daly[1]

[1] Environment, Soils and Land Use Department, Teagasc, Johnstown Castle Research Centre; [2] Geological Survey Ireland, Beggar's Bush, Haddington Road, Dublin, D04 K7X4, Ireland.

**Summary:**

- 9,921 samples in the northern half of Ireland covering a range of soil types and landscapes have been used to produce a range of agronomic indicators of soil fertility and environmental risk.
- One sample per 4 km$^2$ or 1 km$^2$ in Dublin and Galway has been analysed for soil nutrient analysis of pH,%OM, Al, Ca, Co, Cu, Fe, Mg, Mn, P and Zn, and many trace elements.
- Maintaining the soil pH at the optimum level increases the microbiological activity of the soil and results in better soil nutrient recycling/availability and soil health.
- Soil organic matter is the foundation for healthy and productive agricultural soils, and is central to a range of soil functions and ecosystem services. Soil organic matter is important for a soil's physical, chemical, and biological health.
- The P Index depends on the level of available P in soil. This is determined by measuring the amount of the element that is extracted by Morgan's solution. Soil analysis levels are classified into Index 1-4, (1) Very Low, (2) Low, (3) Medium and (4) High.
- To minimise possible losses of nutrients to the environment, the Good Agricultural Practice for Protection of Waters Regulations 2010 requires that the fertilisation rates for soils which have more than 20% organic matter shall not exceed the amounts permitted for Index 3 soils.
- Al is highly correlated with P buffering capacity & solubility and therefore soils with high Al concentration may have lower P bioavailability when pH is not at optimum level.

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/news--events/news/2018/terra-soil-launched.php

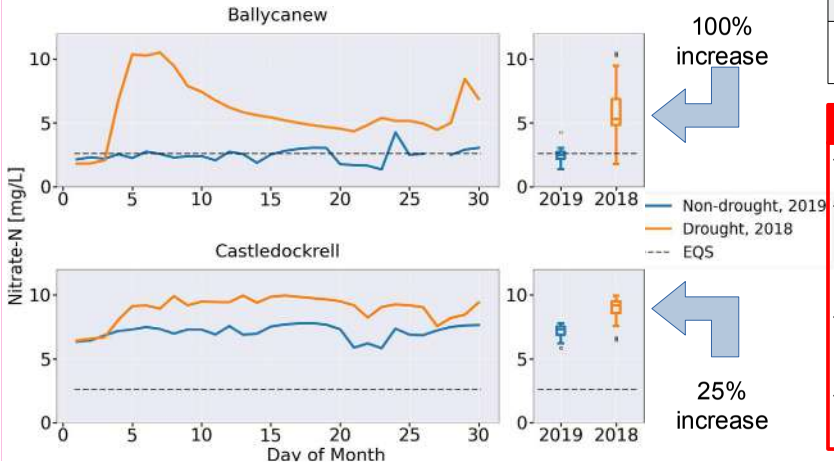
**GSI Website:** https://www.gsi.ie/en-ie/programmes-and-projects/tellus/activities/tellus-product-development/smart-agriculture/Pages/Terra-Soil.aspx

**Email:** rebecca.hall@teagasc.ie; karen.daly@teagasc.ie; mairead.fitzsimons@gsi.ie

# Climate Change and Water Quality

## What is the impact of drought on N losses?

Stream N concentrations for the month of November after a dry summer compared to a normal summer.




## Catchment Characteristics

Two river catchments with different biophysical & land use characteristics

| Catchment | Landuse | Soil | Typical risk |
|---|---|---|---|
| Ballycanew | Grassland | Poorly-drained | P loss |
| Castledockrell | Arable | Well-drained | N loss |

## Take home messages

- ✓ Climate impacts water quality
- ✓ Droughts can cause increased rate of N-mineralization, potentially leading to high losses at the next rainfall event
- ✓ Catchment characteristics will determine the relative severity of climate impacts.
- ✓ Catchments which typically are not N-risky can become so under drought conditions.

# The Impact of Climate Change on Water Quality

Jason Galloway

Agricultural Catchments Programme, Teagasc, Johnstown Castle.

**Summary:**

The Agricultural Catchments Programme (ACP) was established in 2009 to evaluate the effectiveness of Ireland's Nitrate Action Plan (NAP). Long-term measurements of stream water nutrient concentrations (nitrate and phosphate), along with supporting information relating to climate, land use and soil characteristics has allowed the ACP to examine the impact of climate change on water quality. Here results are presented showing the impact of drought in two agricultural catchments in County Wexford.

- During drought rates of N-mineralization are greatly increased which can led to a substantial build-up of N. At the same time drought stress on plants leads to drastically reduced uptake of N.
- Depending on catchment characteristics, this can lead to a greatly increased risk of N loss.
- Drought led to an increase in nitrate (N) concentrations in 2 agricultural catchments in Co. Wexford.
- The size of this increase varied greatly between catchments, with drought contributing to a 100% increase in stream water nitrate concentrations in Ballycanew compared to a 25% increase in Castledockrell.
- Climate change can cause areas which typically are not considered to be vulnerable to nitrate losses to become so. During extreme climate events care should

## Other resources & online information

**Twitter:** @ TeagascACP

**Websites:** https://www.teagasc.ie/environment/water-quality/agricultural-catchments/

https://www.acpmet.ie/

**Email:** jason.galloway@teagasc.ie

# Pinch Points for Prevention of Nutrient & Sediment Losses

## Where are the typical pinch points?

- Open Drains and Internal Farm Roadways can be pathways for mobilised nutrient and sediment loss to waters. Need to find these "pinch points".

### MAP OPEN DRAIN RISK


| | | |
|---|---|---|
| RED | Category 1 | Farmyard Connection |
| PURPLE | Category 2 | Outlet |
| ORANGE | Category 3 | Outflow |
| YELLOW | Category 4 | Secondary |
| GREEN | Category 5 | Disconnected |

### MAP ROADWAY RUNOFF RISK


- Soiled roadway Runoff has same profile as dairy soiled water
- Losses also occur from roadway materials that store nutrients
- Look for connections at underpasses, farmyards, bridges
- Look for connections directly into rivers or open drains

Prioritise Pinch Points for Management

## Funding

- EPA Research Programme 2014-2022.
  - Roadrunner & WaterMark

## Take home messages

- ✓ Open drains where present need to be ranked in terms of their connectivity risk for P & N loss to waters.
- ✓ Highest ranked risk are open drains connected to the farmyard and roadway runoff.
- ✓ Roadway runoff is rich in nutrients and sediment & connectivity with waters must be prevented all year round.
- ✓ Need right measure in the right place

# Finding Pinch Points to Prevent Nutrient and Sediment Losses to Water from Open Drains and Farm Roadways

Owen Fenton[1]; Karen Daly[1]; Patrick Tuohy[2]; John Murnane[3]

[1]Teagasc, Johnstown Castle; [2] Teagasc, Moorepark; [3]University of Limerick

**Summary:**

- Connectivity between farm roadway runoff, open drains and waters must be broken (by law) on all farms.
- Farm roadway runoff and open drain waters contain nutrients and sediment that negatively affect water quality during both the open and closed periods of the year.
- Connectivity between roadway runoff and waters occurs during rainfall and is worst nearer the farmyard where the source of nutrients is highest.
- Connectivity only occurs at a few locations on any roadway network such as direct runoff into waters (open drains, rivers, streams) or indirect runoff (underpasses, main roads, farmyards).
- Breaking roadway runoff connectivity at each location will require a bespoke solution.
- There are five categories of open drains: farm connection; outlet; outflow; secondary and disconnected. The farmyard connection presents the highest risk in terms of nutrient and sediment loss.

## Other resources & online information

**Twitter:** @ROADRUNNER_Project

**Teagasc Website:** https://www.teagasc.ie/publications/2021/the-farm-roadway-visual-assessment-booklet.php

**Google "Roadway Runoff Visual Assessment Booklet". This will guide the user of the booklet to locate connectivity points between roadway runoff and waters on any farm.**

**Email:** owen.fenton@teagasc.ie; karen.daly@teagasc.ie

# Land Drainage Design

## Problem Diagnosis

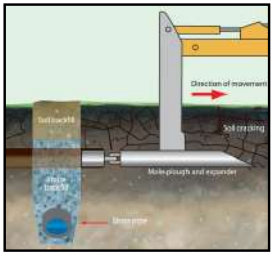
In Mineral soils:

- Soil Test Pits - at least 2.5 m deep
- Design varies with soil type
- Water enters through permeable layers
- Other layers need help

## Shallow Drainage System

Mole/Gravel Mole drain/Subsoiling:

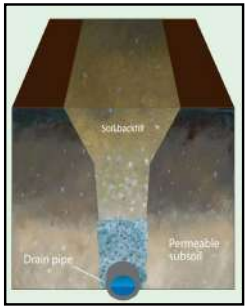
- Aim to fracture and crack the soil
- Effectiveness depends on:
  - Soil clay/stone content
  - Implement used
  - Weather conditions
- In tandem with collector drains




## Groundwater Drainage System

Field Drains, typically at 1-2 m depth:

- Exploit permeable layers
- Collect and discharge groundwater
- Effective control of the water table



# The Drainage of Mineral Soils

Pat Tuohy[1] and Owen Fenton[2]

[1]Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork; [2]Teagasc, Johnstown Castle, Environment Research Centre, Wexford.

**Summary:**

- Two main types of drainage system exist: a groundwater drainage system and a shallow drainage system. The optimum system and its design depend entirely on soil drainage characteristics.
- With appropriate drainage, grass production has been shown to increase by between 4 and 7 t DM/ha per year.
- The objective of any form of land drainage is to remove excess water from the soil, to lower the water table, and to reduce the period of waterlogging. This lengthens the growing season, the grazing season, the utilisation of grazed grass by livestock and the accessibility of land to machinery. Drainage of poorly drained mineral soils has positive effects on greenhouse gas emissions by reducing losses of nitrous oxide, while drainage is linked to carbon loss on carbon-rich soils, such as peats. Therefore, these should not be drained. A number of drainage techniques have been developed to suit mineral soil types.
- There are two main categories of land drainage: Groundwater drainage system: A network of deeply installed field drains exploiting permeable layers. Shallow drainage system: Where the permeability is low at all depths a shallow system, such as mole or gravel mole drainage, improves soil permeability by cracking the soil and encourages water movement to a network of field drains.
- A number of test pits (at least 2.5 m deep) should be excavated within the area to be drained. These test pits should be dug in areas that are representative of the area as a whole. As the test pits are dug, observe the faces of the pits, establish the soil type and record the rate and depth of water seepage into the soil test pit (if any). Visible cracking, areas of looser soil and rooting depth should be noted as these can convey important information regarding the drainage status of the different layers. The depth and type of drain to be installed will depend entirely on the interpretation of soil characteristics.

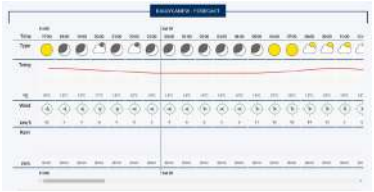
## Other resources & online information

**Teagasc website:** The Teagasc Manual on Drainage - and Soil Management is available online, www.teagasc.ie/publications and provides extensive information with regard to land drainage.

# ACP MET WWW.ACPMET.IE

## Hourly and Daily Summary Met data for all Catchments

## Forecast from Met Éireann



## Satellite Soil Moisture Content

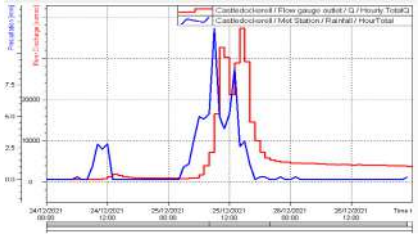
Volume of Water in the soil m3/m3 signal depth of 5-10 cm

Ballycanew, Co. Wexford 18th July 2022

## Christmas Day Castledockerell, Co. Wexford

| Date | Rainfall Daily Total (mm) | PE Daily Total(mm) |
|---|---|---|
| 24/12/2021 | 9.2 | 0.4 |
| 25/12/2021 | 62.8 | 0.1 |
| 26/12/2021 | 0.4 | 0.8 |
| 27/12/2021 | 2 | 0.1 |
| 28/12/2021 | 4.6 | 0.8 |
| 29/12/2021 | 9 | 2.6 |
| 30/12/2021 | 14 | 0.3 |

## River Flow and Rainfall



# Current and Recent Weather in Six ACP Catchments

Una Cullen

Agricultural Catchments Programme, Teagasc, Johnstown Castle.

**Summary:**

The Agricultural Catchments Programme (ACP) established a website giving farmers access to weather data generated from seven met stations in our catchment areas. Data is transferred from each met station every hour to the website where total or mean hourly and daily values are displayed for Rainfall, Air Temperature, Soil Temperature, Wind Speed, Wind Direction and Potential Evapotranspiration. The previous ninety days data is available for each catchment station. This data can be downloaded in csv (comma-separated values) format which can be opened with Microsoft Excel.

The website also gives local forecasts, weather warnings and general farming remarks for each catchments areas. This information is provided by Met Éireann. The most recent addition to this website is volumetric soil moisture content for all catchments. This is calculated from NASA space agency satellite sensors.

**Parameter Details:**

- Rainfall in mm is the total hourly or daily amount
- Air temperature is degrees Celsius and is the average figure
- Average soil temperature is recorded at a single location at 10 centimetres depth
- Average wind speed and is displayed in kilometres per hour
- Average wind direction and is recorded in degrees. The Arrow is pointing in the direction the wind is coming from
- Potential Evapotranspiration is the amount of water that could be transferred from soil to the air by evaporation from the soil (and other surfaces) and by transpiration from plants, where there is complete crop cover and no shortage of water in the soil. It is calculated from recorded Air Temperature, Relative Humidity, Solar Radiation and Wind Speed using the Penman–Monteith equation.

Also shown on the board is data for Christmas day, 2021. 62 mm of rain was recorded in our Castledockerell station on that day. The associated river flow discharge for the same time period is shown on the graph.

