Teagasc
Agriculture and Food Development Authority

Agriculture and Food Development Authority
Johnstown Castle

FARMING FOR A BETTER FUTURE

Resilient and Sustainable Farming Systems

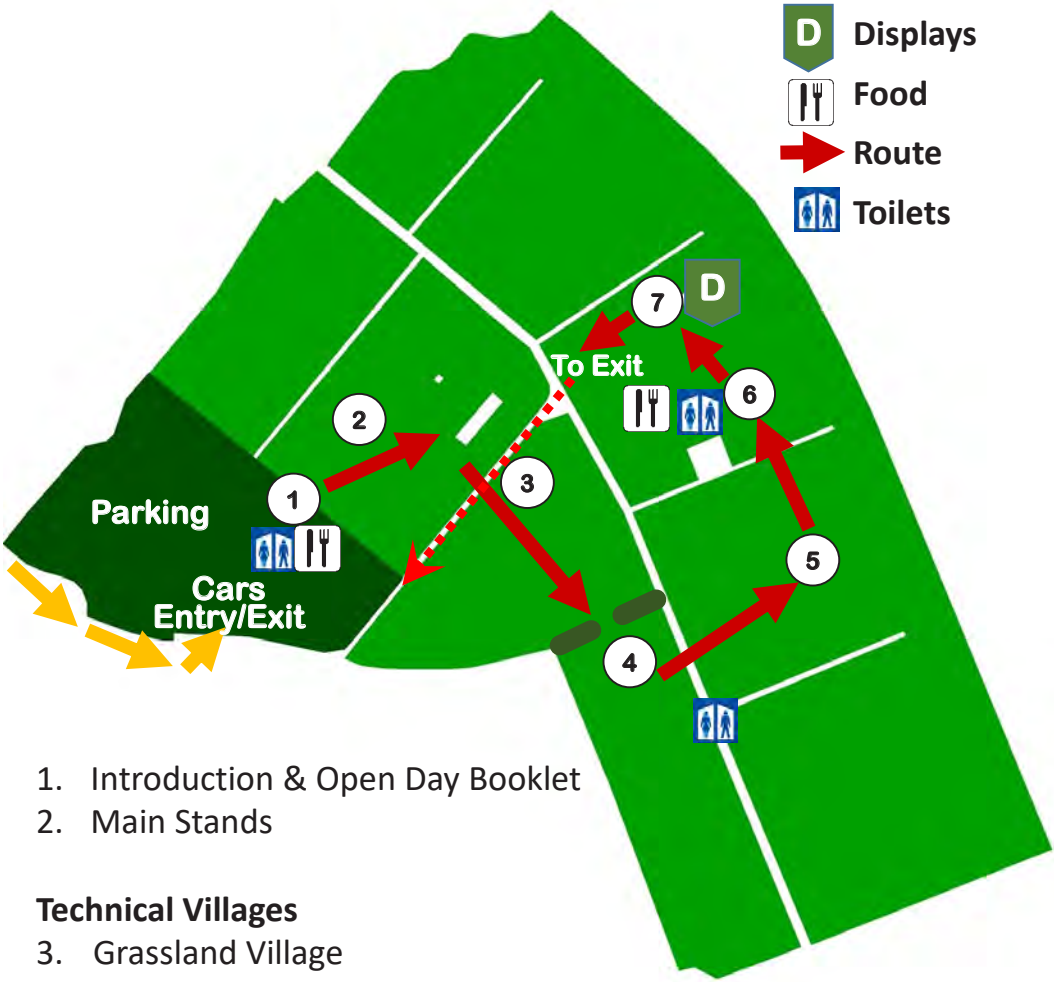
OPEN DAY

Teagasc, Johnstown Castle Environment Research Centre, Co. Wexford

Tuesday, 16 July 2024

FARMING FOR A BETTER FUTURE 2024

‘ Resilient and Sustainable Farming Systems’



1. Introduction & Open Day Booklet
2. Main Stands

Technical Villages

3. Grassland Village
4. Sustainability Tech Village
5. Livestock Systems Village
6. Advisory, Education & Policy Village
7. Health & Safety Demo Area

FARMING FOR A BETTER FUTURE

ACKNOWLEDGEMENTS

Teagasc acknowledges the support of Research, Advisory, Technical, Farm & Maintenance and Administration Staff for preparing and delivering this open day event

TUESDAY, 16TH JULY 2024

Compiled and edited by:

David Wall & Karen Daly

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

ISBN: 978-1-84170-702-0

Table of Contents

Technology Village

Livestock Systems

Advisory Education & Policy

Farming Lifestyle

Health, Safety and Bio-Security

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 2024

Foreword

I am delighted to welcome you to the Johnstown Castle Open Day "Farming for a Better Future – Resilient and Sustainable Farming Systems. Farming systems for the future must be both economically, environmentally and socially sustainable. Profitability has long been a challenge for the sector, but in recent years, it is the environmental issues that have come to the fore. These encompass emissions reduction, water quality, biodiversity loss as well as adapting to a changing climate. Policy in this area, both national and EU is complex, and policies such as the Nitrates Directive, the Climate Action Plan, the Carbon Removals and Carbon Farming Regulation, the Nature Restoration Law, the CAP Strategic Plan, and the currently debated Soil Monitoring and Resilience Law, all have implications for farmers and the agriculture sector. Irish agriculture has shown itself capable of great change and development over many decades. The key priority for Teagasc at this point in time is to provide leadership and support to the agri-food sector as it changes and adapts to meet these challenges. This Open Day will discuss the key benchmarks and indicators (KPIs) for sustainable farming systems, and how Irish farms can reach these. It will identify the technologies and farming practices that are important to help farms to become more resilient in the face of a changing climate. Technology will play a very big role in meeting the challenges, and there is a large research programme at Johnstown Castle and other Teagasc centres to develop and adapt the technologies needed for the future. These include innovations that are currently ready to be put into use on farms (and indeed are already in use on many farms) such as white clover and red clover silage, slurry additives, sustainable fertilisers, home grown protein feeds for winter milk, spring dairy production on multi-species swards, profitable dairy beef production, practices to enhance farmland biodiversity both above and below ground. These technologies will all be on display at the open day, and you will also learn about other technologies being researched for the future such as feed additives to reduce methane production, carbon sequestration, soil biostimulant

technologies, drought resistant swards, and using slurry separation and digestate to replace chemical nitrogen. In addition, performance details of the farming systems operating at Johnstown Castle which include winter and spring calving dairy systems, dairy calf to beef, and the new organic beef finishing trial will be outlined. There will also be a lot of information for tillage farmers around soil health, crop nutrition, and cover crop establishment and management.

The supports available to farmers to adopt and implement these technologies on their farms will also feature prominently at the Open Day. Teagasc runs a number of important campaigns and programmes such as the new Better Farming for Water 8-Actions for Change campaign along with the ASSAP and ACP, the Signpost Progamme (including AgNav), and the Grass10 campaign (incorporating Clover150) which will be part of the Open Day, and advisers will be present to talk to farmers. These are multi-actor campaigns and programmes, and we acknowledge the strong contribution of our many partners. Our forestry and organics teams will also be present to outline the opportunities in these sectors. Knowledge transfer is obviously key to seeing widespread change at farm level, and this means a very important role for the Teagasc Advisory service and also the Teagasc Education service in leading this change. Overall it promises to be a great day, packed with knowledge and I very much hope you enjoy the day and find it informative and useful.

Professor Frank O'Mara

Director Teagasc

FARMING FOR A BETTER FUTURE 2024

Welcome to Johnstown Castle

David Wall & Karen Daly

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

On behalf of the staff at the Teagasc, Soils, 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 2024. The theme today is 'Resilient and Sustainable Farming Systems" which will help farmers deal with the many challenges facing the sector such as changing weather patterns, price volatility, policy changes, to name but a few. Many of the technologies and farm practice strategies we have on show today will help farmers maintain productivity while increasing the profitability and environmental sustainability of their family farm businesses. These include, multispecies and grass-white and red clover swards, grazing and silage conservation management, sustainable fertiliser technologies and organic manure management, winter and spring dairy cow management and nutrition, dairy-beef and organic beef finishing production systems, animal health, tillage soil management and farm planning. Reducing gaseous emissions, protecting water quality, enhancing biodiversity and soil health in order to reduce the environmental footprint of grassland and tillage production systems will be essential to maintain the competitiveness and sustainability of Irish farms and the agricultural and food sector. All of these technologies and much more will feature strongly at FARMING FOR A BETTER FUTURE 2024.

Many of these technologies can also help address the high input prices that

Irish farmers are currently experiencing and strategies can be put in place to mitigate their impact on farm profitability. Today's event is comprised of three main 'speaking' stands where the key challenges and indicators for reaching sustainability targets that farmers are facing into will be addressed. We will take you through some of the strategies and technologies available to meet these challenges, including enhancing soil health, water quality, biodiversity and reducing gaseous emissions while maintaining economic sustainability. We will discuss how knowledge will be transferred to empower farmers and the supports available to support the transition at farm level. And most importantly, how and when to best implement these strategies and technologies within your farming system. The main stand are followed by a series of 'villages' where the latest research findings is presented and knowledge and practical advice can be gained on a range of topics; grassland and tillage soil management, water quality, soil fertility and health, biodiversity, gaseous emissions, carbon farming and sequestration and livestock production systems.

The key management practices and technologies to improve farming sustainability will be shown throughout the day with demonstrations that will be both informative and interactive. You will also have the opportunity to meet our advisory service, education officers, and KT programmes e.g. Ag Sustainability Support Advisory programme (ASSAP), Signpost programme and Grass 10 programme in the Knowledge Transfer village and discuss the supports and services available to you. Our farm Health & Safety team will also be on site to demonstrate and discuss how we can make our farms safer working environments for farmers and their families.

FARMING FOR A BETTER FUTURE 2024 has been developed to update farmers and the wider agricultural industry on the latest emerging research and to become more informed potential solutions that can be adopted on farms to overcome emerging challenges. We encourage everyone to ask questions of the experts on the day to gain such knowledge. In preparation for this event, particular attention has been paid to health and safety, and biosecurity 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 not to 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 resilient and

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 Indicators for Resilient and Sustainable Farming systems

Karen Daly and David Wall

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

Farmers have faced and overcome the challenge of economic, social and environmental sustainability for some time now, however, challenges concerning agriculture's role in maintaining and improving the surrounding environment have been increasing in recent years. The EU Green deal has set targets to halt biodiversity decline, improve water quality, reduce fertiliser and pesticide use and protect soil health. In Ireland, the agricultural sector is facing multiple policies and frameworks and very challenging environmental targets. The sectoral targets to reduce greenhouse gas and ammonia emissions, improve water quality and reverse the decline in farmland biodiversity are fast approaching. The trends in emissions, water quality and biodiversity continue to decrease or remain static and we urgently need to work together to implement solutions and 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 home-grown 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/multispecies sward establishment and enabling a significant reduction in nitrogen fertiliser use. Use of using 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 fertiliser are used and that optimal soil fertility can directly reduce emissions by c. 40%.

Carbon farming and sequestration

A carbon farming framework for Ireland is under development by government that needs

accurate information to monitor, verify and report on carbon capture and removals and research is underway to bring this data to government. Strategies that we can adopt now to increase carbon sequestration include increasing trees on farms through hedgerow management, on farm forestry and agro-forestry. Currently our national inventories are using default values to account for carbon emissions and sequestration in agricultural soils and research is underway to refine these emission factors for different soil types, land-use, land management practices. Research on the effects of water table management of drained grassland peat soils and improving the accuracy of mapping our drained grassland peats is getting underway. This will improve the accuracy of the inventory and identify technologies to reduce emissions from soils and the management practices to enhance carbon sequestration.

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 54% of Irish surface waters are at satisfactory or good status, with the presence of too much P and N in our waters as the primary challenges. Agriculture has a significant role to play in helping achieve good water quality targets and the Teagasc Better Farming for Water campaign has a clear objective to reduce nutrient and sediment loss to water through its 8-Actions for change focussing on nutrient management, farmyard management and land management. 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 Sustainability Support and Advisory Programme (ASSAP) provides free advice to farmers on appropriate practices to improve water quality.

Biodiversity

The EU biodiversity strategy aims to have at least 10% of agriculture area under high-diversity landscape features by 2027. The area of seminatural habitat and number of bird species and pollinators has declined. 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 achieve the 10% target. A range of technologies from multispecies swards, hedgerow management, field margins and results 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 strategies and solutions available to improve environmental sustainability on farms. The researchers and advisers are available to support farmers on how to adopt these on their farms. There are insights to future research investigating emerging technologies to help farmers further improve sustainability and resilience of their farming systems. Many of the actions and strategies that you will see today have multiple co-benefits and also improve farm profitability. Please identify the solutions and actions that will work on your farm and you could implement into the future.

Other resources & online information

Email: david.wall@teagasc.ie; karen.daly@teagasc.ie

Practical actions for efficient and environmentally sustainable farms

Owen Fenton and Bridget Lynch

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

Integration of actions into farming systems

The aim of the Johnstown Castle Open Day is to make our research and technologies farm ready with scientific rigor leading the way. Our proposal to you is: implement one additional technology on your farm (or with your customers) in each farming season over the next 12 months.

We acknowledge that it has been an extremely testing 12 months on Irish farms with all farm enterprises negotiating difficult weather conditions from harvest 2023 through to early summer 2024. However, as an industry our environmental reduction targets remain. It is acknowledged that farmers are weary and that, the ask to do more for the future of our agricultural industry by adopting more and perhaps new technologies on farm may seem overwhelming and a challenge for next year.

Table 1 maps out scientifically proven effective technologies as they apply in the farming system and season. When stacked, the accumulative benefit of multiple technologies will move the dial for the improvement of soil health and fertility, enhancement of farmland biodiversity, reduction in agricultural gaseous emission and improved quality of waterbodies. Indeed, many of the technologies and underlying principles are cross-cutting with benefits for two or more pillars for each action, and can also have positive benefits for farm efficiency/profitability.

Actions to enhance soil health, carbon sequestration and fertility

Soil health: Our soils are precious resources that underpin sustainable food production and many other important ecosystem services for society. Our soils support the production of food, feed and fibre. There are many other functions supported by soil including, the re-cycling of nutrients, sequestration of carbon & regulation of our climate, purification and storage of water. Soils are also an important habitat for biodiversity, containing nearly 60% of all life on the planet. In Ireland our grass-based animal production and high yielding arable cropping systems rely heavily on the availability of healthy soils to deliver high quality, profitable and sustainable food production on farms. The traditional view of high quality soil, measured by the soils performance for crop production alone, is now considered inadequate, as it does not consider the wider impact that soils have in the environment and for society. A decline in soil structural quality which leads to soil degradation and compaction is often the consequence of more intensive management practices. This can also lead to reduced capacity for water to infiltrate and drain through the soil, to store water and to purify water in the landscape. Chemical indicators in soils provide much information in relation to nutrient cycling, primary production and carbon sequestration functions in soils. In particular soil pH and soil organic matter are key factors, which regulate nutrient availability in soils and the delivery of different soil functions including carbon sequestration and macro/micro nutrient cycling. Soil biology is the “engine of the soil” and soil biodiversity and the soil microbiome is at the centre of soil functioning. Biological indicators provide valuable information on the effects of past and current management on soil health. For example, the abundance and presence of earthworms is a useful and easily identifiable soil health indicator. However, much of the soil biology cannot be seen with the naked eye and requires more sophisticated analysis, which may not always be practical for routine in-field soil health assessments. However, much can be inferred

about biological health of the soil by visually examining the soil habitat. Strategies to avoid soil compaction in grassland include maintaining soil organic matter, keeping a living root in the soil, avoiding trafficking wet soils with heavy machinery and high stocking rates. Soil structure is weaker when wet and prone to damage. In grasslands, pugging and poaching from livestock treading, as well as machinery rutting, will occur if soils are wet, and must be avoided. When driving machinery across soil, stick to tramlines or straight passes and avoid trafficking the entire field, even in dry conditions. Controlled traffic farming, which uses GPS technology is designed to ensure machinery uses defined and permanent paths. Also traffic during appropriate soil moisture conditions, reduce number of passes and manage headlands. Try also to reduce axle loads by using trailers with multiple axles. Lowering tyre pressures (to safe levels, use larger tyres, VF/IF tyres and more wheels are options) helps to spread weight over greater surface areas and can greatly reduce the risk of soil compaction. Tracks, wide tyres or duel wheels work on the same principle and can also be beneficial.

Soil carbon sequestration: is an important mechanism that removes carbon dioxide from the air and stores it in the soil. Strategies for carbon sequestration include avoiding soil compaction, increasing the proportion of grazing on the farm, improving existing hedgerows, improving soil fertility, establishing clover and multi-species swards, planting extra hedgerows and additional woodlands/forests and restoring a wetland. On tillage farms strategies include improving soil fertility, including organic manures applied to crops, and during non-cropping times introducing cover crops and incorporating straw. There are a number of factors that influence the rate of carbon sequestration in agricultural ecosystems including: climate; soil type and land-use.

Soil fertility: Good productive soils are the foundation of any successful farming system and key for growing sufficient high quality grass to feed the herd. Therefore, the management of soil fertility levels should be a primary objective of every farm where maintained or enhanced production is an aim. To measure soil fertility we test soil to identify the pH level, phosphorus (P) level, and potassium (K) level. A recent review of soils tested at Teagasc indicates that the majority of soils in Ireland are below the target levels for pH (pH 6.3), P and K (i.e. Index 3) and will be very responsive to application of lime to increase pH, and also P & K. On many farms sub-optimal soil fertility is leading to a drop in output and income if allowed to continue. Therefore, five steps to soil fertility management are:

1) take soil samples for the whole farm and repeat over time (3 to 5 years); 2) lime should be applied to neutralise soil acidity and raise the soil pH to the target soil pH for the crop been grown. For mineral soils, a soil pH 6.3 is recommended for grassland. The soil pH should be higher (Barley / Beet) for tillage crops and aim to maintain at pH 6.5 to 6.8. Apply lime as a priority in line with the lime advice as per the soil test report; 3) target Index 3 - aim to have optimum soil P and K (Index 3) fertility levels in all fields; 4) Use slurry/farmyard manure on the farm as efficiently as possible, and top up with fertiliser as required. Implement the 5R principles of right rate, right type, right application method (e.g. LESS), right timing and right place. Aim to apply slurry and manures to fields that have high P and K requirements (e.g. grass/maize silage). Apply in spring time under cool and moist weather conditions to maximise N recovery and 5) have a balanced nutrient supply.

Clover (white and red) offers an alternative to expensive artificial fertilizers and helps towards environmental sustainability. Incorporating clover in grassland swards has the potential to reduce costs, improve profitability, reduce greenhouse gas emissions and enhance soil biodiversity, and should also be considered within a nutrient management plan.

Teagasc provides tools to aid with Nutrient Management Planning (NMP) and grass production and utilisation. NMP Online is an online tool that allows agri-professionals to produce high quality nutrient management plans for farmers by combining their expert knowledge of soil fertility with

a range of information sources. The key benefits of NMP Online are that it helps to efficiently complete complex nutrient calculations, enables you to access latest aerial imagery and mapping, create user friendly reports and maps and training and ongoing updates for available for all users. PastureBase Ireland is another tool to help Irish dairy, beef, and sheep farmers manage their grass production and utilisation. Additional features are continuously being added to improve the user experience and the quality of the information available to the farmer user. Recently, nutrient use efficiency (NUE) calculator and mapping functionality for a farm have been added to PastureBase. In addition, AgNav is a new sustainability toolkit being jointly developed by Teagasc, ICBF and Bord Bia - with the support of the Department of Agriculture - that provides farmers with accurate and verifiable data to support decision making on farm to help meet agriculture's Climate Action.

Biodiversity: actions to maintain, enhance, diversify, and connect existing habitats and create new habitats.

Biodiversity provides us with clean air, fresh water, healthy soil, fuel, fibres and the food we eat. It can help us to mitigate against and adapt to climate change. Despite the many benefits of biodiversity, it continues to decline and biodiversity loss has far-reaching consequences for future generations. Farmland has the capacity to make a big difference in halting biodiversity loss. The key message to communicate in relation to managing farmland biodiversity is to, maintain first, enhance second and create if not already in existence. Protecting farmland biodiversity, while maintaining a productive farm business is achievable by following these key steps:

1) Identify what habitats are already present; 2) Maintain, enhance, diversify and connect existing habitats; 3) Where there are few existing habitats, create new habitats.

Every farm has some value for biodiversity, but some farms offer more value than others. One way to enhance biodiversity on your farm is to manage hedgerows less intensively. Maintaining a diversity of habitats is important, as different habitats support different species. Different pollinators have different traits, thus supporting a higher species richness (diversity) of pollinators can contribute to increased pollination and increased pest control, which increases crop seed yield and economic value. Habitats in poor condition can be enhanced through sensitive management. If invasive alien species are present, aim to remove them because they displace native species. Noxious weeds such as docks, ragwort and thistle can be kept under control by mechanical means or by spot treatment. Linear farmland features such as hedgerows, field margins and watercourses, managed appropriately can act as corridors for nature through the landscape, allowing farming and biodiversity to co-exist. Maintaining and managing existing old hedgerows with high levels of associated fungi, lichen, moss and invertebrates is far more beneficial than planting new hedges. No matter which biodiversity-friendly areas are on the farm, it is vital that evidence-based actions are used to manage these, to protect and enhance farmland biodiversity. It is imperative that new habitats such as planting trees or incorporating a pond, are located in the right part of the farm and that they do not replace existing habitats.

Six actions farmers can take that will allow biodiversity to coexist within a productive farming system are: 1) Create nesting sites for solitary mining bees; 2) Create nesting sites for cavity nesting bees; 3) Plant native trees; 4) Avoid the use of herbicides and fertiliser under hedges; 5) Allow hedgerows and margins to flower and fruit; 6) Identify and protect species rich grassland.

Actions to reduce gaseous emissions:

Three main greenhouse gases (GHGs) carbon dioxide, methane and nitrous oxide, and the two main GHGs for agriculture are methane and nitrous oxide. 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. The strategies proposed to reduce emission on your farm include optimising soil fertility, which 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 (LESS) 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%. Ammonia is not a greenhouse gas, but it can indirectly contribute to greenhouse gas emissions. Ammonia comes mainly from management of animal manures (housing, slurry storage and land-spreading) but also from grazing animals, and finally from spreading of synthetic fertiliser. Teagasc has carried out extensive research on technologies to reduce these emissions such as: protected urea, low emission slurry spreading (LESS), clover, extended duration grazing, slurry additives and others.

Better Farming for Water – 8 Actions for change:

Abundant, clean and good quality water is a fundamental cornerstone of any thriving society and is necessary for a vibrant economy and enjoyable living environment. All farmers can play a role in protecting and improving water quality, by focusing on three critical management areas:

1) nutrient management; 2) farmyard management and 3) land management. In terms of nutrient management: Reduce purchased N and P surplus per hectare; Ensure soil fertility is optimal for lime, P and K and only apply fertiliser and organic manure at appropriate time and conditions. In terms of farmyard management have sufficient slurry and soiled water storage capacity and manage and minimise nutrient losses from farmyards and roadways. In terms of land management fence off watercourses to prevent bovine access; target use of mitigation actions such as riparian margins, buffer strips and sediment traps to mitigate nutrient and sediment loss to water and maintain over-winter green cover to reduce nitrate leaching from tillage soils.

Conclusions

There are many actions for efficient and environmentally friendly farms spread across soil health, soil fertility, soil carbon sequestration, biodiversity, gaseous emissions and water quality. All of the actions mentioned are scientifically robust, which should give farmers the confidence for adoption out on farms. Our proposal to you is to select one additional technology to adopt on your farm (or with your customers) in each farming season to apply in the next 12 months. When stacked, the accumulative benefit of adoption on farm of multiple technologies will ensure we move the dial for the improvement of soil health and fertility, enhancement of farmland biodiversity, reduction in agricultural gaseous emission and water bodies. Indeed, many of the targets and underlying principles are cross-cutting with benefits for two or more pillars for action.

Other resources & information

Email: owen.fenton@teagasc.ie; bridget.lynch@teagasc.ie

Table 1. Mitigation targets and application to farming system and season.

Target	Farm Action	Summer	Autumn/ Winter	Spring
Soil				
Build and maintain organic matter	Organic manures, incorporation of straw, cover crops, keep a living root in the ground	√	√	√
Protect good structure and prevent compaction	Avoid or restrict machinery or animal traffic when soils are moist/wet. Use larger tyres with lower pressures. Consider lower intensity tillage	√	√	√
Maintain and/ or improve soil fertility	Soil test, Nutrient Management Plan, increase N fixation, recycle organic manures	√	√	√
Enhance existing clover and multi-species swards	Reduce chemical N application, over sowing to replenish, diversify swards	√	√	
Improve and plant extra hedgerows	Hedgerow rejuvenation & management, plant new & diverse hedgerows		√	√
Restore a wetland	Consult with local Signpost Climate Advisor	√		
Biodiversity				
Identify and protect species rich grassland	Notify an advisor. No grazing or mowing during flowering; No reseeding and low to no fertiliser use	√		√
Avoid use of herbicide or fertiliser under hedges	Create a no herbicide and fertiliser margin under hedgerows	√	√	√
Allow hedgerows and margins to flower and fruit	Allow hedgerows to flower; cut on 2-3 year rotation cycle. Allow margins to flower but cut or graze once a year after flowering	√		√
Create nesting site for mining and cavity nesting bees	Create a bare soil bank or a bee box. If some hedgerows are left unfenced livestock can create bare soil banks for you. Diversity is key.		√	√
Plant native trees	Source locally grown native species		√	√

Target	Farm Action	Summer	Autumn/ Winter	Spring
Gaseous Emissions				
Increase individual animal productivity & efficiency	Use dairy & beef breeding indexes	√		
Grassland management	Measure & budget grass using PastureBase Ireland	√	√	√
Chemical fertiliser (5Rs–Right rate, type, place, timing, method)	Soil test, Nutrient Management Plan, apply in suitable conditions	√	√	√
Clover and multispecies swards	Identify high fertility pastures for over-sowing/ reseeding	√		√
Reduced concentrate crude protein	Reduce the crude protein content of concentrate fed at grass	√		
Organic fertiliser: LESS	Apply slurry with Low Emission Slurry Spreading in suitable conditions	√		√
Slurry tank cover	Cover over ground slurry storage	√	√	√
Water quality				
Reduce purchased N & P surplus / ha	Complete a Nutrient Management Plan for your farm		√	√
Optimal soil fertility	Soil test, Nutrient Management Plan, apply in suitable conditions	√	√	√
Fertiliser/ organic manure timing and conditions	Use local met stations & grass growth predictions	√		√
Sufficient slurry and soiled water storage capacity	Engage with advisor to calculate your slurry and soiled water storage capacity	√		√
Minimise nutrient losses (farmyards & roadways)	Assess run off from farmyards & roadways, improve & repair		√	√
Fence off water courses	Consult with ASSAP advisor on alternative water supplies if needed	√		√
Targeted mitigation actions	Use PIP maps & local knowledge to identify and manage high risk areas	√	√	√

Supporting Sustainability on the Ground

Pat Murphy[1] and Siobhan Kavanagh[2]

[1]Teagasc, Crops, Environment, and Land-use Research Centre, Johnstown Castle, Co. Wexford.

[2]Teagasc, Kildalton Agricultural College

Introduction

Sustainable agriculture can be defined a '*production system for food and other outputs which sustains 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 challenge for farming to demonstrate improvement in sustainability has become the clear priority for the sector – agriculture needs to reduce its negative impacts on the environment and deliver positive environmental goods and outputs for society. While improvements have occured, there is a need to pick up the pace of change.