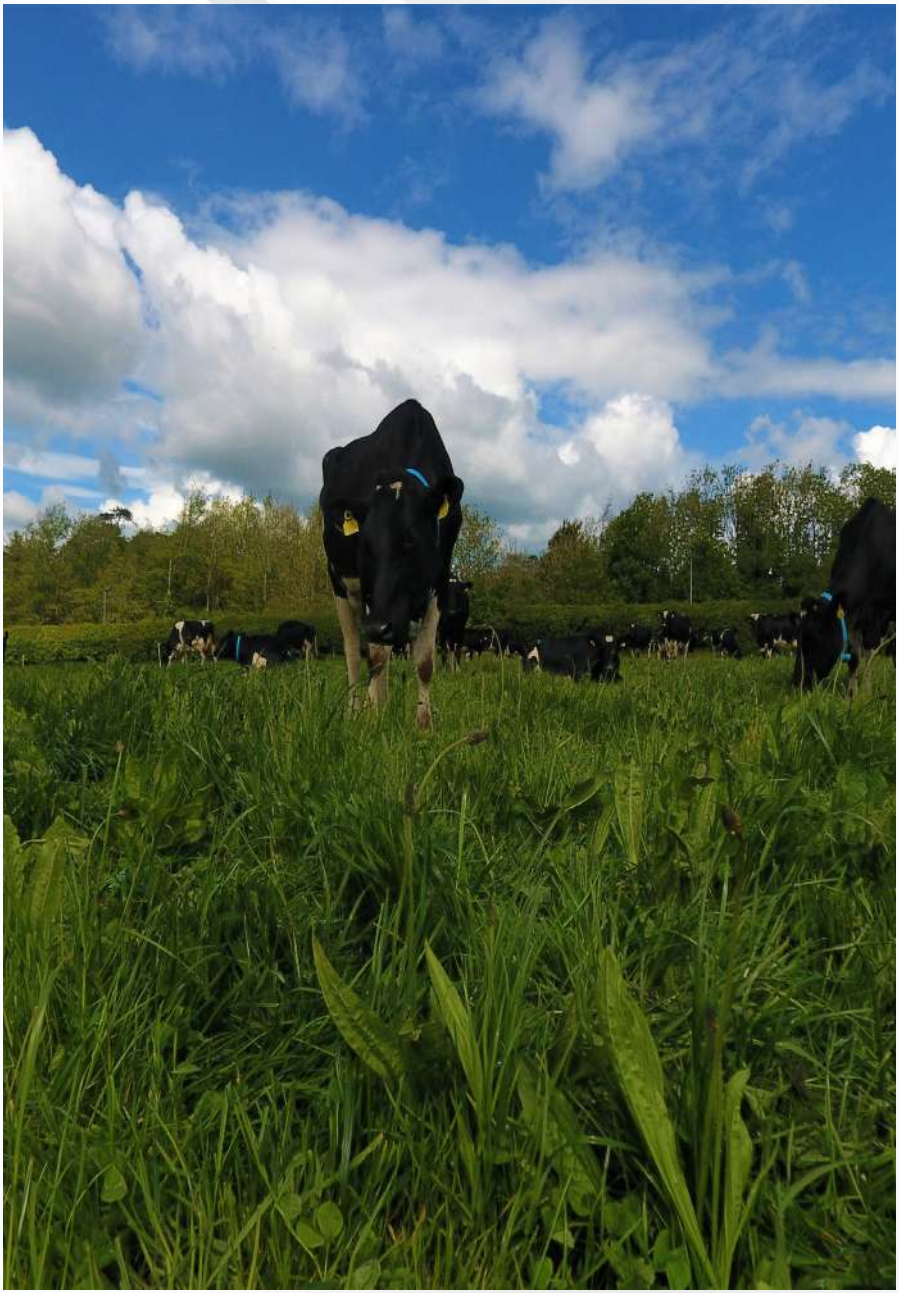
## Other resources & online information

**Twitter:** @ TeagascACP:

**Websites:** https://www.teagasc.ie/environment/water-quality/agricultural-catchments/

https://www.acpmet.ie/

**Email:** una.cullen@teagasc.ie



# Livestock Systems

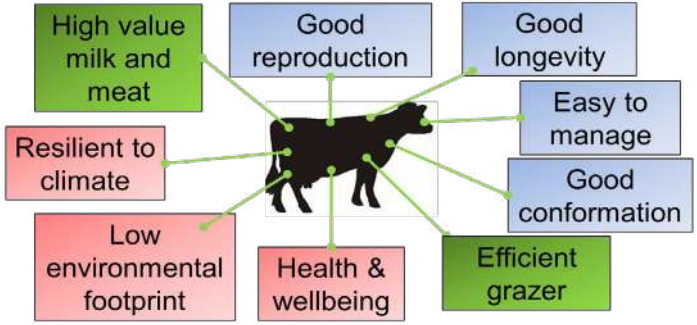
## FARMING FOR A BETTER FUTURE

# Future-Proofing your Herd Genetics

## Co-op Performance

| | Spring | Winter | Johnstown |
|---|---|---|---|
| *Production* | | | |
| Milk | 5354 | 5843 | 6737 |
| Solids | 431 | 461 | 564 |
| Fat % | 4.27 | 4.2 | 4.43 |
| Protein % | 3.58 | 3.51 | 3.72 |
| *Fertility* | | | |
| Calving Int | 384 | 414 | 374 |
| 6 wk % | 70 | 50 | 83 |
| % AI Bred | 62 | 65 | 100 |
| % heifers calved @ 22-26mths | 75 | 47 | 100 |
| EBI | 126 | 101 | 186 |

## Cow of the future




## Take home messages

**EBI continues to deliver across all dairy systems**

- **Cumulative**
- **Permanent**
- **No Additional Cost**

# Future-Proofing your Herd Genetics

James Dunne[1,2]

[1]Teagasc Ballyhaise College, Co. Cavan
[2]Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork.

**Summary:**

- Higher EBI herds outperform their lower EBI contemporaries
- The EBI continues to evolve to deliver profitable, low environmental hoofprint cows for the Irish dairy sector

## Introduction

The Economic Breeding Index (EBI) summarises the expected performance of an animal's progeny for a range of characteristics into a single euro value. The EBI is useful for comparing which cows to breed from and which dairy bulls to use. The daughters of a bull with an EBI of €300 are expected to be, on average, €100 more profitable per lactation (i.e., >€400 per lifetime) than the daughters of a bull with an EBI of €200. Analysis of average co-op performance data compared to that of the Johnstown castle research herd shows the potential to improve overall farm performance through improved herd genetics. The average EBI for the Johnstown herd stands at €186 placing it in the Top 5% of herds nationally.

## The Future Cow

The significance of being forward thinking is as important today as it has been heretofore. The characteristics of the dairy cow of the future are outlined. The characteristics highlighted in green are those that are well covered in the EBI; those in blue, while included in the EBI, can be improved and those in red require attention. Nonetheless, indirect improvement in the traits in red continue to be realised without explicit inclusion in the EBI to date. As a result the carbon footprint per kg fat and protein corrected milk yield produced by the modern high EBI cow is 14% less than the cow that existed at the introduction of the EBI. This has been achieved through a combination of improved milk solids yield, better reproductive performance and greater longevity. Hence, genetic gain through improving EBI is a major contributor to the abatement of carbon on Irish dairy herds, while also being economically advantageous to Irish farmers.

## Conclusion

The EBI continues to evolve and contribute towards improved performance and profitability on Irish dairy farms, as well as favourably impacting the environmental credentials of milk production.

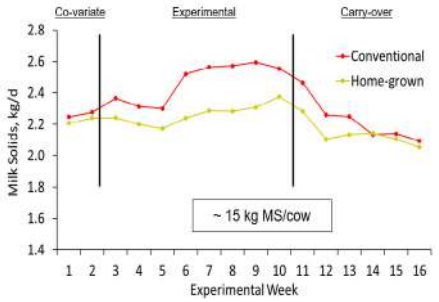
# Home-Grown Protein Sources

## Background

- European Union policy encouraging protein self-sufficiency
- Requirement to reduce the $CO_2$ footprint of dairy systems
- Objective: *Compare performance of autumn-calving cows fed faba beans and rapeseed meal ('**Home-grown protein**') with cows fed soybean meal and maize distillers ('**Conventional protein**')*

## Results

| Experimental period | Treatment | |
|---|---|---|
| **Item** | **Home** | **Conv.** |
| Milk yield, kg/d | 28.6 | 30.5 |
| Milk protein, % | 3.50 | 3.57 |
| Milk fat, % | 4.25 | 4.29 |
| MS yield, kg/d | 2.20 | 2.38 |




## Diet details

| Item | Home-grown | Conventional |
|---|---|---|
| Forage Ingred. | Maize/Grass silage | Maize/Grass silage |
| Concentrate Ingred. | Faba beans, rapeseed, beet pulp, barley | Soyabean, maize distillers, beet pulp, barley |
| Crude Protein, % | 16.2 | 16.2 |
| Starch, % | 16.5 | 16.5 |
| NDF, % | 36.7 | 36.7 |

## Take home messages

- ✓**Home-grown diets reduced animal performance**
- ✓**Likely due to inadequate metabolizable protein/AA supply**
- ✓**Further development of cost-effective solutions to nutrient limitation needed**

This experiment was funded by Teagasc Core Funding and the Dairy Research Ireland Dairy Levy Trust

# Evaluating the Milk Production Performance of Autumn Calving Cows, Utilizing EU-sourced Ingredients Including Faba Beans and Rapeseed, Relative to a Control System Utilizing Soybean Meal and Maize Distillers

Michael Dineen[1]; Aidan Lawless[2]; Joe Patton[1]

[1]Teagasc, Moorepark; [2]Teagasc, Johnstown Castle.

**Summary:**

- European Union policy heavily encourages protein self-sufficiency
- In addition, there is a requirement to reduce the carbon dioxide footprint of winter-milk systems
- The objective of this study was to evaluate the milk production performance of autumn calving cows fed faba beans and rapeseed meal, relative to cows fed soybean meal and maize distillers, as the primary dietary protein sources
- Although diets were similar in terms of crude protein and energy concentration, home-grown diets containing faba beans and rapeseed reduced animal performance relative to a control system containing soybean meal and maize distillers
- The reduction in performance was likely due to inadequate metabolizable protein/AA supply
- Further investigation is required to develop cost-effective approaches to overcome the nutrient limitation when home-grown protein sources are included in winter-milk diets

## Other resources & online information

**Website:** https://www.teagasc.ie/animals/dairy/research-farms/johnstown-castle/

**Email:** michael.dineen@teagasc.ie; aidan.lawless@teagasc.ie; joe.patton@teagasc.ie

# Perennial Ryegrass vs. Multi-species Swards

## Background

- Multi-species sward (**MSS**) annual dry matter yield superior to perennial ryegrass (**PRG**) monoculture in cut plots conditions at Johnstown Castle
- Question: How will grazing **MSS** swards affect animal performance?
- Objective: *Compare **MSS** performance to **PRG** swards at farmlet scale under grazing with dairy cows across full lactation cycle*

## Results (2020-2021)

| Sward parameters | Treatment | |
|---|---|---|
| Item | PRG | MSS |
| Annual herbage, t DM $ha^{-1}$ | 15.0 | 14.2 |
| Pre-grazing mass, kg DM $ha^{-1}$ | 1,505 | 1,469 |
| Post-grazing height, cm | 4.23 | 3.88 |
| Chemical N, kg $ha^{-1}$ | 195 | 73 |
| Concentrate fed, kg DM $cow^{-1}$ | 784 | 853 |

| Animal parameters | Treatment | |
|---|---|---|
| Item | PRG | MSS |
| Milk yield, kg/lactation | 6,777 | 6,845 |
| Milk protein, % | 3.65 | 3.61 |
| Milk fat, % | 4.30 | 4.26 |
| MS yield, kg/lactation | 546 | 547 |

## Experimental design

| Item | PRG | MSS |
|---|---|---|
| Sward species | PRG + WC (10%) | Grasses + clovers + herbs |
| Cows | 20 | 20 |
| Stocking rate | 2.6 | 2.6 |
| Pre-grazing mass, kg DM $ha^{-1}$ | 1,500 | 1,500 |
| Post-grazing height, cm | 4 | 4 |

## Take home messages

- ✓**Milk production similar for PRG&MSS**
- ✓**Annual herbage production reduced, albeit with reduced fertilizer N input**
- ✓**Results are from the first two years of a long-term study - further work will investigate sward persistency, etc.**

This experiment was funded by Teagasc Core Funding and the Dairy Research Ireland Dairy Levy Trust

# Multi-species Swards: Grazing Trial at Johnstown Castle

Aidan Lawless[1]; Michael Dineen[2]; Joe Patton[2]; David Wall[1]; John Finn[1]

[1]Teagasc, Johnstown Castle; [2]Teagasc, Moorepark.

**Summary:**

- Multi-species swards (MSS) have shown several agronomic and environmental benefits in plot trials, such as increased dry matter yield when compared with a perennial ryegrass (PRG) monoculture
- To test MSS in a grazed system, a grazing trial with two high-EBI spring-calved dairy herds is ongoing at Teagasc, Johnstown Castle
- Overall, dairy cattle on MSS performed similarly to a herd on PRG
- Annual herbage production was reduced for MSS when compared with PRG, albeit with reduced fertilizer nitrogen input (195 and 73 kg N $ha^{-1}$ $yr^{-1}$ for PRG and MSS, respectively)
- Results to date have been very promising and the reduction in nitrogen inputs are very significant
- It is envisaged that this systems trial will run for a further five years and hopefully answer some key questions
- These include sward persistency and changes to sward composition over time, cow health and production, long-term annual forage production, methods to rejuvenate the sward (if needed), benefits of more diverse swards for the soil structure, greenhouse gas emissions, water quality, soil carbon sequestration, and biodiversity effects

## Other resources & online information

**Website:** https://www.teagasc.ie/animals/dairy/research-farms/johnstown-castle/

**Email:** aidan.lawless@teagasc.ie; michael.dineen@teagasc.ie; joe.patton@teagasc.ie; david.wall@teagasc.ie; john.finn@teagasc.ie

# DairyBeef 500 Campaign

## New 5-year Teagasc campaign focused on sustainable dairy-beef production

### Key pillars of campaign

- **Knowledge Transfer supporting programme**
  - *Ballyvadin demo farm*
  - *DairyBeef 500 demo farms*
- **Education providing programme**
  - *Upskilling of farmers, advisors, lecturers and students*
- **Research led campaign**,
  - Disseminating latest findings and technologies
- **Regular communication outputs**

### Campaign objectives

- Net profit of €500/ha (ex. land, labour & subsidies)
- Reduced age of slaughter
- Reduced carbon footprint
- Improve beef merit of dairy-beef calves
- Provide training courses to new entrants and existing dairy-beef producers

# Teagasc DairyBeef 500 Campaign

Alan Dillon[1] , Sean Cummins[2], Tommy Cox[3], Fergal Maguire[4]

[1]Teagasc Advisory Offices Gortboy, Kilmallock, Co. Limerick, [2]Teagasc Kildalton, Piltown, Co. Kilkenny, [3]Teagasc Advisory Office, Mohill, Co. Leitrim, [4]Teagasc Grange Beef Research Centre, Dunsany, Co. Limerick.

**Summary:**

In response to the changes in both dairy and beef systems, Teagasc have developed a new campaign which focuses on dairy-beef production. The DairyBeef 500 Campaign will include a number of current dairy-beef projects, including: Green Acres Dairy Calf to Beef Programme; male dairy calf contract-rearing and dairy calf-to-beef systems studies; and the evaluation of beef sires from across a range of breeds for crossing on the dairy herd. Additionally, the campaign will collaborate with existing Teagasc programmes, which will include the new Teagasc Signpost Farm Programme and the Grass10 Campaign.

The DairyBeef 500 Campaign has set a target of €500 net profit per ha (excluding own labour and land charge). It is envisaged that the programme will consist of beef farmers with a wide range of intensities. On intensive farms, the objective will be to grow and harvest as much grass as possible, supporting high carcass output per hectare. On more extensive farms, there will be a greater emphasis on maximising carcass output per head, implementing systems of lower stocking intensities focused on the provision of environmental ecosystem services, although systems of lower carcass output per hectare; the optimum mix will depend on the individual farmer's circumstances and priorities.

## Objective of DairyBeef 500

The primary objective of the DairyBeef 500 Campaign will be to promote the adoption of best practice at farm level to increase the future viability and sustainability of the Irish beef sector. It will promote greater integration of the dairy and beef sectors through the adoption of key technologies on farms to enhance the competitiveness of dairy-beef systems and ensure a reliable outlet for calves from the dairy herd that meet certain quality and health criteria.

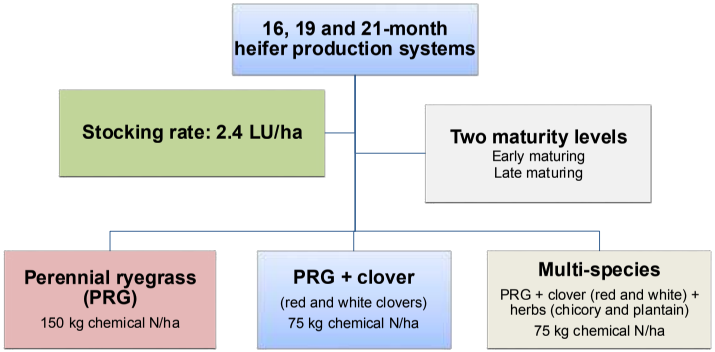
The programme aims to:

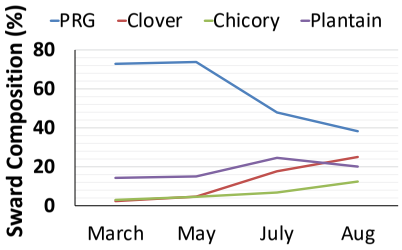
- Target a net margin of €500 per hectare excluding land and family labour.
- Increase the adoption of best practices, especially in relation to grassland management and calf rearing.
- Reduce the environmental footprint of dairy-beef production.
- Establish a cohort of profitable dairy-beef producers.
- Create greater integration between beef and dairy industries.
- Improve the beef merit of calves coming from the dairy herd.

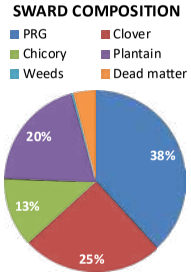
The overall aim of the DairyBeef 500 Campaign is to promote and demonstrate dairy-beef systems which are socially, environmentally and financially sustainable.

# Johnstown Castle Dairy-Beef research

- **Focused on sustainable dairy-beef production systems**
  - **Profitable, low environmental impact and socially acceptable**
    - Systems of reduced slaughter age
    - Reduced dependence on N inputs



# Johnstown Castle Dairy Calf-to-Beef Research

Nicky Byrne[1], Ruth Dunne[2], David Wall[2], and Padraig French[3]

[1]Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath, [2]Teagasc, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford, [3]Teagasc, Moorepark Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork.

Recent dairy-beef systems research at Teagasc Johnstown Castle has focused on the impact of stocking density on physical animal and system performance of heifer and steer production systems. High stocking rates (SR) play an important role in supporting dairy-beef systems of high carcass output/ha, but it is essential that the SR implemented is aligned with farms grass growth and utilisation potential. When compared against 'low' and 'high' SR, the grass growth, utilisation and provision of winter feed of 'medium' SR dairy-beef systems (heifer and steer) was best aligned with herd demand and had no negative impact on animal performance, unlike 'high' SR which reduced animal performance and produced insufficient winter feed. Plot-based studies at Johnstown Castle have highlighted the potential benefit of multi-species swards for increased dry matter (DM) production under reduced levels of chemical nitrogen (N) and improved drought tolerance, relating this increased DM production to increased clover content.

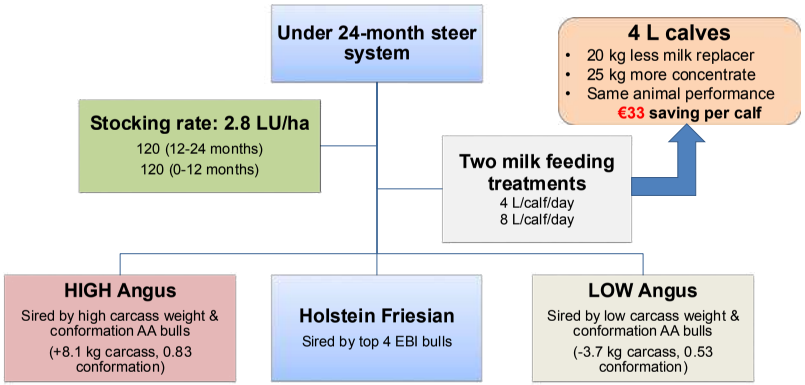
Based on this previous animal and plot research and the policy ambition to reduce agricultural emissions by between 22% and 30% by 2030, mainly through reduced N use and reduced slaughter age, a new project has been put in place at Johnstown Castle to investigate if the benefits of MSS are maintained under grazing at a 'moderate' SR and what impact the inclusion of clovers and herbs have on animal and farm system economic and environmental performance. Three farm systems of differing sward types: grass-only (perennial ryegrass - 150 kg N/ha), grass-clover (perennial ryegrass + red and white clover – 75 kg N/ha) and multi-species (perennial ryegrass + red and white clover + plantain + chicory – 75 kg N/ha), were established. Each farm system will implement a heifer production system, stocked at 2.4 LU/ha or 190 kg organic N/ha, keeping in line with the expected DM production potential of the various sward types.

This project aims to develop more profitable and environmentally efficient dairy-beef heifer production systems, through evaluation of contrasting dairy-beef animal types (Early vs. Late-maturing high beef genetic merit genotypes), low-cost grass-forage-only diets and contrasting slaughter ages (16, 19 and 21 months of age). This study provides the optimum environment to assess the persistence of multi-species swards within an intensive pasture-based system, by measuring DM yield stability and population change of component species overtime. The contribution of sward type to calf performance over their first grazing season is of particular interest, as this is a period of underperformance on commercial farms with calves often failing to meet live weight targets, contributing to a wide range in slaughter performance of dairy-beef cattle (age, weight, conformation and fatness).

This project will increase the level of information on pasture-based dairy-beef heifer production, as much of the current information is focused on steer production systems. The information generated will contribute to improved production blueprints for profitable and environmentally sustainable dairy-beef systems, focused on reduced slaughter age and improved N use efficiency (minimising the level of N fertiliser and concentrate, while maintaining high carcass output).

# Grange Dairy Calf-to-Beef System Evaluation

- **57% of carcasses processed are of dairy origin**
  - More animals failing to meet carcass specifications
  - High dropout rate in farmers who purchase calves
  - Increasing need and demand for higher quality dairy-beef calves




## Physical, financial and environmental performance

| | HF | HIGH AAX | LOW AAX |
|---|---|---|---|
| Age at slaughter (months) | 22.8 | 21.8 | 21.8 |
| Carcass weight (kg) | 300 | 305 | 300 |
| Carcass conformation | O- | O= | O= |
| Carcass fat | 3= | 3+ | 3+ |
| Carcass output/ha (kg) | 960 | 976 | 960 |
| $CO_2$ eq per carcass kg | 14.2 | 12.9 | 13.2 |
| Human edible protein ratio (kg/kg) | 0.75 | 1.05 | 1.02 |
| Net margin (€/ha) | 462 | 728 | 607 |

## Take home message

**Using high carcass merit sires on the dairy herd will:**

- ✓ **Improve profitability of beef farms**
- ✓ **Reduce GHG emissions**
- ✓ **Produce additional human edible protein**

# Grange Dairy Calf-to-Beef System Evaluation

Nicky Byrne[1], Donall Fahy[1], Jamie O'Driscoll[1], Mark Kearney[1] and Noirin McHugh[2]

[1]Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath, [2]Teagasc, Moorepark Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork.

A recent study at Grange looked at the effect of sire genetic merit for carcass weight and conformation on dairy calf-to-beef system performance. The objective was to compare the physical and financial performance of male progeny from three dairy-beef genetic groups, within an efficient grass-based production system. The sire genetic groups were Holstein-Friesian (HF) and two Angus (AAX) groups representing the main calf breeds born in the dairy herd. The HF group were the progeny of the top four sires on the Economic Breeding Index (EBI) active bull list in the previous breeding season. The two AAX groups were the progeny of AA sires that were ranked high (HIGH AAX) or low (LOW AAX), for carcass weight and conformation score. All progeny were from HF dams and sired by AI bulls.

The effect of early-life calf nutrition (indoors) on lifetime performance was evaluated. Half the calves in each of the 'genetic' groups received either 4 or 8 litres (L) of milk replacer/day. An intensive grass-based system of production was implemented with 48-hour grass 'allocations' grazed to a 4-cm sward height. When housed for the 'first' winter, steers were offered high dry matter digestibility (DMD >72%) grass silage ad-libitum and 1.5 kg of concentrates per head daily. In the indoor finishing period, steers were offered high DMD grass silage ad-libitum and 5 kg of concentrates per head daily. Steers were body condition scored (BCS) fortnightly during the 'finishing' phase, and drafted for slaughter at a BCS of 3.75 (scale 1-5), equating to a target carcass fat score of between 3= and 4-.

There were no differences in lifetime growth or carcass performance of calves reared on 4 or 8 L of milk/day. The HIGH and LOW AAX steers had the same slaughter age and finishing period (63 days), which was one month shorter than HF steers. Over the calf-rearing phase the average daily live weight gain (ADG) for each genetic group was 0.70 kg. During the 'first' grazing season ADG for HF, HIGH AAX and LOW AAX were 0.79, 0.71 and 0.74 kg, respectively. Corresponding values during the 'first' winter were 0.67, 0.73 and 0.76 kg, and during the 'second' grazing season were 0.98, 1.04 and 0.98 kg and during the 'finishing' period were 0.94, 1.04 and 0.98 kg. There were small differences in carcass weight and conformation score between the AAX groups (numerically in favour of HIGH AAX). The HF steers had a similar carcass weight but were leaner and more poorly conformed than the AAX groups, which resulted in a lower carcass value. Over their lifetime AAX groups consumed a total of 549 kg of concentrate (fresh weight) compared to HF steers consuming 695 kg.

HIGH AAX steers achieved the highest net margin, due to their improved carcass weight and conformation and value/kg carcass, and both AAX groups performed better than HF steers due to higher carcass performance and shorter finishing period. The HIGH AAX steers had the lowest 'carbon footprint', producing 9% less $CO_2$ eq per carcass kg than HF steers. An alternative means of assessing the efficiency of ruminant production systems is food-feed competition, which examines the ratio of human edible protein produced (meat) versus human edible protein fed to cattle (grain). Both AAX groups were net producers of human edible protein, whereas HF steers produced 25% less protein than they consumed in their production, meaning for 1 kg of human edible protein fed to cattle only 0.75 kg of human edible protein was produced in the form of meat.

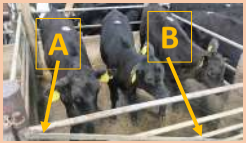
# Genetics of Dairy-Beef

**Dairy beef index (DBI)**
- Use to select beef bulls for breeding
- Easy calving good carcass traits

**Sire advice**
- Selects mating of beef bull for dairy cows
- Maximises calf beef merit

**Commercial Beef Value (CBV)**
- Identifies the most profitable animals for slaughter
- Non-breeding beef farmers
- Key profit traits for finishers

**Which calf is the most profitable????**




CBV €21 CBV €131
Predicts €110 of difference

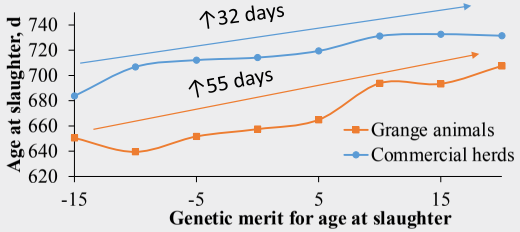
Slaughter performance

| Calf A | Calf B |
|---|---|
| 289Kg | 316Kg |
| O= 4- | O= 3+ |
| 653 days | 648 days |

@ 450 c/kg
€122 difference

**Breeding for age at slaughter**

Economically and environmental important
- Younger slaughter = ↓Feed costs, ↓ labour, ↓ housing requirement, ↓methane
- Breeding values will be launched in Autumn 2022 by ICBF




- DBI is a breeding index for dairy farmers to select beef bulls
- CBV is an economic value for non-breeding beef farmers
  - Identifies more profitable animals at slaughter
- Age at slaughter is a new trait to improve slaughter age

# Breeding Tools: Improving the Genetics of Dairy-Beef

Alan Twomey[1], Andrew Cromie[2], Nicky Byrne[3]

[1]Teagasc, Moorepark Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork; [2]Irish Cattle Breeding Federation, Ballincollig, Co Cork; [3]Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath.

**Summary:**

- **The genetic merit of animals in dairy-beef systems** has a large influence on overall farm performance. Advances in animal breeding have provided technologies to help aid both dairy and beef farmers improve the slaughter performance of dairy-beef animals.
- **Dairy Beef Index (DBI)**: The improvements in fertility of the dairy herd, coupled with the increased usage of sexed semen, will result in a reduced number of male off-spring sired by dairy bulls, and thus increase the number of calves sired by beef bulls. The DBI is a breeding tool to help dairy farmers select beef bulls which are easy calving and short gestation (which are both economically important to the dairy farmer), as well as being good for beef traits, such as carcass weight and conformation. It is a 'win-win' for both beef and dairy farmers, a more saleable calf for dairy farmers and a higher performing animal for slaughter for beef farmers.
- **Sire advice:** To maximise the beef potential of the beef calf crop from dairy herds, the ICBF sire advice tool now includes a dairy-beef mating option. This tool identifies the best matings to ensure that calving ease is maintained but importantly that beef potential is maximised. For example older cows are less likely to have calving difficulties so the sire advice will prioritise larger bulls to these cows to ensure higher value beef calves are produced.
- **Commercial Beef Value (CBV):** The CBV was launched by the ICBF in 2021. This is a genetic value to aid beef farmers in the purchase of calves/ store cattle by giving them a better insight into the animal's genetic merit for beef traits. It compromises of five key traits that are important for animals destined for beef production/slaughter (i.e. non-breeding): carcass weight, carcass conformation, carcass fat, docility and feed intake. This is the first tool to allow non-breeding beef farmers to select animals based on their genetic merit and control the genetics of animal that enters into their beef system.
- **Breeding for age at slaughter:** New breeding values for age at slaughter will be available at the end of year, Although the current breeding objectives involves selecting animals that can breed heavier progeny at a specific age (i.e., faster growing), there are some animals within and across specific breeds that require extra days to reach 'fitness' (a sufficient carcass fat score) for slaughter. Animals that are older at slaughter require more 'feed days' and also are emitting methane for longer. These breeding values for age at slaughter are a good predictor of which animals will be slaughtered at a younger age. On average as the estimated breeding value for age increased by 5 days the actual difference between animals in the Grange dairy-beef research herd was 9 days and on 10 dairy-beef commercial herds was 5 days.

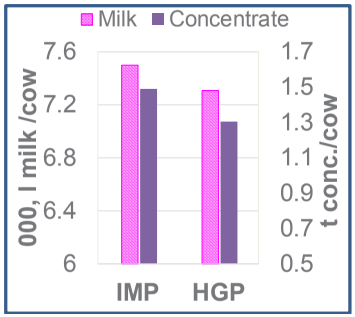
# Improving the Carbon Footprint of Winter Milk

## Why is Carbon Footprint important?

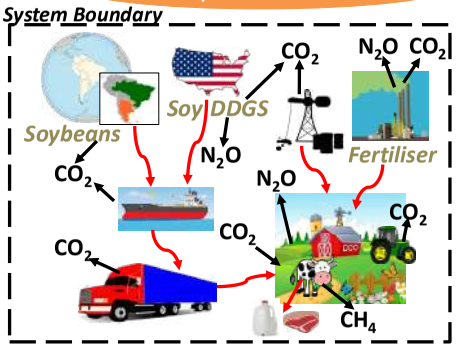
- Low carbon footprint becoming a market requirement
- Concentrate feeds important driver of carbon emissions
- Replaced imports (IMP) with homegrown (HGP) feedstuffs

## Modelling Carbon Footprint

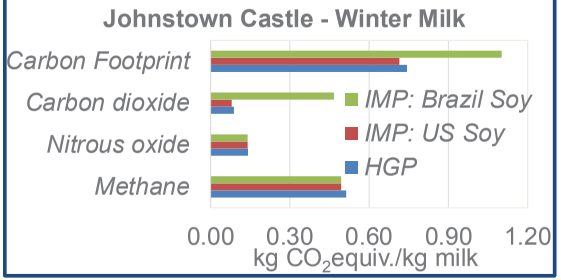
### Farm Characteristics




### Life Cycle Assessment




## Main Points




## Take home messages

- **Replacing least cost IMP with HGP feed reduced footprint despite yield penalty**
- **Suppliers should be compensated for feeding HGP or sustainable soybeans**

This work was funded by ERA-GAS (DAFM: 2019EN2011)

# Improving the Carbon Footprint of Winter Milk Production Systems

Donal O'Brien[1]; Joe Patton[2]; Aidan Lawless[1]; Marion Cantillon[1,3]; Mike Dineen[2]

[1]Teagasc, Johnstown Castle; [2]Teagasc, Moorepark, [3]University College Cork

**Summary:**

- To fulfil milk purchasers requirements in relation to sustainable sourcing, many Irish and EU dairy companies have committed to decreasing the carbon footprint of milk by about 20%-30% by 2030 and to net zero by 2050.
- Carbon footprint is an indicator of the amount of greenhouse gas (GHG) associated with a product, service or system. Milk production systems emit three major greenhouse gases, namely methane ($CH_4$), nitrous oxide ($N_2O$) and carbon dioxide ($CO_2$). These gases are expressed in terms of $CO_2$ to determine carbon footprint.
- Concentrate feedstuffs, particularly from regions where conversion of forests and grassland to arable land is common e.g., Latin America and South East Asia are a major driver of carbon emissions. Winter milk suppliers rely on imported feeds for protein during the housing period.
- The carbon footprint of a winter milk system feeding imported protein (IMP) was compared against a system offering homegrown feedstuffs (HGP). Both of these systems were located in Johnstown Castle. The standard winter milk system imported soybean and distillers dried grains (DDGS). The alternative winter milk system replaced imports with rapeseed meal and fava/field beans.
- Carbon emissions and removals from milk production were modelled according to the recommended methodology, life cycle assessment (LCA). The system boundary of the dairy LCA model extended from the extraction of raw materials through to the sale of milk and dairy cattle from the farm.
- In spite of producing slightly less (-2%) milk per cow, the winter milk system offering native feedstuffs (HGP) had a substantially (-32%) lower milk carbon footprint than the standard system reliant on imports. The reduction in milk yield and revenue associated with switching from imports to homegrown feeds may be avoidable through precision nutrition or by using sustainably produced feedstuffs. Both of these options incur extra costs that winter milk suppliers are unlikely to bear unless compensation payments are provided for reducing carbon emissions.