This is the challenge for all Irish farmers and, a very significant number of farmers are already examining their production systems and looking at ways in which they can improve environmental outcomes. This is evidenced by the numbers of farmers at environmental focused events at national and local level. The environmental targets which must be met over the next 5 to 6 years will require the engagement of the vast majority of farmers across the country in significant practice change.

In the past, we mainly relied on regulation and schemes to drive change at farm level. While these will remain a key part of the 'toolkit' on their own they will not drive the level of change required – nor do we want them to. If we try to exclusively regulate our way to achieving environmental objectives we will end up with a smaller and more restrictive industry. We will also be implementing measures right across all farms and all landscapes when they may only be needed or beneficial in limited areas or circumstances.

It has also become very clear over the last number of years that we have no 'silver bullets' in our toolkit. Each farmer will be required to make changes across a large number of different aspects of their farm.

To achieve the level of change required farmers will need assistance. This has been increasingly recognised by all in the industry. There are now 70 advisers – 40 in Teagasc and almost 30 in the dairy co-ops in the ASSAP and Signpost Programmes who are providing free advice to farmers. There is an acceptance that there is a need for more. There has also been a shift in the role of all advisors, whether Teagasc, private consultants or industry based to focus more on sustainability issues.

Identify Areas for Improvement

Some farmers may decide to take on fundamental shifts in their production systems, for example to go organic or to plant a significant area of forestry. 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.

The first step it to identify the key areas for improvement. Some key resources and supports have been developed to assist in this process. For water quality, the data and associated maps developed by the EPA are a fantastic resource. From these a farmer can see what is the quality of their local river, what are the local challenges, be they Nitrogen, Phosphorus, Urban Waste Water

Pesticide etc. Using the PIP maps the vulnerability of land to losses of P and N can be seen. In priority areas for action (PAAs), LAWPRO have carried out detailed assessments identifying the challenges to water quality. All this information will help to guide what actions are needed at farm level.

In relation to GHGs and ammonia emissions the starting point for any farmer on the journey to becoming more sustainable is to establish their farm's current performance. AgNav and the Bord Bia Farmer Feedback Report provide farmers with assessments of their greenhouse gas and ammonia emissions along with providing an opportunity to assess the potential for improvement by implementing a range of actions.

In relation to biodiversity the assessment of space for nature carried out by DAFM to support the ECO-Scheme payments has made a start in providing farmers with a measure of how they perform in leaving space for nature on their holdings.

Get Help to consider your options

No two farms are the same; so it follows that the priority issues to be tackled and the solutions to them will be different for each farm. There are a huge number of actions which need to be implemented at farm level over the next few years and it is impossible to take them all on at once. Some actions are a much higher priority than others. That is why it is important to seek help. Help is available for a variety of sources including

- ASSAP advisers (Teagasc and Dairy Co-Op advisers),
- Signpost Advisers,
- Your farm adviser be they Teagasc, Private or Industry
- Discussion groups and Events
- Web sites, webinars, podcasts etc

Working with your adviser you will be able to identify what might be appropriate in your situation.

Make a plan focusing on priorities for improvement

There are no silver bullets and farmers are being asked to make a multitude of changes over the next few years. For example there are approximately 30 measures in the Green House Gas MACC which are required to meet our agricultural emissions targets and when looking at water quality ASSAP advisers look at 43 different practices on farms. Biodiversity has a similar number of potential measures. Some examples of easy wins include:

- Switch to protected urea. Urea emits ammonia and CAN emits nitrous oxide – a greenhouse gas.
- Use low emissions slurry spreading
- Minimise losses of nutrient from your farmyard and roadways
- Fence off watercourses and prevent animal access
- Do not spread organic manure too early or too late in the season and only spread when conditions are suitable.
- Manage hedgerows less intensively.
- Create nesting habitats for solitary bees.

- Increase your space for nature using hedgerows, trees and margins
- Install solar panels
- Reduce N usage and increase N use efficiency

Use the available supports to tackle the bigger issues

While a number of measures have low cost or even save money (Protected Urea, improved EBI, improved soil fertility, improved hedgerow management) other come at a considerable cost. For many of these there is assistance in the form of schemes or capital grants. In most cases, schemes fully compensate for the costs of materials and labour involved in implementing measures. The Farming for Water EIP supports a wide range of measures that can improve water quality. TAMs III grants are available for a wide variety of environment related capital projects.

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. Each farmer will have to identify and implement the best solution for their farm business from a range of possible measures. The Teagasc Advisory Service and other professionals are ready to help farmers develop tailored solutions for their farm and financial supports are available for many possible measures.

Change is difficult but Irish farming has shown previously that it is capable of change. By working together we can make the necessary changes. Let's start today.

Other resources & information

Email: siobhan.kavanagh@teagasc.ie; pat.murphy@teagasc.ie

Grassland & Soils Village

FARMING FOR A BETTER FUTURE

Acting on Soil Test Results for Soil Fertility

1. Soil Analysis

- Fertiliser Costs have increased €€€
- 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 of soil testing & analysis = € 1.25/ha

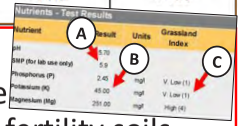
2. Taking soil samples

- ✓ 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
Target 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.

Interpreting and acting on soil test results

Veronica Nyhan, Mark Plunkett, David Wall

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

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 from every field or area managed e.g. paddock. The area sampled should be between 2 to 4 ha. If the field is large >5ha split the field into two areas for soil sampling
- Sample the top 10cm of soil. Achieving the full 10 cm with the soil corer is critical for accurate soil test results as nutrient can be stratified in the surface layers of soils
- Take a minimum of 20 soil cores in a 'W' pattern across the field or area sampled
- Ensure 3 to 6 months between soil sampling and the last application of P or K
- Leave 2 years between liming and soil sampling where assessment of soil pH is required
- 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/

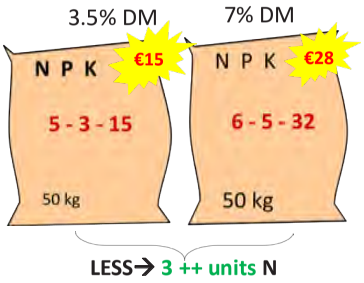
Teagasc Website: https://www.teagasc.ie/crops/soil--soil-fertility/

Email: veronica.nyhan@teagasc.ie; mark.plunkett@teagasc.ie; david.wall@teagasc.ie

Acknowledgements: We thank lab, staff at Johnstown Castle including Patricia Berry, Brendan Healy, Linda Moloney Finn, Wendy Pierce for their assistance.

Making the best use of Fertilisers

The value of slurry



NBPT Protected Urea

High grass growth	√
Low GHG	√
Low Ammonia	√
Lower cost	√

Lime is a fertiliser

- 25 – 33 % of N fertiliser LOST in low pH soils

  1 in every 3 bags of fertiliser!!
- On low pH soil helps to release *N* (**80kg/ha** / 64 units N/acre) *+ P & K*

Take home messages

- ✓ **Apply lime based on soil test**
- ✓ **Get your slurry analysed**
- ✓ **Compare composition of fertiliser when purchasing**

Strategies to reduce reliance on chemical nitrogen fertiliser on farms

Mark Plunkett[1], Niall Kerins[2], Siobhán Kavanagh[3] and Francis Quigley[4]

[1]Teagasc, CELUP, Johnstown Castle, Co. Wexford, [2]Teagasc, Austin Stack Park, Tralee, Co. Kerry, [3]Teagasc, Kells Road, Kilkenny, [4]Teagasc Kildalton Agricultural College, Piltown, Co. Kilkenny

Summary:

- Use soil analysis results to identify fields that need pH correction or improvements in phosphorus (P) and potassium (K).
- Get slurry analysed for nutrient content.
- Apply slurry using low emission slurry spreading (LESS) systems in the springtime to get maximum benefit from nitrogen (N), P and K, and target silage ground.
- Reduce fertiliser waste by calibrating fertiliser and slurry spreaders, adhere to buffer zones, and consider the use of precision technology including global positioning systems (GPS) for more targeted application.

Where should cattle farmers start to reduce greenhouse gas emissions?

Step one on any farm should be to reduce the reliance on chemical N in grassland and cropping systems. Chemical N releases nitrous oxide (N_2O), a potent greenhouse gas, into the atmosphere when applied to land. Nitrous oxide is one of the three main greenhouse gases (the others being carbon dioxide (CO_2), and methane(CH_4)). Therefore, if a farmer reduces the amount of chemical N used on the farm the amount of N_2O emitted is reduced.

According to the Teagasc MACC 2023, reducing chemical N by 25% has the potential to reduce total emissions by 0.5 million tonnes (Mt) or 11% of the total emissions reduction needed.

What are the main fertiliser reduction strategies?

Use a nutrient management plan

Improving farm N use efficiency is the first step to reducing farm N requirement and reducing total farm carbon emissions. The starting point is maintaining and following a farm fertiliser plan on a regular basis to manage soil fertility and identify farm nutrient requirements annually.

Soil sampling

Soil analysis is a small cost and provides the basis to planning nutrient applications. Take soil samples to the correct sampling depth of 10 cm, every 2 to 4 hectares (ha) and take fresh soil samples every 3 to 4 years.

Soil pH

Aim to maintain soils in the agronomic range pH 6.3 to 6.5 for productive ryegrass swards, and pH 6.5 to 6.8 for clover-dominated swards. For successful clover establishment aim to build soil pH in advance of sowing. Optimum soil pH has the largest impact on improving nutrient availability, efficiency of applied organic or inorganic fertilisers and productivity of a clover sward. For example, at optimum pH soils can release up to 70 kg N/ha/year and reduce soil N_2O emissions annually.

Considerable progress was made improving soil pH through liming from 2012 to 2018. However, across beef enterprises there has been a significant increase in the proportion of our soils that have low pH. Currently, 65% of soil samples from cattle farms indicate a lime requirement or the fields from which they were obtained. According to the Teagasc MACC 2023, the target is to use 1.75 m tonnes of lime per annum up to 2025, and 2.5 m tonnes per annum to 2030. In 2022 we used 1.4 m tonnes of lime, this reduced to 1.0 m tonnes in 2023 due to poor weather conditions which limited opportunities to apply lime.

Soil Phoshorus (P)

Aim to maintain soil P at Index 3 (5.1 to 8.0 mg/l) for optimum productivity on moderate to intensively managed farms. Increasing soil P from Index to Index 3 will increase grass production capacity by ~1.5 t/ha DM/year and reduces soil N_2O emissions. Sufficient P supply is important throughout the growing season. For example, early applications of P are required to promote grass growth at the beginning of the grass-growing season (March/April).

Soil Potassium (K)

Aim to maintain soil K at Index 3 (101 to 150 mg/l) for optimum productivity. Increasing soil K from Index 1 to Index 3 will increase grass production capacity by ~2.0 t DM/ha/year. Apply maintenance (Index 3) levels of K in springtime based on stocking rate to reduce risk of grass tetany. Aim to apply 'build-up' rates of K in the autumn to reduce the risk of luxury uptake of K during the main growing season. Recent research from Johnstown Castle indicates that autumn applications of K improve N efficiency compared to either spring or mid-season applications. Maintaining optimum levels of soil K increases the percentage of clover in both ryegrass- and clover-based swards.

Use clover or multi-species swards

Clover can fix between 80-120 kg/ha N /year depending on the underlying soil fertility and sward management. Multi-species swards may also offer extra benefits in terms of drought resistance.

Make best use of slurry

Slurry is a valuable fertiliser for growing grass on beef farms. Purchased inorganic fertiliser is one of the highest variable costs on beef farms; however, correct use of slurry can help reduce costs associated with growing grass. Slurry provides a balance of nutrients for grass growth in terms of N, P and K along with other trace elements. Good quality cattle slurry applied through low emission slurry spreading (LESS) in the springtime can have 9 units/ac N (1.0 kg/ha N), 5 units/ac P (0.5 kg/ha P) and 32 units/ac K (3.5 kg/ha K) available respectively, per 1,000 gallons applied. However, the N:P:K nutrient content within slurry can vary across beef farms. The 'quality' of cattle slurry is primarily influenced by its dry matter (DM) content and the diet of the animal producing the

slurry. Slurry DM content can be estimated using a slurry hydrometer. The N:P:K content (and DM) can be analysed by testing slurry in a laboratory. Slurry can be analysed at a relatively low-cost and the resulting information means more appropriate and targeted application rates can be applied to the grass crop.

Compared to splash plate application, slurry spread using LESS substantially reduces grass contamination meaning it can be applied to grass covers of up to 1,000 kg/DM/ha. A grass cover of 1000 kg's/DM is equivalent to a grass height of 7 – 8 centimetres long. Low P and K index soils benefit immensely from slurry. Soil fertility maps in the Teagasc Nutrient Management Plan should be reviewed to identify paddocks that are shaded pink or blue as these paddocks are index one or two, respectively, for P and K.

The EU nitrates directive rule states that, "from 1 January 2024 farms with a grassland stocking rate of >130 kg organic N/ha need to apply organic manure through LESS. Furthermore, from 1 January 2025 LESS application is mandatory on farms stocked >100 kg organic N/ha".

What type of chemical fertiliser should cattle farmers use?

If inorganic fertiliser must be applied, then switching from calcium ammonium nitrate (CAN) and urea to NBPT Urea (i.e. protected urea) will directly reduce both greenhouse gas and ammonia emissions, while also being cheaper. Calcium ammonium nitrate-based fertilisers release N_2O, which is one of the main greenhouse gases of concern. NBPT Urea has 71% less N_2O emissions compared to CAN and it has 78% less ammonia emissions compared to straight urea. Of the tools assessed by Teagasc, using NBPT Urea nitrogen fertiliser offers the single largest emission reduction potential to Irish farmers. On a drystock farm, switching to NPBT Urea has the potential to reduce total emissions by up 6%, depending on chemical N usage. In terms of cost, NBPT Urea is substantially cheaper than CAN, and has the potential to reduce fertiliser costs by 15-20%.

Recent research on low-N compound fertilisers has found that N_2O emissions could be reduced by around 40% with compounds such as 18:6:12 compared to high-N compounds (e.g. nitrate-based 24's and 27's). Use low-nitrate compounds such as 18:6:12 and 10:10:20 to reduce farm carbon emissions.

How can the accuracy of fertiliser application be improved?

- Setup and calibration of fertiliser spreaders is very important to ensure even distribution of fertilisers when spreading. This involves adjusting the spreader settings to achieve accurate application rates and uniform coverage. Proper calibration not only maximizes the benefits of fertilisation but also minimizes the risks of over- or under-application, which can lead to yield losses, environmental pollution, and increased production costs.
- Keeping the machine in good condition. Regular maintenance, including cleaning, lubrication, and inspection of components, is essential to ensure proper functionality. Worn vanes, in particular, can significantly impact the spread pattern and distribution uniformity. As vanes wear out over time, this will result in uneven spreading, resulting in areas of over- or under-fertilisation. By replacing worn vanes promptly, farmers can maintain consistent application rates and optimize fertiliser efficiency.
- Different fertilisers exhibit varying flow characteristics and spread patterns. Different fertiliser types have different particle sizes and densities, leading to variations in spreading behaviour. Consequently, adjustments to spreader settings are needed to maintain an

accurate spread width and flow rate, and achieve uniform coverage across the field. Failure to adjust spreader settings to suit the product can result in uneven distribution and suboptimal fertiliser utilization.

- To mitigate the risk of over-application and to reduce environmental impact, farmers can utilize headland control mechanisms. These systems allow operators to adjust the spread pattern when spreading at the field's edges, preventing excess application in headland areas. By minimizing overlap and reducing wastage, headland control mechanisms not only conserve resources but also help protect nearby hedgerows and watercourses from pollution. This proactive approach to precision farming promotes sustainable agricultural practices while enhancing crop productivity and environmental stewardship.

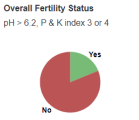
Other resources & online information

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

Email: gary.lanigan@teagasc.ie

NMP Online Maps

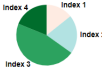
Phosphorus (P) Map



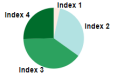
	Ha's	%
Yes	7.19	19%
No	30.95	81%

Potassium (K) Map

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	7.19	19%



Index	Ha's	%
1	5.45	14%
2	7.84	21%
3	17.66	46%
4	7.19	19%

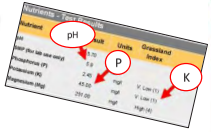


Index	Ha's	%
1	1.30	3%
2	11.99	31%
3	15.15	40%
4	9.70	25%

pH (soil acidity) Map

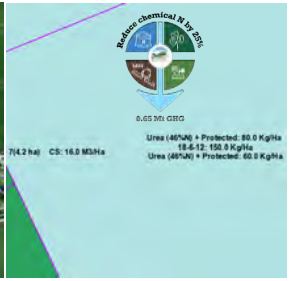
Lime Requirement Map

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

Fertiliser Advice Map



NMP Online - Your Soil Fertility Plan made Simple

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

[1]Teagasc, Soil, Environment and Land-use Research Centre, Johnstown Castle, Co Wexford; [2]Teagasc, Athenry, Co. Galway

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 50cent/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.

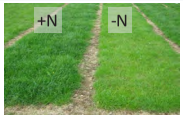
Email: padraig.foley@teagasc.ie; pat.murphy@teagasc.ie

Maintain and enhance Soil Nutrient Supply

Teagasc Agriculture and Food Development Authority
NUTRI-KNOW Novafert BioNets
An Roinn Talmhaíochta, Bia agus Mara Department of Agriculture, Food and the Marine
Funded by the European Union

	Nitrogen (Harty *et al.*)	Phosphorus (Graca *et al.*)	Potassium (McCarthy *et al.*)	Sulphur (Aspel *et al.*)
	kg/ha			
Example Total nutrient (0-10 cm) (Average)	2840 – 5570 (3725)	389 – 1752 (768)	9102 – 22785 (14676)	250 – 400 (338)
Example Annual plant uptake from soil background supply	107 – 194	e.g. 26 (Ashekuzzaman *et al.*)	e.g. 135	8 – 15

Deficiencies →



Tools →

Maintain and Enhance Soil Nutrient Supply

Patrick J. Forrestal[1], John B. Murphy[1], Thomas McCarthy[1], Dónal Kinsella[1]

[1]Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford.

Summary:

- Soil is a key resource on farms and nationally, a resource that has taken thousands of years to form.
- The first step to ensuring healthy soil is to ensure that soil loss from your fields is as close to zero as possible as annual loss adds up over time. Soil lost by erosion is typically the finest particles, these are the particles of highest cation exchange capacity and consequently the most nutrient rich particles. Lost particles of soil are irreplaceable except over thousands of years.
- Maintaining and building healthy resilient soils for example by returning carbon to soils, by ensuring soil compaction is avoided or remediated with the goal of soil particle aggregate formation will provide structure and soil pore space for root activity along with air and water infiltration to help optimise soil life including earthworms and the nutrient supply from any given soil.
- Soils hold a long-term bank of nutrients which supports resilient crop productivity. The soils on every farm provide a baseline amount of nutrients including N, P, K, and S to plants annually. Soils have a wide range in their inherent nutrient content and plant supply capacity. For example one study showed a range of 107 – 194 kg N/ha/year across three Irish soils – across all soils the range is even greater.
- Particularly in situations of high crop off-take such as silage and in arable cropping, the return of nutrients and carbon for example via organic manures, straw chopping and/or cover cropping is important to maintain healthy soils by improving soil aggregation, soil biology and cycling of the soil plant available nutrient pool.
- Grazing off-take from fields is much lower and in-situ recycling of nutrients and carbon through dung and urine deposits along with ungrazed plant residuals contribute to nutrient and carbon cycling in these grazed soils.
- Tools for further enhancing and building inherent soil nutrient supply include the use of legumes such as white and red clover, beans, peas and leguminous cover crops, soil sampling and testing, guided application of lime, bio-based recycled fertilisers that often contain carbon, and conventional mineral fertilisers.
- Soils are a precious resource for the current and future generation of farmers and wider society.

Other resources & online information

Twitter/ X: @ novafert @NutriKnow @bbionets_eu @ForrestalPJ

Websites: https://www.teagasc.ie/environment/soil/ https://www.novafert.eu/ https://www.nutri-know.eu/ https://bbionets.eu/ **Email:** patrick.forrestal@teagasc.ie

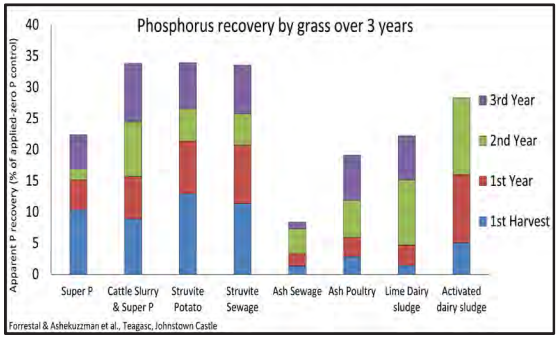
Acknowledgements: We thank lab, field, farm and administrative staff at Johnstown Castle including Carmel O'Connor, Cathal Redmond, Eleanor Spillane, Rioch Fox, Patricia Berry, Brendan Healy, Linda Moloney Finn, Wendy Pierce and their teams for assistance. Funding support from the European Union and the Department of Agriculture, Food and the Marine.

Bio-based & recycled fertilisers, bioeconomy tools
to supplement soil nutrient supply

Grant No.: 101060835

Main Points

- Recycling of nutrients & carbon in the European bioeconomy using bio-based and recycled fertilisers reduces our dependence on imported mineral fertilisers and supports healthy soils
- Potential for significant savings on mineral fertiliser cost
- Phosphorus (P) supply from different recycled nutrient sources varied but yield and soil fertility was maintained using a range of bio-based fertilisers in the lighthouse demos of www.novafert.eu



Fertiliser Treatment	4 Year Avg. Grass Yield (t DM/Ha)
Zero Fertiliser	5.7
Chemical Fertiliser (CF)	14.6
Cattle Slurry + CF	14.6
Struvite Potato + CF	15.2
Struvite Sewage + CF	14.8
Ash Sewage + CF	14.8
Ash Poultry + CF	14.2
Lime Dairy Sludge + CF	14.3
Activated Dairy Sludge + CF	14.5

Mineral fertiliser displacement values for a 1st cut grass silage

Bio-based fertiliser	t/ha	% of mineral fertiliser displaced (Index 2 soil 1st cut silage & build up) N	P	K	S	Value €/ha
Lime dairy sludge	1.7	4	100	1	4	114
Activated sludge	6.8	32	100	3	25	164
Cattle slurry	33	48	55	56*	38	242
Potato struvite	0.3	12	100	2	0	128
Sewage struvite	0.3	12	100	0	0	125
Ash poultry	0.6	0	100	37	83	186
Ash sewage	0.4	0	100	3	53	119

*90kg K/ha is the maximum recommended in one application

Take Home Messages

- Bio-based fertilisers maintained yield and soil fertility when included in a fertiliser programme while displacing a significant portion of N, P, K and/or S mineral fertiliser requirements
- Most bio-based fertilisers were able to supply the entire P maintenance and build-up requirement
- Several products had as good or better plant P availability over long term vs mineral fertiliser P
- Potential to reduce farm costs, import reliance, maintain soil health and lower emissions

Bio-based and recycled fertilisers, bioeconomy tools to supplement soil nutrient supply

Dónal Kinsella[1], John B. Murphy[1], Aoife Egan[1], Patrick J. Forrestal[1]

[1]Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford.

Summary:

- Recapture & reuse of nutrients using bio-based & recycled fertilisers can help to lessen dependence on imported chemical fertilisers, reduce farm costs and lower emissions.
- 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 alternative tools such as recycling of organic wastes and biological N fixation to meet crop nutrient demand.
- A multi-year bio-based fertiliser living lab and lighthouse demonstration was established in Teagasc Johnstown Castle in 2019 to demonstrate displacement of chemical fertiliser with recycled nutrients including cattle slurry, dairy processing sludge, ashes, struvite, separated manure solids and poultry manure pellets.
- The Novafert project has identified 86 bio-based recycled fertiliser products and 47 nutrient recovery technologies in the Irish and European Bioeconomy including struvite, compost, digestate, a range of dairy processing sludge, ammonium salts, ashes, biochar, ammonia recovery scrubber water, mineral nitrogen concentrates, treated sludges and different forms of granular/pelletised and powder products derived from animal manures and digestate including poultry.
- Field measurements over a five year period show that imported mineral fertiliser reliance can be reduced with yield, soil fertility and health maintained or improved using a wide variety of bio-based recycled fertilisers.
- Most bio-based fertilisers were able to supply P maintenance and build-up requirement.
- The use of a range of alternative fertilisers is being demonstrated to farmers and relevant stakeholders through the work of the EU horizon funded NOVAFERT project.
- The Nutri-know project is also sharing the knowledge generated in 12 EIP-AGRI Operational Groups around Europe demonstrating the recapture and reuse of nutrients at farm scale.
- The BBioNets project is further working to promote the development and uptake of bio-based technologies in the agriculture and forestry sectors lessening reliance on external and fossil fuel based imports. the soil profile (1 metre)

Other resources & online information

Twitter/ X: @ novafert @NutriKnow @bbionets_eu @ForrestalPJ @donalkinsella12

Website: https://www.novafert.eu/ https://www.nutri-know.eu/ https://bbionets.eu/

Email: donal.kinsella@teagasc.ie; patrick.forrestal@teagasc.ie

Acknowledgements: We thank lab, field, farm and administrative staff at Johnstown Castle including Carmel O'Connor, Cathal Redmond, Eleanor Spillane, Rioch Fox, Patricia Berry, Brendan Healy, Linda Moloney Finn, Wendy Pierce and their teams for assistance. Funding support from the European Union.

Grass10 – Achieve 10 Grazings per paddock per year

Objectives

-Increase level of pasture measurement

-Incorporate clover into swards

-Improve nutrient management on farm

2024:

Very difficult year for grazing

Grass Production to July 1st :

➢1 ton DM/ha lower Vs 10 yr Ave.

Apply N plus K for summer

Building Grass for Autumn will be important

➢1st Target: 28-30 day Rotation by Sept 1st

Where is grazing at?

➢Dairy: 7 Grazings/Pdk/yr

➢Drystock: 5.5 Grazings/Pdk/yr

Grass10 / PastureBase Ireland - Improving sustainability of our grass based systems

John Maher[1], Niamh Doyle[2], Joseph Dunphy[3] and Ciaran Hearn[1]

[1]Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork; [2]Teaagsc, Johnstown Castle, Co. Wexford; 3Teagasc, Athenry, Co. Galway

Summary

- The objective of the campaign is to achieve 10 grazings/paddock per year utilising 10 ton of pasture dry matter/ha
- There is a requirement to focus the grassland industry on the establishment and management of grass/clover swards
- Soil fertility on most grassland farms is sub-optimal. Grass requires a continuous and balanced soil nutrient supply to achieve its production potential.

Grass10 Campaign

The Grass10 campaign aims to promote sustainable grassland excellence on Irish livestock farms (dairy, beef and sheep). The Grass10 partners are Department Agriculture Food & the Marine, Grassland Agro, AIB, FBD and the Farmers Journal. The primary objective of the Grass10 campaign is to utilise 10 tonnes of pasture dry matter (DM)/ha per year by achieving 10 grazings per paddock on grassland farms. The following farm practice changes are prioritised:

- Improving grassland management skills
- Improving grazing infrastructure
- Soil fertility — improve soil pH, P and K levels.
- Increase the level of reseeding & improving the level of clover in pastures
- Increasing PastureBase Ireland (PBI) usage

PastureBase Ireland

PastureBase Ireland is a multi-purpose web-based tool that allows farmers to improve pasture management. There are multiple benefits of utilising PBI including increased pasture growth, more efficient nutrient application and higher quality pasture being available to grazing animals. PastureBase Ireland is continually expanding its functionality to meet the demands of 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.