## Other resources & online information

**Twitter:** @ERAGAS_MELS

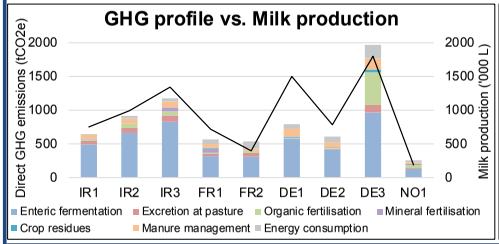
**Teagasc Website:** https://www.teagasc.ie/animals/dairy/research-farms/johnstown-castle/

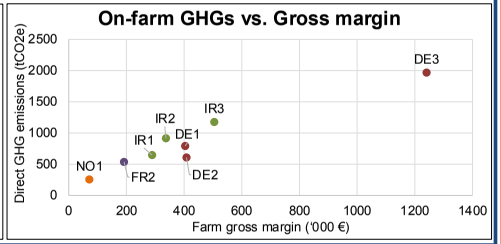
**Email:** donal.mobrien@teagasc.ie

# GHG Emissions on Dairy Farms

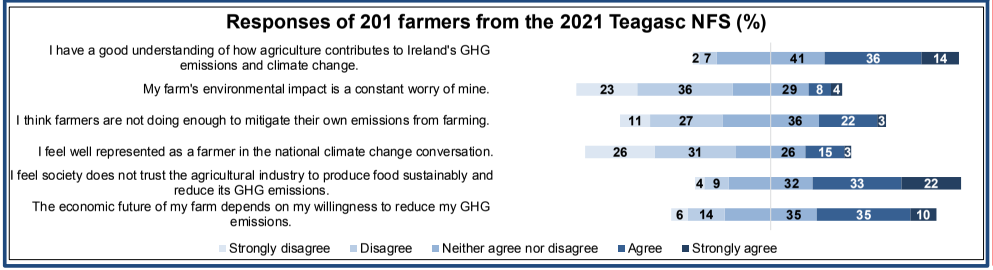
Funding

## Trade-off between economics and GHGs on European farms




## Perceptions of Irish dairy farmers around the GHG debate




## Take home messages

- **There is a trade-off between economic performance and GHG emissions on European dairy farms.**
- **57% of Irish survey respondents do not feel represented in the climate change conversation.**
- **45% agree that the economic future of their farm depends on their willingness to reduce GHG emissions.**

# GHG Emissions on Dairy Farms

Lorraine Balaine[1]; Úna Sinnott[2,3], Cathal Buckley[1]; James Breen[2]; Dominika Krol[3]

[1]Teagasc, Athenry; [2]University College Dublin; [3] Teagasc, Johnstown Castle

**Summary:**

- This research was conducted as part of the MilKey project, which explores the economic, environmental, and social dimensions of dairy sustainability. The work is divided into two parts: 1) a case study analysis of economic performance and GHG emissions on European farms and 2) a survey examining the perceptions of Irish dairy farms around the GHG debate.
- In the first part, 9 case study farms were selected, including 3 in Ireland (IR), 2 in France (FR), 3 in Germany (DE), and 1 in Norway (NO). Farms were chosen to represent national production systems. On-farm direct GHG emissions were estimated using the Intergovernmental Panel on Climate Change (IPCC) methodology, which is the same method that estimates national GHG emissions.
- The case study analysis reveals that the larger the gross margin, the higher the GHG emissions associated with farm production. There is thus a trade-off between economic and GHG performance.
- GHG emissions on European dairy farms come from enteric fermentation, excretion at pasture, mineral and organic fertilisation, crop residues after harvest, and energy consumption. Enteric fermentation is the largest contributor to dairy emissions.
- In the second part, survey data was collected from 201 Irish dairy farmers through the 2021 Teagasc National Farm Survey (NFS). The questions measured farmers' levels of (dis) agreement with statements regarding the GHG debate.
- Survey results indicate that farmers' perceptions around the GHG debate vary. Specifically:
  - 57% of respondents do not feel represented in the national climate change conversation.
  - 50% feel that society does not trust the agricultural industry to produce food sustainably and reduce GHG emissions.
  - Even though 45% agree that the economic future of their farm depends on their willingness to reduce GHG emissions, only 12% consider their farm's environmental impact as a constant source of worry.

## Other resources & online information

**MilKey Website:** https://www.milkey-project.eu/

**Twitter:** @EragasMilKey

**Email:** lorraine.balaine@teagasc.ie; una.sinnott@teagasc.ie; cathal.buckley@teagasc.ie; james.breen@ucd.ie; dominika.krol@teagasc.ie

# Multi-species Swards – Potential for Sustainable Beef Production?

**Challenges for Irish Beef Producers**
- ↓ Input costs & ↑ farm profit
- ↓ Environmental emissions
  Methane ($CH_4$) & Nitrogen (N)

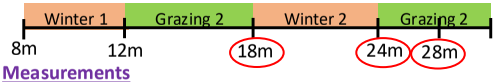
**Multi-species swards: ≥ 3 species**

| Grasses | Legumes | Herbs |
|---|---|---|
| PRG | White Clover | Chicory |
| Timothy | Red Clover | Plantain |

**Beef Production System Experiment**

**Grassland Treatments**
Multispecies (MSS) vs Grass-clover (GC)
→ Grazed & Conserved

**Production System**
- Suckler steer weanling-to-beef
- Late-maturing breed – genetically divergent in "fatness"
- 3 Slaughter ages – 18, 24 & 28 months




**Measurements**

**Herbage**
- Yield & nutritive value
- Seasonal changes & sward persistency

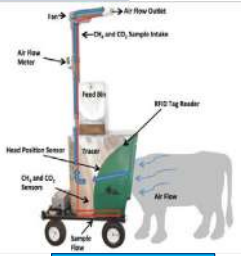
**Animal**
- Intake, digestibility & N-excretion
- Methane ($CH_4$) emissions & effect on rumen microbiome
- Growth & carcass traits

**Farm System Modelling**
€ & Greenhouse gases

**N-excretion**

**$CH_4$ measurement**

*In vitro* - RUSITEC



*In vivo* – Greenfeed

# Multi-species Swards – Potential for Sustainable Beef Production?

Marie O'Rourke, Sinead Waters, Alan Kelly and David Kenny

Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

## Introduction

Irish agriculture, has obligations under national, and EU legislation to reduce greenhouse gas (GHG) emissions and nitrogen (N) losses to the environment. In the context of beef systems, there is a particular focus on the reduction of biogenic methane. Increasing farm input prices, particularly fertilizer, has made low-cost efficient grass-based animal production systems more important than ever. Perennial ryegrass (PRG) has been the dominant constituent in grass seed mixtures to renew grassland. To fulfil its production potential, PRG requires fertile soil and high rates of inorganic N input. High inorganic fertilizer N costs and environmental impacts challenge the sustainability of this system.

## Grassland Management

In the context of PRG-only swards, or indeed multi-species swards, striking a balance between grass quantity and quality is of paramount importance. As grass matures, the concentration of fibre is increased in the sward, which can reduce digestibility of the grazing sward. A reduction in grass digestibility leads to an increase in enteric methane ($CH_4$) emissions by promoting the abundance of ruminal microbes associated with methane production. Therefore, optimal grazing management and the inclusion of various highly digestible forages have the potential to promote increased average daily gain in animals, reducing days to slaughter and consequently the $CH_4$ output of an animal in its lifetime.

## Multi-species Sward

Incorporating white clover into PRG swards or multi-species swards (MSS), reduces the chemical nitrogen requirements of the sward, reducing cost and nitrous oxide emissions. Some studies have demonstrated the $CH_4$ reduction potential of white clover and MSS, due to the increased sward digestibility. Furthermore, certain herbs, such as chicory, contain bioactive compounds which may impact the activity of rumen microbes as well as the VFA profile of the rumen.

## MSS & PRG/WC Research

Research at Teagasc Grange is investigating the implication of including white clover in PRG-dominated swards, and multi-species swards in a beef production system. There will also be an evaluation of ensiled PRG/WC and MSS mixtures over the indoor winter period. Methane output of MSS will be evaluated both in vitro using the artificial rumen simulation technique (RUSITEC), and in vivo using the Greenfeed system.

# Reducing Enteric Methane with Dietary Feed Additives

Teagasc Agriculture and Food Development Authority

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

**The 'METH-ABATE' project**
- **Develop methane reducing feed additives**
- **Slow release technology for pasture based delivery**
- **No negative effect on animal production/performance**
- **Farm level cost effectiveness analysis of feed additives**


*In vitro*


Sheep


Beef cattle



| Additive | $CH_4$ ↓ *in vitro* |
|---|---|
| *Asparagopsis taxiformis* | 68% |
| Brown seaweed | 36% |
| Brown seaweed extract | 15% |
| Olive by-products | 26% |

SEASOLUTIONS


Bovaer® (3-NOP)


Oxidising methane inhibitors



Brown seaweed / seaweed extracts


Fats/oils


Red seaweed

- ✓ **Fed in a TMR or included in concentrates 1x/2x per day**
  - **Develop into a slow release nut/long acting bolus**
- ✓ **No negative effects on dry matter intake, growth rate, health**
- ✓ **Mode of action - Use up hydrogen in the rumen**
  **- Alter the rumen microbiome**
  **- Inhibit the methane production process**

# Strategies to Reduce Enteric Methane Emissions from Irish Agriculture - Dietary Feed Additives

Emily Roskam[1], Caroline O'Donnell[2] and Sinead M. Waters[1]

[1]Teagasc Animal and Bioscience Research Department. Teagasc Grange, Meath, Ireland, [2] Microbial Ecology Laboratory, National University of Ireland, Galway

Enteric methane accounts for ~58% of Irish agricultural emissions. Supplementing ruminants with dietary feed additives, i.e. fats/oils, seaweeds, plant extracts, chemical oxidising methane inhibitors, Bovaer® (3-NOP) has the potential to reduce the amount of methane produced by directly affecting the methane producing pathway, altering the rumen environment to make the methane producing microbes less active or re-directing hydrogen to other sources and away from forming methane.

**Fats/Lipids:** The addition of fats/lipids high in poly unsaturated fatty acids (PUFAs), i.e. soya, linseed and rapeseed oil, to ruminant diets has shown to reduce methane production. PUFAs undergo biohydrogenation, meaning they utilise hydrogen in the rumen that normally is used for methane and unsaturated fatty acids become saturated. For every 1% increase in diet fat content, daily methane emissions are predicted to decrease by 3.77%.

**Seaweeds:** Seaweeds are traditionally used in animal nutrition due to their high mineral and protein content, the increased nutrient digestibility and anti-helminthic benefits. The tropical red seaweed, Asparagopsis taxiformis has attracted worldwide attention by consistently reducing methane output in sheep and cattle trials, with reductions of up to 80% recorded. The Irish climate is unsuited for the commercial production of Asparagopsis taxiformis. Hence, Teagasc are investigating the methane reducing capabilities of locally grown brown and green seaweeds.

**Bovaer®:** Developed by DSM, the synthetic compound Bovaer® (3-NOP), has been widely researched in dairy and beef animals. Bovaer® is broken down into compounds that are already naturally present in the rumen. It inhibits an enzyme required for the final step in methanogenesis and thus halts the methane production process. Bovaer® has to be fed continuously throughout the day for the continued suppression of methane. Further research is underway globally, to develop a slow release form of the product. The feed additive is approved for commercial application in the European dairy industry and was recently shown to reduce methane emissions by ~30% in beef cattle trials at Teagasc Grange.

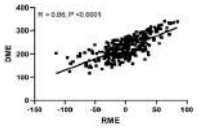
**Oxidising Methane Inhibitors (OMI):** The most novel feed additive assessed in Teagasc Grange to date, is produced by a Galway biotechnology company, Glasport Bio. These are synthetic compounds that have a 'dual action' approach to reducing methane production. The OMI inhibit the main microbial enzyme necessary for methanogenesis in the rumen. They also introduce oxygen into the rumen which reduces the activity of methane producing microbes. The OMI have been assessed using the RUSITEC system in Teagasc Grange, have been fed to sheep (Teagasc Athenry) and will be fed to dairy x beef bulls (Teagasc Grange) to assess their anti-methanogenic potential and effects on animal productivity.

# Breeding to reduce Methane Emissions

- Need to reduce agricultural Greenhouse gas emissions by 22-30% by 2030
- **Breeding:** Potential to permanently and cumulatively reduce methane emissions in future generations of livestock
- Enteric methane emissions - **heritable trait** ($h^2$ estimates = 0.19 to 0.30)
- Longer term strategy to lower methane emissions

**Beef Data and Genomics Programme** (BDGP) key to national roll out.

- **Higher genetic merit** (5 star) animals have significantly lower methane output/day
- **More efficient** – lower feed intake, slaughtered earlier, heavier carcass




**Current research** - Enteric methane emissions and performance data collected on > 1,000 beef cattle

**Residual methane emissions** (RME)

- optimal trait for ranking beef cattle in terms of $CH_4$ emissions
- Low RME animals produced ~30%
- Less $CH_4$ (g/day) and $CH_4$ (g/ kg carcass weight)
- No difference in animal productivity (DMI, RFI, ADG, carcass output) between high and low RME
- Genomically based breeding values for methane output being formulated
  - **Breeding** estimated to deliver a 1% annual reduction in $CO_2$eq
  - New **carbon sub-index** being developed for national dairy breeding programme

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

# Breeding Low Methane Emitting Beef Cattle

Paul Smith[1], David Kenny[1], Alan Kelly[2], Stuart Kirwan[1] and Sinéad Waters[1]

[1]Teagasc Animal and Bioscience Research Department. Teagasc Grange, Meath, Ireland, [2]University College Dublin, School of Agriculture and Food Science, Belfield, Dublin 4, Ireland

Methane, a greenhouse gas (GHG) produced during the breakdown of feed in the forestomach or rumen of cattle and sheep, accounts for 60% of Irish agricultural GHG emissions. A 10% reduction target for enteric methane emissions, by the end of 2030, has been set for the Irish agricultural sector. The genetic selection of low methane emitting animals is one of multiple methane mitigation strategies, currently under investigation at Teagasc, aimed at increasing the sustainability of the Irish ruminant livestock sector.

**Breeding low methane emitting cattle:** Until recently, the development of a national low methane emissions breeding programme had been limited due the lack of technology available to measure emissions from large cohorts of animals within a commercial setting. However, with the advent of the GreenFeed Emissions Monitoring System, it is now practically feasible to estimate methanogenic output of individual animals, both at pasture and under intensive finishing conditions. Recent data from Teagasc Grange and ICBF has highlighted a 30% difference in daily methane emissions between beef cattle of similar breed, age and diet. Therefore, there is significant potential to harness the genetic variation for methane emissions that exists within the national herd, to bring about permanent and cumulative reductions in the methane output of future generations of livestock, via implementation of a low methane emitting breeding programme.

**Reducing age at slaughter:** The breeding of more feed efficient and faster growing animals has great potential to decrease the lifetime emissions of beef animals. Indeed, decreasing the age at slaughter from 27 to 24 months, has the potential to deliver a “methane savings” of >19kg of methane per animal, over the course of their lifetime.

**Residual methane emissions:** The recent collaboration led by Teagasc in partnership with ICBF and UCD has identified the residual methane emissions (RME) index as the optimal metric for disentangling the relationship of daily methane emissions with feed intake. Residual methane emissions can be described as the difference between methane emissions predicted for an animal based on its body size and feed intake and that which it actually produces. At the ICBF National Progeny Performance Test Centre in Tully (Co. Kildare), individual RME values were calculated for 282 crossbred beef cattle (steers and heifers). Animals were ranked as high (undesirable) and low (desirable) in terms of RME. Low RME animals (efficient) produced, on average, 30% less methane, despite having the same growth rate and feed efficiency as high (inefficient) ranking RME contemporaries. Results highlight the potential to breed more environmentally sustainable animals without having a negative impact on the animals’ performance, and indeed profitability. Further work is currently ongoing to study the underlying biology of the trait in an effort to potentially incorporate RME into the national breeding indices for Irish beef cattle.