White clover

There is now an increasing demand and requirement to include white clover in grazed pastures due to its ability to biologically fix nitrogen, allowing for significant reductions in chemical nitrogen fertiliser while maintaining pasture production. White clover can also increase improve animal performance (more milk solids/more carcass) due to its greater nutritional value. There are challenges in establishing clover at farm level. These issues revolve around time of sowing,

soil fertility, herbicide choice and grazing management. There is a huge requirement to focus on educating the grassland industry in the establishment and management of grass/clover swards.

Nutrient management

Pasture production requires reasonable quantities of nutrients such as Nitrogen (N), Phosphorous (P), Potassium (K) and Sulphur (S) supplied at the correct time. A recent review of soils tested indicates that the majority of soils in Ireland are below the target levels for pH (i.e. 6.3) or P and K (i.e. Index 3). On many farms, sub-optimal soil fertility will lead to a drop in output and income if allowed to continue. It is important to complete a farm fertiliser plan to guide fertiliser / manure decisions and to avoid further decline in soil fertility levels.

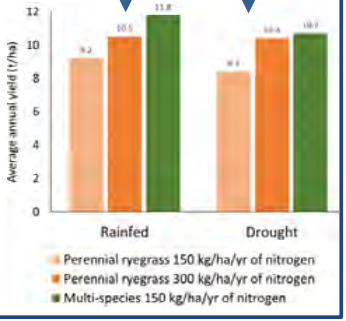
Grass10 wishes to acknowledge the support of our industry stakeholders in the Grass10 Campaign.

Multi-species swards
- multiple added benefits

Funded by EU, DAFM/DAERA
Multi4More
WALSH SCHOLARS
LegumeLegacy

Multi-species mixtures – yield, fertiliser, resilience?

- Multiple tests of multi-species mixtures as a strategy for high yields, drought resistance and forage quality.
- Multi-species mixtures with 150kg/ha under drought were highest yielding, even compared to perennial ryegrass in rainfed conditions with 300 kg/ha N.
- Mixtures had highest yield stability, lower nitrous oxide emissions intensity, lowest weed biomass.
- New research: livestock systems, persistence, fertiliser replacement value; environmental benefits (water quality, carbon storage, biodiversity, soil health).



Take home messages

- ✓ Multi-species: consistently higher yields from lower-nitrogen systems
- ✓ Mitigate the impact of drought & increase drought resilience
- ✓ Similar (sometimes better) livestock performance on lower-N multi species mixtures compared to higher-N grass-only.

Multi-species grassland mixtures – what are the benefits?

John Finn[1]; Guylain Grange[1]; Emery Wang[1,2]; Bridget Lynch[1], Caroline Brophy[2]; Dominika Krol[1]; Ali Sultan Khan[1]; Valerio Snicheletto[1,2], Shona Baker[1]

[1]Teagasc, CELUP, Johnstown Castle Co. Wexford; [2] Trinity College Dublin

Summary:

- 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), and 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 should not be a problem.
- New research is focusing on livestock performance (dairy, dairy calf to beef, beef and sheep systems), grassland persistence, fertiliser replacement value. Preliminary results from Teagasc and other research show similar (sometimes better) livestock performance on lower N mixtures compared to higher N grass-only swards.
- Although the agronomic performance of mixtures is important, mixtures have higher performance across other environmental indicators, compared to monocultures and grass-clover. Teagasc 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/

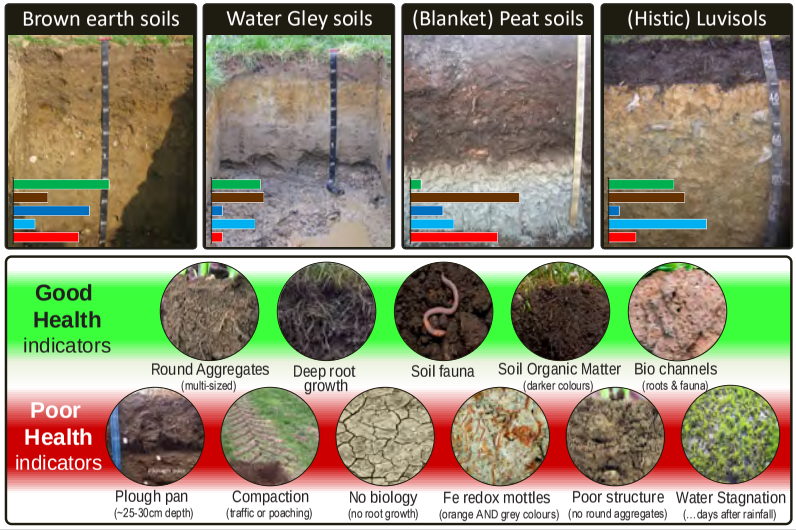
Email: john.finn@teagasc.ie

Multi4More, funded by DAFM and DAERA https://multi4more.ie/

LegumeLegacy, funded by EU MS-C https://legumelegacy.scss.tcd.ie/

How do I assess Soil Health *in situ*?

Different soils have different properties, which dictate their different **functions**... and vulnerabilities.
A quick look at the topsoil and profile can give us valuable information about the type of soil & its **health status**.



Legend: potential soil functions & vulnerabilities

- Plant productivity
- Carbon sequestration & storage
- Water percolation
- Nutrient retention (no leaching)
- Resistance to compaction

Take home messages

- Soil health assessments can be carried out *in situ (in the field)* using key soil indicators.
- A combination of topsoil indicators & soil profile features are required.
- The different soil functions we expect our soil to provide are reliant on maintaining a good soil health status.

Assessing Soil Health status in situ

Luis Lopez-Sangil[1], Fiona Brennan[1] and David Wall [1]

[1]Teagasc, Soil, Environment and Land use Research Centre, Johnstown Castle, Co. Wexford

Summary:

- Soils are multifunctional living systems. They support most of our food production and many other ecosystem services critical for society (water and climate regulation, nutrient cycling, biodiversity etc,).
- But soils are a limiting resource too, considered non-renewable and irreplaceable at human time scale. In the EU, 60 to 70% of our soils are currently degraded and continue to deteriorate, costing the Union tens of billions of € every year. Protecting healthy soils from degradation is critical for human wellbeing, food production and economic development.
- Soil health assessments can be done in situ. A quick look at the topsoil and profile (after digging 40-50cm of soil pit) can give us valuable information about the type of soil and its health status.
- Soils can be very diverse, and their different physical, chemical and biological properties dictate their functionalities and vulnerabilities. Soils also vary greatly by depth, with soil organic matter (SOM) and biological activities normally accumulating at the top. These natural differences need to be accounted when assessing soil health.
- Features indicating biological activity from roots, soil fauna and microorganisms are the main indicators for good soil health status: check for deep and dense root growth (extending into the subsoil), presence of rounded multi-sized aggregates, earthworms and other macrofauna, high porosity, crumbly structure, bio-channels, dark colours from SOM accumulation…
- Several soil types in Ireland are affected by water stagnation (that is, when excess of water accumulates in the soil for prolonged periods of time), and are prone to compaction (from trafficking and herd trampling) or nutrient leaching, the main issues posing serious challenges for farmers and soil life. Features like iron redox mottles, compacted layers (plough pans), lack of roots or porosity can help us identify and anticipate these issues even before affecting productivity and water quality.
- Assessing these features is an effective tool to monitor the health status of our soils, their capacity to perform functions and their resilience to environmental disturbances.

Other resources & online information

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

EU Commission's proposal for a Directive on Soil Monitoring and Resilience: https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_3637

Soil Health is our Wealth (Teagasc Johnstown Castle): www.youtube.com/watch?v=djgRiZaqFaM

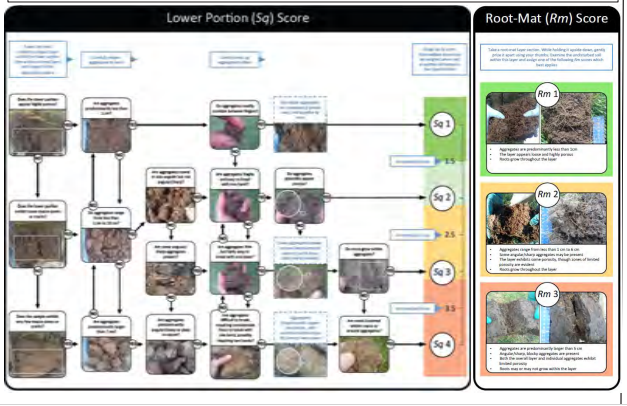
Email: luis.lopez-sangil@teagasc.ie; fiona.brennan@teagasc.ie; david.wall@teagasc.ie

Assessing Soil Compaction & Structural Health

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 Structural Health

David Wall[1]; Giulia Bondi[1]; Emanuela Lepore[1]; Owen Fenton[1]

[1]Teagasc, Soil, Environment and Land use Research Centre, Johnstown Castle, Co. Wexford

Summary:

- Soil health 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

Related information 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: david.wall@teagasc.ie; giulia.bondi@teagasc.ie; owen.fenton@tegasc.ie

Acknowledgements: We thank the farm and technical staff who helped establish and maintain field trials for these projects, and assisted with the soil analysis. We also thank Teagasc Advisory for assisting with finding suitable sites for this research and the Farmers for access to field sites across the country.

Preventing & Alleviating Physical Soil Damage

Prevention

- ✓ Maintain soil organic matter
- ✓ Keep a living root in the soil
- ✓ Avoid trafficking wet soils with heavy machinery & high stocking rates
- ✓ Spread the load: Larger tyres, lower inflation pressures, VF/IF tyres, more wheels.
- ✓ Control Traffic:
  - Appropriate soil moisture
  - Reduce number of passes
  - Manage headlands
  - Consider fixed tramlines

Alleviation approaches

- ✓ Identify compaction and it's depth
- ✓ Rest land: Reduce traffic; Change crop
- ✓ Vary cultivation depth (tillage)
- ✓ Switch headlands (tillage & grassland)
- ✓ Apply organic amendments to problem areas
- ✓ Subsoiling should be a last resort!

Take home messages

- Prevention is better than cure!
- Machinery traffic main threat
- Soil moisture critical – avoid working when soils are wet

Managing our soils to protect physical structure

Dermot Forristal[1]; Owen Fenton[2]

[1]Teagasc, CELUP, Oak Park, Co. Carlow; [2] Teagasc, CELUP, Johnstown Castle, Co. Wexford

Summary:

- Soil physical structure, which is easily damaged, is an important aspect of healthy soils and needs to be protected.
- Physical damage can be caused by machinery or animal traffic that exerts a stress on the soil that it cannot withstand without deforming. Soil compaction is one result where pore space is reduced and aggregates become blocky and difficult for roots to penetrate. This results in shallow root development, poor access to nutrients and water, reduced soil functioning and depressed crop or grass yields.
- Soil moisture plays a critical role in determining a soils susceptibility to compaction; traffic must be avoided when soils are wet and vulnerable. While wet weak soils are obvious in many situations, it is not uncommon for tillage soils that have dried out on top to still be wet and vulnerable at depth. These situations need careful management.
- Prevention of soil damage is better than any efforts to cure, as in particular deep loosening / subsoiling may leave the soil more prone to future damage at depth.
- Maintaining the soil in good condition will help: ensure drainage allows water to escape; keep deep rooting plants in the soil and; maintain organic matter levels.
- Avoid heavy machines and particularly high axle loads. Spread the load by using larger tyres or tracks and more wheels. Use the lowest tyre pressures allowable for the load being carried. Use newer tyre technology such as IF and VF rated tyres which allow more deflection and greater contact area provided the correct inflation pressure is used.
- Grazing in wet conditions will damage the soil, so control or limit it and use on/off grazing to minimise walking etc. where practical.
- Control traffic to minimise damage: consider gateways and travel direction to minimise loads on vulnerable parts of fields. Only travel when ground conditions are dry enough. GPS systems can allow fixed pathways to be used to confine the soil impact.
- Examine soils with a spade (Visual assessment methods) to determine damaged areas and alleviate by: reducing traffic; changing crop; switching turning headlands; varying tillage depth; spiking (surface compaction only) or in extreme situations; subsoiling.
- Non-inversion crop establishment systems (min-till, direct drill), while having stronger soils, need to be protected from compaction. Earlier sowing of winter crops can ease the pressure on soils but will increase weed pressure in particular, but also BYDV and early disease risk.

Other resources & online information

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

Email: dermot.forristal@teagasc.ie; owen.fenton@teagasc.ie

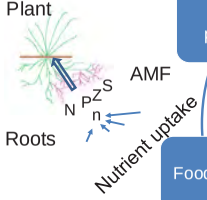
Acknowledgements: We thank the farm and technical staff who helped establish and maintain field trials for these projects, and assisted with the plant and soil analysis.

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

Funding

Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara
SOILGUARD
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 soil fertility and pH in intensively managed systems

Soil Biodiversity – benefits, and strategies to improve biodiversity in your soil

Fiona Brennan[1]; Kerry Ryan[1], Katie Martin[1, 2], Aaron Fox[1], Yahaya Jebril Amanor[1,3], Karla Burke[1,4], Sean Conway[1,5], Eithne Browne[1], Niranjana Rose Edwin[1,5,6], Aoife Duff[1]

[1]Teagasc, CELUP, Johnstown Castle; [2] UCD; [3]SETU; [4]UL; [5]UG; [6]Teagasc Moorepark

Summary:

- Soil biodiversity underpins agricultural productivity on farms and delivers a range of ecosystem services.
- 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/elimination 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.
- In intensively managed systems maintaining a balanced fertility and liming to correct soil pH (with the use of soil tests) 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, while reducing microbially-mediated losses of nitrous oxide (N_20).

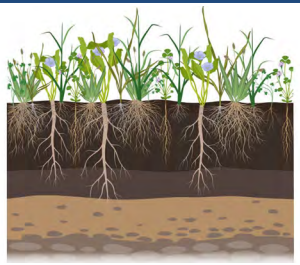
Other resources & online information

Twitter: @Soilmicrobio; @SOILGUARD_H2020 @Root2Res

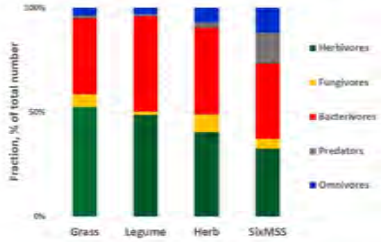
Email: fiona.brennan@teagasc.ie

Plant Diversity Enhances Soil Biology

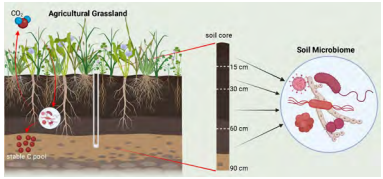
Diversity Aboveground = Diversity Belowground



Feeding type composition of the nematode assemblage



Ikoyi et al. 2023



Ryan et al. 2023

Diversity benefits

- Positive effect on soil nematodes – more stable food web
- Higher diversity, maturity, structure indexes and more sensitive taxa
- Different microbial communities associated with different plant species
- Greater microbial function at lower depths

Take home message

Increasing plant diversity can have positive effects on soil biology and soil function

Plant Diversity Enhances Soil Biodiversity in Grasslands

Fiona Brennan[1]; Israel Ikoyi[1,2], Kerry Ryan[1], John Finn1

[1]Teagasc, CELUP, Johnstown Castle, Co. Wexford; [2] UCC

Summary:

- Healthy soils are critically important for agricultural production
- Soils are living ecosystems, and the life within soils is essential for soil functions including: being intrinsic to plant establishment; recycling, transforming and scavenging nutrients for plant growth; providing essential plant vitamins and hormones; suppressing pests, pathogens and disease; protecting against plant stress; regulating climate; and maintaining soil structure.
- How we manage our soils strongly impacts belowground biodiversity
- Low diversity grassland swards can result in a reduction in the availability and diversity of food sources accessible to soil organisms, potentially resulting in a loss of soil biodiversity and impacts on belowground food webs. More diverse grassland swards can have positive effects on soil biology and soil functions by increasing the complexity of the soil habitat belowground and diversifying carbon inputs through exudates into the ground, which feeds soil life
- We saw positive effects on soil nematodes associated with the more diverse multi-species mixture than monoculture ryegrass swards. There was higher diversity, maturity and structure indexes of nematodes in the mixture, as well as the occurrence of more sensitive nematode groups (predators and omnivores).
- A lower proportion of herbivorous nematodes (that feed on plant roots) and a higher proportion of predatory nematodes (that may have a role in biocontrol of plant pests) occurred in the more diverse multi-species mixture. This indicates a more stable soil food web.
- Different microbial communities were associated with different grassland plant species, indicating increased soil diversity should manifest in plant mixtures.
- There was greater microbial activity related to carbon cycling deeper in the soil profile when deeper-rooting plant species were present.

Other resources & online information

Twitter: @Soilmicrobio; @SOILGUARD_H2020

Email: fiona.brennan@teagasc.ie

Acknowledgements: We thank the farm and technical staff who helped establish and maintain field trials for these projects, and assisted with the plant, soil and molecular analysis.

Organic Farming Systems

FARMING FOR A BETTER FUTURE

Increasing soil P levels on Organic farms

24 kg of Phosphorus required (per Ha) to move a soil up 1 index (including maintenance)

Amount required to supply 24kg/ha of Phosphorus

	Cattle Slurry	FYM	Dairy Sludge	GRP
Volume	10,560 (gallons/Ha)	17.8 (ton/Ha)	3.40 (ton/Ha)	4.07 (bags/Ha)
Spreading Cost	€143	€98	0*	€8.50
Purchase Cost	0	0	0*	€136
Total Cost	€143	€98	0*	€144.5

Assumptions: Slurry spreading costs at €70/hour and 5,000gls spread/hour; FYM spreading costs at €130/hour and 24ton spread/hour; Fertiliser spreading costs at €42/ton. *Assumes dairy sludge can sourced and spread for free (depends on your proximity to processing plant)

Available Nutrient Content & Guide Value (€) Jan 2024

	N	P	K	Value
Cattle Slurry (6% DM) kg/1000 gals	4.5	2.25	16	€45
FYM kg/ton	1.35	1.2	6	€18
Dairy Sludge kg/m3	0.88	7	2	€40

Based on GRP at €670/ton; SOP at €800/ton
(N value based on conventional Urea at €400/ton)

Take home messages

- What are P & K indices on your farm?
- Does your farm need Lime?
- Silage fields – prioritise with slurry/ other available organic manures

How to make the best use of organic manures on your farm

Marianne Mulhall, Specialised Organic Advisor

Teagasc, Oakpark, Carlow

Summary:

Organic farmers have a selection of organic manures available to help maintain and improve soil fertility. In order to know what are the most appropriate products and how much is needed depends on a number of factors;

- Have you current up to date soil samples?
- Does your farm need Lime?
- What are the P & K indices on the farm?
- Do a Nutrient Management Plan every 4-5 years,
- Silage fields – prioritise with slurry/other manures,
- Maximise available organic manures,
- Clover plays a vital role in fixing N,
- Use of Low Emissions equipment and spring spreading of slurry gives increased N use efficiency.

Farmers must have up to date soil samples results and a Nutrient Management Plan, which will outline which fields on the farm are low in P, K and pH. Once this is known, the appropriate organic manures and lime can be allocated to the fields that are most in need of fertility build-up. Table 1 shows the nutrient values in a variety of organic manures and how much is required to build fertility from an Index 1 P to Index 2 P. Using this information and by following your NMP, a farmer can plan how much manure needs to be spread and which fields are most in need.

As organic farming focuses on being a low input system of farming it is recommended to use all organic manures that are available to help improve or maintain soil fertility and only when the available organic manures are well utilised that you should consider buying in other sources of P and K such as Ground Rock Phosphate and Sulphate of Potash.

Other resources & online information

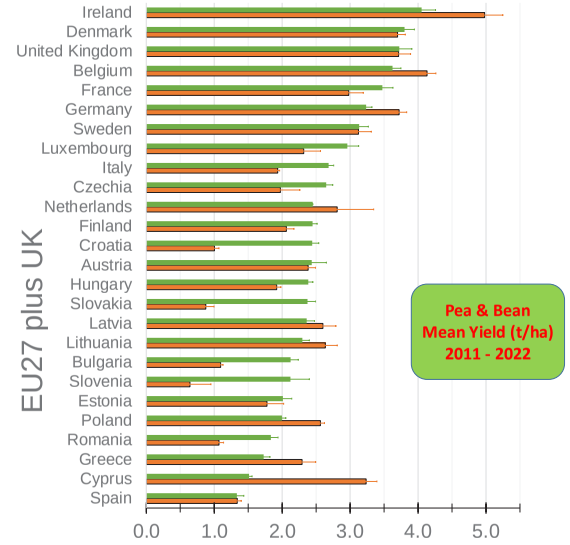
Email: marianne.mulhall@teagasc.ie

Potential of Home Grown Protein Crops

Advantages of Intercrops (Cereal/Legume mix)

- Easy to grow
- Excellent source of starch and protein
- Number of harvesting options (silage, crimp or full harvest)
- Protein aid available (approx. €250/ha)
- Low cost of production
- Competitive crop against weeds
- No N needed as legumes fix enough N for the intercrop
- Great biodiversity benefits (above & below ground)
- Numerous species mix options depending on end use and soil type.

Highest Yields in Ireland



Potential of Protein Crops in Ireland

Martin Bourke, Specialised Organic Advisor

Teagasc, Gorey, Co. Wexford

Summary:

Increasing the area sown with legume crops such as peas and beans grown in Ireland, and the potential to grow legumes intercropped with cereals offers several benefits to farmers.

Economic Benefits

- **Reduced Fertiliser Costs:** Legumes fix atmospheric nitrogen, reducing the need for synthetic nitrogen fertilisers.
- **Diversified Income:** Offering an alternative crop for farmers, diversifying income sources.
- **Market Demand:** Increasing demand for plant-based proteins creates market opportunities for legume crops.

Agronomic Benefits

- **Soil Health Improvement:** Enhanced soil fertility through nitrogen fixation and organic matter addition.
- **Crop Rotation Benefits:** Improved crop rotation systems by breaking pest and disease cycles, leading to healthier higher yielding subsequent crops.
- **Weed Suppression:** Dense legume canopies suppress weed growth, reducing the need for herbicides.

Environmental Benefits

- **Reduced Greenhouse Gas Emissions:** Lower need for synthetic fertilizers leads to reduced greenhouse gas emissions.
- **Biodiversity Enhancement:** Support for beneficial insects and soil microorganisms, promoting biodiversity.

These benefits can contribute to a more sustainable and resilient farming system in Ireland.

Other resources & online information

Email: martin.bourke@teagasc.ie

Protein Crop Production Costs

Grain / Legume Intercrop Production Costs

	Growing Costs excl. VAT (€/ha)
Seed	333
Slurry/FYM Application	120
Plough, Till, Sow & Roll**	252
Harvesting (Combine)**	156
Total Materials & Machinery	**861**

** Teagasc Crop Costs & Returns Booklet 2024

Costs per tonne	Without Protein Payment	With Protein Payment
Yield (t/ha)	**€/t**	**€/t**
3.0	287	204
4.0	215	153
5.0	172	122

Take home messages

- ✓ Low cost of production
- ✓ Can be fed as concentrate or ensiled
- ✓ Legume crops offer environmental benefits

Teagasc
Agriculture and Food Development Authority

GROFarmS
Growing Resilient Organic Farming Systems

UCD Dublin

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

Organic Farming Target:

10% of land area by 2030 (currently 5% area & 5% of farmers)

Novel Organic Farming Systems Demonstration Trials

(beef, sheep, tillage, mixed farming)

Organic Finishing Research Trials

- **Beef –** Johnstown Castle (Kildavin farm in conversion) & Grange trials technically & financially efficient organic beef production
- **Hill & Lowland Sheep –** Athenry

Environmental Impact of Organic Production Systems

- Nitrogen & Phosphorus balance, Greenhouse gas emissions,
- Soil health, biodiversity and carbon turnover,

Measure Organic Sustainability - National Farm Survey (NFS)

Keep up to date on Organic Research:

www.Teagasc.ie/GROFarmS

Environment Sustainability Technology Village

FARMING FOR A BETTER FUTURE

What is Biodiversity

Biodiversity friendly areas on the farm


Flowering Hedgerow


Non-farmed areas


Waterbodies


Trees


Hay meadow


Biodiversity exists above and below ground

Take care not to destroy an existing biodiversity friendly area to create a new one. Identify and protect what is already there.

Permanent pasture, mixed species sward, clover pasture, cover crops, and old farm buildings can all benefit biodiversity too.

Biodiversity is….

Biological diversity includes

- Species richness (e.g. Ireland has 102 different bee species)
- Ecosystem complexity (integrity, diversity and resilience)
- Genetic variation (variability in hereditary characteristics)

Ireland has ~31,500 species living within 117 habitats

What is biodiversity?

Saorla Kavanagh[1], Fiona Brennan[1] John Finn[1]; Daire O'Huallachain[1] and Simon Leach[1]

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

Summary:

Biodiversity or biological diversity is the variety of all life on Earth. Broadly speaking it includes:

- species richness (all the different species, from worms to whales). There are 102 species of bee in Ireland,
- ecosystem complexity (this includes diversity, integrity and resilience). Grasslands, sand dunes, rainforests are all types of ecosystems,
- genetic variation (e.g. blue and white bluebells).

Biodiversity is declining at an alarming rate. Farmland Biodiversity is an important national resource. Ireland has roughly 31,500 species living within 117 habitats. Here are three steps to protecting farmland biodiversity while maintaining a productive farm business:

1. Identify what is already there

2. Maintain, enhance, diversify and connect existing habitat

3. Create new habitat

Other resources & online information

Twitter: @SaorlaKK

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

Email: saorla.kavanagh@teagasc.ie

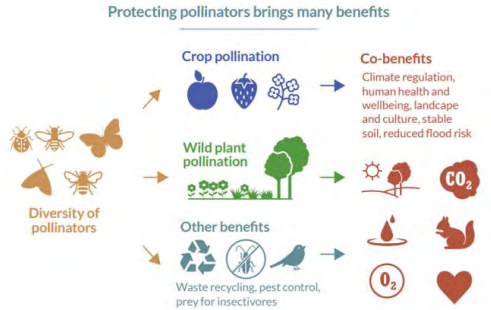
Why value Biodiversity

The pollinator example

Maintaining pollinator diversity is important

Different types of pollinators have different traits

More species = more pollination & pest control & increased crop seed yield & economic value



*don't destroy an existing habitat to create a new one

Pollination services contribute to

- Agricultural and horticultural industries
- Maintaining biodiversity e.g. support native flowers and provide berries for birds
- Supporting and regulating healthy ecosystems e.g. pollinator larvae control crop pests
- Intermediate ecosystem services e.g. landscape aesthetics & crop production
- Food security and a healthy diet e.g. half of plant-derived sources of vitamin A require pollination

How can you help?

1. **Identify what is already there***
2. **Maintain, enhance, diversify and connect existing habitat**
3. **Create new habitat (but not on existing wildlife habitat)**

Why value biodiversity?

Saorla Kavanagh[1], Fiona Brennan[1] John Finn[1]; Daire O'Huallachain[1] and Simon Leach[1]

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

Summary:

Biodiversity provides us with clean air, fresh water, good quality soil and crop pollination. It helps us fight climate change and adapt to it as well reduce the impact of natural hazards.

Maintaining a diversity of species is important as different species benefit us in different ways. For example, different pollinators have different traits. Research has shown that a higher species richness (diversity) of pollinators can contribute to increased pollination and increased pest control, which increases crop seed yield and economic value.

Pollination services contribute to

- Agricultural and horticultural industries
- Maintaining biodiversity e.g. support native flowers and provide berries for birds
- Supporting and regulating healthy ecosystems e.g. pollinator larvae control crop pests
- Intermediate ecosystem services e.g. landscape aesthetics & crop production
- Food security and a healthy diet e.g. half of plant-derived sources of vitamin A require pollination

Maintaining and enhancing biodiversity on farmland will help to maintain a healthy and sustainable farming system and ensure the land remains in a good or better state, keeping farming options open for future generations.

Other resources & online information

Twitter: @SaorlaKK

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

Email: saorla.kavanagh@teagasc.ie

Hedgerows for Biodiversity

Benefits of hedgerows

Less intensively managed hedgerows can help: offer shade for livestock, mitigate against flooding, sequester and store carbon, increase crop production, and biodiversity.


Act as roadways for wildlife


Provide fruits for birds


Margins are a source of food for pollinators


If unfenced livestock can create nesting sites for bees

Recommended species

Alder Buckthorn (*Frangula alnus*), Bird Cherry (*Prunus padus*), Blackthorn (*Prunus spinosa*), Buckthorn (*Rhamnus cathartica*), Common Alder (*Alnus glutinosa*), Dog Rose (*Rosa canina*), Guelder Rose (*Viburnum opulus*), Holly (*Ilex aquifolium*), Hawthorn/Whitethorn (*Crataegus monogyna*), Hazel (*Corylus avellana*), Honeysuckle (*Lonicera periclymenum*) and Spindle (*Euonymous europaeus*)

What to aim for and what to avoid

- ✓ At least 2.5 metres high and 1.5 wide
- ✓ Some hedges flowering and fruiting every year
- ✓ Allow at least one tree to grow (e.g. Rowan)

Box cut hedges have lower biodiversity value

Management

- ✓ Hedgerows cut every year won't produce many flowers or fruits
- ✓ Cutting hedgerows on a 2-3 year rotation is best for encouraging biodiversity

Hedgerows for biodiversity

Saorla Kavanagh[1], Fiona Brennan[1] John Finn[1]; Daire O'Huallachain[1] and Simon Leach[1]

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

Summary:

Hedgerows are vital for maintaining farmland biodiversity. They provide food, safety and shelter and act as important roadways to allow many species to travel throughout the countryside. Good quality hedgerows provide the four essential needs of biodiversity:

- Sources of food: pollen, nectar, fruits, berries
- Places to breed
- Places to nest and overwinter
- Corridors to travel across the landscape

Connecting the new hedge with existing linear features will make it easier for pollinators and other wildlife to get to and from your new hedge safely.

Recommended tree species: Crab Apple (Malus sylvestris), Bay Willow (Salix pentandra) Goat Willow (Salix caprea), Grey Willow (Salix cinerea), Oak (Quercus petraea, Quercus robur), Rowan (Sorbus aucuparia), Wild Cherry (Prunus avium). Do not plant cultivated varieties of these plants.

Farmer tips:

- When planting use more plants than necessary -accept there will be losses.
- Weeds can protect plants against rabbits and hares and can shield plants from the wind.
- If the site is very fertile, use a larger hedge whip size.

Other benefits of hedgerows

- Hedgerows provide essential resources for bees.
- Hedgerows are the location most likely to be used by ground nesting mining bees on Irish farms.
- Hedgerows that are managed less intensively will have more flowers and have been shown to provide a more suitable habitat for bumblebees compared to intensively managed hedgerows.
- Extending field margins on farmland and across landscapes could encourage pollinators by increasing wild floral resources and nesting habitats.
- Managing hedgerows less intensively can have a strong effect on pollination services to crops and non-crop areas[6].
- Cutting hedgerows on rotation (not cutting every hedge every year) is the simplest way to increase the number of flowers and therefore the amount of food for pollinators on the farm.
- Less intensive management practices could enhance carbon stocks and bigger hedgerows have higher carbon stocks compared to smaller hedgerows.

Other resources & online information

Twitter: @SaorlaKK

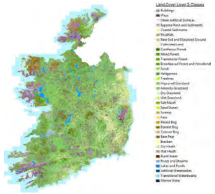
Teagasc Website: www.teagasc.ie/environment/biodiversity--countryside/research/

Email: saorla.kavanagh@teagasc.ie

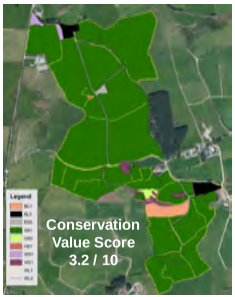
Biodiversity in the National Farm Survey

Main Points

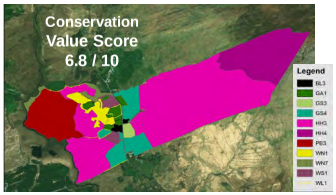
- We aim to use satellite derived land cover mapping to quantify habitat area and measure change over time on the representative set of farms in the National Farm Survey.



- **The Tailte Éireann/EPA National Land Cover Map delineates the landscape at parcel scale.**
- **We can apply established 'conservation value' scores to land cover types/habitats at the farm level.**



Farm area dominated by habitats with lower conservation values.



Farm area dominated by habitats with higher conservation values.

Significant Range in Conservation Value Scores Between Farms

These two farms differ in the type and wildlife value of farmland biodiversity habitats.

Funding

- Teagasc

Take Home Messages

- There is currently no regular, repeated, national-scale monitoring of habitats or biodiversity on farmland in the wider countryside.
- Habitat assessment on NFS farms will link a biodiversity indicator with the time series of agronomic, economic, environmental and social data collected by the Teagasc National Farm Survey.

Developing a biodiversity indicator in the Teagasc National Farm Survey

John Finn[1]; Trevor Donnellan[2]; Brian Moran[2]; Cathal Buckley[2]; Simon Leach[1]

[1]Teagasc, Crops, Environment and Land-use Research, Johnstown Castle, Co. Wexford
[2]Teagasc Agricultural Economics and Farm Surveys Dept., Athenry, Co. Galway

Summary:

- The National Farm Survey (NFS) has been conducted annually by Teagasc since 1972. A random, nationally representative sample of between 1,000 and 1,200 farms is selected annually.
- The inclusion of a biodiversity metric in the NFS would provide an initial baseline assessment of habitat quantity and diversity on different types of Irish farming systems in a way that is nationally representative of the farming systems in the NFS.
- On farmland in the wider countryside, there is currently no monitoring of habitats or biodiversity that is part of a regular, repeated, national-scale programme.
- A distinct advantage of using the NFS set of farms is that the habitat data can also be investigated in tandem with other financial, environmental and social and economic data collected as part of the FADN.
- Repeated assessment (over time) would also show whether and how habitat biodiversity on different types of Irish farms is changing through time and in response to national and EU policy objectives.
- The incorporation of a biodiversity metric into NFS would also help develop the inclusion of biodiversity in the planned development of the new EU FSDN (Farm Sustainability Data Network).

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; simon.leach@teagasc.ie

Teagasc
Agriculture and Food Development Authority

What Forest Type will suit you?

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

Comprehensive Teagasc Support for farm planning & integrating new forestry

Tom Houlihan[1]; Frances McHugh[1],

[1]Teagasc, Forestry Advisory

Summary:

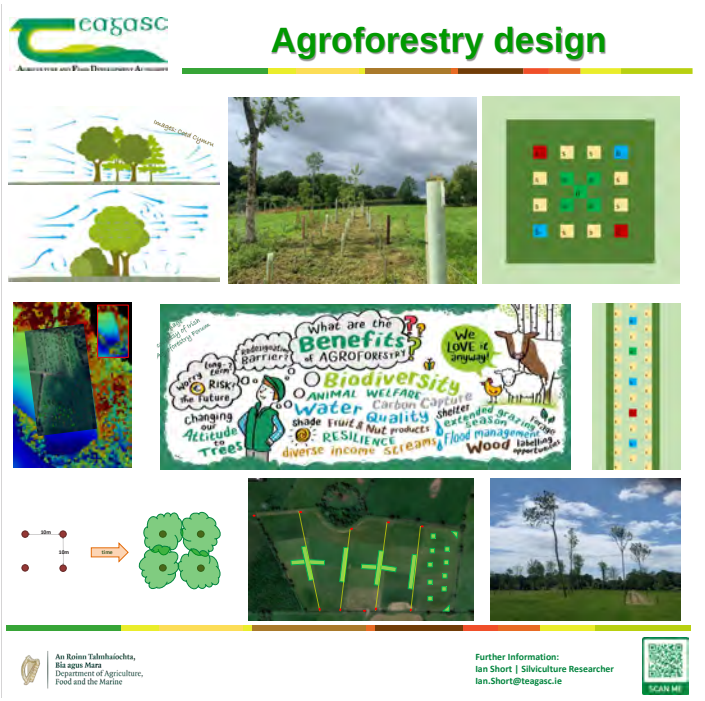
- The DAFM Forestry Programme 2023-2027 provides excellent opportunities for forest creation for all farmers and landowners.
- There have never been more planting options or stronger incentives available to support your objectives, including improving farm finances, enhancing the farm environment and developing an excellent resource on the farm
- The highly attractive Forestry Programme includes strong financial incentives for the variety of forest option available (called Forest types), each with their own silvicultural, environmental and practical objectives.
- There are planting options suitable for all farms, regardless of enterprise or scale. These include native woodland, agroforestry (combining farming and trees on the same land) and the more commercially-focused conifer and broadleaf options.
- There are also attractive options for landowners planting smaller areas under the new Native Tree Area Scheme.
- For existing forest owners, there are also a range of DAFM support schemes.
- Teagasc forestry staff are available to provide comprehensive decision supports to farmers and landowners with existing forestry and/or considering new forest creation including its integration with farming enterprises, activities and schemes.
- Eligible planting sites for afforestation (based on soil type and site fertility) under Forestry Programme 2023-2027 are set out in the Land Types for Afforestation publication (DAFM, 2023). These include mineral soil, organo-mineral soil with peat depths of less than or equal to 30 cm or suitable modified fen and cutaway raised bogs. Environmental considerations incorporated into the planting approval process to safeguard the environment may have an impact on land availability for afforestation.

Other resources & online information

Teagasc Website: www.teagasc.ie/forestry

Email: forestry@teagasc.ie

Keep right up to date by subscribing to our www.teagasc.ie/forestrynews


teagasc
Agroforestry design
What are the Benefits of AGROFORESTRY?
We LOVE it anyway!
Biodiversity
Animal Welfare
Carbon Capture
Water
Quality
Shade
Fruit & Nut produces
RESILIENCE
diverse income
Streams
Flood management
Wood
Shelter
Extended grazing season
Changing our Attitude to Trees
Risk?
the Future
An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine
Further Information:
Ian Short | Silviculture Researcher
Ian.Short@teagasc.ie
SCAN ME

Agroforestry Design

Ian Short[1]; Rachel Irwin[1]

[1]Teagasc Forestry Development Dept., Ashtown, Dublin

Summary:

- Integrating trees in farms (agroforestry) has many benefits to the agricultural enterprise and to society
- Establishing agroforestry can be for multiple objectives, e.g.
  - Shelter
  - Shade
  - Soil water infiltration
  - Extending grazing season
  - Animal welfare
  - Biodiversity*
  - Flood mitigation
  - Product diversification
  - Pollination
- The design of the agroforestry system is dependent on the objectives, normal agricultural practices, perceptions and attitudes.
- Trees and livestock/pasture = Silvopastoral
- Trees and crops = Silvoarable
- Use multiple tree/shrub species

Eligible planting sites for afforestation (based on soil type and site fertility) under Forestry Programme 2023-2027 are set out in the Land Types for Afforestation publication (DAFM, 2023). These include mineral soil, organo-mineral soil with peat depths of less than or equal to 30 cm or suitable modified fen and cutaway raised bogs. Environmental considerations incorporated into the planting approval process to safeguard the environment may have an impact on land availability for afforestation.

**Ensure an existing biodiversity-friendly habitat is not destroyed to create a new one. Consider the biodiversity value of the land before planting forestry. For example, planting trees on an existing species rich wet grassland is not beneficial to biodiversity.*

Other resources & online information

Twitter: @IanShort_Forest; @teagascforestry

Teagasc Websites: https://www.teagasc.ie/crops/forestry/grants/agroforestry/

https://www.teagasc.ie/crops/forestry/research/small-woodlands-on-farms/

https://www.teagasc.ie/news--events/daily/forestry/growing-quality-timber-in-agroforestry-systems.php

https://www.teagasc.ie/rural-economy/rural-development/diversification/agroforestry/

Irish Agroforestry Forum: https://www.irishagroforestry.ie/

Email: ian.short@teagasc.ie; rachel.irwin@teagasc.ie

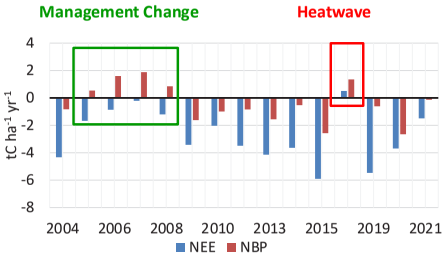
Field Scale Carbon Balance - grassland & arable

Introduction

- The C balance or net biome productivity (NBP) is = Net Ecosystem Exchange (NEE) + C imports – C exports
- National Inventory Report reports a net C sequestration rate of 0.1 tC ha^{-1} yr^{-1} or 0.38 tCO_2 ha^{-1} yr^{-1} for managed mineral soils
- Irish measured data suggests a higher mean C sequestration rate of 0.64 tC ha^{-1} yr^{-1} or 2.34 tCO_2 ha-1 yr^{-1}

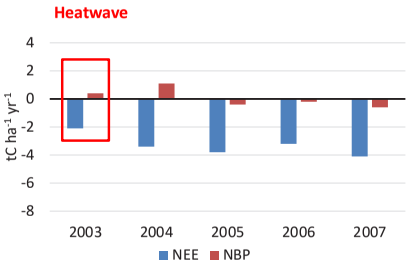
Results from long-term monitoring

Grassland – Johnstown Castle



- The net C balance ranged from a **source of 1.87 t C ha^{-1} yr^{-1} to a sink of 2.65 t C ha^{-1} yr^{-1}** driven mainly by land management decisions and extreme climatic events

Cropland – Oakpark



- The C balance ranged from a net **sink of C at a rate of 0.6 t C ha^{-1} yr^{-1} to a net source of C at a rate of 1.1 t C ha^{-1} yr^{-1}** during the 2003 heatwave

Funding

- Department of Agriculture, Food and the Marine (DAFM), Terrain-AI, Vistamilk, Dairy Levy.

Take home message

Managed mineral soils are sequestering more C than reported in the National GHG Inventory

Field scale carbon balance from grassland and arable systems

Rachael Murphy[1.2]; Karl Richards[1.2]; James Rambaud[1,2]; George Gleasure[1]; Gary Langian[1]

[1]Teagasc, Crops, Environment and Land-use Research, Johnstown Castle, Co. Wexford
[2]Teagasc Climate Centre

Summary:

- The flux tower technique measures the net ecosystem exchange (NEE) of carbon dioxide (CO_2) which is the difference between carbon (C) uptake by plants through photosynthesis and C release from the soil to the atmosphere through soil and plant respiration
- When we combine the NEE measured by the tower with C imports e.g. slurry applications, and C exports e.g. grass removals by grazing animals, this gives us the net biome productivity (NBP) or the C balance at the field scale
- The National GHG Inventory Report reports a net C sequestration rate of 0.1 tC ha^{-1} yr^{-1} or 0.38 tCO_2 ha^{-1} yr^{-1} for managed mineral soils
- Irish measured data suggests a higher mean C sequestration rate of 0.64 tC ha^{-1} yr^{-1} or 2.34 tCO_2 ha-1 yr^{-1}
- Long-term measurements from Johnstown Castle (grassland) and Oakpark (cropland) show how the NBP can change over time due to management decisions and extreme climatic events

Acknowledgements:

Thank you to Patricia Berry, Jessyca DeMedeiros, Brendan Healy, Simon Leach, Luis Lopez-Sangil, Linda Moloney Finn, Carmel O'Connor, and Wendy Pierce in Teagasc, Johnstown Castle for their assistance with laboratory sample analysis and creating figures for papers.

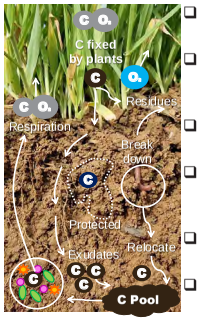
Other resources & online information

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

Email: rachael.murphy@teagasc.ie; gary.langian@teagasc.ie

Enhancing Carbon Sequestration in Agricultural land

Carbon dynamics



- Plants use sunlight, CO_2, and water to produce carbohydrates
- Plants exude carbohydrates through their roots and feed soil organisms to obtain nutrients
- Fallen leaves and branches and root mortality add carbon to soil
- Soil organisms decompose the organic matter and release CO_2 through respiration
- Clay minerals stick to carbon and protect it inside aggregates
- Water and temperature regulate microbial activity

POTENTIAL OF SOILS TO SEQUESTER CARBON

Soil class	CO_2 Uptake	CO_2 Release	Potential of SOC Sequestration
Sandy			**LOW** Sand binds weakly with carbon
Clay			**MEDIUM TO HIGH** Dependent on land use changes
Peat			**VERY HIGH** Water drives biology and gas fluxes

How can we increase soil organic carbon?

Minimize disturbance	**Grassland**	**Tillage**
Direct drill/Reduced-till	★★★★★	★★
Follow contour lines		★★
Avoid compaction	★	★

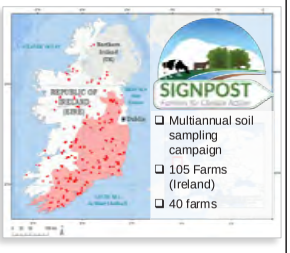
Maximize soil cover	**Grassland**	**Tillage**
Cover crops		★★★★★★
Keep harvest-residues and incorporate straw		★★★★

Maximize biodiversity & living roots	**Grassland**	**Tillage**
Diversify swards/crops	★★	★★
Increase hedgerows areas	★ to ★★	★ to ★★

Incorporate livestock	**Grassland**	**Tillage**
Apply organic manure	★	★★
Increase the proportion of grazing	★ to ★★	★

Restoring ecosystem	**Grassland**	**Tillage**
Planting woodlands/forest	★★★★★	★★★★★
Restoring drained wetland	★★★★★★	
Improve soil fertility	★★	★★

SIGNPOST



Take home messages

- ✓ Protect existing soil carbon stocks
- ✓ Implement and combine management practices to increase carbon sequestration

Enhancing Carbon Sequestration in Agricultural Lands of Ireland

Castellon, A.[1], O'Sullivan, L. [1], Wall, D. [1], Fahy, A. [1], Holloway, P. [2] & Bondi, G. [1]

[1]Teagasc, CELUP, Johnstown Castle Co. Wexford
[2]University College Cork, Department of Geography

Summary:

- Fundamentals of Carbon dynamics. Plants fix Carbon in their tissues and produce carbohydrates. The decomposition of plant residues and plant's root exudates introduce Carbon into the soil. Clay minerals and microbes fix Carbon in soil. Finally, organic matter decomposition and soil respiration release Carbon in form of CO_2.
- Natural capacity of different soil types to sequester Carbon.
- Different land management practices highlighting their potential to sequester carbon.
- Classifying the practices according to the soil health principles: minimizing disturbance, maximizing coverage, maximizing plant biodiversity and living roots, integrating livestock into the system. Including an additional category to remark the relevance of restoring natural ecosystems.
- A brief description of the Signpost Programme and main achievements in 2023 in relation to soil sampling.
- Take home message: protect the existing carbon stocks, and implement and combine different management practices to increase the carbon sequestration in soils.

Other resources & online information:

Bondi, G.; Devereux, K.; Cardenaz, G.; Miranda, D.; Castellon-Meyrat, A.; Michel C.; Righetti, A.; Daly, K. (2024). On the road to Carbon estimates: the Signpost Deep Soil Sampling Campaign. Teagasc news events. https://www.teagasc.ie/news--events/daily/environment/on-the-road-to-carbon-estimates-the-signpost-deep-soil-sampling-campaign.php

Teagasc Daily. (2020). Enhancing soil carbon sequestration to contribute to carbon neutrality on Irish farms. https://www.teagasc.ie/publications/2020/enhancing-soil-carbon-sequestration-to-contribute-to-carbon-neutrality-on-irish-farms.php

Acknowledgement:

Special thanks to Kate Devereux, Gabriela Cardenaz, Daniel Miranda, Alessandro Righetti, John Cardiff, James Reck, Carl Michel, Parag Bhople, Luis Lopez-Sangil, Maame Kukua, Felipe Bachionde-Santa, Tom Murphy, Wayne Hayes and Simon Leach at Teagasc, Johnstown Castle for their assistance in soil sampling, laboratory sample analysis and cartographic data provision.

We thank the Signpost Farmers for providing access to field sites across the country for this research.

Other resources & online information

Email: alex.meyrat@teagasc.ie; giulia.bondi@teagasc.ie

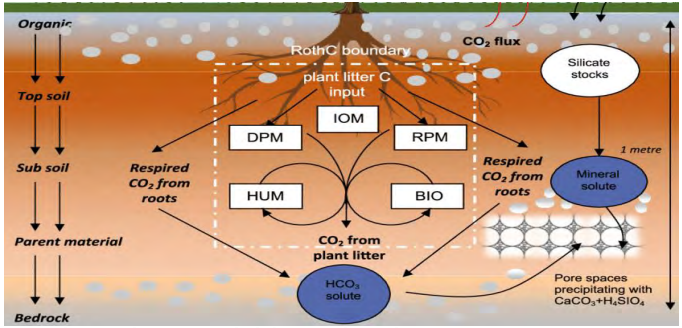
Soil Organic Carbon Stocks in Grasslands

Background

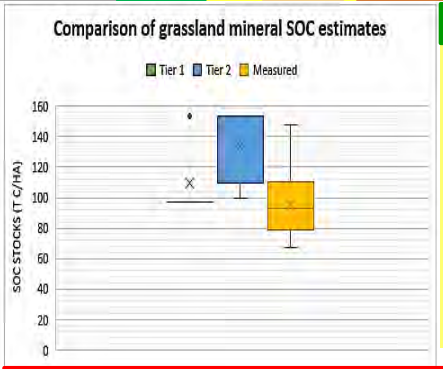
- Important to protect existing soil organic carbon (SOC) stocks & store more SOC in grasslands

Modelling SOC stocks

- Nationally SOC stocks estimated using 'models'
- Two basic modelling methods: IPCC Tier 1 & 2



RothC - Tier 3 model for estimating SOC



Results

- Tier 1 & 2 are not fully representative
- Not adapted to local conditions
- Not reflective of management practice

Take home messages

- Tier 1 & 2 methods for estimating SOC in grasslands are inaccurate at site (field) level
- Need to move to Tier 3 SOC models to better represent the carbon stock changes in Irish grasslands (account for soil type & management)

Modelling soil organic carbon stocks in Irish mineral grasslands

Brendan McGoldrick[1], Donal O'Brien[1], Rowan Fealy[2]

[1]Teagasc, CELUP Johnstown Castle, Co. Wexford; [2]Maynooth University

Summary:

- Grasslands have the capacity to store large amounts of soil organic carbon (SOC), especially under Ireland's moist climatic conditions. They also have capacity to remove CO_2 from the atmosphere through a process known as carbon sequestration. However, before we can determine the soil carbon sequestration, we first need to establish baseline SOC stocks for grassland.
- Deep soil sampling and flux towers provide reasonably accurate measurements of SOC stocks. However, both are unfeasible to rollout at a large scale due to high costs, standardization issues and destructive sampling required. A cost effective alternative to measurement of SOC is modelling. The IPCC apply a three-tiered approach to model SOC stocks. Tier 1 is the basic method, Tier 2 intermediate and Tier 3 the most complexity and data intensive.
- Before moving to a higher Tier, it is necessary to assess the performance of Tier 1 and Tier 2 methods. Both of these modelling methods were evaluated against direct field measurements taken from 27 mineral grassland sites. The SOC stock was modelled according to the Tier 1 approach in the IPCC guidelines and the country specific method in the national emission inventory.
- The IPCC Tier 1 approach, commonly used in calculating SOC stocks for mineral grasslands struggled to capture the variability in SOC stocks measured at selected Irish sites. The country specific Tier 2 approach using Irish derived coefficients tended to over-estimate SOC field measurements. Both approaches inadequately represent SOC stocks in mineral grassland. This findings warrants investigating the use of a more complex modelling method.
- The next steps for this research is to apply the Rothamstead and SoilR models to long-term grassland experiment under temperate climatic conditions. The latter model can be applied at different scales and requires readily available input data. It will be used to examine the influence of grassland management with a dynamic representation of environmental conditions (e.g. weather and soil type).

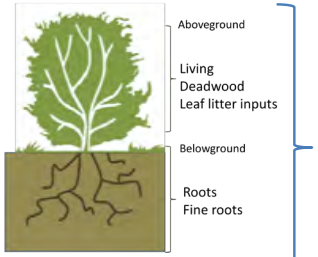
Other resources & online information

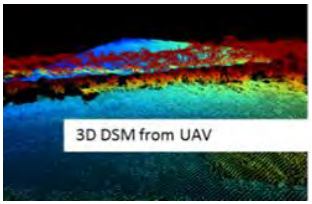
Email: brendan.mcgoldrick@teagasc.ie; donal.mobrien@teagasc.ie

Carbon Sequestration by Hedgerows in Ireland

Farm-Carbon Project:

Biomass assessment





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

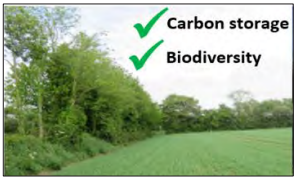
Take home message

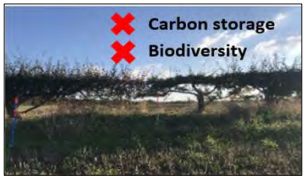
- ✓ Rejuvenation of older hedges, less intensive management, or planting of new hedgerows enhances carbon sequestration
- ✓ Supports biodiversity and other ecosystem services

Main findings:

- **Hedgerow management directly affects the amount of C stored over time**
- **Pilot county survey: Loss of 0.3t C/ha/yr due to cutbacks and removals**

Carbon stock change (tC/ha/year) for two hedgerow			
		Hedgerow	
		Managed	Unmanaged
Hedgerow type	Regular (<4m width, "box"	-1.97	1.14
	Irregular (>4m width, wider crown, includes treelines)	-2.69	2.87





PROJECT PARTERS

FUNDING

Carbon sequestration by Hedgerows on the Irish landscape: Farm-Carbon

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

[1]Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford
[2]Forest Environment Research and Services (FERS)

Introduction:

The EU aims to be climate neutral by 2050. Land use and management that supports carbon sequestration and the enhancement of existing carbon sinks are central to this ambition. Unlike the majority of the EU, Ireland's Land Use Land Use Change and Forestry (LULUCF) sector is currently a net source of emissions. Hedgerows are estimated to cover ~689,000 km, and have previously been suggested to be a carbon sink. To include hedgerows in national inventory reporting, a mechanism to assess carbon stock changes (CSC) over time is required. In the Farm Carbon project, we took direct measurements of hedgerow biomass to develop relationships between measured hedgerow biomass and 3-D digital elevation model (DEM) data (remotely captured using drones). The equations generated can be used to assess CSC of biomass between time steps, required for inventory reporting.

Direct measurements of hedgerow biomass

Summary:

- The Farm-Carbon pilot study indicates that Ireland's hedgerows may be in decline and may thus potentially be a net carbon source in the LULUCF inventory. The project highlights:
    - Less intensive management practices could enhance carbon stocks.
    - Irregular shaped hedgerows (>4m width, wider crown) have significantly higher carbon stocks than regular shaped hedgerows (<4m width, "box" profile).
    - Emergent hedgerows have the highest carbon sequestration potential (3.69 tC ha^{-1} yr^{-1}), followed by irregular unmanaged (2.87 tC ha^{-1} yr^{-1}) and regular unmanaged hedgerows (1.14 tC ha^{-1} yr^{-1}).
    - Managed hedgerows were found to be carbon emission sources, with irregular and regular managed hedgerows emitting 2.69 tC ha^{-1} yr^{-1} and 1.97 tC ha^{-1} yr^{-1}, respectively.
    - Significant biomass losses occur due to the removal of irregular hedgerows.