# Advisory, Education & Policy

## FARMING FOR A BETTER FUTURE

# Teagasc Advisory and Training Services - Helping Farmers Towards a Better Future

Ger Shortle

Teagasc Wicklow/Carlow/Wexford Advisory Region

The Wicklow/Carlow/Wexford Region has an unusually wide range of farming enterprises, each with a substantial scale. Teagasc Advisory and Training Services in the region are geared to meet the needs of this wide range of farmers through a highly professional team of advisors and administrative staff who focus on providing the best available information and advice to our clients.

## Main farming enterprises in the Wicklow/Carlow/Wexford Region

| Enterprise | Number/Area | % of National Total |
|---|---|---|
| **Tillage** | **84,000 ha** | **26%** |
| **Breeding Ewes** | **316,000** | **13%** |
| **Dairy Cows** | **131,500** | **8%** |
| **Suckler Cows** | **65,600** | **7%** |
| **Forestry** | **60,000 ha** | **8%** |
| **Breeding Sows** | **10,200** | **7%** |

Horticulture is also a significant activity in the region; it leads the country in strawberry production and has substantial areas potatoes, carrots, brassicas and salad crops.

This diversity and intensity of food production brings with it great opportunities for enterprising farmers as well as substantial challenges. Chief among the challenges is achieving and maintaining the environmental, economic and social sustainability of farms in the region and this is a major focus of our advisors – as it is across the country.

## How we deliver advice and support to farmers

The cornerstone of our service is the one-to-one relationship that advisors have with their clients. Depending on the type of annual contract, each client can avail of office and phone consultations as required and on-farm visits when needed. Many clients attend regular Discussion Group meetings, facilitated by an advisor. These meetings are valued as an excellent way to learn from, and exchange knowledge with farmers who are in a similar situation to themselves. Some discussion groups focus on the needs of specific demographic groups, such as young farmers, new entrants or women.

All clients receive monthly newsletters with practical and timely advice for their specific enterprises and the Teagasc Today's Farm magazine six times a year. All farmers, clients and non-clients can avail of the opportunity to attend farm walks, demonstrations and other public events

and joint industry programmes, such as the Glanbia and Boortmalt Programmes, reach a wide audience.

Further education and training can be accessed through our adult farmer education courses and programmes which range from half-day courses up to the Green Cert.

## Our Range of Services

We offer a broad range of farm management services covering sustainable production and business advice. Efficient production remains at the core of our programme with a strong focus on: herd and flock management advice; breeding advice; grassland management; animal nutrition and ration formulation; farm buildings and paddock layout advice; soil analysis, nutrient management and crop nutrition and crop agronomy.

Many of our clients avail of business and financial planning services and tools such as the Teagasc Profit Monitor and Cost Control Planner, which, are recognised as standards across the industry. While those who want to look at alternative enterprise development can avail of our Options Programme.

One of the biggest challenges facing farming is maintaining social sustainability:

- How to maintain farm viability?
- How to plan for succession, inheritance and retirement?
- How to ensure labour and skills needs are met?

Teagasc Farm Partnership Services aim to assist farmers with meeting these challenges through good planning and availing of the incentive and benefits that are now part of national policy.

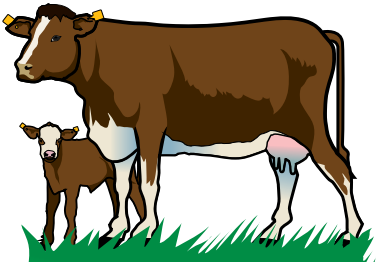
Of course, a very considerable part of all advisors' time is taken up with assisting clients with the changes coming with the New CAP in 2023 and the new ACRES Scheme. This work will be more important than ever and we will continue to provide the most up to date advice available in this area.

## Our Resources

Teagasc provides an independent and confidential advisory service through our office network backed up by our unique model which combines research, advice and training in one organisation. All our clients have access to the latest information through their specialist and research colleagues

Our network of Signpost Farms show the way to achieving a sustainable future for farmers and we work closely with colleagues in ASSAP, Joint Industry Programmes and other agencies to ensure that we get the best outcomes for farmers.

# Where are you on the 12 Steps to reduce Gaseous Emissions on YOUR FARM?



| | Action needed |
|---|---|
| **12.** Incorporate clover | Include clover in all reseeding mixtures (**5 kg/ha/ 2 kg/ac**) and consider oversowing clover in suitable fields |
| **11.** Reduce age at slaughter by 1 month | Aim for a combination of improved beef genetics, better grassland management and better health management |
| **10.** Reduce age at first calving | Calve heifers at **22** to **26** months and aim for **20%** replacement rate |
| **9.** Increase calf output/cow | Improve calving rate by keeping records, creating a breeding season plan and culling poor/empty cows |
| **8.** Improve suckler herd quality | Select 4 and 5 star beef sires on replacement/terminal indicies |
| **7.** Improve animal health | Create a herd health plan, including an annual vaccination plan, in consultation with your vet |
| **6.** Better grassland management | Install paddock infrastructure, walk farm weekly and extend grazing season |
| **5.** Reduce chemical N by 10kg/ha | Apply lime, incorporate clover and make best use of slurry / FYM |
| **4.** Use 100% LESS | Apply slurry in spring / early summer using Low Emission Slurry Spreading Technology (LESS) |
| **3.** Build or maintain soil fertility | Continue to use P & K fertilisers such as **18:6:12** |
| **2.** Apply lime | Identify fields low in pH using soil analysis and apply lime to correct deficiency |
| **1.** Use protected urea | Apply protected urea instead of CAN/straight urea |










# Where are you on the 12 Steps to reduce Gaseous Emissions on YOUR FARM?

| | Action needed |
|---|---|
| **12.** Incorporate clover | Incorporating **5 kg/ha** (**2 kg/ac**) will replace up to **100 kg/ha** (**80 units/ac**) of chemical N/year |
| **11.** Finish cattle earlier | Use Dairy Beef Index (DBI) to produce earlier finishing cattle |
| **10.** Reduce age at first calving | Calf heifers at **22** to **26** months and aim for **20%** replacement rate |
| **9.** Increase milk solids/cow | Milk record, cull poor cows and aim for **305** day lactation |
| **8.** Improve dairy herd quality | Use high EBI bulls and increase herd EBI by **>€10**/year. |
| **7.** Improve animal health | Use sexed semen to accelerate genetic gain |
| **6.** Better grassland management | Create a herd health plan |
| **5.** Reduce chemical N by 10kg/ha | Weekly farm walk, measure grass and extend grazing season |
| **4.** Use 100% LESS | Apply lime, incorporate clover and make best use of slurry / FYM |
| **3.** Build or maintain soil fertility | Apply slurry in spring / early summer using Low Emission Slurry Spreading Technology (LESS) |
| **2.** Apply lime | Continue to use P & K fertilisers such as **18:6:12** |
| **1.** Use protected urea | Identify fields low in pH using soil analysis |
| | Apply protected urea instead of CAN/straight urea |

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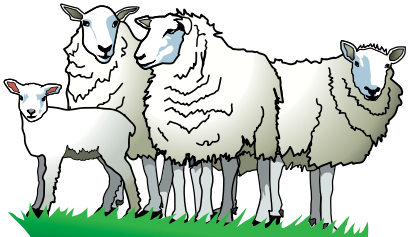
SIGNPOST
Farmers for Climate Action

# Where are you on the 12 Steps to reduce Gaseous Emissions of YOUR FARM?



| | Action needed |
|---|---|
| **12.** Incorporate clover | Incorporating **5 kg/ha** (**2 kg/ac**) will replace up to **100 kg/ha** (**80 units/ac**) of chemical N/year |
| **11.** Finish lambs earlier | Improve breeding & grassland management. Weigh regularly |
| **10.** Reduce age at first lambing | Lamb ewes for 1st time at **12** months |
| **9.** Target high prolificacy | Target **1.55** lambs reared per ewe / year & over **90%** of hill sheep in lamb |
| **8.** Improve ewe replacement quality | Use Eurostar sheep index |
| **7.** Improve animal health | Create a flock health plan |
| **6.** Better grassland management | Use paddocks for rotational grazing |
| **5.** Reduce chemical N by 10kg/ha | Apply lime, incorporate clover and make best use of slurry / FYM |
| **4.** Use 100% LESS | Apply slurry in spring / early summer using Low Emission Slurry Spreading Technology (LESS) |
| **3.** Build or maintain soil fertility | Continue to use P & K fertilisers such as **18:6:12** |
| **2.** Apply lime | Identify fields low in pH using soil analysis |
| **1.** Use protected urea | Apply protected urea instead of CAN/straight urea |

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SIGNPOST
Farmers for Climate Action

# Where are you on the 12 Steps to reduce Gaseous Emissions on YOUR FARM?

| | Action needed |
|---|---|
| **12.** Manage hedgerows | Optimum carbon capture & biodiversity |
| **11.** Apply sulphur | Apply 15 to 20kg S/ha/yr to improve N efficiency |
| **10.** Apply protected urea | Reduce fertiliser N costs |
| **9.** Chop straw | Adjust P & K requirements |
| **8.** Apply organic fertilisers | Replace a proportion of crop N, P & K with suitable organic fertilisers |
| **7.** Grow cover crops | Plant cover crops to reduce N losses & reduce chemical requirements N |
| **6.** Grow legume crops | Legume crops (beans / peas) & reduce chemical requirements N |
| **5.** Split N applications | Reduces losses through leaching / volatilization |
| **4.** Apply optimum N rates | Adjust N rates based on fertiliser N cost & grain value per tonne |
| **3.** Increase N efficiency | Apply fertilisers when soil & weather conditions are suitable |
| **2.** Balanced soil fertility | Maintain optimum levels of P, K, S & micro nutrients |
| **1.** Correct soil pH | Maintain soil pH 6.5+ to increase nutrient efficiency |

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SIGNPOST
Farmers for Climate Action

# Reducing P & Sediment Loss from farms

## Phosphorus (P) & sediment loss from farms

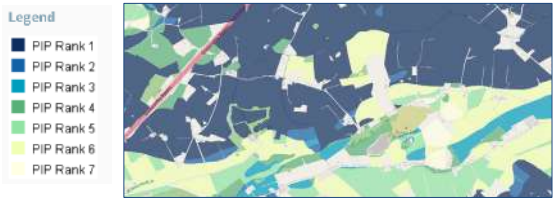
- Most P losses from poorly draining soil
- P binds tightly to soil particles
- Heavy rainfall leads to overland flow of water
- P and soil sediment washed off into drainage network

## Advice to minimise P & sediment losses to water

- 'Break the pathway' with riparian margins or buffer strips
- Identify and manage Critical Source Areas (CSAs) on your farm
- Fence off streams & prevent cattle access
- No slurry spreading if ground is saturated or heavy rain is forecast

## Take home messages

### Establish if land is P Risky




**EPA PIP Map for Phosphorus:** The higher the PIP rank (darker colours) the greater the risk of P loss.

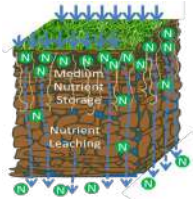
### Identify Critical Source Areas (CSAs)

Red Lines indicate CSAs on farm

# Reducing N Loss from farms

## Nitrogen (N) loss from farms

- Most N losses from free draining soils
- N does not bind tightly to soil
- Leaching occurs where more N available than plant needs
- Excess N is ***leached*** by rain to waters




## Advice to minimise N losses to water

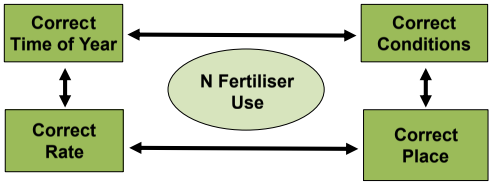
- Adhere to the closed periods for N applications
- Apply N when soil temp is > 5.5ºC & rising
- Soil moisture deficit – saturated / drought impacts uptake
- Match application rates to grass growth rates
- Ensure soil fertility (Lime/P/K) is optimum for max uptake
- Use clover, protected urea and LESS

## Take home messages

### Establish if land is N Risky


**EPA PIP Map for Nitrogen:** The higher the PIP rank (darker colours) the greater the risk of N loss.

### N – 'Optimise Use'



# Agricultural Sustainability Support and Advisory Programme (ASSAP)

Noel Meehan[1] and Pat Murphy[2]

[1] ASSAP Manager, Teagasc, Deerpark, Ballinasloe, Co. Galway

[2]Head of Environment KT, Teagasc, Johnstown Castle, Co Wexford

## Introduction

In Ireland all water policy and management is led by the Water Framework Directive. Under this directive Ireland has been set a target of achieving at least 'good status' for all waters in Ireland. However, despite a lot of good work over the last 20-30 years we are falling short in achieving this target and water quality has declined in recent years. Ireland's response to challenges around water quality is set out under the national river basin management plan. As part of this plan, 190 Priority Areas for Action (PAA) have been identified across the country where water quality improvements need to be made. There are multiple pressures across each of these PAA's including industry, waste water treatment plants and septic tanks, forestry, agriculture and urban pressures.

## Summary

- Ireland has been set a target by the EU Water Framework Directive of achieving 'Good Status' for all waters.
- The River Basin Management Plan for Ireland sets out Ireland's plan to achieve good status
- The ASSAP service is available to farmers in 190 Priority Areas for Action (PAAs) and is a key part of helping achieve good status
- The ASSAP is a free and confidential advisory service available to all farmers in a PAA

## Implementation of the ASSAP

The Local Authority Waters Programme (LAWPRO) have deployed a catchment assessment team of 60 scientists across the country to assess streams in PAAs in detail and identify the significant pressures impacting water in each PAA. This group communicates the detailed information about the PAA to all of the stakeholders across the local community including agricultural and non-agricultural land owners and businesses.

Where an agricultural pressure is identified the farmers in the area will receive the offer of a free farm visit from an advisor under the ASSAP programme.

The ASSAP programme is made up of a group of 33 advisors (20 working under Teagasc jointly funded by DHLGH and DAFM and 13 advisors from the dairy processing co-ops). These advisors are available to provide farmers with a free and confidential advisory service that farmers in a PAA can avail of on a voluntary basis.

The advisors will meet the farmer to assess the farm for any potential issues that are having an effect on the water quality in the local stream. In general an advisor will assess the farmyard,

nutrient management practices and general farm land management practices including the use of pesticides and other toxic substances like sheep dip, etc.

At the end of a visit the advisor and farmer will agree on where the farmer should focus improvements or actions, if any are required, on his farm. The practical advice will be designed to 'break the pathway' and prevent nutrients and other contaminants from entering water. A written summary of the advice and actions will be provided and a timeframe for completion agreed between them.

*Figure 1: Heavy rainfall leads to overland flow of water, Phosphorus and soil particles*

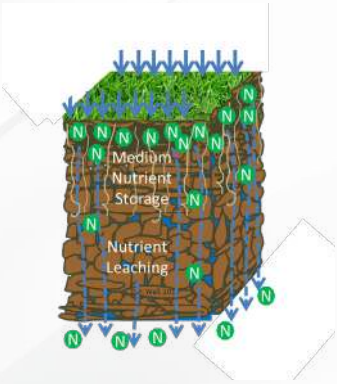



*Figure 2: Nitrogen that is not used up by grass/plant is available to be leached to groundwater/streams during heavy rainfall*

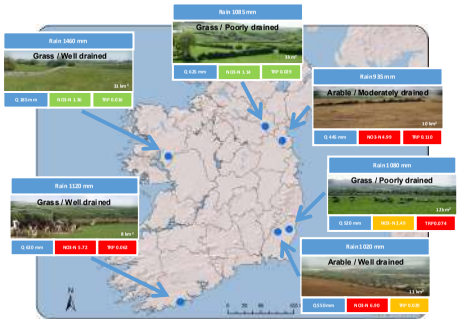
## Conclusion

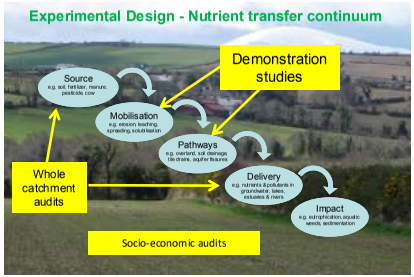
The ASSAP programme is collaborative and the funding and support received from DAFM, DHLGH and the dairy industry has been critical to allow a new approach to enabling local landowners to engage positively in seeking solutions to local problems with the support of a confidential advisory service. Support from the farming organisations for the programme has been very strong and this is vital in communicating and informing farmers about the ASSAP programme and its key messages.