Current habitat quality scorecards often overlook the carbon benefits of hedgerows and an integrated scorecard combining biodiversity and carbon indicators is proposed.

Policy incentives for less intensive management, new hedgerow establishment, and regeneration of older hedges could enhance both carbon sequestration and biodiversity ecosystem services.

Other resources & online information

Farm-Carbon Report: https://www.epa.ie/publications/research/climate-change/Research_Report-454.pdf

Teagasc Website: Farm-Carbon - Teagasc | Agriculture and Food Development Authority

Email: lilian.osullivan@teagasc.ie

Acknowledgements: We thank the laboratory and field technical staff at Teagasc, Johnstown Castle for their assistance in laboratory sample analysis. Special thanks to the farmers for providing access to field sites across the country for this research.

Measuring, Reporting & Verifying (MRV)

Carbon Sequestration

Advancing Carbon Sequestration Techniques

1 Long term C Measurements (Deep Soil Sampling an soil Nutrient tests) (M)

2 Short term C Measurement Remote sensing (Flux, Eddy Covariance Tower) (M)

Climate, Soil & Land-use and activity data (NMP Online, pasture based)

3 Grass/crop growth and soil modelling (M/R)

Terrain-AI

4 Carbon sequestration

VistaMilk

Importance: Accurate monitoring and verification is essential for effective climate action.

MRV is a platform for Measuring, Reporting, and Verifying greenhouse gas emission. It can also quantify and report changes in Soil Organic Carbon (SOC) for including in the national GHG inventory & guide management.

Take home messages

- ✓ Establishing baseline levels of soil organic carbon stocks in agricultural soils is essential.
- ✓ Effective MRV of carbon sequestration involves measuring change in C stocks at depth across landscapes *(covering different soil types & land uses)* and at national scale.
- ✓ GHG emissions will also be accounted for!

Methods for Monitoring, Verifying and Measuring Carbon Sequestration

Parag Bhople[1]; Saw Min[1]; Rachael Murphy[1, 2]; Giulia Bondi[1]

[1]Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford
[2]Teagasc Climate Centre

Summary:

- Soil as a dynamic entity within natural and managed landscapes provide multiple ecosystem services such as carbon storage, air quality, atmospheric chemistry and elemental cycling for human wellbeing and nature conservation.
- Agriculture has a bright future in Ireland and more changes are expected to happen in near future than have happened over the past decades where carbon will be seen as a prime crop leading to: Carbon Farming.
- Irregularities in agricultural practices negatively affect the balance of nutrients in soils and may lead to carbon loss to atmosphere which will deteriorate the quality and nutrient status in soils while at the same time if C in atmosphere is more, it will lead to environmental constraints such as weather warming and reducing the quality of air in the atmosphere.
- As an essence of life, soils need to be protected, restored, monitored and managed judiciously for making agriculture as a solution to climate change. Therefore, using the traditional and advanced scientific techniques, C status across landscapes and land-uses is reported in national records and inventories.
- Signpost programme has conducted an extensive soil sampling campaign, quantifying carbon stocks at different depths and measuring carbon accumulation over long time periods across various soil types, land uses, and management practices.
- NASCO utilize flux towers to measure the short-term, annually variations in carbon stocks at the field scale when combined with C import and C export data, also from different ecosystems.
- Remote observations of carbon stocks can be used to develop models that extrapolate these stocks across various land uses, soil types, and management practices, refining the national GHG inventory for soil organic carbon.
- Altogether, this knowledge will help decision makers to strategize and propose new policies for environment and development of more sustainable agriculture and farming systems across the country.

Other resources & online information

NASCO: https://www.teagasc.ie/environment/climate-change--air-quality/soil-carbon/national-agricultural-soil-carbon-observatory/

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

Vista Milk: https://www.vistamilk.ie/

Terrain-AI: https://terrainai.com/

Teagasc Website: https://www.teagasc.ie/

Email: giulia.bondi@teagasc.ie; rachael.murphy@teagasc.ie

AGNAV Online sustainability platform for farmers and advisors

Objective

- Work with farms to improve the sustainability of farming systems in Ireland
- Reduce workload through data integration
- Create farm specific action plans

How does AgNav work?

- Published LCA models
- Existing activity data
- Farmer permission

Visit www.agnav.ie

The AgNav process

Carbon and future development

- Methodology to calculate C sequestration under development
- Exploring new databases to allow for MRV
- Decision support tool to identify practices to reduce GHG emissions from farms
- Ability to create farm specific action plans

Take home messages

- AgNav is an ambitious initiative to chart a path forward for sustainable farming
- Will provide a method to measure GHG emissions and C removals
- AgNav is used in the Life Carbon Farming project

The role of AgNav in monitoring, reporting and verifying carbon farming

Herron J[1], O'Brien D[2], Jordan S[3], Shalloo L[1]

[1]Teagasc Moorepark, Co. Cork; [2]Teagasc, CELUP, Johnstown Castle, Co. Wexford;[3]Teagasc, CELUP, Oakpark, Co. Carlow

Summary:

- AgNav is a digital sustainability platform under development by Teagasc, the Irish Cattle Breeding Federation (ICBF) and Bord Bia - with the support of the Department of Agriculture, Food and the Marine, that provides farmers with accurate and verifiable data potentially relevant for carbon farming schemes.
- The AgNav platform integrates Teagasc life cycle assessment (LCA) models into the ICBF infrastructure to calculate carbon footprints of commercial farms. Using this infrastructure enables farmers and advisors to assess the environmental performance of commercial farms. Through data integration, farm data residing in existing databases (e.g. ICBF and Bord Bia) is collated to build a picture of each unique farming system. Gathering existing data for individual farms streamlines the assessment process and can improve the accuracy of results. For transparency, activity data used is presented on user interfaces.
- The core features of AgNav are:
    - Assess – A farmer either individually or in consultation with a farm advisor can establish current farm performance for a number of relevant environmental sustainability indicators on the platform with data from ICBF and the Bord Bia sustainability survey.
    - Analyse - Where farmers and/or advisors identify opportunities for practice change that could result in improved performance, they can determine the impact of implementing these practices with the "Forecast" decision support tool available in AgNav.
    - Act - After selecting the most appropriate actions for their farm, a farmer and/or the advisor will use the "Action Planner" to create a sustainability plan for the farm which can include targets and timelines for completion.
- AgNav is currently being used to develop plans for livestock farmers participating in LIFE carbon farming. This platform will monitor, report and verify the actions applied on these farms over the course of a 5-year project.
- The first phase of AgNav is only available to beef and dairy farms that are Bord Bia certified. The ambition is to expand the scope of AgNav to accommodate all cattle farms as well as other enterprises, irrespective of their affiliation to AgNav partners. Moreover, while the initial stage of the AgNav platform focuses on greenhouse gas and ammonia emissions, future stages will include wider environmental goals e.g., water quality, carbon sequestration, biodiversity.

Other resources & online information

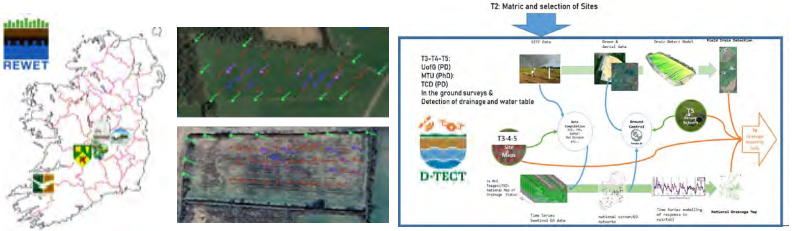
Website: https://www.agnav.ie and https://www.life-carbon-farming.eu/

Email: jonathan.herron@teagasc.ie; donal.mobrien@teagasc.ie

Drainage Status of Grassland Peat Soils in Ireland

Overview

- ≈ 340,000 ha of grassland (and some cropland) on peat soils
- The level of drainage/depth of the water table dictates emissions
- A recent review has provided new information on drainage status
- It is now agreed that approx. **140,000 ha are drained**
- The remaining **200,000 ha is considered to be rewetted**
- This change (from a position where all was assumed drained) has yielded significant changes to emissions estimates



REWET aims to classify the factors which dictate the effectiveness of rewetting.
D-TECT will investigate drainage status at landscape scale.

Funding

- DAFM-EPA co-funded projects
- Interreg: Smart Carbon Farming

Take Home Message

✓ Recent changes in our understanding of the drainage status of grassland peats has reduced estimated emissions from **9 to 3.9 M tonnes CO_2e**

✓ This was the direct result of detailed analysis by Teagasc which increased the accuracy of emission estimates

✓ Future policy relating to rewetting and restoration will be significantly influenced by this revision

Drainage Status of Grassland Peat Soils

Patrick Tuohy[1], Owen Fenton[2], Lilian O' Sullivan[2]

[1]Teagasc, Moorepark, Fermoy, Co. Cork; [2]Teagasc, CELUP Johnstown Castle, Co. Wexford

Introduction:

Peatlands form where high rainfall or impeded drainage causes waterlogging; restricting oxygen supply and suppressing decomposition of organic matter. Given the accumulation of vast amounts of organic material, peatlands offer significant value in terms of carbon (C) storage. Over many generations, drainage of these peats was actively encouraged and incentivised with a focus on maximising the peat resource in terms of energy production, horticulture and agriculture. It is estimated that 339,000 ha of peat soils are under grassland today. The depth of the water table within the peat is the key factor which controls whether accumulation or decomposition of organic matter is the dominant process. Consequently, the long term stability of peat is very sensitive to any changes brought about by drainage. When effectively drained, aerobic conditions mineralise C stored in the peat and greenhouse gases (GHG) such as carbon dioxide and nitrous oxide are released to the atmosphere. This process transforms peatlands from C-sinks into C-sources.

Summary:

- Until recently, all grassland peat soils (339,000 Ha) were assumed to be artificially drained within national emission inventory reporting (as no information had been available on their drainage status) they were therefore estimated to be responsible for significant emissions (9 million tonnes CO_2-equivalent annually).
- A detailed review was undertaken to evaluate drainage status of grassland peat soils and to assess if assumptions regarding drainage could be verified.
- The results of this review were published in Mid-2023 and concluded that only a proportion of this area was effectively drained.
- This finding was incorporated directly into the EPA's National inventory report (March 2024)
- With this change it is now recognised that 141,000 Ha of grassland peats are drained and the remainder (≈198,000 Ha) are considered to be rewetted (which still give rise to emissions however at a much lower rate than their drained counterparts).
- This change in drainage status has reduced estimated emissions from 9 to 3.9 M tonnes CO_2-equivalent annually form this land use.
- To reduce these emissions further, there needs to be targeted changes in management such that C sources are minimised and sinks promoted on a local and global scale.
- Management of grassland peat soils at farm scale will require a knowledge of the distribution of peat soils and their drainage status.
- Rewetting or water table management is defined as raising the water table in soils that had previously been drained. This can be done by reducing water losses from the site by decreasing surface drainage surface runoff, sub-surface seepage or groundwater extraction. This remains the key lever to reduce emissions form this land use where applicable.

Other resources & online information

Email: owen.fenton@teagasc.ie; patrick.tuohy@teagasc.ie

Greenhouse Gas Emissions on Grassland Peat Soils

Overview

- Irish peat soils are large C sinks, containing between 1000~4000 tC ha^{-1}.
- Over 300,000 ha of Irish peatland are drained for permanent pasture and the drainage transform them from long-term C and N sinks into sources.

ASPEN

Site
- Grassland peat soil
- Drained and rewetted
- Nutrient rich and poor

N_2O emission measurement
- Automated chambers were used
- After N amendment including CAN, cattle urine and sheep urine

Carbosol

CO_2 and CH_4 measurement
- Quantify CO_2 and CH_4 dynamics
- Combination of automated chambers and eddy covariance technique
- Different water table levels

Funding

- ASPEN: EPA funded projects
- Carbosol: Teagasc Funded

Take Home Message

- The new techniques including automated chambers and EC tower are used to measure GHG emission.
- Different factors will affect GHG emission including water table level and nutrient status are considered.
- Early Carbosol data suggests that the site is a small net greenhouse gas balance source, but lower than IPCC estimate.

Emissions to air and water dynamics in grassland on organic soil

Wenxuan Shi[1]; Ian Clancy[1,2]; Owen Fenton[1]; Patrick Tuohy[3], Rachael Murphy[1]; Gary Lanigan[1], Giulia Bondi[1], Karl Richard[1]; Matthew Saunders[2]; Christy Maddock[1], Luis Lopez-Sangil[1], James Rambaud[1], George Gleasure[1]

[1]Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford;
[2] Discipline of Botany, Trinity College Dublin;
[3]Teagasc, Moorepark;

Summary:

- A large number of sites and projects (e.g. ASPEN, Carbsol-H2O) currently examine emissions to air and water from agricultural grassland sites in Ireland.
- N_2O emissions are examined from both drained and rewetted grassland peat soil in different nutrient status (nutrient rich and poor).
- Automated chamber systems are used to give high resolution measurement of N_2O emissions after nitrogen amendments e.g. EPA ASPEN.
- Refined emission factors for nitrogen amendments on grassland peat soils will be developed.
- Carbosol (Core-funded project) seeks to build upon previous work in Ireland to quantify the GHG and C dynamics (including to water) of grasslands on organic soil.
- GHG dynamics are measured at the point and ecosystem scale using automated chambers and an eddy covariance tower as part of the NASCO network. This data is coupled with ancillary and farm management data to quantify the net greenhouse gas budget of these sites.
- Understanding the contributions of respiration from autotrophic (Ra, carbon released through plants and vegetation) and heterotrophic (Rh, carbon released by microbial decomposition of carbon) respiration.
- This work will quantify the extent to which rewetting curtails carbon losses over a wide spatial and temporal scale in Ireland.

Other resources & online information

Email: Ian.Clancy@teagasc.ie; wenxuan.shi@teagasc.ie; owen.fenton@teagasc.ie; Patrick.tuohy@teagasc.ie

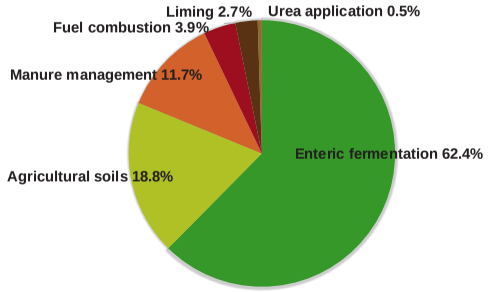
Gaseous Emissions on Farms

Main Points

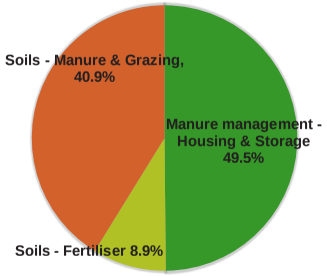
Greenhouse gases are responsible for climate change while ammonia emissions pollutes air, affects health and biodiversity.

A proportion of these emissions are attributed to agriculture, while carbon sequestration & losses are accounted for under 'land use, land use change and forestry' (LULUCF).

GHG Emissions



Ammonia Emissions



Take home messages

Main emissions on farms are greenhouse gases and ammonia

To reduce these emissions:

- ✓ Optimise soil fertility
- ✓ Reduce N fertiliser (clover & mixed species swards)
- ✓ Use best practice for slurry management (covers, timing, LESS)
- ✓ Use efficient animals (breeding and animal health)

Gaseous emissions on farms

Dominika J. Krol; Rachael Murphy; Gary Lanigan; Karl Richards

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

Summary:

- Irish agriculture contributes 38.5% of national greenhouse gas (GHG) emissions and over 99% of ammonia emissions. Ireland is obligated to reduce these emissions, therefore it is important that agricultural sector supports these efforts. Reducing emissions is often a win-win option that also improves efficiency and profitability of the farm enterprise.
- There are three main greenhouse gases-carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4), each coming from various farm activities. Methane is mainly associated with enteric fermentation of ruminants and some of it also comes from manures of these animals. Nitrous oxide is emitted from soils after fertilisation, spreading of manures and deposition of excreta by grazing animals. Agricultural emissions of carbon dioxide are very small, but that's because bulk of CO_2 emissions related to land activities are counted in a separate category called 'land use, land use change and forestry'.
- Land use, land use change and forestry category looks at balance between carbon dioxide being sequestered by land (i.e. in peat soils and hedgerows) and emitted to the atmosphere.
- Ammonia is an air pollutant responsible for negatively effects on human health and biodiversity. It also accounts for a large nutrient loss (Nitrogen) on farms.
- To reduce these emissions, we can manage their sources. For nitrous oxide and ammonia, we can reduce nitrogen fertilisation by optimising soil fertility, using clover and mixed species in grassland swards. We can reduce emissions by switching from CAN fertiliser to protected urea products. Also using best practice when spreading organic manures is important i.e. LESS application methods, targeting low loss weather, matching application to plant demand.
- To reduce methane emissions, we need to focus on ruminants by breeding more efficient cows, safeguarding animal health and reducing age of slaughter.
- In order to reduce land emissions of carbon dioxide, we need to look after soil health to promote carbon sequestration and protect existing carbon stocks in the soil. This includes extensive management of peat soils and their rewetting as well as planting and maintain trees and hedgerows on farms.

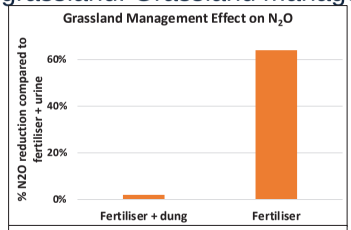
Other resources & online information

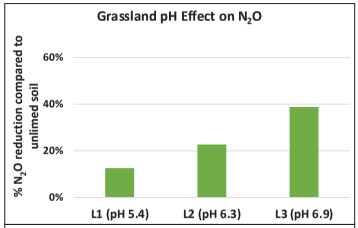
Email: dominika.krol@teagasc.ie;

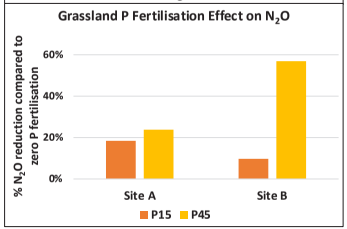
Fertiliser Management to reduce Emissions

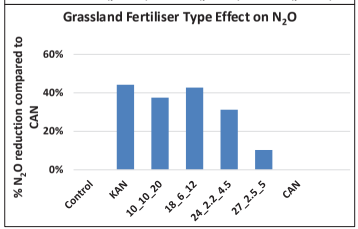
Main Points

- Nitrous oxide (N_2O) is a potent greenhouse gas coming from slurry and fertiliser application and animal excreta deposition to grassland. Grassland management affects these emissions.









Funding

- DAFM MINE 15S655
- FACCE ERA-GAS MAGGE pH

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

Take home messages

- Grazed and fertilised grassland has higher emissions than fertilised only grass due to higher N input
- Optimising soil pH and phosphorus fertilisation levels reduce N_2O losses
- Fertiliser form matters!

  In high-loss weather protected-Urea, 18-6-12 and 10-10-20 have lower emissions compared to 27-2.5-5 and CAN.

Grassland management to reduce emissions

Dominika J. Krol; Rachael Murphy, Gary Lanigan; Karl Richards

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

Summary:

- Nitrous oxide is a potent greenhouse gas emitted from soils after fertilisation, spreading of manures and deposition of excreta by grazing animals. It is responsible for nearly 19% of all greenhouse gas emissions in agriculture.
- Level of emissions of this gas depends on management decision on the farm and can be mitigated by improved management.
- As nitrous oxide depends on the level of nitrogen (N) supplied to soil, emissions are typically higher from grazed grasslands also receiving synthetic fertiliser compared to fertilised only grasslands (i.e. cut for silage). This is due to nitrogen from animal excreta. While this source is difficult to reduce, it is worth remembering that extending grazing season to early spring can reduce emissions associated with cattle housing and storage of manures but extending grazing season in late autumn can negatively impact emissions and water quality on heavy soils.
- Soil pH affects nitrous oxide emissions. By liming soils close to agronomic optimum, we can reduce emissions following N fertilisation of these soils by nearly 40% compared to unlimed soils (pH 5).
- Soil phosphorus levels also affect nitrous oxide emissions. By applying P fertiliser we can reduce nitrous oxide emissions following N fertilisation of these soils by between 10 and 18% (15 kg P / ha) and 24 and 57% (45 kg P /ha).
- Nitrous oxide emissions are highest in warm and wet weather, so when applying N fertiliser in these conditions, losses can be higher. To avoid these, we can apply protected urea, 18-6-12 and 10-10-20 fertiliser formulations as these have much lower emissions than 27-2.5-5 and CAN.

Other resources & online information

Email: dominika.krol@teagasc.ie;

Acknowledgements:

The authors would like to thank the many laboratory, technical field staff and farm staff at Teagasc Johnstown Castle for their assistance with experimental trials, sample collection and analysis.

Clover-based swards for lower Carbon footprint

Main Points

- Nitrogen fertiliser production requires very high inputs of fossil fuels, and releases greenhouse gases in the field.
- Clover-based swards (grass-clover or multi-species) can displace nitrogen fertiliser use, reduce carbon footprint, and reduce N_2O emissions and emissions intensity (Fig. 2).

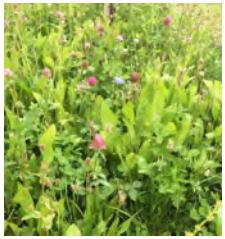


Fig. 1 Clover-based mixtures can ensure no loss in yield with lower N fertiliser levels.

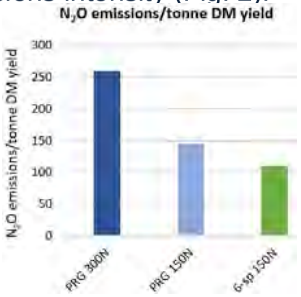


Fig. 2 Lower N_2O emissions intensity from clover-based mixtures

Funding

- DAFM
- Teagasc Walsh Scholarship Scheme

Take home messages

- Lower levels of nitrogen fertiliser reduce carbon footprint of farming systems.
- Clover-based swards (grass-clover or multi-species mixtures) can ensure no loss of yield, and have lower nitrous oxide (N_2O) emissions intensity.
- Multi-species swards can provide a range of other multiple benefits such as higher yield stability, soil biodiversity, soil fertility, with high forage quality.

Clover-based swards for lower carbon footprint

Dominika Krol[1]; Ali Sultan Khan[1,2]; Shona Baker[1] John Finn[1]; Shaun Connolly[1]

[1]Teagasc, CELUP, Johnstown Castle Co. Wexford; [2] University of Galway

Summary:

- The production of nitrogen fertiliser requires very large amounts of energy, which is usually provided from fossil fuels. Reducing nitrogen fertiliser use thus reduces fossil fuel use.
- Clover-based swards (grass-clover or multi-species mixtures) can ensure no compromise in forage yield, despite reducing fertiliser nitrogen, due to symbiotic nitrogen fixation in the clover root nodules.
- Although a lot is known about how different fertiliser formulations and application levels affect greenhouse gas emissions, relatively little is known about how grass-clover and multi-species swards affect gaseous emissions.
- Increasing the proportion of clover in a sward from 0% to 100% resulted in increased nitrous oxide emissions from about 1.2 to 2 kg ha-1 year-1 N_2O-N emissions, but this was still lower than 3.2 kg ha-1 year-1 of N_2O-N emissions from a grass monoculture receiving higher nitrogen level (300 kg ha-1 yr-1).
- A six-species sward with 150 kg ha-1 yr-1 of nitrogen fertiliser had significantly reduced nitrous oxide emissions intensity compared to a perennial ryegrass monoculture at higher (300 kg ha-1 yr-1) and equal (150 kg ha-1 yr-1) levels of nitrogen fertiliser.
- Further work is continuing, and includes measurement of gaseous emissions from multi-species swards (Multi4More) as well as emissions from digestate from anaerobic digestion.

Other resources & online information

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

Email: dominika.krol@teagasc.ie

Acknowledgements:

The authors would like to thank the many laboratory and field staff at Teagasc Johnstown Castle for their assistance with experimental trials, sample collection and analysis.

Slurry Solutions:

reduce gaseous emissions & increase nutrient value

Main Points

- Slurry additives can help reduce emissions (= N loss)
- Limiting factors: capital costs, lack of availability, others?
- Check slurry dry matter before spreading - get N values and adjust rates
- LESS reduces emissions during land spreading and increases available N for plant uptake
- Solid-liquid separation reduces volume of slurry stored

Nutrients in Cattle slurry

Slurry Dry Matter (%)	N Units/1000 gal	P Units/1000 gal	K Units/1000 gal
2	4	2	13
4	6	3	21
6	9	5	32
7	10	6	36

Funding

- Department of Food, Agriculture and the Marine
- SEAI

Take home messages

✓Use slurry additives that have a solid scientific backing.

✓Adjusting rate of slurry application can reduce emissions and make slurry go further.

✓Slurry is a valuable fertiliser (€€€) Targeting slurry to silage fields and fields with lowest P & K fertility will help maximise the nutrient value of slurry

Slurry Solutions: Reducing Emissions and Increasing Efficiency

Shaun Connolly[1]; Benjamin MaCartan[1]; Dominika Krol[1]

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

Summary:

- Slurry is valuable source of nutrients and can help maintain soil fertility/health but also leads to methane & ammonia emissions during storage and nitrous oxide & ammonia emissions during land spreading.
- Optimal use of slurry can help to reduce emissions and reduce chemical fertilizer use.
- Most commercial slurry additives on the market today have no effect on emissions during storage. Only use additives that have a proven scientific backing, such as sulphuric acid.
- Low emission slurry spreading is a proven technology that reduces ammonia emissions during spreading by reducing the surface area of the slurry on land. This leads to greater N availability for plants.
- Liquid-solid separation is an option some farmers may be considering. Recent reports suggest is can reduce the volume of slurry stored by 15-20%. Further research will be carried out in Johnstown Castle on this subject in the near future. A recent meta-analysis has shown that this technique may increase ammonia emissions, especially during storage, but reduce greenhouse gas emissions such as methane and nitrous oxide associated with manure management.
- Check your slurry dry matter prior to spreading using a slurry hydrometer, this will give you the NPK value of your slurry. Adjust rates accordingly using the tool in link below.
- Applying slurry in the spring time when temperatures are low and grass growth has begun is the most efficient time to spread slurry. Summer application will lead to greater losses of ammonia and reduced N availability. Spreading slurry out of season leads to water quality issues and wastes nutrients.

Other resources & online information

Teagasc Website: https://www.teagasc.ie/environment/climate-change--air-quality/signpost-programme/current-technologies/getting-the-most-from-your-slurry/

Email: shaun.connolly@teagasc.ie

Acknowledgements:

The authors would like to thank the many laboratory, technical field staff and farm staff at Teagasc Johnstown Castle for their assistance with experimental trials, sample collection and analysis.

Anaerobic Digestion (AD)

Main Points

- AD is a proven and rapidly advancing technology
- Target of 5.7 TWh of biomethane by 2030
- Biomethane & AD Feedstock supply are potential future sources of income for farmers
- 120,000 hectares of grassland + 3.5 million m^3 slurry
- Biomethane target: > 2.1 million tonnes CO_2 saved.