# Agricultural Catchments Programme (ACP) - More than a decade of catchment research

## WHAT IS ACP?

- 12 years running
- Combined Research and Knowledge Transfer
- 23 staff across 6 catchments with 300+ farmers
- Biophysical and socio-economic research
- Focus points for Catchment Science KT
- Policy Evaluation (Nitrates & Derogation, WFD, Food Wise 2025, Climate Action Plan)



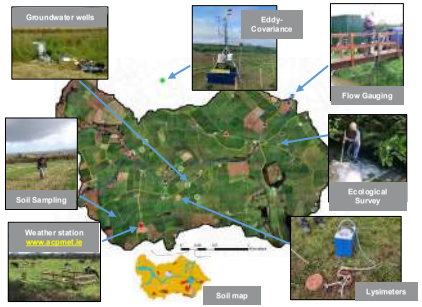




## KEY FINDINGS AND MESSAGES

- No clear, straightforward link between nutrient concentrations in streams and source pressures (farming intensity) at the catchment scale – physical landscape, soil type and weather can override source pressures
- There are time lags between changes in agricultural pressures and water quality state
- There are no "one-size-fits-all" mitigation strategies
- An integrated approach to water quality research and knowledge transfer is key to sustainable agriculture

## CURRENT RESEARCH ACTIVITIES

- High resolution monitoring of water quality and quantity
- Quantification of N & P loss on derogation & non-derogation farms
- Greenhouse gas and ammonia emissions
- Soil C sequestration
- Development of models to represent the hydrologic, sediment, and nutrient dynamics in the ACP catchments
- Investigating farmer attitudes towards adoption of mitigation and management practices



# Farm Advisory Service in the Agricultural Catchments Programme

Edward Burgess

Agricultural Catchments Programme, Teagasc, Johnstown Castle;

**Summary:**

- When too much nitrogen or phosphorus flows into a local river, it seems logical to think that this is directly linked to nearby farms. Perhaps some farms apply too much fertiliser, for example. However, over a decade of research in six water catchments, known as the Agricultural Catchments Programme, reveals why this approach is not so straightforward.
- The long-term study reveals that nutrients flow off some fields easier than others, because of differences in soils and bedrock, as well as farming practices and weather. We need to consider variability in the landscape and how this influences nutrient losses to water. As there are many different factors in the landscape that impact nutrient loss the situation is best dealt with by interaction with individual farmers.
- More intensive farming inevitably results in more nitrogen inputs. But the complexities uncovered by the catchment programme make it more difficult to introduce countrywide measures that will be effective everywhere. A local knowledge of soil characteristics enable catchment advisors to provide tailored advice that maximises nutrient efficiencies and minimises losses.
- Giving farmers maps with soil types and nutrient concentrations is one way forward. This tackles another observation from the ACP. There is often a mismatch between how much phosphorus is added and what a crop requires. Maps allow farms to better tailor fertilisation inputs to crop needs within the same farm.
- We do not want the nutrients leaving the soil around the roots. We want to keep them in place and farmers do not want to lose nutrients to waterways, especially at a time when fertiliser prices are rising.

## Other resources & online information

**Twitter:** @ TeagascACP

**Websites:** https://www.teagasc.ie/environment/water-quality/agricultural-catchments/

https://www.acpmet.ie/

**Email:** edward.burgess@teagasc.ie; mark.boland@teagasc.ie; suzanne.neary@teagasc.ie

kevin.madden@teagasc.ie; oisin.coakley@teagasc.ie

# Organic Farming

**Changes Required**

- No chemical fertilisers/herbicides
- Potentially Reduced Stocking Rate
- Housing may have to be adapted
- Longer withdrawal medicine periods

**Financial Implications**

- Reduced fertiliser bill
- Potentially Reduced output
- Increase in beef price received
- Organic Farming Scheme Premia

**Management Techniques**

- White clover on improved grasslands
- Maximise the amount of grazed grass in the diet
- Reduce dependency on imported concentrate feed

**Step 6 – Conversion Period**

- Normally 2 years – allows time for land to adjust
- Must adhere to organic standards
- Can sell produce as organic once conversion period is completed

**Step 5 – Training Course**

- QQI Principles of Organic Farming
- 25 Hour course
- Blended course – online & farm visit
- Register at www.teagasc.ie/rural-economy/organics/training

**Step 1 - Consider**

- Could you farm without chemical fertilisers/herbicides?
- Can you modify your animal housing to incorporate a bedded lying area?
- Is your current stocking rate below 2LU/Ha

**Step 4 – Apply for OFS**

- Apply for the Organic Farming Scheme
- Scheme opens regularly
- Apply online via Agfood
- Consult with your farm advisor
- Change status of land parcels on BPS

**Step 2 - Investigate**

- Talk to existing organic farmers
- Consult your farm advisor
- Attend farm walks/open days
- Familiarise yourself with the organic farming standards

**Step 3 – Choose an OCB**

- Choose an Organic Certification Body
- Irish Organic Association
- Organic Trust
- Complete a Conversion Plan
- Register as an organic operator

# Organic Farming Scheme

64Ha Dairy Farm
Yr 1 = €24,400
Yr 2 = €23,800
Yrs 3 – 5 €20,600

| | Year 1-2 (in-conversion) 1-70ha (€/ha) | Year 3-5 (fully converted) 1-70ha (€/ha) |
|---|---|---|
| Dry-stock | 300 | 250 |
| Tillage | 320 | 270 |
| Dairy | 350 | 300 |
| Horticulture | 800 | 600 |
| >70Ha receives €60/Ha in conversion and €30/Ha thereafter | | |
| Participation payment = €2,000 in first year and €1,400 per annum thereafter. | | |

44Ha Sheep Farm
Yr 1 = €15,200
Yr 2 = €14,600
Yrs 3 – 5 €12,400

34Ha Suckler Farm
Yr 1 = €12,200
Yr 2 = €11,600
Yrs 3 – 5 €9,900

5Ha Horticultural Holding
Yr 1 = €6,000
Yr 2 = €5,400
Yrs 3 – 5 €4,400

70Ha Tillage Farm
Yr 1 = €24,400
Yr 2 = €23,800
Yrs 3 – 5 €20,300

# Organic Farming

Elaine Leavy[1]; Joe Kelleher[2]

[1]Teagasc, Mullingar; [2] Teagasc, Newcastle West

**Summary:**

- Organic farming can be very profitable. Increased rates under the new Organic Farming Scheme will make organic farming an attractive option across all farming systems. Consult with organic farmers and advisors and attend organic farm walks before making the decision to convert.
- Organic production is defined as "an overall system of farm management and food production that combines best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preference of certain consumers for products produced using natural substances and processes".
- Irish organic food enjoys an excellent reputation both at home and especially across Europe. Latest figures show the organic retail food market in Ireland is now worth over €260 million annually (source: Bord Bia, 2021). In the European Union, the market for organic food is worth €45 billion (2020). The largest markets exist in Germany (€15 billion euro), France (€12.7 billion), and Italy (€3.9 billion). This growth represents an opportunity for Irish farmers to supply more organic food.
- At farm level in Ireland, the organic sector has experienced a large influx of new farmers in recent years with 2,200 farmers now farming organically including approximately 380 who entered conversion in spring 2022. About 70% of organic farmers are cattle farmers. Organically managed land now occupies approximately 2.5% of the total Utilizable Agricultural Area (UAA) in the country, which is over a doubling in area compared to the previous decade. This compares with an average of 8.5% of UAA across the European Union.

**Is organic farming profitable?** There is a perception that organic farming is difficult, contains a lot of 'red tape', is demanding on labour and returns low levels of productivity. The reality is quite different. The best organic farmers, using good husbandry and management skills, can achieve stocking rates up to 170 kg N/ha. In terms of paperwork, detailed records must be kept but farmers in the Bord Bia Quality Assurance scheme are already familiar with this type of record keeping.

## Steps to Successful Organic Conversion:

**Consider:** If you can answer yes to some or all of these questions then you should consider switching to organic production.

**Crop systems:** Can you incorporate a grass/clover break into your rotation? Do you have a source of farmyard manure/compost/slurry on or near your farm? Can you see yourself farming without relying on pesticides and chemical fertilisers?

**Animal systems:** Is your current stocking rate below 2 livestock units per ha? Can your animal housing be modified to incorporate a bedded lying area? Do you already use no or relatively low levels of artificial fertiliser?

**Investigate:** Get acquainted with the adjustments required by talking to other organic farmers and contacting a local advisor. Familiarise yourself with the Organic Standards. A major factor distinguishing organic farming from other approaches to sustainable farming is the existence of internationally acknowledged standards and certification procedures. These standards have been developed to provide organic producers with consistent, clear rules as to how organic food should be produced.

**Complete an organic course:** A 25-hour 'Introduction to Organic Production' course has to be completed before acceptance into the DAFM Organic Farming Scheme (OFS).

**Maximise payments from the Organic Farming Scheme and other supports:** Payment rates under the Organic Farming Scheme have increased significantly under the next CAP programme which commences on January 1st 2023. Many of the rates available to farmers have increased by in excess of 50% from the previous scheme. Details of the rates available under the next OFS scheme are outlined in the table below;

| | Year (1-2) (1-70ha (€/ha)) Year | Year (3-5) (1-70ha (€/ha)) |
|---|---|---|
| **Drystock** | **300** | **250** |
| **Tillage** | **320** | **270** |
| **Dairy** | **350** | **300** |
| **Horticulture** | **800** | **600** |

**70 Ha receives €60/ha in conversion and €30/ha thereafter**
**Participation payment = €2,000 in first year and €1,400 per annum thereafter.**

**Choose an organic certification body (OCB):** In Ireland, there are two land-based certification bodies (IOA or Organic Trust) which certify organic operators involved in land-based farming under the auspices of the DAFM. The farmer initially applies to one of the certification bodies. Once the application is accepted, a conversion date is granted and the conversion period (normally 2 years) commences. The Organic Certification Body carries out an annual inspection to check compliance with the standards and to ensure that organic records are in order. Spot inspections may also be carried out to check for compliance with organic regulations.

**Complete an organic conversion plan:** This involves a detailed description of management practices on the farm, the changes required on the farm, soil analysis, faecal analysis, livestock housing plan, animal health plan (in consultation with your veterinary surgeon) and land/crop rotation plan. The plan can be drawn up by the farmer alone or in consultation with the farm advisor.

## Other resources & online information

**Twitter:** @TeagascOrganics

**Teagasc Website**: https://www.teagasc.ie/rural-economy/organics/

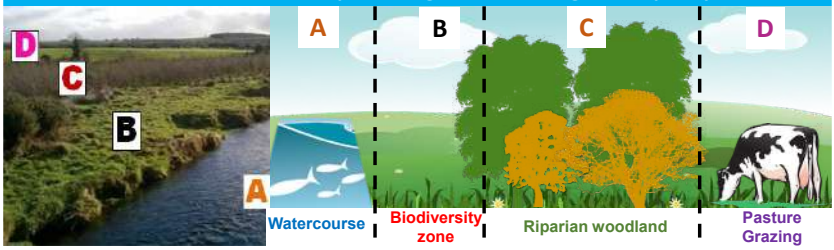
# Forestry - Supporting

## Farm biodiversity

## Carbon uptake


## Woodlands for Water

New native woodland protecting and enhancing water quality




# Farm Sustainability

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

## Excellent revenue streams

## Take home messages

- ✓ **Economic, environmental and societal benefits**
- ✓ **Highly tax and labour efficient – an excellent legacy & 'pension pot'**
- ✓ **Attractive DAFM planting grants & annual premia**
  - ✓ Forest types to meet all objectives
  - ✓ Eligible land retains BPS eligibility
  - ✓ Excellent Teagasc supports for informed decision making

# Sustainably Integrating Trees on the Farm

Tom Houlihan

Teagasc, Forestry Development Department, Cleeney, Killarney, Co. Kerry

**Summary:**

- **New forest creation can deliver a range of benefits on your farm.** Whether small or large areas are involved, setting clear objectives and timely planning are central to success. Is the provision of additional farm income or a tax efficient future pension fund a strong priority? Do you wish to enhance the farm environment? Every tree species, conifer or broadleaf, has its own unique biodiversity characteristics. The more diversity of species and structure that occur in a forest, the more biodiversity and ecosystem benefits are likely to be delivered. Teagasc provides comprehensive supports to help inform good decision-making.
- **New farm forests can incorporate either individual or a mix of forest types**, which are suited to prevailing site conditions. For example, this flexibility allows landowners to combine, as appropriate, commercial forests and those designed specifically with water quality protection in mind. For example, new native woodland, alongside an undisturbed water setback, can form a landscape feature that protects and enhances water quality in suitable farm locations. This 'Woodland for Water' option can provide an ideal buffer against potential nutrient or sediment from adjoining land uses reaching sensitive watercourses.
- **Carbon benefits:** The planting of new forests is also a significant land-based measure to help address the effects of climate change. Forests play an important role in the capture and removal of carbon dioxide from the atmosphere and subsequent storage in forests, biomass and soils, a process called sequestration. Farm forests, in appropriate locations, can significantly benefit the carbon efficiency and green credentials of farm businesses including reducing their carbon footprint. The Forest Carbon Tool (www.teagasc.ie/forestcarbontool) provides indicative data for potential carbon sequestration associated with new forest enterprises. It includes current planting options under the DAFM Forestry Programme. This tool is particularly useful when considering the relative carbon removal merits of different forest categories and planting combinations.

The forestry option has many benefits but it is important that farmers and landowners are fully aware of all implications in advance of informed decision-making. Teagasc forestry staff provide independent and objective advice that supports whole farm planning and the appropriate forest options tailored to your objectives and farm characteristics. Contact your local Teagasc forestry staff and log onto www.teagasc.ie/forestry for further information.

## Other resources & online information

https://www.teagasc.ie/forestry

https://www.teagasc.ie/forestcarbontool

# Teagasc Education and Training - Pathways for the Land-based Sector

Brian Morrissey, Carmel Finlay, Tara Fitzsimons

Teagasc, Curriculum Development & Standards Unit, Grange, Dunsany, Co. Meath

**Summary:**

- Teagasc provides a range of education and training pathways to suit the differing needs of farm families and the wider agri-food industry.
- Teagasc Further Education courses are suitable for people who wish to develop a career in agriculture, horticulture, equine or forestry.
- All learners entering fulltime education at agricultural colleges complete a two-year programme.
- A "Green Cert" is an educational award that qualifies the holder as a "trained farmer" for the purposes of DAFM (Department of Agriculture, Food and the Marine, www.dafm.ie) schemes.
- Teagasc Education Officers run part time and distance education courses from Teagasc offices throughout the country.
- Teagasc agriculture and horticultural colleges and Teagasc partner/private colleges hold college open days each autumn and spring for potential applicants and their families.

## Introduction

Education and training is a key consideration for all farmers given that it will improve the overall technical and financial efficiency of a farm. Teagasc is the primary provider of accredited further (vocational) education for the land-based sector, and provides progression routes to other educational programmes. Teagasc has a major input into higher education and post-graduate education delivery through its extensive partnership with the higher education sector. This means that Teagasc education and training enable progression from Level 5 through to Level 10 on the National Framework of Qualifications. Teagasc also has a substantial involvement in providing short courses and continuous professional development across the land-based and food sectors. It is important to select the most suitable educational programme, whether for full-time, part-time or distance education courses or continued professional development. Teagasc Education has an un-matched advantage because we are part of an integrated research, advisory, and education organisation. Teagasc courses are delivered at 7 colleges, with 1,100 hectares of farmland, 1,000 dairy cows, 300 suckler cows, 1,400 ewes, and 100 hectares or more in crop or biomass production. Teagasc also has partnerships with Institutes of Technology and universities; links to 1,500 land sector hosts; and access to 87 benchmark farms. Teagasc is committed to supporting all students, including those with disabilities or specific learning difficulties within their learning environment. Teagasc education and training is developed, delivered, and assessed with built-in quality assurance and all courses are validated by Quality and Qualifications Ireland (QQI).

### Planning your education pathway - 5 steps

There are 5 steps you can follow when planning your education pathway.