	10 - 20 GWh per annum plant	40 GWh per annum plant	40+ GWh per annum
Cost of producing biomethane per MWh[1]	€160 to €220 per MWh	€120 to €150 per MWh	€120 per MWh
Current cost of fossil gas	Circa. €50 per MWh		
Current cost of carbon (ETS) on a MWh basis	Circa. €20 per MWh		
Green premium required for biomethane	€90 to €150 per MWh	€50 to €80 per MWh	€50 per MWh

Source : National Biomethane Strategy & Teagasc

Funding

- Teagasc
- Department of Food, Agriculture and the Marine

Take home messages

- Potential for AD in Ireland – largest in Europe
- Range of reactor sizes suitable for Ireland
- Biomethane production can become a stable source of income
- Potential opportunity for farmers in future to diversify income streams by producing feedstock for AD

Anaerobic Digestion: A future income for the farming community

Shaun Connolly[1]; Ciara Beausang[2]

[1]Teagasc, CELUP, Johnstown Castle, Co. Wexford; [2]Teagasc, Grange, Co. Meath

Summary:

- Anaerobic digestion is a process by which organic materials are broken down my micro-organisms in the absence of oxygen. In doing so, methane is produced which can be further refined to produce biomethane (gas that constitutes 99% methane) and pumped directly into the grid.
- Biomethane is then burned in instead of gas originating from fossils, reducing overall emissions as a result.
- Anaerobic digestion is a proven technology that has been in existence since 1859 with a long track record of scientific publications and industry engagement. 40% of slurry/manure produced in Denmark is now being used in anaerobic digestion plants.
- Ireland has one of the largest potentials to displace fossil gas by use of anaerobic digestion in Europe due to the large agricultural sector providing valuable feedstocks.
- A target of 5.7 TWh of biomethane by 2023 has been set by the Irish Government which will require approx. 140 40 GWh anaerobic digestion plants to be built.
- Using grass and slurry as the primary feedstocks, approx. 120,000 hectares of grassland (2.93% of total Irish grasslands) and 3.5 million m3 of slurry is required to meet the biomethane target.
- This will lead to savings of 2.1 million tonnes of CO_2 if reached.
- The by-product of anaerobic digestion is digestate which has a higher concentration of available nitrogen (total ammoniacal nitrogen) compared to cattle /pig slurry and is good source of nutrients for landspreading.

Other resources & online information

Teagasc Website: https://www.teagasc.ie/rural-economy/rural-development/diversification/anaerobic-digestion/

Email: shaun.connolly@teagasc.ie

Acknowledgements:

The authors would like to thank the many laboratory and field staff at Teagasc Johnstown Castle for their assistance with experimental trials, sample collection and analysis.

Farm Level GHG Mitigation Costs

Background

- Irish dairy among most greenhouse gas (GHG) efficient worldwide
- GHG targets for agriculture: -10% 2025, -25% 2030 (base 2018)
- Financial costs associated with implementing mitigating strategies

Mitigation Strategies

1. Animal productivity

2. Grass production

3. Better reproductive performance

4. Early compact calving

5. Reduce crude protein

6. Protected urea

7. White clover

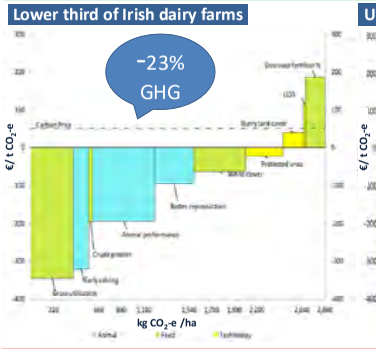
8. Slurry tank cover

9. Decrease fertiliser N

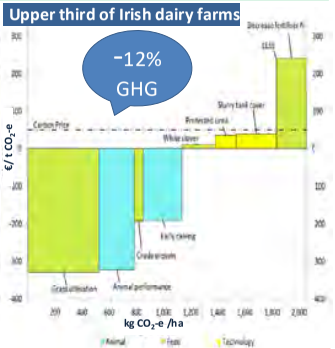
10. LESS

Bottom-up GHG cost curves

Lower third of Irish dairy farms



Upper third of Irish dairy farms



Take home messages

- GHG mitigation potentials and costs are farm specific
- Tailored approach required to optimise GHG reductions

Mitigation of gaseous emissions from livestock: A farm-level method to examine the financial implications

Marion Cantillon[1,2], T. Hennessy [2],Barbara Amon [3,4] ,Frederico Dragoni[3], Donal O'Brien[1]

[1]Teagasc, CELUP, Johnstown Castle, Co. Wexford; [2] University College Cork; [3] Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Germany; [4] University of Zielona Gora, Faculty of Civil Engineering, Architecture and Environmental Engineering, Poland.

Summary:

- Irish farmers are among the most greenhouse gas (GHG) efficient producers of milk and meat in the world, but collectively they are a major contributor to national GHG emissions (>30%). Under Climate Action Plan 2023, agriculture must decrease GHG emissions by 10% by 2025 and by 25% by 2030 compared to 2018 levels.
- Dairy farms are at the forefront of initiatives aimed at sustainably reducing emissions. Various GHG mitigation measures have been researched, ranging from land management and animal practices. Each strategy has different mitigation potential and costs.
- Farm-level marginal abatement cost curves were developed to assess the financial implications of implementing GHG mitigation measures on dairy farms over a 10 year period. Case study farms were selected from the bottom, middle and top third of the national farm survey based on financial performance for the baseline year 2020.
- Ten mitigation measures were modelled: animal productivity, grass production and utilisation, better reproductive management, early calving, reduce crude protein, decrease fertiliser N, protected urea, white clover, slurry tank cover and low emission slurry spreading (LESS)
- The annual GHG abatement potential for the bottom, middle and top dairy groups was 1.7, 1.8 and 1.4 t CO_2-e/ha, respectively. This corresponded to a 23%, 19% and 12% reduction in GHG emissions. The majority (54%-86%) of the abatement potential could be realised with cost beneficial and net-zero cost measures. Reducing the CP content of concentrate offered to grazing cows was the most cost-beneficial way to mitigate GHG emission followed by improving grass production and utilisation.
- Cost-effective mitigation measures were similar across farm performance levels, but top-performing farms had more cost-prohibitive technological interventions. The MACC method helps identify cost-effective measures at the farm level, emphasising the need for decision support tools at farm level.

Other resources & online information

Twitter https://www.mels-project.eu/the-project/

DOI; https://doi.org/10.1016/j.jenvman.2023.119904

Email: marion.cantillon@teagasc.ie; donalmobrien@teagasc.ie

Carbon farming on grassland farms

What actions can be taken on farms to reduce GHG emissions & increase C sequestration?

Animal management

- Improve young stock management
- Utilise the Commercial Breeding Value
- Increase live weight gain/reduce age of slaughter
- Genetic selection for improved performance & low enteric methane

Fertiliser

- Low emissions slurry spreading (LESS)
- Use protected urea

Soil Management

- Optimize soil pH

Grassland/Pasture

- Improve grassland management
- Grass legume mixtures
- Improve forage quality

Other

- Plant trees/woodland & manage hedgerows
- Conversion to nature

Take home messages

- Choose actions you can undertake and implement them
- Sign up for the Teagasc SignPost Advisory Programme

Transitioning towards climate neutrality: The H2020 ClieNFarms Project

Susan Moloney[1] and Deirdre Hennessy[2]

[1]Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork.
[2]School of Biological, Earth and Environmental Science, University College Cork, Cork.

Summary:

ClieNFarms is a European Horizon 2020 project across 14 countries and has 34 partners. The overall objective is to co-develop and upscale locally relevant solutions to reach climate neutral and climate resilient sustainable farms across Europe. In Ireland, the focus is primarily on implementing solutions in the MACC to reduce greenhouse gas (GHG) emissions and increase carbon sequestration from dairy and beef production systems. ClieNFarms is interested in better understanding the drivers and barriers that influence decision making with regard to the choice of agricultural practises that are potentially more climate friendly.

The main actions on farms to reduce GHG emissions & increase carbon sequestration are outlined

Animal Management:

- Improve young stock management
- Utilise the Commercial Breeding Value
- Increase live weight gain
- Reduce age of slaughter
- Genetic selection for improved performance and low enteric methane

Grassland:

- Improve grassland management
- Incorporate white clover
- Improve forage quality

Fertiliser:

- Low emission slurry spreading
- Use protected area
- Precision fertiliser applications

Soil Management:

- Optimize soil pH
- Avoid soil compaction

Other:

- Plant trees/woodland and manage hedgerows
- Conversion to nature

This project is funded through the EU Horizon 2020 Research and Innovation Programme under grant agreement no. 101036822.

Taking Steps to Reduce GHG Emissions

DAIRY - JACK KEARNEY
RATHCORMACK, CORK

> By getting soil fertility right, I can make the most use of NBPT Protected Urea. 77% of my feriliser N was in this form in 2023.

- 55% of soils optimum for pH, P & K
- 36% of grazing area with high clover
- Chemical N use ↓ 36% since 2021
- Grass yield ↑ 9% since 2021

SHEEP - SHANE MOORE
ATHLEAGUE, ROSCOMMON

> Reducing emissions is a win-win for me – it's good for the environment and importantly it's good for my pocket.

- Weaning rate: 1.7 lambs per ewe
- Average lamb age at finishing = 7 months
- Chemical N ↓ 8% since 2020
- 15% chemical N applied as Protected Urea

TILLAGE - DON SOMERS
ENNISCORTHY, WEXFORD

> The Signpost Programme has given me the opportunity to access information, improve nutrient use efficiency & water quality, and to future proof my farming business.

- Cover cropping since 2016
- Importing organic manures since 2020
- Adopting precision farming techniques
- Using 74% NBPT Protected Urea

Taking Steps to Reduce GHG Emissions

SUCKLER BEEF - JOHN PRINGLE
AUGHRIM, WICKLOW

> There's nothing to be afraid of. Efficiencies bring money. It's a win-win for the farmer and the climate.

- Chemical N use ↓ 20% since 2021
- 100% of slurry applied with LESS
- Heifers finished at 21 months
- 87% heifers calf at 22-26 months

DAIRY CALF TO BEEF - CIARAN BARTLEY
BOHER, LIMERICK

> My biggest and best investment has been lime, resulting in improved grass growth and better response to fertiliser.

- 360t of lime spread over past 4 years
- 5ha red clover silage
- Using NBPT-Urea, 18-6-12 & 10-10-20
- ↓ slaughter age to 22 months
- Drained mineral clay soils

TAKE HOME MESSAGES

- Signpost Farmers are taking steps to reduce GHGs
- These changes are also benefitting the farmers financially
- What steps can you take on your farm?

Check out the 12-Step's to reducing gaseous emissions on your farm here!

Signpost Farms: Taking Steps to Reduce GHG Emissions

Tom O'Dwyer[1] and Siobhan Kavanagh[2].
[1]Teagasc Moorepark; [2]Teagasc Kilkenny

Irish farmers are taking steps to reduce emissions from their farming activities. While agriculture accounted for 38.5% of total emissions in 2022 (EPA, 2024), agricultural emissions declined by 0.3% compared to 2021 (with a further decline anticipated for 2023). National figures indicate reduced sales of fertiliser nitrogen (N) and upward trends in the usage of protected urea, lime and LESS.
Reducing greenhouse gas emissions on your farm is possible and achievable. Many of the currently available solutions have other benefits, including increased farm system efficiency, improvements to water quality and improved profitability. However, to achieve these benefits requires change.
The Signpost Farms Programme was created to help farmers understand their on-farm options to reduce greenhouse gas emissions, and then to support them in implementing the new practices on their farms. Listed below are the practical solutions promoted with the Signpost Farmers, and with all farmers through our series of "12 Steps" leaflets. These solutions are available to all farmers now. Simultaneously, Teagasc and others are researching solutions that will help farmers continue to reduce emissions and improve farm performance in the future.

Table 1: Available solutions to reduce GHG emissions

1. Reduce fertiliser N use (through optimising soil pH and soil P and K levels, increasing the proportion of grass/ clover swards)
2. Use NBPT - urea (protected urea) as your source of fertiliser N.
3. Manage and make best use of animal slurries and manures.
4. Increase and optimise milk and meat production from pasture.
5. Use breeding indices to inform better breeding decisions.
6. Achieve targets for age at first calving and replacement rate.
7. Target earlier finishing of beef cattle and lambs.
8. Review your animal health management practices and improve where appropriate.
9. Improve hedgerow management and consider planting new hedgerows or trees.
10. For tillage farmers, mitigation measures include sowing cover crops, straw incorporation and the use of organic manures (to replace fertiliser N).

Table 2: What we have learned

1. Farmers are willing to adopt new farming practices, once they are clear on the benefits of such practices to their farm business.
2. Gains (reductions in total emissions) can be counterbalanced by increased farm scale, and in some cases factors outside the farmer's control (such as weather).
3. Change takes time, some solutions may require a sustained effort over many years.
4. One size does not fit all – tailored, farm specific solutions are necessary.
5. Good farm data is necessary to inform better decisions.

Other resources & online information

QR code for Signpost 12 Steps leaflets

Better Farming For Water Campaign

Nutrient Management

01 Reduce purchased nitrogen (N) & phosphorus (P) surplus per hectare

02 Ensure soil fertility is optimal for lime, phosphorus and potassium

03 Ensure application of fertiliser and organic manure at appropriate times and conditions

Farmyard Management

04 Have sufficient slurry and soiled water storage capacity

05 Manage and minimise nutrient loss from farmyards and roadways

Land Management

06 Fence off watercourses to prevent bovine access

07 Promote targeted use of mitigation actions such as riparian margins, buffer strips & sediment traps to mitigate nutrient and sediment loss to water

08 Maintain over-winter green cover to reduce nutrient leaching from tillage soils

Better Farming for Water Campaign

Introduction:

The 'Better Farming for Water' campaign aims to support and accelerate the adoption of actions on all farms to improve all water bodies (where agriculture is a significant pressure) to Good or High Ecological Status.

The campaign will support all farmers to reduce the loads of nitrogen, phosphate, sediment and pesticides entering our river network through either diffuse or point source pathways from agricultural sources. This will be achieved through the on-farm adoption of 8-Actions for Change, which involve better nutrient, farmyard and land management.

These 8-Actions for Change provide a structured, relatable approach for farmers to effectively engage with improving water quality. They will help to advance the understanding of the need for actions, and instill confidence that the actions undertaken are worthwhile and will result in sustained, positive improvements in water quality.

Delivery of the campaign

The 'Better Farming for Water' campaign will be delivered by way of six key pillars:

- Stakeholder engagement through a Multi-Actor Approach.
- Building Awareness by acquisition and utilisation of water quality data.
- Upskilling farmers, students, advisors, teachers and industry professionals.
- An impactful Knowledge Transfer programme.
- A supporting Research Programme to identify and develop effective mitigation actions.
- A strong Communications Plan with the target audiences.

Overview of delivery

Other resources & online information

Teagasc Website: https://www.teagasc.ie/environment/water-quality/better-farming-for-water/

Targeted mitigation

Fence watercourses to prevent bovine access

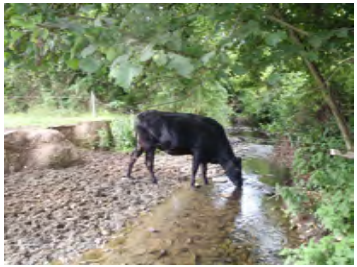
Main Points

Cattle access to watercourses may offer a cheap source of water…. but at what cost?

Cattle access to watercourses resulted in increases in:

- *E. coli* concentrations
- Deposited bed sediment
- Phosphorus

Negative environmental impacts, including habitat degradation, persisted even when animals were periodically removed from watercourses



Funding

The COSAINT project, ***Cattle access to watercourses: environmental and socio-economic implications,*** was a five-year, inter-institutional project funded by the Environmental Protection Agency (EPA).

Take home messages

- **Cattle exclusion from watercourses can improve the ecological quality of watercourses in the short, and long-term.**
- **One year of full cattle exclusion resulted in improvements in:**
  - **deposited stream sediment,**
  - **phosphorus concentrations,**
  - **ecological communities**

Fence watercourses to prevent bovine access

Cattle access to watercourses: environmental and socio-economic implications. COSAINT

Daire Ó'hUallacháin[1]
[1]Teagasc, CELUP, Johnstown Castle, Co. Wexford;
Project partners: Dundalk Institute of Technology; Dublin City University; University College Dublin

Summary:

- Cattle access to watercourses resulted in a significant increase in: deposited bed sediment, *E coli* concentrations, and accumulation of phosphorus in sediment.

  These phosphorus reservoirs can represent a source of phosphorus to waters through release into the water column.

- Improvements in water quality parameters due to cattle exclusion from watercourses were particularly apparent in relation to bed sediment mass and macroinvertebrate community health. Exclusion of cattle from watercourse improved the quality of environmental indicators over the short and long terms. Levels of deposited stream sediment and concentrations of phosphorus in the sediment were significantly reduced and improvements in macroinvertebrate communities were observed following 1 year of cattle exclusion. Improvements also persisted over a longer period of fencing, with significant improvements persisting for 10 years post fencing.

- Providing greater knowledge and support to farmers improves confidence in their own ability to undertake water protection measures such as fencing of watercourses.

- Fencing off watercourse to prevent bovine access is recognised as one of the "8-Actions for Change" within the Better Farming for Water campaign.

- Fencing and cattle exclusion alone may not be sufficient to restore the ecological condition of affected watercourses. Future policy could consider multiple mitigation measures that integrate with one another (see 8-Actions for Change). For example, fencing to exclude cattle could be coupled with targeted riparian buffer management to yield other environmental benefits such as biodiversity and carbon sequestration, thereby achieving maximum environmental improvements.

Other resources & online information

Teagasc Website: https://www.teagasc.ie/environment/biodiversity--countryside/research/completed-projects/cosaint/

Email: daire.ohuallachain@teagasc.ie

Teagasc
Agriculture and Food Development Authority

Targeted mitigation

Riparian buffers

Better Farming for Water
8 Actions for Change

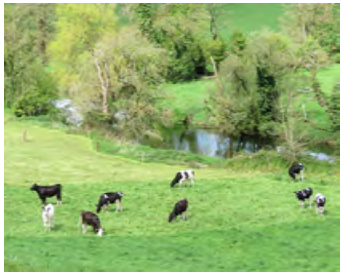
Main Points

Riparian buffers, adjacent to rivers, streams and field drains, are key locations for mitigation measures to improve water quality.

Riparian buffers can help 'break the pathway' between source (e.g. phosphorus & sediment) and river.

Narrow linear grassy margins can be ineffective for subsurface flows and aggressive surface runoff (see image).

Targeting buffers based on soil information, flowpaths, and existing knowledge improves effectiveness.



Funding

The SMARTER_BufferZ project, ***Specific Management and Robust Targeting of Riparian Buffer Zones,*** was a five-year, inter-institutional project funded by the Environmental Protection Agency (EPA).

Take home messages

- **Wooded buffers are effective a delivering a range of ecosystem services (water quality, biodiversity, carbon storage).**
- **EPA maps (e.g. flowpaths, delivery points, see inset) can help target the right measure to the right places.**
- **'Break the pathway' measures should be considered, along with source reduction measures.**

Targeted mitigation: Riparian buffers

Specific Management and Robust Targeting of Riparian Buffer Zones SMARTER_BufferZ

Daire Ó'hUallacháin[1]
Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford;
Project partner: James Hutton Institute

Introduction:

Riparian buffers are patches of land adjacent to rivers, streams and field drains, and are key locations for targeting mitigation measures that aim to address water quality. Coupled with water quality benefits, riparian buffers have the potential to deliver a wide range of ecosystem services including providing habitats for biodiversity, managing flood threat, promoting carbon sequestration and providing aesthetic and recreational services.
When targeting riparian buffers, the Right Measure: Right Place approach needs to be considered.

Introduction:

- Riparian buffers can help 'break the pathway' between source (e.g. phosphorus and sediment) and river.
- Narrow linear grassy margins can be ineffective for subsurface flows and aggressive surface runoff (see image).
- Appropriately targeted wooded buffers can deliver multiple ecosystem services
- Targeting buffers based on soil information, flowpaths, and existing knowledge improves effectiveness.
- Identification of flow pathways (e.g. EPA PIP flow delivery paths) facilitates moving away from "fixed width" approaches for riparian buffer management, towards a more "location-specific" understanding and management (right measures: right place).
- Targeted use of mitigation actions such as riparian margins is recognised as one of the "8-Actions for Change" within the Better Farming for Water campaign.
- Targeted use of riparian margins alone may not be sufficient to restore the ecological quality of affected watercourses. Future policy could consider multiple mitigation measures that integrate with one another (see 8-Actions for Change).

Other resources & online information

Website: www.smarterbufferz.ie;

https://www.teagasc.ie/environment/water-quality/better-farming-for-water/

EPA PIP flow delivery paths https://gis.epa.ie/EPAMaps/Water

Riparian buffer measure selection tool https://measure-selection-tool.hutton.ac.uk/

Email: daire.ohuallachain@teagasc.ie

Teagasc
Agriculture and Food Development Authority

Targeted mitigation

Drainage ditches & Farm roadways

Better Farming for Water
8 Actions for Change

Main Points

Drainage ditches and roadways can act as sources and pathways for nutrients and sediment to enter waterbodies.

- Target risky ditch: farmyard connection
- Slow the flow: drops sediment and phosphorus
- Maintenance – P will build up over time

- Roadway sediment holds high concentrations of N and P
- Pathway – connectivity to nearby waterbodies
- Divert away from waterbodies

Funding

Department of Agriculture, Food and the Marine, and Teagasc

Projects: Road-Ready, Teagasc Heavy Soils Programme, SENSUS

Take home messages

- **Drainage ditches directly connecting farmyard to river pose greatest risk**
- **Roadway sediment contains very high concentrations of nutrients**
- **Need to select "right measure for right place"**

Targeted Mitigation: Breaking surface connectivity on farms – drainage ditches and roadways

Linda Heerey[1], Daniel Gyamfi Opoku[2], Lungile Sifundza[1], Paul J. Maher[2], Tomas Condon[2], Owen Fenton[1]; Karen Daly[1]; Patrick Tuohy[2]; John Murnane3.

[1]Teagasc, CELUP, Johnstown Castle, Co. Wexford; [2] Teagasc AGRIC, Moorepark; [3]University of Limerick

Summary:

Drainage ditches

- Drainage ditches are designed to move excess water away quickly from agricultural land to nearby rivers and lakes. However, they can potentially transport sediment and nutrients.
- In particular, drainage ditches which directly connect a farmyard to a river/lake pose the greatest risk for transporting nutrients.
- A range of in-ditch and pathway-control measures aim to mitigate against nutrient loss by breaking the pathway between the farm and the river/lake.
- In general, these measures aim to slow the flow of water so that the phosphorus and sediment being carried by the water is dropped, and to allow nitrogen to be attenuated.
- Very important that all measures are maintained and cleaned out, otherwise they risk becoming a source.

Farm roadways:

- Under the Nitrates Action Programme, water on farm roadways must not directly enter open drains or rivers/lakes.
- Sediment on roadways has been found to contain significantly high concentrations of nutrients all year round, and runoff from farm roadways can negatively impact water quality.
- Nutrient concentrations are high for all farm enterprises (i.e., beef, dairy and sheep).
- Particular areas of concern on farm roadways include the immediate area around the farmyard, and areas where livestock may be stalled (i.e., at junctions, bends).
- Connectivity can occur directly (e.g., runoff into drains, rivers, lakes etc.), or indirectly (e.g., farmyards).
- Mitigation measures aim to break connectivity between the source and watercourse, and a custom approach is best here.
- Examples include cambering road towards field (cross fall 1:25), concrete berms to direct runoff away from open waters, moving entry points to paddocks away from water course to reduce sediment/nutrient entering water course.

Other resources & online information

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

Acknowledgements: Thank you to Patricia Berry, Jessyca DeMedeiros, Brendan Healy, Simon Leach, Luis Lopez-Sangil, Linda Moloney Finn, Carmel O'Connor, and Wendy Pierce in Teagasc, Johnstown Castle for their assistance with laboratory sample analysis and creating figures for papers.

Minimising Nutrient / Sediment Loss from Farmyards

Teagasc Agriculture and Food Development Authority

Better Farming for Water 8 Actions for Change

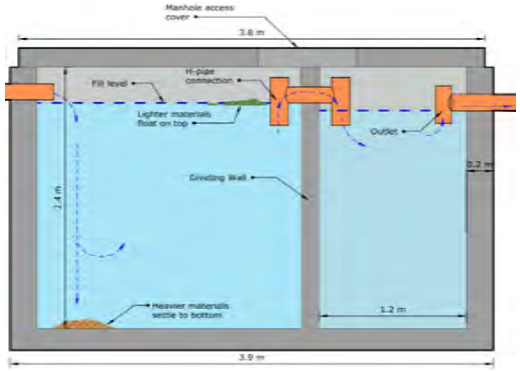
Main areas of concern

- Open silage pits & concrete aprons
- Animal & machinery routes

How to minimise losses

- **Collect & move waste silage to a manure store**
- **Regular sweeping of yards (store in a manure pit)***
- **Use a settlement tank & pond and filter discharge through topsoil**
- **Good house/yard keeping!**

*Aim to have spare capacity in soiled water and slurry tanks to cover the busy calving season



Minimising nutrient and sediment loss from farmyards

Tom Fallon

Farm Buildings & Infrastructure Specialist Teagasc

Introduction:

Farmers are doing a very good job in collecting faeces and urine from livestock because the vast majority of animals are now housed and fed under cover. Dairy farmers are in the process of meeting the requirement to have extended (31 days by 31.12.2024) storage of parlour washings. The runoff from the majority of farmyards enters drains or dykes that invariably connect with streams or rivers. The two main areas of concern are

- Open silage pits and aprons
- Animal and machinery routes in and around the farmyard

It is impossible to collect all the runoff from these areas. The runoff is predominantly rainwater but it can be contaminated with nutrients and sediment.

Silage pits and aprons:

- Reduce silage waste as far as possible: having adequately sized facilities, rolling the pit well etc. will all help see: https://www.teagasc.ie/publications/2024/todays-farm---mayjune-2024.php
- It is important to have available a dedicated farmyard manure store to take waste silage
- Clean open silage pits and aprons (along with animal and machinery routes) at regular intervals with a tractor mounted brush and bucket.

Settlement tank:

A settlement tank could provide a useful back up because there will be times (especially in the calving season) when it is not possible to keep yards clean. For example we expect a tank with internal dimensions of 3.5m X 2.5m and 2.7m deep will be adequate to intercept a yard area of 0.16 ha. It is important that this tank is emptied regularly and spread on land as per the rules pertaining to soiled water.

Other resources & online information

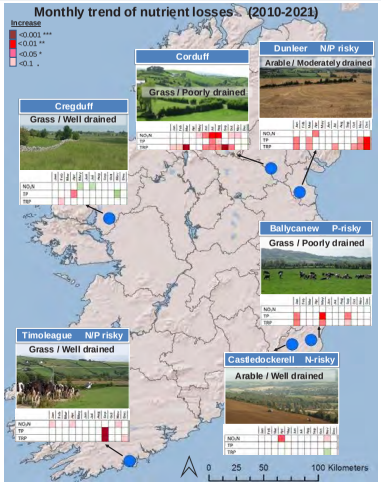
Size of settlement tanks based on 'wet volume' outlined in the reference below:

'Sediment control Practices- Sediment traps and basins', Minnesota Pollution Control Agency: https://stormwater.pca.state.mn.us/index.php?title=Sediment_control_practices_-_Sediment_traps_and_basins

Email: tom.fallon@teagasc.ie

Climate Change influence on N & P losses

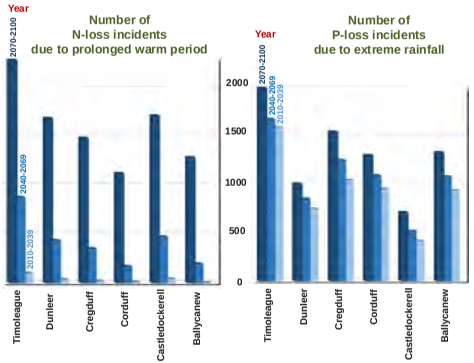
Main Points



Long-term high-temporal resolution data enable detection of any trends/slight changes in nutrient dynamics

Facilitate development of appropriate measures

More frequent extreme rainfall and droughts, predicted in climate change scenarios, will increase nutrient losses as we move toward the end of the century



Funding

- The Agricultural Catchments Programme (ACP), is funded by the Department of Agriculture, Food, and the Marine (DAFM).

Take home messages

- ✓Water quality is complex: It is influenced by farming and mediated by climate and physical conditions.
- ✓The response of nutrients to climate change is catchment-specific.
- ✓Climate-resilient measures are needed to be developed and implemented NOW.
- ✓Mitigation and adaptation measures should be tailored to the site and weather conditions.

Influence of climate change on nitrogen and phosphorus losses to water

Golnaz Ezzati[1], Per-Erik Mellander[1]

[1] Teagasc, Agricultural Catchments Programme, CELUP, Johnstown Castle, Co. Wexford

Summary:

- Inter-annual and inter-seasonal trends of nutrient and sediment losses to surface water, and the impact of climatic conditions on dynamics of the nutrients, were investigated in six ACP-catchments.
- Nutrient concentrations were driven by temperature, soil moisture deficit, and rain, and controlled by soil chemistry and drainage
- There was increasing inter-seasonal trends in the climatic drivers of nutrient and sediment losses
- Prolonged wet periods followed by heavy rainfall would trigger P losses.
- Prolonged warm periods followed by heavy rainfall would trigger N losses.
- According to projected climate change scenarios, the number of triggering events would increase significantly toward end of the century.
- Temperature and precipitation are increasing stepwise in moderate and extreme climate change scenarios. This would result in higher number of nutrient loss events that are triggered by extreme weather events.
- Mitigation and adaptation measures are needed to be developed and implemented now in order to prevent future flushes of nutrients to the waterbodies following to an extreme weather event.
- The measures should be tailored to the characteristics of the catchment and the weather conditions at different sites.

This work was completed as part of Water Future Project (EPA-Ireland) in collaboration with The Agricultural Catchments Programme (ACP).

Other resources & online information

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

Email: golnaz.ezzati@teagasc.ie; pererik.mellander@teagasc.ie

Soil Fertility Trends & Organic P distribution

Agriculture and Food Development Authority

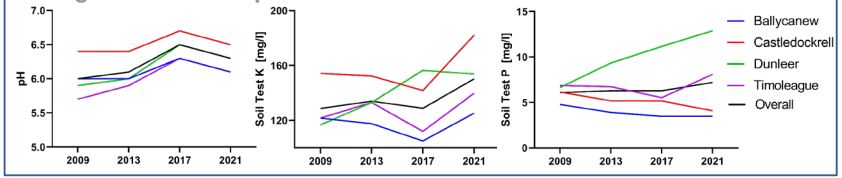
Better Farming for Water
8 Actions for Change

Main Points

Summary of soil sample data collected over 12 year period

across 4 agricultural catchments (grass & tillage) and >1500 fields

✓ Slight increase in pH ✓ Soil K increased ➢ Varied results for soil P



Soil Test Phosphorus (P)

- Soil P concentration varies significantly within & between farms and at catchment scale
- Organic manures are a key source of P on farms
- Slight increase (1%) in the number of sampling units with excessive P content (P index 4)!
- Fields with excessive P mainly found surrounding the farmyards

Funding

Funded by the Department of Agriculture, Food and the Marine (DAFM)

Take home messages

- Despite positive soil pH and K trends, there is still a lot of work to do to improve soil fertility and in relation to better on-farm nutrient management
- Exploit opportunities for better organic P distribution on farms. 28 – 61 % of the total catchment areas are below the agronomic optimum.
- Do not apply P (organic or inorganic) to index 4 soils as high risk of P loss

Soil Fertility trends and organic phosphorus distribution

Rebecca Hall

Teagasc, Agricultural Catchments Programme, CELUP, Johnstown Castle, Co. Wexford

Summary:

- Positive trends in terms of soil pH are reflective of the recent national research and advisory campaign in Ireland around the importance of liming.
- Significant variation of P status between catchments. For instance, Dunleer has an increase in fields with excessive P concentrations (soil index 4), mainly due to the spreading of poultry manure.
- Ballycanew, Castledockrell and Timoleague had a decline in the number of fields and areas with excessive P status (P Index 4) over the 12 year sampling period.
- Within individual catchments between 28 – 61 % had a P index 1 or 2. Which is below the agronomic optimum and a concern from agronomic perspectives.
- Large variation in soil fertility within farms. The variation of field soil fertility is often associated with historical nutrient management practices. Such as slurry application on fields close to the farmyard.
- There is scope to correct nutrient imbalances with better fertiliser management. Particularly with soil P, where on-farm redistribution of fertiliser P inputs should be applied to lower index soils. This has the potential to increase farm P use efficiency and decrease P loss risk to surface water.

Other resources & online information

Twitter: @ROADRUNNER_Project

Twitter: @ TeagascACP

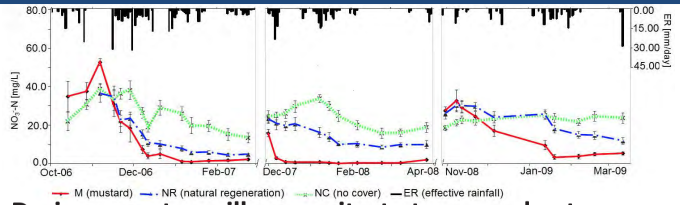
Websites: https://www.teagasc.ie/environment/water-quality/agricultural-catchments/ https://www.acpmet.ie/

Email: rebecca.hall@teagasc.ie

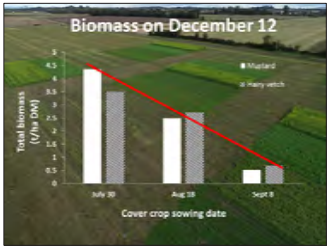
Cover Crops:
reducing nitrate losses from tillage soils

Better Farming for Water
8 Actions for Change

Main Points



- **Drainage water will carry nitrate to groundwater**
- **Sown cover crops can substantially reduce N loss**
- **Natural regeneration can also be effective**
  - need good early growth
- **Sowing date is important**
  - earlier is better to uptake nitrate before leaching begins
- **Species choice**
  - Faster growing species for later sowing



Attitudes and Perceptions

- Viewed positively – motivated by soil health & structure, feed source, following crop benefits
- Majority will continue to sow beyond lifetime of environmental schemes
- Agronomy R&D important
- Discussion groups, demos and farm walks – multiagency collaboration important

Take home messages

- **Overwinter vegetation is an effective tool to reduce nitrate loss**
- **Choose between good natural regeneration or a sown cover crop**
- **Early uptake of nitrate is key – establish covers early**

Reducing overwinter N loss from arable land using cover crops

Richie Hackett[1]; Bridget Lynch[2]; Karl Richards[2];

[1]Teagasc, CELUP, Oak Park, Co. Carlow; [2]Teagasc, CELUP, Johnstown Castle, Co. Wexford

Summary:

- Nitrate can be leached from arable land over the winter months
- Using living vegetation to reduce the amount of nitrate in the soil can substantially reduce nitrate leaching
- Both natural regeneration or a sown cover crop can be effective; sown cover crops are likely to give more consistent effects.
- Facilitating good growth is essential so early sowing (ideally before late August) is vital.
- Faster developing species should be considered for later sowing dates
- Avoid large additions of nutrients (e.g slurry, fertiliser) to cover crops where objective is to reduce leaching.
- Agronomic benefits of cover crops are variable and often small so tailor expenditure on cover crop establishment.
- Catch crops are viewed positively by farmers – they are motivated by potential positive impacts on soil health and structure, benefits for the following crop, improvements in water quality and as a feed source.
- Farmers are motivated to grow catch crops beyond the time horizon of environmental schemes and financial incentives.
- Participatory KT approaches are important – discussion groups and demonstrations and farm walks.
- Advisors are key sources of information for farmers – multiagency collaboration (research, advisory and industry) is important to expand the network available to farmers.
- More agronomy research is required.

Other resources & online information

Twitter: @ TeagascACP

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

Youtube https://www.youtube.com/watch?v=8P7nShiQLrc

Email: richie.hackett@teagasc.ie; bridget.lynch@teagasc.ie

Decreasing the Risk of N loss to Water

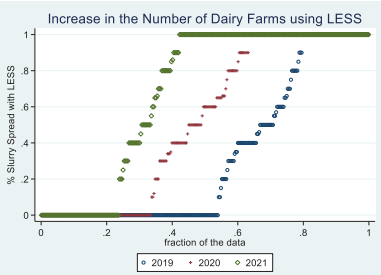
Nutrient Use Efficiency (NUE) & N Balances on livestock farms

N Balance (kg/ha N) indicates the *potential risk* of nutrient loss
NUE (%) highlights the proportion of N retained in the farm system

ACP Farms			
	NUE (%)	N Balance	% use of LESS
	2021	2021	2021
Dairy	32.7	151.5	92%
Cattle	20.2	79.8	41%

NFS Farms			
	NUE (%)	N Balance	% use of LESS
	2020-2022	2020-2022	2021
Dairy	26.7	166	67%
Cattle	26.3	55.3	25%

Two key Factors
✓ Reduce inputs
✓ Use LESS equipment



Funding

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine
Agricultural Catchments Programme
Phase 5 (2024-2027)

Take home messages

Decrease N Balance!

Key Drivers of NUE:

- **Using LESS = Increases NUE**
- **Lower N inputs = Increases NUE**
- **Apply N in optimum weather conditions using local met data to guide decisions**
  e.g. ACP.met

The role of innovation in nitrogen use efficiency on Irish dairy farms

Michele McCormack[1]; Bridget Lynch[2]

[1]Teagasc, Athenry, Co. Galway; [2] Teagasc, CELUP, Johnstown Castle, Co. Wexford

Summary:

- Using Teagasc National Farm Survey data for a sample Agricultural Catchment Programme (ACP) farms, regression analysis revealed a number of factors that have an effect on Nitrogen balances and Nitrogen Use Efficiency (NUE) at farm Level.
- A comparison of nationally representative farms within the NFS and ACP farms show that, on average, ACP dairy farms have a higher NUE than the national average and are applying almost all slurry with LESS (92%).
- The results of the regression analysis indicate that a significant factor influencing (NUE) in livestock (Dairy & Cattle) systems is the reduction of inputs. This finding suggests that lowering the amount of nitrogen inputs, such as fertilizers and other nitrogen-rich materials, can lead to more efficient use of nitrogen within farming systems. By optimizing input levels, farmers can improve NUE, potentially reducing environmental impact and enhancing the sustainability of agricultural practices.
- Results also show that Low Emission Slurry Spreading (LESS) equipment is significantly beneficial in improving NUE all farms. This practice ensures that more nitrogen remains available in the soil for plant uptake, thereby enhancing Nitrogen Use Efficiency (NUE). By using LESS equipment, farms can reduce nitrogen losses to the atmosphere, which typically occur through volatilization when slurry is applied using traditional spreading methods. As a result, a greater proportion of the applied nitrogen is retained in the soil, making it available for crops to absorb and utilize. This not only improves crop yield and growth but also minimizes the environmental impact of farming by reducing nitrogen emissions and potential contamination of water bodies. The uptake in LESS has increased in the last number of years and in 2022 over 75% of dairy farms are using this method.

Other resources & online information

Reports: Buckley, C., Donnellan, T., Dillon, E., Hanrahan, K., Moran, B., & Ryan, M. (2022). Teagasc National Farm Survey 2022Sustainability Report. Athenry, Co., Galway, Ireland.

Mellander, P.E., Lynch, M.B., Galloway, J., Žurovec, O., McCormack, M., O'Neill, M., Hawtree, D. and Burgess, E., 2022. Benchmarking a decade of holistic agro-environmental studies within the Agricultural Catchments Programme. Irish Journal of Agricultural and Food Research, 61(1), pp.201-217

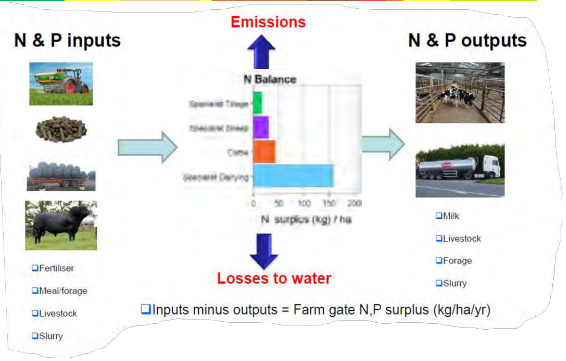
Email: bridget.lynch@teagasc.ie; michele.mccormack@teagasc.ie

Grazing Management to reduce N & P losses

Main Points

Additional steps needed to improve water quality

- Reseed unproductive swards to grass+clover @10-15%/yr
- 100% of farm area @ optimal soil fertility (pH, P, K)
- Know your numbers: Total N and P surpluses
  - ✓ Appropriate stocking rate to match grass growth
  - ✓ Reduce amount and crude protein content of ration
  - ✓ Use N within soiled water (4 units N) and slurry (9 units N)
  - ✓ Apply sulphur on free draining soils (15 units/acre = grazing)
- Reduce losses
  - ✓ Use min-till soil cultivation methods (Avoid Autumn reseeding)
  - ✓ Adhere to slurry and fertiliser closed periods & buffer margins
  - ✓ LESS & Protected Urea



Take home messages

- ✓ Simplified farm nutrient plans required to improve nutrient efficiency
- ✓ Increase soil fertility & clover in swards
- ✓ Reduce use of purchased N and P

Grazing management practices to reduce nitrogen and phosphorus losses to water

Brendan Horan[1]; William Burchill[2]; Tomas Condon[1]

[1]Teagasc, Moorepark, Co. Cork; [2] University College Cork

Summary:

To achieve desired improvements in water quality, additional steps are needed to reduce nutrient losses from Irish farms which negatively impact on surface and groundwater quality. This impact is linked to biophysical landscape characteristics (e.g. soil types, slope, and climate) and land management factors (e.g., land use, fertiliser, slurry, effluent, stocking rates) culminating in nitrogen (N) and phosphorus (P), sediment and faecal bacteria losses from land to water. In response to such losses, the development of simplified farm nutrient plans to improve nutrient efficiency is urgently required and should include the following:

- The identification of farm specific point source risk hazards. Farmyard infrastructure makes a significant contribution to agricultural nutrient load management. Based on a farmyard assessment of critical infrastructure, a plan of farm infrastructure improvement can be developed including requirements for animal housing and management, nutrient storage, separation of clean and soiled water, design of roadways and exclusion fencing.
- Total N and P movements within farms can be measured and quantified to describe the net surplus by difference between inputs to and outputs from the farm system. Previous studies have indicated that between 50 and 80% of calculated N and P surplus can result in leaching, runoff or atmospheric emissions. These balances can be used to determine nutrient use efficiency of different farms and thus set efficiency targets, guide future farm management decisions and monitor the effect of management changes over time.
- Reseeding underproductive swards; 10-15% of the lowest productivity pastures should be reseeded each year to high pasture profit index (PPI) ryegrass varieties and medium leaf size white clover using min-till cultivation methods in spring to increase pasture production and to aid in the establishment of clover.
- Soil fertility – target to achieve optimal soil fertility, i.e. pH 6.3 to 6.5 and P and K index three, across the farm. A pH of 6.5 to 6.7 can be targeted to promote white clover establishment. Application of P fertiliser and slurry should be avoided on P index four soils to reduce the risk of P loss. Correcting soil fertility and sulphur application can yield up to 2 t of additional pasture annually thereby reducing total purchased feed requirements and increasing N use efficiency on grassland farms.
- Use of protected urea fertilisers – using fertilisers with urease inhibitors can significantly reduce gaseous emissions from grazing systems, thereby reducing fertiliser N application requirements.
- Additional mitigations such as on/off grazing during high-risk periods for leaching, feed additives and the incorporation of plantain within grazed pasturesarecurrentlyunder investigation which may also reduce N losses from farms in the future.

Other resources & online information

Email: brendan.horan@teagasc.ie; wburchill@ucc.ie; tomas.condon@teagasc.ie

Improving nutrient application timing decisions with Remote Sensing

Teagasc Agriculture and Food Development Authority

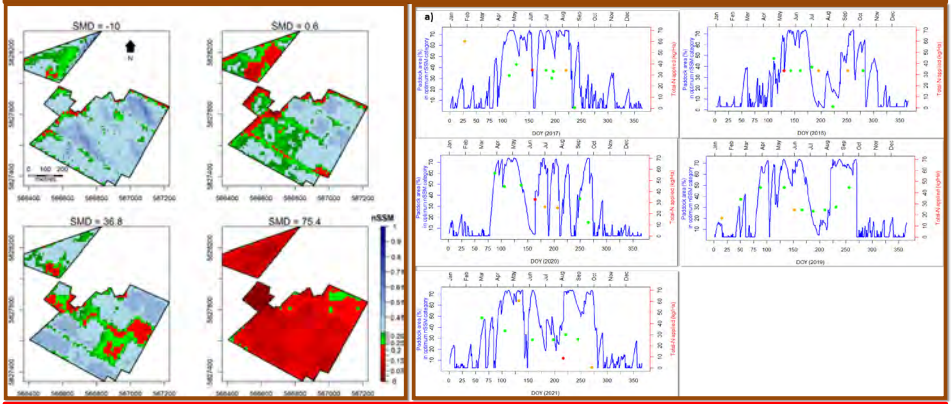
Better Farming for Water 8 Actions for Change

Introduction

- NAP sets out regulations for minimising risk of nutrient (N&P) pollution to water
- Optimum utilisation of applied fertiliser can occur when suitable soil moisture conditions are present
- Combined Soil Moisture Deficit (SMD) and Sentinel-2 derived approach to provide info on soil moisture levels

Funding: Teagasc Walsh Fellowship & Vista Milk SFI Research Centre

Approach



Take home message

- High-resolution soil moisture information crucial for decision support
- Adhering to simple rules & dates for Nutrient application decisions may not always be compatible with actual soil conditions on farms

Remote sensing can improve fertiliser application timing decisions

Rumia Basu[1]; Owen Fenton[2]; Asaf Shnel[1]; Eve Daly[3]; Patrick Tuohy[1]

[1]VistaMilk SFI Research Centre, Moorepark, Teagasc; [2] Teagasc, CELUP, Johnstown Castle, Co. Wexford; [3]Earth and Ocean Sciences, School of Natural Sciences, University of Galway

Summary:

- Soil moisture in Ireland is commonly expressed as Soil Moisture Deficit (SMD), which is only a temporal estimate of soil moisture conditions.
- Knowledge of spatial variability in soil moisture regime is crucial for farm management.
- High-resolution normalised surface soil moisture (nSSM) at the farm level was estimated using Sentinel-2 imagery, producing maps of surface soil moisture at 10m resolution.
- Combining SMD and nSSM, thresholds in soil moisture (SMT) were defined which identified areas on farm for safe trafficability and optimum crop growth.
- SMT and SMD conditions were used to analyse nitrogen (N) application decisions to identify conditions where N uptake may have been poor
- Proof of concept for improved decision support system for Irish farms with respect to nutrient utilisation and overall farm management.

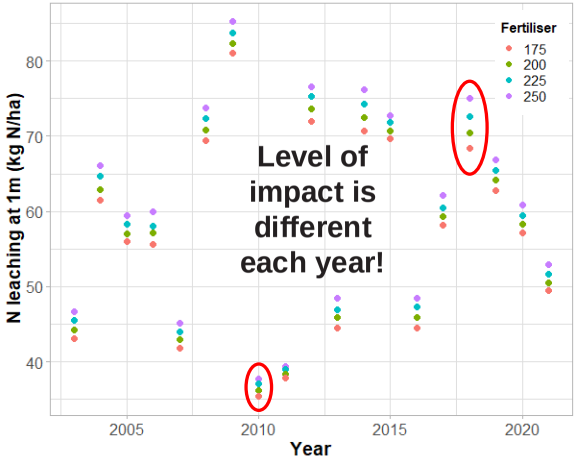
Other resources & online information

Email: rumia.basu@teagasc.ie; owen.fenton@teagasc.ie; patrick.tuohy@teagasc.ie

Dairy farm management and N leaching

Impact of Weather x N Fert. level

The MoSt grass growth model and a whole farm model explored how year, N fertiliser level and N leaching interact*



Precision fertiliser application reduces risk, especially on the worst years!

Be smart with fertiliser application!

Do **NOT** spread fertiliser when:

- Heavy rain is forecast
- Soil temperatures are below 5°C
- Grass growth predictions are low due to drought conditions

Take home message

- Weather variability has the biggest impact on N leaching
- Increase in farm N surplus leads to greater risk of N leaching
- Fertilise only when grass can use it!

Nitrogen management measures for better water quality outcomes on dairy farms

Elodie Ruelle[1]; Garima Lakhanpal[2],[3]; Owen Fenton[2], Brendan Horan[1], Karl Richards[2], Donal O'Brien[2]

[1]Teagasc, Moorepark, Co.Cork; [2]Teagasc, CELUP, Johnstown Castle, Co. Wexford; [3]University of Waterloo, Canada

Summary:

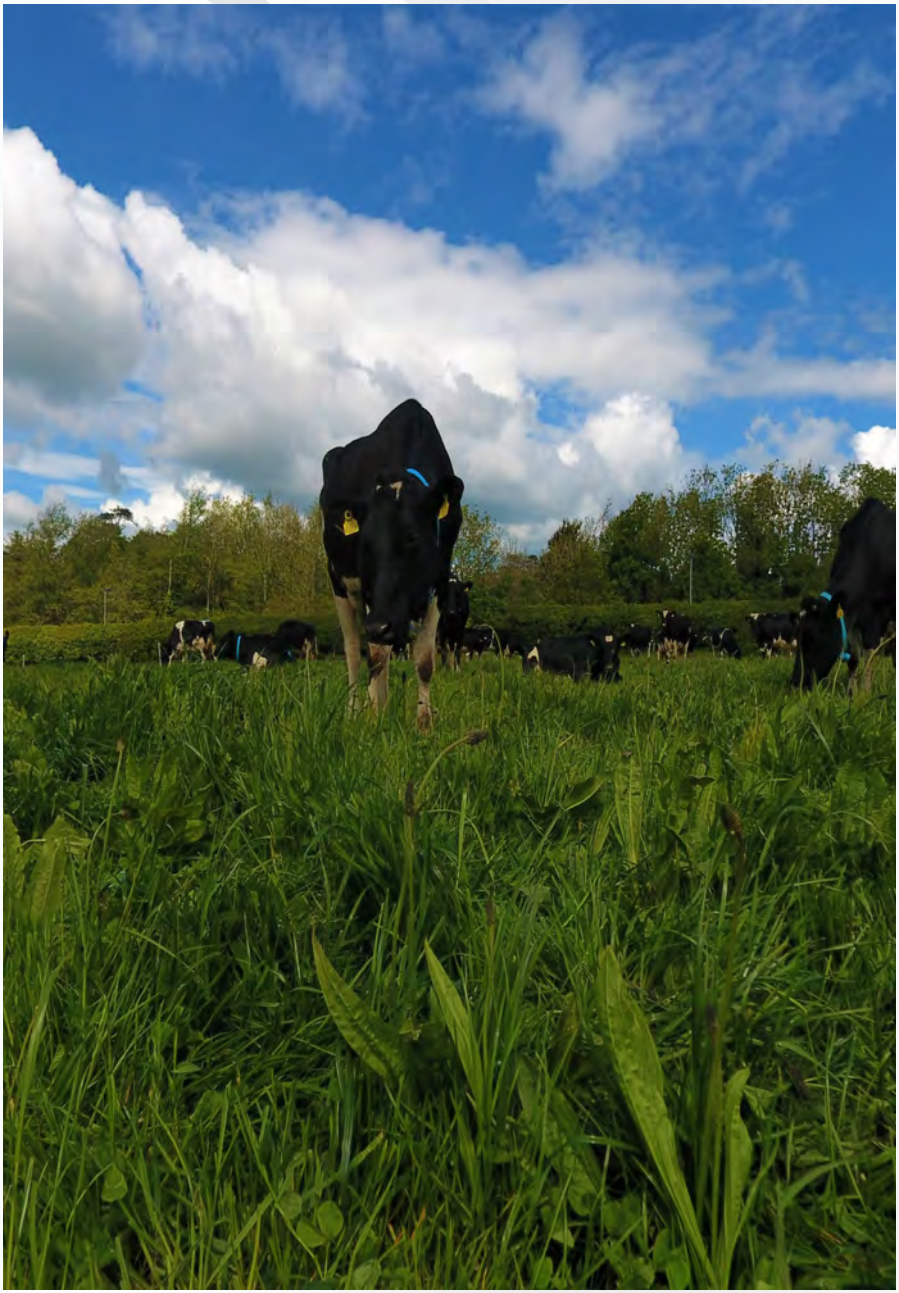
- The Department of Agriculture, Food and the Marine (DAFM) requested Teagasc to model the impact of a number of farm nitrogen mitigation measures so as to guide policy on the most effective current and future actions to deliver the catchment-based nitrate load reduction calculated by the EPA in 2021.
- Two models were applied to simulate nitrogen mitigation measures, MoSt GG/PBHDM and €riN. The MoSt GG/PBHDM is a dynamic mechanistic model that simulates a range of physical characteristics with a daily time step. The €riN model is a budgetary simulation model operating at a monthly time step.
- For both models, the expected impact of reduced chemical N on N leaching was similar. Using the MoSt GG/PBHDM model, decreasing chemical N, at an organic N level of 250 kg of N/ha, from 250 kg/ha to 225 kg/ha, (-10%), 200 kg/ha (-20%) and 175 kg/ha (-30%) resulted in a reduction of N leaching by 1.3 kg/ha (2.1%), 2.7 kg/ha (4.4%) and 3.9 kg/ha (6.4%) respectively. The equivalent reductions in N leaching using €riN were 2, 4 and 6 kg/ha, respectively.
- Similar to the reduction in chemical N, both models showed a similar impact of a reduction of organic N/ha (stocking rate) on nitrogen leaching. Using the MoSt GG/PBHDM model, reducing organic N/ha from 250 kg to 230 kg (8% reduction) and 250 to 220 kg (12% reduction), at a chemical N application of 250 kg N/ha, was computed to reduce N leaching by 1.5 kg/ha (2.5%) and 2.2 kg/ha (3.6%) respectively at 1m depth. The corresponding reductions using the €riN model were 3 and 4 kg/ha, respectively.
- While different management strategies lead to a reduction in N leaching, the biggest driver of variability in N leaching was the weather.