1. Identify your education and training requirements
2. Review which courses would meet these needs
3. Consider your long term career plan
4. Decide on the course or courses you want to take
5. Talk to Teagasc staff

You can do a lot more research on your education pathway on the Teagasc public website (www.teagasc.ie/education), and you can apply for most Teagasc courses through the online application system you will find there.

### Quality Assurance

Our courses are developed to take account of the needs of the industry as determined by the Education Forum, a long-standing stakeholder group that Teagasc convenes. We operate a Quality Assurance process for delivery and assessment, external course authentication and regular Whole College evaluation. Teagasc provide a learner handbook to students, learner support when required, and a student assistance programme. And we take into account the learner experience through our student satisfaction and graduate feedback surveys.

### Further Education Courses

These courses are suitable for people who wish to develop a career in agriculture, horticulture, equine or forestry. Further education training programmes are focused on practical skills training in addition to theory-based learning. Many graduates of further education courses in agriculture return to farming either in a full-time or part-time capacity. Teagasc offer the following QQI Accredited Level 5 and Level 6 courses:

### QQI Level 5 Certificate Courses

- Certificate in Agriculture
- Certificate in Horticulture
- Certificate in Horsemanship
- Certificate in Forestry

### QQI Level 6 Advanced Certificate Courses

- Specific Purpose Certificate in Farming (Teagasc “Green Cert”)
- Advanced Certificate in Agriculture (Dairy Herd Management)
- Advanced Certificate in Agriculture (Drystock Management)
- Advanced Certificate in Agriculture (Agricultural Mechanisation)
- Advanced Certificate in Agriculture (Crops & Machinery Management)

- Advanced Certificate in Horsemanship
- Advanced Certificate in Equine Breeding (Stud Management)
- Advanced Certificate in Forestry
- Advanced Certificate in Pig Management
- Advanced Certificate in Poultry Management

### Full Time Agriculture Education

All learners entering full time education at agricultural colleges complete a two-year programme. This allows students to gain both knowledge and practical skills in a wide variety of subject matter encompassing both Level 5 and Level 6 course work and practical learning periods, while also allowing them to specialise in their preferred farm enterprise. Options include Dairy Herd Management, Drystock Production, Crops & Machinery*, Agricultural Mechanisation*, Pigs*, or Poultry *.

*Note: these courses may not be offered every year

### What is a "Green Cert" award?

A "Green Cert" is an educational award that qualifies the holder as a "trained farmer" for the purposes of DAFM (Department of Agriculture, Food and the Marine, www.dafm.ie) schemes. Being the holder of a "Green Cert" is also one of the Revenue conditions of stamp duty exemption on the transfer of land (www.revenue.ie). Teagasc provides full-time, part-time, and distance education and training towards many land-based educational awards in agriculture, horticulture, forestry, equine and other subjects. Teagasc offers the Distance Education Green Cert for Non-Agricultural Award Holders and the Part-Time Green Cert courses.

### QQI Level 6 Specific Purpose Certificate in Farming "Green Cert"

The QQI Level 6 Specific Purpose Certificate in Farming is commonly known as the Teagasc Green Cert. Participants first complete the QQI Level 5 Certificate in Agriculture in order to gain entry to the QQI Level 6 Specific Purpose Certificate in Farming. There are 2 modes of delivery available for completion of this Green Cert programme:

1. Part-time: duration 2.5-to-3 years approximately in an agricultural college or local Teagasc training centre
2. Distance Education*: duration 18-to-20 months approximately in an agricultural college or local Teagasc training centre

**Note: Only holders of major awards at Level 6 or higher on the NFQ in a non-agricultural discipline are eligible to apply for the Distance Education option.*

### Higher Education Courses

Higher Education courses are suitable for people who wish to gain a qualification at higher level in the land-based sector. Courses are available in universities and a number of Institutes

of Technology. Graduates of higher level programmes may return to farming while others will develop careers in the agricultural services sector. Recruitment to these courses is through the CAO system. There are progression routes from further education into higher education courses.

### Teagasc Professional Diploma in Dairy Farm Management

The Teagasc Professional Diploma in Dairy Farm Management is aimed at those intending to manage a commercial dairy farm as an owner, partner or employed manager. The course consists of two years professional work experience on approved commercial dairy farms, while attending block release periods at Kildalton College and Moorepark Agricultural & Grassland Research and Innovation Centre. Applicants to the PDDFM programme must possess a Level 6 Advanced Certificate in Agriculture or an equivalent agricultural award. Course fees are currently €990 per annum. Students are paid at least minimum wage by host farms, which is currently €10.50 per hour worked.

### Education addressing the climate challenge

Teagasc Education is integrating measures to address the climate change challenge across its activities. For example, college farms are participating in the Signpost Farms programme; we have dedicated Sustainable Farming in the Environment modules at level 6 with sustainability to the forefront of all husbandry modules; and we use climate-smart technologies and methods in teaching and learning, for example, Low Emission Slurry Spreading, Protected Urea, Biodiversity (planting hedgerows, coppicing/laying), genetics, energy audits, multi-species swards. These kinds of measures are also used in the management of college farms, for both livestock and tillage enterprises.

### Life Long Learning and Continuing Education

While QQI Level 5 and Level 6 courses are a foundation for learning, farmers need to continually improve knowledge and skills. As with any career, it is very important to keep up-to-date with new developments or advances in technology and Teagasc facilitate a range of means of achieving this:

- Formal Training through Teagasc ConnectEd for accredited short courses such as Best Practice in Milking Routine, Managing Ruminant Animal and Managing Crop Nutrition and Health and Safety.
- Informal Training through Teagasc Evolve for non-accredited by attending discussion group meetings, open days, conferences.

### Walsh Scholarship programme

The Knowledge Transfer Walsh Scholarship Programme is designed to equip participants with the skills and knowledge to be effective in building the capacity of farmers to adopt new practices and technologies. Students complete a knowledge transfer-focused research project during their scholarship with Teagasc, while studying for a higher degree. For more information, visit www.teagasc.ie

### Locations, information, open days

Teagasc Education Officers run part-time and distance education courses from Teagasc offices throughout the country. For more details, visit your local Teagasc office or log on to www.teagasc.ie/education/local-education-centres/

Teagasc agricultural and horticultural colleges and Teagasc partner/private colleges hold college open days each autumn and spring for potential applicants and their families. Further information can be obtained from the college of your choice or by visiting www.teagasc.ie/education

| | |
|---|---|
| **College of Amenity Horticulture, Botanic Gardens** | **john.mulhern@teagasc.ie** |
| **Gurteen Agricultural College** | **jparry@gurteencollege.ie** |
| **Ballyhaise Agricultural College** | **john.kelly@teagasc.ie** |
| **Kildalton Agricultural & Horticultural College** | **tim.ashmore@teagasc.ie** |
| **Mountbellew Agricultural College** | **edna.curley@mountbellewagri.com** |
| **Clonakilty Agricultural College** | **keith.kennedy@teagasc.ie** |
| **Pallaskenry Agricultural College** | **derek.odonoghue@pallaskenry.com** |

Teagasc
Agriculture and Food Development Authority

# Certificate in Business Strategy

Smurfit Executive Development
UCD Michael Smurfit Graduate Business School

## BENEFITS

- Course accredited by UCD
- Complete before next calving season
- Residential, excellent networking
- Business insights from other industries
- Identify your management style
- No academic qualifications required

## THEMES

- Creating the right strategy for growth
- Financing the future strategy
- Key stakeholder relationships
- Bringing the strategy to implementation

"Would I do it again? Definitely"

**Martin Quigley**

**Contact Mark Moore 087 4179131 for further details**

# Course in Farm Business Strategy Delivered by Teagasc in Collaboration with the UCD Michael Smurfit Business School

Mark Moore

KT Outreach and Innovation, Teagasc

**Summary:**

- The course will take place in November and December 2022.
- The course is accredited by UCD.
- The course is residential and will be held in Tipperary, the first module is three days, the second is two days, with one final day to present your business strategy.
- Participants work on their own strategy between modules with some support from Teagasc mentors.
- There is no requirement to have academic qualifications to join the course, managing a farm full or part time is the key qualification. This is executive education, where ca. 15 participants discuss business cases and their own experience.
- Each participant will create a strategy unique for their own business, this is the key 'deliverable'.
- Key areas addressed during the course include:
  - How to create a robust strategy.
  - Identifying your own key personality characteristics and those of key stakeholders.
  - How to optimise your interactions with others, including staff etc.
  - Negotiation. How to plan your negotiations with banks, suppliers etc to create optimal outcomes.
  - Farm accounts. How to gain the greatest value from these documents.

## Other resources & online information

**Email:** mark.moore@teagasc.ie

**Phone:** 087 4179131

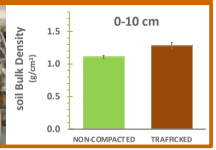
# Physical Indicators of Soil Health

## Soil Texture: what is it & why is important?


- a method to measure the size of soil mineral particles: **sand**, **silt** & **clay** (<2µm).
- **Many soil functions depend on soil texture** (nutrients supply, water retention, carbon sequestration, proneness to compaction…)

## Soil Compaction: how to measure it?

- via soil Bulk Density (ring method).
- affects plant growth.
- needed for accurate soil carbon stocks.

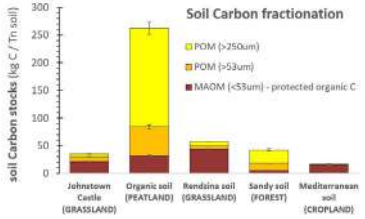



## How much water a soil can retain?

- we calculate this by measuring the **soil water retention curve**
- it also tells us how difficult will be for roots to **access water during droughts**.


## Soil Carbon stability

- We analyse fractions of soil carbon (C) based on their level of mineral protection:
- **Soil minerals** (such as clay, iron oxides, calcium…) can protect (‘*sequester*’) organic matter from being depleted by microbes into $CO_2$ back to atmosphere.
- This is known as **MAOM** (mineral-associated organic matter), and is **key for C sequestration** in soils.




## Take home message

**Soil physical indicators are crucial to measure the health & quality of our agro-ecosystems, and building resilience to various pressures.**

# Physical indicators of Soil Health

Luis Lopez-Sangil

Teagasc, Johnstown Castle

**Summary:**

- Soils are multifunctional living ecosystems. They support most of our food production and other natural services for society, such as nutrient recycling, atmospheric $CO_2$ sequestration and water regulation. Soils are a limiting resource though, so protecting soil health from degradation is critical for food production and human wellbeing.
- Among the main physical indicators governing soil health (and modulating its degradation) are: soil texture, compaction, water retention & organic matter stability. Measuring these factors is an effective tool to assess the health and quality of our soils, and their resilience to environmental disturbances.
- Soil texture (also known as particle-size analysis) is a method to classify soils according to the size of their mineral particles: SAND (2 – 0.05 mm diameter), SILT (0.05-0.002 mm) or CLAY (<0.002 mm). The relative proportion of these particles affects things like soil proneness to compaction, nutrient retention, water infiltration and purification, or carbon sequestration. For instance, clay soils are naturally more exposed to compaction by heavy farm machinery, as smaller particles can rearrange into lower volumes when compressed.
- Soil compaction can be an important issue in Irish soils. It leads to lower water infiltration rates (and thus, soil run-off and flooding during heavy rainfalls). It can also diminish water retention, and plant growth (roots find it harder to penetrate soil).
- We measure compaction by calculating the soil bulk density, using the ring method as gold-standard. We also use this method for calculating soil C stocks accurately.
- Soils have different abilities to purify and retain rainfall water. This has direct implications on how an area or landscape can cope with flash-flooding downstream, or support plant growth (water uptake) during summer droughts. This capacity to retain and release water can be assessed by measuring the soil water retention curve. We do this by sampling an intact soil core from the field: using an automated device (HYPROP™), we can measure how much water it can hold within, and the physical energy it takes for roots to access it. Soils do also capture carbon ($CO_2$) from the atmosphere through plant photosynthesis and organic matter (OM) deposition. The OM in soils is made of carbon (>50%). Part of the OM can be protected ('sequestered') by soil minerals (such as clay, iron oxides, calcium) from being converted back into $CO_2$ by microbes. This fraction is known as mineral-associated OM (MAOM), and its stability is crucial for soil C sequestration.

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/environment/johnstown/

www.youtube.com/watch?v=djgRiZaqFaM

**Email:** luis.lopez-sangil@teagasc.ie (Soil Quality Research Technologist)

# Soil, Crop & Slurry Analysis at Teagasc Johnstown Castle

## Laboratory Equipment

State-of-the-art analytical equipment to facilitate research
- soil nutrient efficiency,
- land-use, biodiversity and
- the soil microbiome

Lachat flow through analyser used for Morgan's P, K, Mg analysis

Agilent ICP-OES and ICP-MS used for mineral analysis in soils and crops

Biorad qPCR kit Microbiological and molecular analysis helps us better understand the biology in our soil

Automated pH instrument used for soil pH and soil SMP buffer pH (LR test)

## Training & Development

TY work experience (4-6 places) and undergraduate internship positions (6+ places) are provided in the labs annually

## Take home messages

- Approximately 5,000 soil samples tested annually for ~30 parameters.
- Soils are analysed for nutrients, total minerals, %OM, TC, TOC, TN & S, bulk density, soil texture & soil biology.
- Approximately 10,000 crop/slurry samples are tested annually up to 15 parameters.
- Crop/slurry samples are analysed for total mineral content, heavy metals and total C, N & S.

# Soil, Crop & Slurry Analysis at Teagasc Johnstown Castle

The research labs at Teagasc Johnstown Castle are serviced by 12 permanent and contract staff. Several more permanent and contract lab and field technicians help facilitate research activity at Teagasc Johnstown Castle.

**Summary:**

- All soil, crop and slurry samples analysed at Teagasc Johnstown Castle research centre are the product of research activities being conducted at Teagasc Johnstown Castle or affiliated research institutes
- Approximately 5,000 soil samples and 10,000 crop samples are analysed at Johnstown Castle each year
- Samples are typically analysed for nutrient content e.g. (Morgan's P, K), total mineral content (e.g. Cu, Zn) C, N and S and soil biology.
- The labs are equipped with state-of-the-art instrumentation with the numbers of parameters that can be analysed increasing/changing to meet the needs of the research program.
- Based on the numbers of samples currently being processed through the labs, and the number of parameters that can be analysed there are on average 100K soil tests and 150,000 crop tests carried out annually.
- Teagasc Johnstown labs provide internship positions (of up to 6 month's duration) to under graduate students each year. Typically, 6 internship positions are awarded to students from various Irish universities annually.

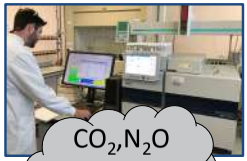
## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/environment/johnstown/

**Email:** linda.moloneyfinn@teagasc.ie (Lab Manager)

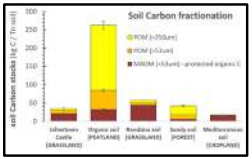
# Water, Greenhouse Gas & Soil Carbon analysis

## State of the art instrumentation measuring soil nutrient & carbon loss to atmosphere, ground and surface water



$CO_2$,$N_2O$ & $CH_4$ analysis

Soil C, N, S analysis




Soil C results

Water analysis P, $NO_3$ , $NH_3$ etc

TOC & TN analysis

Soil texture analysis

## 44 Research Projects supported

- 24 Water related, including Catchments
- 9 Carbon related, including Soil Carbon observatory
- 21 Soil & Biodiversity related

## Take home messages

- State of the art laboratory instrumentation
- Provides accurate analysis for research projects
- 20,000 Water samples/yr
- 20,000 Soil carbon samples/yr
- 50,000 Greenhouse gas samples/yr

# Water, Greenhouse Gas & Soil Carbon Analysis

The research labs at Teagasc Johnstown Castle service the research needs of approximately 50 permanent and contract researchers/post docs and over 40 Walsh scholarship (PhD) students. There are currently 44 live research projects being conducted by/in conjunction with researchers at Johnstown Castle generating samples for water, greenhouse gas, soil, biodiversity/ecology and microbial analysis.

**Summary:**

- All water, gas and soil carbon samples analysed at Teagasc Johnstown Castle research centre are the product of research activities being conducted at Teagasc Johnstown Castle or affiliated research institutes
- Approximately 20,000 water samples, 20,000 soil carbon tests and 50,000 gas samples are analysed at Johnstown Castle each year
- Water samples are typically analysed for P, nitrate/nitrite, ammonia, TOC and TN
- The greenhouse gases analysed on site are methane ($CH_4$), carbon dioxide ($CO_2$) and nitrous oxide ($N_20$)
- As well as soil carbon analysis, soil texture and soil bulk density analysis is also carried out on soil samples. These soil characteristics can help determine compaction levels in soil and the ability of soil to store and transfer nutrients, retain water and store carbon
- The labs are equipped with top of the range analytical equipment. Methods are constantly being adapted to meet the needs of the research program
- Future development of the laboratories as part of the National Agricultural Sustainability Research and Innovation Centre (NASRIC) will help to further advance agri-environmental research at Teagasc Johnstown Castle

## Other resources & online information

**Teagasc Website:** https://www.teagasc.ie/environment/johnstown/

**Email:** linda.moloneyfinn@teagasc.ie (Lab Manager)

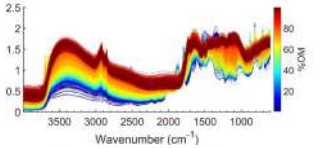
**Email:** denis.brennan@teagasc.ie (Water Lab)

# Emerging Analytical Technologies

## Fast and cost-effective methods for soil analysis

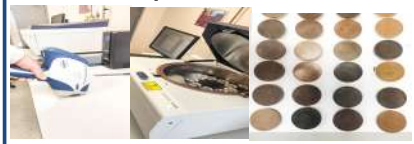
### What new technologies exist for analysing soils?

**Mid-Infrared Spectroscopy**




Analysis of clay, sand, silt, pH, CEC, %OM, carbon, among other soil attributes in 2 minutes

**X-Ray Fluorescence**



**Elementary Analysis of soil composition:** Aluminium, calcium, magnesium, phosphorus, nickel, copper, zinc, manganese, iron, cobalt, lead, chromium and cadmium, among many others.


*Research jointly supported by Geological Survey Ireland and Teagasc (Terra Soil Collaborative Agreement 2018).*

### Take home messages

- ✓ **Reduced time and cost associated to soil analysis**
- ✓ **Useful for monitoring large spatial areas**
- ✓ **Can monitor the soil health over time and improve soil management**
- ✓ **No chemical waste is generated**
- ✓ **The Emerging Analytical Technologies can assist in the Agriculture 4.0 implementation in Ireland.**

# Emerging Analytical Technologies - Mid-Infrared Spectroscopy and X-ray Fluorescence as a Fast and Cost-effective Method for Soil Analysis

Felipe Bachion de Santana[1], Rebecca Hall[1], Eric C. Grunsky[2], Mairéad M. Fitzsimons[2], Vincent Gallagher[2], Karen Daly[1]

[1]Teagasc, Johnstown Castle; [2] Geological Survey Ireland

**Summary:**

- Agriculture 4.0 requires rapid, low-cost and automatic responses for soil analysis
- Emerging Analytical Technologies such as Mid-Infrared and X-ray can predict a range of soil attributes in a few minutes
- Emerging Analytical Technologies are useful for monitoring large spatial areas;
- Emerging Analytical Technologies proposed by Teagasc and GSI are eco friendly and do not generate chemical waste
- Handheld equipment can be used to screen soils in situ
- Fast and low-cost analytical methods enable an increase in the number of soil analyses without substantial costs
- Mid-Infrared combined with X-ray can mitigate the number of samples analysed in the chemical lab

## Other resources & online information

**Twitter:** @teagasc

**Teagasc Website:** https://www.teagasc.ie/environment/research/laboratory-facilities/spectroscopy-laboratory/

**GSI Website:** https://www.gsi.ie/en-ie/programmes-and-projects/tellus/activities/tellus-product-development/smart-agriculture/Pages/Terra-Soil.aspx

**Google** "Teagasc spectroscopy laboratory" for more information.

**Email:** felipe.bachiondesanta@teagasc.ie or karen.daly@teagasc.ie

# Farm Succession and Inheritance Planning

James McDonnell

Teagasc, Farm Management and Rural Development Department, Oak Park, Carlow

**Summary:**

- Farm Succession and Inheritance are subjects for every farm family
- Planning for succession is one of the most important aspects in the life of the farm business
- Planning for and carrying out succession can be a complex process. It needs to be given time at an early stage in the business cycle to ensure that the process is successful
- Open communication within the family is one of the most important factors contributing to a successful succession and inheritance process
- Use all the available support

## Introduction

The subject "Transferring the family farm" is one that every farm family should plan for during the life of the farm. People in general do not like to talk about succession and inheritance. It is a sensitive subject as farmers may feel it marks the end of their farming career. If the goal is for the farm business to continue functioning (well) beyond the tenure of the current owner/operator, then talking about and planning for succession is vitally important to ensure a smooth transition and viable future. It is important to understand that within farm transfer, there are two processes: succession and inheritance.

- Succession is defined as the gradual transfer of management of the farm from one generation to the next.
- Inheritance is defined as the legal transfer of the farm assets from one generation to the next.

Planning for both these processes in an open, collaborative way is critical to avoid extreme conflict and breakdown within the family unit.

## Succession Planning

Succession is very important for the farm business, but it can be difficult and complex. The farmer and spouse are faced with trying to maintain a viable farm business for the next generation, treat all of their children fairly (not necessarily equally) and provide financial security for their own retirement. Fortunately, succession also incentivises the next generation to expand or change the farm in order to generate sufficient income for additional family members, and it provides the necessary resources, labour and skills to carry the plan through.

It is important to note that succession is not a single event but a process which occurs over a period of time. Planning early for succession allows for a lot of the main issues to be addressed and resolved before transition starts. The goal in involving all family members in planning is to build consensus over the plan and proposed outcomes for the farm. A key starting point to this is establishing the needs, expectations and fears of all family members with regard to the farm business.


## Communication

Effective communication is the key ingredient to successful succession planning. It allows for family members to share concerns, decide on options available and what actions to take. It also allows for effective planning and helps prevent disputes, misunderstandings and unnecessary anger.

Typically, when it comes to discussions around succession and inheritance, farmers are "passive" communicators. This means that there are a lot of assumptions around who is getting the farm and the plans for the future, but these are not always explicitly communicated to the people involved.

When communicating on succession and inheritance, it is important to discuss and clarify the three key aspects of how family, ownership and management will play out, overlap and change over time/at different points in the future. When planning any discussion on succession, the following should be considered:

1. Who should be involved in the discussion?
2. What needs to be discussed?
3. When and where to meet?
4. What life stage are the children at?


## Conclusions

Communication is the key to effective succession planning. It is important to have the discussion early and with all family members. This should help prevent disagreements and ensure that all family members have had the opportunity to discuss their needs, fears and requirements as to how the farm business will continue. For further information, log onto the farm succession page on www.teagasc.ie at the following link https://www.teagasc.ie/rural-economy/farm-management/succession--inheritance/ or open the camera on your smartphone and scan the QR code.

# Farming Lifestyle

## FARMING FOR A BETTER FUTURE

# Health and safety for sustainable farming

John McNamara [1], Francis Bligh[2] and Rioch Fox[3]

[1]Teagasc, Health and Safety Specialist, Kildalton, Co Kilkenny.
[2]Teagasc, Health and Safety Specialist, Abbey Street, Roscommon. [3]Teagasc, Johnstown Castle, Co. Wexford.

**Summary:**

- Farm accidents and ill health cause tragedy, suffering and long-term disability. These can also jeopardise a person's capacity to farm effectively and hence jeopardise farm income. Therefore, it is in everyone's best interest to give practical safety and health management adequate attention.
- In 2021, ten fatal accidents occurred associated with farming, one with 'forestry and logging' and one due to farm construction. An estimated 2,800 serious accidents take place each year.
- Farmers have been identified as an occupational group who have a high level of ill health. Research suggests that farmers need to give more attention to their health, including having a regular medical check-up with their GP.
- Considerable grant aid support for farm safety improvements is currently available through the Targeted Agricultural Modernisation Scheme (TAMS11). Farmers need to consider how to make optimum use of this scheme.
- Managing health and safety is vital for farming sustainability. More awareness of health promotion practices are needed among the farming community.

## Introduction

Farming is one of the most dangerous work sectors in Ireland. Typically, about 20 workplace deaths occur in the agriculture sector annually. In 2020, 20 farm deaths occurred, accounting for 37% of all workplace deaths. In 2021, the number of farm deaths reduced to 10 with one in 'forestry and logging' and one due to farm construction. In 2022, six deaths (provisional figure) have been reported up to July 25th. Childhood deaths are particularly tragic and in recent years, there has been a significant increase in the occurrence of these fatalities. Farm accidents causing serious injury occur at the high level of 2,800 per year. In the previous 5-year period the percentage of farms for the main enterprises having an accident was as follows: dairying (18%), drystock (17%), sheep (11%) and tillage (12%). An accident can lead to a permanent disability and interfere with a person's capacity to farm effectively. Farmers as an occupational group have been identified with having high levels of preventable ill health. Ill health effects quality of life and a person's capacity to farm effectively. Thus managing health and safety is vital for farming sustainability. More awareness of health promotion practices are needed among the farming community.

## Legal duty to complete a Risk Assessment

All workplaces, including farms have a legal duty under Safety, Health and Welfare at Work (SHWW) legislation to conduct a risk assessment to ensure that work is carried out safely. The 'green covered' Risk Assessment Document is available to accompany the Farm Safety Code of Practice. It is a legal requirement to complete this updated document annually and when major

changes occur to farming systems. The requirement to conduct a risk assessment replaced the requirement to prepare a safety statement for farms with three or less employees, which are estimated to make up about 95% of farms nationally.

### Safety of children on farms

The safety of children and young persons must be paramount on farms. The following precautions need to be considered when children are present on a farm:

- Provide a safe and secure play area for children away from all work activities. Where children are not in a secure play area a high level of adult supervision is needed.
- Children should not be allowed to access heights.
- Action should be taken to keep children away from dangerous areas such as slurry tanks. All open water tanks, wells and slurry tanks should be fenced off.
- Give children clear instruction on farm safety issues.
- Children to be carried in the tractor cab (aged 7 or older) need to wear a seat belt.

The renowned safety booklet for children 'Stay Safe with Jesse' is a key reference.

### Preventing machinery accidents

Vehicle and machinery-related deaths account for 53% of all farm deaths. For vehicles, being struck (25%) is the most frequent cause of death followed by being crushed or trapped by the vehicle (24%), fall from vehicle (12%) and being pierced by a vehicle part (2%). With machinery, being crushed (23%), struck (18%) or collapse (18%) are the most frequent causes of death followed by power drive entanglement (14%). The fatal data shows that most accidents occur due to being crushed or struck, so safety vigilance is especially needed when in proximity to moving vehicles/machines. Entanglement deaths and serious injuries are particularly gruesome and occur most frequently with machines used in a stationary position, such as a vacuum tanker or slurry agitator where contact can occur between the person and the PTO. Quads (ATVs) are useful machines on farms for travel but they have a high risk of death and serious injury if misused.

### Preventing accidents with cattle

On Irish farms, livestock deaths make up 19% of all deaths and 42% of farm accidents. Cows or heifer accidents account for 33% of livestock-related deaths, with bulls (18%), horses (8%), bullocks and other cattle (41%) accounting for the remainder. The notable trend is that the percentage of cow/heifer incidents causing death has increased dramatically in the last decade so additional precautions with this livestock group are required. Farmers are advised to keep a bull's temperament under constant review, have a ring and chain fitted, keep a bull in view at all times and always have a means of escape or refuge. Breeding cattle for docility should always be considered.

### Preventing deaths with slurry

Farm deaths associated with slurry and water account for 10% of farm deaths with the majority of these being drowning. Particular care is needed when slurry access points are open and physical guarding needs to be put in place. Slurry gases are a lethal hazard on cattle farms. Hydrogen sulphide is released when slurry is agitated and in calm weather can be present at lethal levels. The key mitigating controls are to pick a windy day for agitating, evacuate all persons and stock from housing and open all doors and outlets. A range of other gases including methane, ammonia

and carbon dioxide are produced from slurry due to fermentation in semi-emptied tanks. Never enter a slurry tank as lack of oxygen or the presence of poison gases could be fatal. Also, never have an ignition source near slurry tank due to the methane explosion risk.

## Farmer health

A major Irish study has indicated that farmers in the 'working age' (16-65 years) have a 5.1 times higher 'all cause' death rate than the occupational group with the lowest rate. The major causes of elevated death rate include cardiovascular disease (CVD), cancers and injuries. A further Irish study indicated that 59% of farmers had a health check with their GP in the last year compared to 74% for the general population. Among farmers just 27% believed that they were too heavy despite 60% being classified as overweight or obese. Farmers have been shown to achieve an adequate 'number of steps' daily; however, in general, the level of moderate-to-high intensity exercise achieved, which is essential for cardiovascular health, is inadequate.

## Looking after wellbeing

We can all go through low points from time-to-time times in our lives and it is not unusual to experience symptoms related to stress, anxiety and depression. Teagasc has a leaflet entitled 'Positive Mental Health in Farming' on its website. In this regard, a number of national organisations that promote positive mental wellbeing are available, including Mental Health Ireland and the Samaritans Ireland. 'Awareness Head to Toe' promotes mental health, general health and farm safety awareness, Embrace Farm support farm families after a farm accident. Information on these and other organisations is available on the web.

## Agricultural Vehicle Standards for Public Roads

Revised standards for use of agricultural vehicles on public roads are in place. In addition to the vehicle, the standards include both trailers and attached machines. The purpose of the standards is to enhance the safety of road users. A booklet on the revised standard can be downloaded from the RSA website at: https://www.rsa.ie/road-safety/road-users/agricultural/introduction-to-vehicle-standards-for-agricultural-vehicles

*Key requirements of the new legislation include:*

Braking: More powerful braking systems will be required for agricultural vehicles operating at speeds in excess of 40 km/h. Most of the correctly maintained tractors which have come into use in the past 30 years already meet these requirements.

Lighting and visibility: Agricultural vehicles will need to be equipped with appropriate lighting systems, flashing amber beacons and reflective markings.

Weights, dimensions and coupling: New national weight limits have been introduced. These will enable tractor and trailer combinations which are un-plated to continue in use at limits which are safe for such vehicles. Plated tractors and trailer combinations can operate at higher weight limits of up to 24 and 34 tonnes for tandem and triaxle agricultural trailers, respectively, when meeting certain additional requirements.

### Accelerated Capital Allowance Scheme.

An Accelerated Capital Allowance programme for farm safety and disability adaptation equipment is in place. To be eligible to claim the accelerated wear and tear allowance, the qualifying equipment purchase must occur between 1 January 2021 and 31 December 2023. Currently, capital allowances are available at 12.5% per annum (p.a.) over eight years for agricultural equipment generally. This scheme allows for accelerated capital allowances of 50% per annum over two years for certain eligible equipment. This eligible equipment includes, for example, chemical storage cabinets, anti-backing gates, big-bag lifters, quick hitch mechanisms for rear and front three-point linkage to enable hitching of implements without need to descend from tractor, as well as adaptive equipment to assist farmers with disabilities. Full details of the scheme are available on the DAFM web site at https://www.gov.ie/en/publication/4133b-farm-safety/?referrer=http://www.gov.ie /farmsafety/

### Sustainable Use of Pesticides Directive

The purpose of the EU Sustainable Use Directive is to put a legislative system in place to ensure that farm pesticides are used responsibly, safely and effectively, while safeguarding the environment. Professional pesticide users (PU) must be registered with DAFM and have a PU Number. Farmers are classified as professional pesticide users. In order to register, a farmer must have completed a training course provided by an approved training provider. A list of training agencies is provided on the DAFM web site at http://www.pcs.agriculture.gov.ie/sud/. In the event of a DAFM inspection, a farmer will be required to produce evidence of having completed appropriate training.

All boom sprayers greater than 3 m boom width must be tested. The interval between tests must not exceed five years until 2025. A list of approved sprayer testers is available on the DAFM website.

### Further Information

New and current information can be downloaded at the following web sites: https://www.teagasc.ie/rural-economy/farm-management/farm-health--safety/

HSA http://www.hsa.ie

## NOTES

**The Environment Edge podcast** https://www.teagasc.ie/environmentedge/

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