Other resources & online information

Reports: Shalloo L., Ruelle E., Richards K., Hawtree D., O'Brien D., Wall D., O'Donovan M. Hennessy D. and Dillon P., 2023 "The Impact of Nitrogen Management Strategies within Grass Based Dairy Systems"

Dillon P., Shalloo L., Murphy D., O'Brien D., Richards K., O'Donovan M. and Ruelle E. 2021 "The Impact of Nitrogen Management Strategies within Grass Based Dairy Systems"

Email: elodie.ruelle@teagasc.ie ; donal.mobrien@teagasc.ie; garima.lakhanpal@teagasc.ie

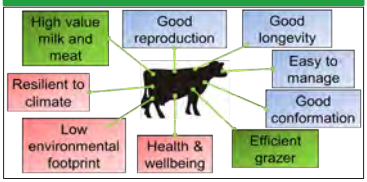


Livestock Systems

FARMING FOR A BETTER FUTURE

Sustainable Breeding for

Cow of the future



Selecting cows for dairy AI

Animal Group	Num of Cows	Milk Kg	Fat %	Prot %	Surv%	CI Dwys	Milk	Fertility	Carbon	Calv	Beef	Maint	Mgmt	Health	EBI €
Cows with EBI	141	101					€ 76	€ 104	€ 0	€ 41	€ 0	€ 4	€ 1	€ 3	€ 230
Missing EBI*	0	12.0	0.14		2.8										
Total Cows	141	10.3	0.12		-5.5										

	Herd Average	Expected %	After Selection	Expected %
EBI	230		**274**	
Protein %	0.12	3.82	**0.15**	**3.92**
Fat %	0.14	4.50	**0.20**	**4.73**

Use the technology

- ✓ Genotyping
- ✓ Sexed Semen
- ✓ Milk Recording
- ✓ ICBF Reports
- ✓ Sire Advice

Implement a herd breeding plan

- Breeding decisions are not just about the bull
- Identify best cows and heifers for breeding to increase rate genetic gain
- Use a team high-EBI bulls with correct balance of traits
- Sexed semen - improve genetic merit of both dairy *and* beef offspring
- **Average of the best = €68 more profit/lactation**
- **Breed from the best, beef for the rest**

Dairy and Beef Production

Maximize quality of beef progeny

- Use **Dairy Beef Index (DBI)** to select beef AI sires
  - Combining beef and calving traits
- Higher Beef Index/Carcass Weight bulls increase **commercial beef value (CBV)** of calf crop
- High CBV calves perform well in calf-to-beef systems
- Use different Bulls for heifers and mature cows
- Use a team of beef bulls to minimise risk

Dairy		Minimum DBI Beef Sub Index to deliver:	
EBI Beef Sub-Index Rank	EBI Beef Sub-Index Value	4 Star CBV Calf	5 Star CBV Calf
Bottom 20%	-€18	>€90	>€130
Bottom 40%	-€9	>€82	>€120
AVERAGE	**-€5**	**>€78**	**>€116**
Top 40%	-€2	>€75	>€113
Top 20%	€2	>€71	>€110

Take home messages

- Use the breeding technologies available to your inform decision making
- Increase genetic gain through selection of females for dairy AI
- Maximise the CBV of your calves by selecting highest Beef SI possible while minimising calving risk

Sustainable breeding for dairy and beef production

James Dunne[1,2] , Stuart Childs[2]

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

Summary:

- Optimal breeding and reproductive programs contribute approximately half of the gains in performance for most herds.
- The Economic Breeding Index (EBI) is for selecting dairy cows and bulls for breeding dairy replacements, the Dairy Beef Index [DBI] is for selecting beef bulls to mate to dairy cows and the Commercial beef Value [CBV] is applied to genotyped calves as a measure of their beef value.
- Sexed dairy semen should be used to generate replacement dairy females from suitable high EBI cows to speed up herd genetic gain with the remainder of the cows mated to beef semen to increase the value of the resulting calves.
- Select a team of high EBI AI bulls from the ICBF dairy active bull list to breed your dairy herd replacements. Use the team of bulls equally with no more than 15% of mating's to any individual bull to minimise genetic and fertility risks.
- To ensure saleable, profitable, and sustainable dairy-beef cattle are generated, use a team of beef AI bulls from the ICBF Dairy-Beef Active bull list. It's recommended to firstly select bulls with a calving difficulty percentage range suitable for the females being mated (i.e., first calvers, second calvers, mature cows), and then select bulls with the highest Beef sub-index value.
- The commercial beef value (CBV) of calves' links with the dairy-beef index incentivising dairy farmers to generate valuable calves for the beef industry..

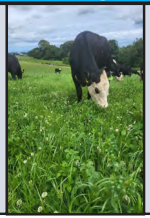
Other resources & online information

Email: james.dunne@teagasc.ie; stuart.childs@teagasc.ie

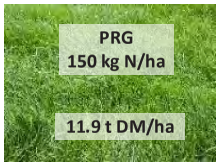
Efficient Dairy-Beef Heifer systems

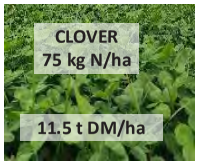
Heifer systems

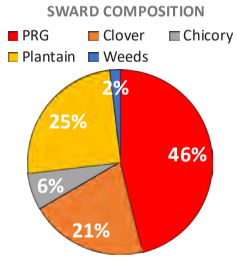
✓Ability to finish off grass
✓Younger finishing age

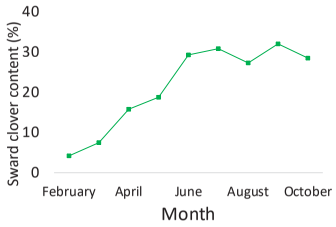


× Fail to meet minimum carcass spec
× High dropout rate of farmers purchasing calves









Physical, financial and environmental performance

	PRG	CLOVER	MSS
ADG (kg/day)			
First grazing season	0.61	0.62	0.79
Second grazing season	0.81	0.92	0.87
Age (months)	19.6	19.2	19.2
Carcass weight (kg)	243	250	249
Carcass conformation	O=	O=	O=
Carcass fat	3=	3=/+	3=/+
Net margin (€/ha)	950	1097	1050
GHG emissions (kg CO_{2e}/kg carcass)	12.37	12.91	12.88

Take home messages

- Incorporating clover or clover + herbs into swards can:
  - Improve animal performance
  - Increase carcass weight
  - Reduce fertiliser and concentrate inputs

Efficient dairy-beef heifer systems

Ellen Fitzpatrick[1], Paul Crosson[2], Rioch Fox1 and Nicky Byrne[2]
[1]Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford
[2]Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

Summary:

Despite a lower carcass weight potential of heifers compared to steers, grass-based dairy-beef heifer systems have the potential for very high carcass output/ha due to increased numbers of animals finished at younger ages from pasture, thus eliminating or reducing the need for an indoor finishing period. Carcass output, the level of inputs required and profitability can be optimised by grazing highly productive and high nutritive value pastures. Clover and herb-rich swards have many benefits including sward nutritive value, animal performance, DM production and biological nitrogen fixation. With chemical N representing one of the most expensive inputs in a grass-based system, reducing our reliance on this vital to improve the viability of dairy-calf to beef systems. Grass-clover and multispecies swards can produce similar DM yields to that of a PRG-only sward, despite receiving reduced chemical N fertiliser, thus reducing the N input requirements, representing a significant saving for input costs, and furthermore improving profitability for farmers.

The objective of the study was to evaluate the physical and financial performance of early-maturing breed dairy-beef heifers consuming pastures based on PRG, PRG and clover, or multi-species swards (MSS). In 2021 and 2022, 105 and 108 dairy × beef heifer calves, respectively, were purchased at approximately 20 weeks of age and were assigned to one of three pasture treatments: 1.) PRG-only, receiving 150 kg total N/ha/annum, 2.) CLOVER (red and white; Trifolium repens and Trifolium prantense), receiving 75 kg total N/ha/annum, and 3.) MSS (PRG, red and white clover, plantain (Plantago lanceolate), and chicory (Cichorium intybus)) swards receiving 75 kg total N/ha/annum. The sire breeds were Hereford and Angus and all progeny were from Holstein-Friesian dams. The calves were balanced across treatments based on breed, date of birth (mean 16 Feb), and live weight (mean 159 kg at arrival on farm). Each pasture type had its own independent 'farmlet' of 10 ha. All treatments were stocked at 2.5 LU/ha and produced 182 kg organic N/ha.

The PRG, CLOVER and MSS pastures produced similar DM yields of 11.9, 11.5 and 11.4 tonnes of DM/ha, respectively. Over the entire grazing season, the average clover content (red and white clover) was 22% and 21% for the CLOVER and MSS pastures, respectively. Despite an additional application of 75 kg N/ha to the PRG treatment compared to the CLOVER and MSS treatments (i.e. 150 vs. 75 kg N/ha), the similar annual DM yields for the three pasture types implies that the inclusion of legumes and improved species diversity can reduce the need for chemical N application. This is a huge benefit in terms of reducing costs and the environmental impact of dairy-beef production. Overall, a greater number of heifers were slaughtered off pasture for the CLOVER and MSS treatments, compared to the PRG treatment (86 vs. 75 vs. 68%). Thus, the indoor finishing concentrate requirement was lower for the CLOVER (25 kg) and MSS (34 kg) treatments compared to PRG (62 kg), which represents a significant saving in costs associated with feed and housing. Despite more PRG heifers requiring housing and higher concentrate inputs to get to a fat score of between 3- and 3+, they were still significantly leaner than CLOVER and MSS heifers, being half a fat grade lower. The inclusion of clover or clover+herbs can generate an additional €100 to €150 net margin/ha, through improved animal performance and lower input costs, offering farmers an opportunity to improve efficiency, while also striving to meet sectorial climate targets.

Johnstown Castle Dairy-Beef research

Introduction

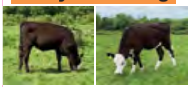
- Limited research on dairy-beef heifer systems
- Potential to increase animal performance from fewer inputs
- 120 heifers per year
  - 60 early-maturing (AA, HE)
  - 60 late-maturing (BB, LM)

Measurements

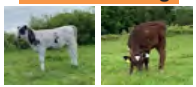
- Animal performance
  - Growth, intake, CH_4, carcass
- Herbage
  - Production, composition, quality
- Farm system modelling
  - Financial and environmental

System design

Early-maturing



Late-maturing



Serial finishing arrangement

17-month	19-month	21-month
		

2023 born heifers

Breed	CBV (€)	DOB	Turnout (kg)	Housing (kg)	Turnout 2nd season (kg)
AA	90	28/2	115	182	293
HE	84	20/2	125	199	308
BB	135	24/2	114	187	284
LM	142	18/2	120	193	299

Take home message

- ✓ Late-maturing heifers of significantly higher CBV, however will this be expressed in this system at young ages?
- ✓ Inclusion of legumes and herbs in grazing swards increasing animal performance from lower inputs

Developing sustainable production blueprints for dairy-beef heifers

Pauric Coleman[1], Ellen Fitzpatrick[1], and Nicky Byrne[2]

[1]Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford
[2]Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath

Summary:

Emissions from Irish agriculture must reduce by 25% by 2030 under national and European legislation. This targeted reduction is to be achieved through a range of actions, which include a reduction in the slaughter age of beef cattle by 3-3.5 months and reducing chemical N use by 20%. Currently approximately ~60% of prime cattle slaughtered originate from the dairy herd. Nationally dairy-beef heifers are finished at approximately 25 months of age on average, with a carcass weight of 280 kg, significantly older than that achieved in pasture-based research systems and high performing commercial farms. A recent study completed at Teagasc Grange clearly demonstrate the potential of high Commercial Beef Value (CBV) dairy-beef steers to support increased animal performance, and profit, while lowering carbon footprint of beef produced over low beef merit animals. The use of late-maturing beef sires on the dairy herd can significantly increase the CBV of resulting progeny compared to early-maturing breeds. However there is little information comparing early and late-maturing cattle of high CBV within a pasture-based heifer finishing systems of significantly reduced slaughter age. Recent research from Teagasc Johnstown castle has shown the benefits of including clovers and herbs in the diets of early-maturing heifers to improve carcass and system performance at 19 months of age. Including clover and herbs into grazing swards improves sward nutritive quality, increasing animal performance and intake, and reduces the need for chemical N inputs.

A new study began in 2023 to investigate the interactions between animal maturity and pasture type at different finishing ages Heifer calves from Holstein Friesian cows mated to Early (Angus or Hereford) and Late (Belgium Blue and limousine) maturing sires were purchased at ~21 days of age. Calves were selected from sires which ranked highly on the Dairy Beef Index (DBI), and that were in the top 20% of their respective breed on the beef sub-index of the DBI. Upon arrival, all calves are fed milk replacer mixed at 12.5% solids twice daily. Initially calves are fed 6L/day up to 30 days of age, at which milk volume is reduced to 4L/day up to weaning at 90 kg live weight. Reducing milk volume encourages concentrate intake, labour and cost while maintaining calf performance. Calves are offered ad-lib access to concentrates and straw throughout the rearing phase. Once weaned calves are turned out to pasture where they receive concentrates for the first two weeks, gradually reducing from 2 kg/day until on a pasture only diet. Heifer calves once weaned from concentrate are then assigned to one of three pasture treatments 1) PRG-only receiving 150 kg N/ha, 2) PRG + clovers (red and white) receiving 75 kg N/ha, and 3) MSS (PRG, red and white clover, plantain and chicory) receiving 75 kg N/ha. Calves assigned to each pasture treatment are balanced for breed, DOB, weight, and sire. All animals will be finished in a serial finishing arrangement at 17, 19 or 21 months of age. Both the 17 and 19 month groups will be finished from a pasture-only diet, while the 21 month group will be rehoused for a 60 day finishing period.

Detailed animal performance measures which included, growth, fat and muscle deposition, skeletal development, intake (indoor and outdoor), methane emissions, feeding behaviour and carcass and primal cut yield and quality, will be measured from both maturities across sward types. Throughout each of the year's herbage production and utilisation, sward composition and nutritive value will be measured from each pasture type. A full farm system analysis will be performed to establish the contribution of pasture type, animal maturity and finishing age to complete farm economic and environmental performance. This will identify the optimum blueprint for sustainable dairy-beef heifer production at young slaughter ages and low chemical N inputs.

Other resources & online information

Email: ellen.fitzpatrick@teagasc.ie; nicky.byrne@teagasc.ie

Grange Dairy-Beef research update

Teagasc Agriculture and Food Development Authority

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

Background

- 58% of carcasses processed are of dairy origin
  - ➢ More animals failing to meet carcass specifications

"Conventional" Grass-only

"Supplemented" 4 kg concentrate July onwards

High CBV
4 - 5 ★
CBV = €95

Low CBV
1 - 3 ★
CBV = €61

Holstein Friesian (HF)
High EBI sires
CBV = € - 1

	Conventional			Supplemented		
	High CBV	Low CBV	HF	High CBV	Low CBV	HF
Finishing age (mths.)	21.1	21.4	23.6	19.8	19.8	23.4
Carcass wt. (kg)	314	306	311	310	284	328
Carcass conf.	O=/O+	O=	P+/O-	O+	O=	O-
Carcass fat	3+/4-	3+	3+	4-	3+	3+/4-
Lifetime ADG (kg/day)	0.91	0.88	0.82	0.92	0.86	0.85
Net profit (€/head)	459	382	269	389	280	187
Net profit (€/ha)	1349	1187	747	1337	1042	519
kg CO_{2e}/carcass kg	12.8	13.0	15.4	11.5	11.9	15.5

Take home messages

- Substituting HF for **High CBV** beef steers = + **€710/ha** profit
- **High CBV** Angus steers + **€228/ha** profit vs Low CBV
  - (€1 CBV = €1.85 additional profit)

Profitable dairy-beef steer production

Nicky Byrne, Jamie O' Driscoll and Paul Crosson

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

Summary:

- High-CBV steers produce more "in-spec" carcasses and generate €238/ha higher net margin than Low-CBV steers
- On a 40ha farm High-CBV steers can generate an income of €54, 000, excluding land and labour charges, and farm subsidies

Introduction

Nationally dairy-beef steers are slaughtered at ~27 months of age during a third grazing season; however, with the policy ambition for younger finishing age, the economic efficiency of systems with lower finishing ages is of great interest.

Impact of CBV and feeding strategy on steer performance

The objective of this study was to assess the potential of the Commercial Beef Value (CBV) in predicting increased animal performance, as well as grass-based feeding strategies aimed at reducing finishing age. All calves on the study were born to Holstein-Friesian (HF) dams, and sired by Angus or HF sires. The Angus calves were subsequently split into two genetic groups, selected for being either 4-star or 5-star (High-CBV) or 1-star, 2-star or 3-star (Low-CBV) for CBV. This resulted in three genetic groups including HF. Within each genetic group, half of the animals were assigned to conventional management, receiving a grass-only diet during the second grazing season and being finished indoors from concentrates and grass silage (Conventional), and the other half received 4 kg of concentrates/head daily from the 1 July during the second grazing season until finished at pasture (Supplemented).

Overall, both Angus groups achieved a higher lifetime ADG than the HF steers. Finishing age was similar between the Low-CBV and High-CBV groups, indicating a similar 'fleshing' ability; however, High-CBV steers produced 18 kg more carcass than Low-CBV steers. In terms of overall market specifications, 73% of High-CBV steers, 53% of Low-CBV steers and 22% of HF steers met the requirements. Failure to meet overall carcass specification was primarily caused by low carcass weights for Low-CBV animals, and poor carcass conformation for HF steers.

Although carcass weight was similar to HF, High-CBV animals were finished ~3 months earlier, requiring only half the number of finishing days indoors, which represents a major saving in feed costs. Concentrate supplementation during the second half of the grazing season reduced finishing age of Angus steers by 1.5 months, which meant that an expensive indoor finishing period was avoided compared to their non-supplemented counterparts.

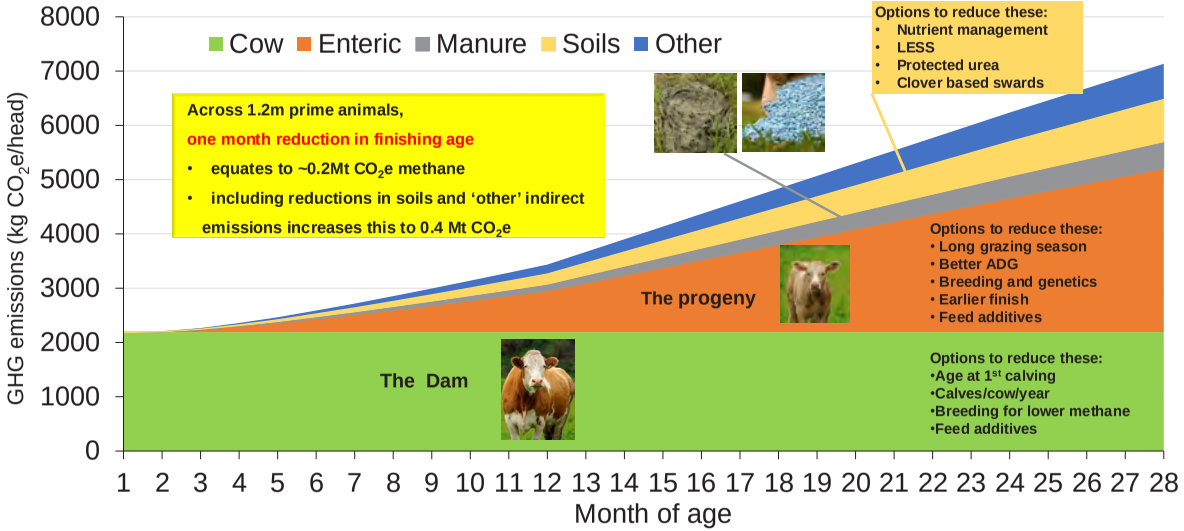
Conclusion

High-CBV steers generate more profit, and produce beef of a lower carbon footprint compared to Low-CBV and HF steers, regardless of management system.

Other resources & online information

Email: nicky.byrne@teagasc.ie; paul.crosson@teagasc.ie

Lifetime Greenhouse Gas Emissions - Does age matter?



Schematic for illustrative purposes depicts categories and approximate quantity of emissions

Beef-Quest - on a mission to reduce finishing age

Paul Smith[1], Mark McGee[1], Edward O'Riordan[1], Paul Crosson1, Bernadette Earley[1], Alan Kelly[2] and David Kenny[1]

[1]Teagasc, Grange Animal & Grassland Research and Innovation Centre, Dunsany, Co. Meath
[2]University College Dublin, School of Agriculture and Food Science, Belfield, Dublin

Summary

- Reducing the finishing age of the prime beef cattle population is a key deliverable as part of the national Climate Action Plan and Teagasc MACC.
- Research is underway to investigate key factors constraining lifetime live weight gain of cattle on commercial Irish farms.

Introduction

Reducing the mean finishing age of the 'prime' beef cattle population to 22-23 months of age, by 2030, is one of the main greenhouse gas (GHG) mitigation strategies for the Irish beef sector. Earlier finishing of beef cattle, not only has the potential to decrease the quantity of GHG emissions (predominantly methane – CH_4) an animal emits over their lifetime, but can be economically advantageous, by lowering total costs associated with rearing an animal, and thus is a key contributor to on-farm profitability. Since 2010, the average finishing age of the Irish prime beef cattle population has reduced by ~2 months, with minimal negative impact on the average carcass weight produced. For example, the average finishing age of suckler-bred steers has reduced by ~1 week/annum with a slight increase in average carcass weight. In spite of this, currently the national mean age at finishing is two-to-three months older than achieved on high-performing grass-based commercial and beef research farms. Reasons for this large variation in lifetime animal performance on Irish beef cattle farms is currently being investigated as part of Beef-Quest, a recently funded project by the Department of Agriculture, Food and the Marine (DAFM).

Beef-Quest

The recently funded Beef-Quest project, a collaboration between Teagasc, ICBF and UCD, will utilise data currently available within the industry, as well as new data generated from a large-scale on-farm study, to investigate the predominant animal nutrition, health and on-farm environmental factors, influencing animal-growth performance on commercial beef farms. Data generated from the project, will be utilised to determine both the environmental and economic benefits associated with the optimisation of animal nutrition, health and on-farm environment, and subsequently aid the identification of the most effective on-farm measures for reducing the finishing age of Irish beef cattle.

Other resources & online information

Email: paul.smith@teagasc.ie; david.kenny@teagasc.ie

Teagasc DairyBeef500 Campaign

Alan Dillon[1], Tommy Cox[2], Gordon Peppard[3], Fergal Maguire[4]

[1]Teagasc Advisory, Gortboy, Kilmallock, Co. Limerick
[2]Teagasc Advisory, Mohill, Co. Leitrim
[3]Teagasc Advisory, Kilkenny , Co. Kilkenny,
[4]Teagasc Advisory, Dunsany, Grange, Co. Meath

Summary:

- Compared to 2022, profitability of DairyBeef500 monitor farms increased by 3% in 2023, to €542/hectare (ha).
- Carcass weights decreased by 9.6 kg and 12.1 kg for dairy x dairy and beef × dairy steers, respectively, between 2022 and 2023.
- Finishing age reduced by 0.5 months for dairy steers, and 0.4 months for dairy-beef steers, between 2022 and 2023.
- Stocking rate remains the primary driver of profit on DairyBeef500 monitor farms. Exceeding €500/ha net profit is difficult for farms stocked under 170 kg organic nitrogen/ha.

Introduction

The Teagasc DairyBeef500 campaign began in 2021 and will run for an initial 5-year period. The campaign centres on a cohort of monitor farms located nationwide, which incorporate best practice in an effort to increase profitability in a sustainable manner. Additionally, the campaign organises a New Entrant Dairy Calf-to-Beef, five-day training course, which is in its second year. Thirty-eight students will have completed the course by the end of 2024. To maximise dissemination from the campaign, the DairyBeef500 team assist local Teagasc B&T advisors organise dedicated dairy-beef discussion groups and host open days in association with media outlets.

Profitability

The 15 DairyBeef500 monitor farms complete Teagasc E-Profit Monitors annually. Despite the very challenging weather conditions which prevailed in the 2023, profitability on the farms increased by 3% relative to 2022. The average net margin, excluding all subsidies, was €542/hectare (ha) in 2023 compared to €517/ha in 2022. During 2023 beef prices increased by 4% from €4.77/kg to €4.96/kg carcass weight. The excessive rainfall in 2023 resulted in delayed turnout to grass in spring and earlier housing in autumn. The shorter grazing season meant animal weight gain from grazed grass was reduced, and extra quantities of concentrates and silage were required instead. On a number of the monitor farms, the increased beef price in 2023 was offset by a lower carcass weight.

The net profit ranged from €47/ha (one of the new entrants) to €1459/ha (one of the established farms operating a high-output bull finishing system). Gross output across the programme farms averaged €3330/ha resulting in an average gross margin across the group of €1341/ha. Variable costs ranged from €1030/ha to €2798/ha with an average of €1990/ha for 2023, which is an increase of 1% compared to 2022 (Table 1). Feed and milk replacer expenditure increased by 7% despite the cost of inputs dropping from the inflated prices of 2022. Fertiliser expenditure decreased by 23% as result of fertiliser price dropping from historic highs seen in 2022. Contractor costs increased by 20% in 2023, mainly due to increased volumes of silage being harvested and extra slurry spreading costs resulting from prolonged housing periods.

Table 1. Mean variable costs (€/ha) on DairyBeef500 monitor farms: 2023 vs. 2022

Variable cost	2023	2022	% Change
Feed/milk/calf ration/forage	1187	1112	+7%
Fertiliser	288	354	-23%
Vet	128	125	+2.4%
Contractor	173	144	+20%
Other	214	178	+20%
Total	1990	1913	+4%

Fixed costs across the programme farms averaged €799/ha in 2023, an increase of 3% (Table 2). From 2022 to 2023, no major increases in individual fixed costs were recorded on programme farms. A number of large-scale investments such as buildings and machinery have been put on-hold due to rapid increase in cost of materials. It is expected these delayed investments will recommence in 2024 and beyond resulting in an increase in fixed costs to in excess of €1,000/ha on many of the farms.

Table 2. Mean fixed costs (€/ha) on DairyBeef500 monitor farms: 2023 vs. 2022

Fixed cost	2023	2022	% Change
Machinery running	137	136	n/a
Depreciation	162	153	+6%
Repairs/Maintenance	114	120	-5%
Land lease	125	121	+3%
Others	261	244	+7%
Total	799	774	+3%

Assessing the effect of stocking rate on the profitability of DairyBeef 500 farmers

The current target net margin for the DairyBeef 500 program is €500/ha, excluding direct payments. Many factors such as calf price and beef price at the date of sale will have a direct impact on the gross output and profitability of this enterprise; however, the main factor within the farmers' control affecting profitability of these systems is the stocking rate operated at farm level.

An analysis of the stocking rate of all DairyBeef 500 program farmers in 2023, showed that in order to meet the program target net margin, in general, stocking rate needed to at a minimum of 2.1 livestock units per hectare (LU//ha), equivalent to 167 kg organic N/ha. At this stocking rate, 70% of program farmers met the profit target, where only 15% of farmers below this stocking rate met it. Program farmers stocking rates ranged from 1.73 to 3 LU/ha or 136kg to 230 kg organic N/ha. Decreasing stocking rate by 10% from 2.2 LU/ha will reduce gross output per hectare by ~ €267/ha and further stocking rate reductions will have greater impact as can be seen in Table 3.

Table 3. Sensitivity analysis of stocking rate (livestock units (LU)/ha)) reduction on DairyBeef500 monitor farm output and profitability

Stocking rate reduction %	Stocking rate (LU/ha)	Gross output/ha	Gross output/ha reduction
0	2.20		
10	2.00	-€267	-€107
25	1.65	-€745	-€298

Challenges to dairy calf to beef enterprises going forward

To achieve net margins of >€500/ha, stocking rates of over 170 kg organic N/ha appear to be necessary. This means that these farms require a nitrogen derogation; however, some producers are concerned about the future status of Ireland's nitrogen derogation. If farm stocking rates are required to be less than 170 kg organic N/ha, the opportunity to obtain a net margin of €500/ha is reduced unless calf purchase prices reduce, beef prices increase and/or input costs reduce substantially. Given the new N allowances for cattle rearing systems, it will be necessary to achieve younger finishing ages to support high stocking rates, as the revised allowances for cattle >12 months have increased.

Grass

Grazed grass is the cheapest animal feed for beef production in Ireland. The cost per kg of live weight gain from grazed grass is approximately one-fifth that of that from an indoor silage and concentrate diet. Consequently, on DairyBeef 500 farms, the aim is to maximise weight gain from grazed pasture over an extended grazing season. The length of the grazing season has a big impact on the level of live weight gained from grass. In 2023, thirteen out of the fourteen farmers had cattle out by mid-February; however, weather conditions deteriorated in March, with many farms needing to rehouse cattle until early-April. In the autumn, all farms housed their cattle earlier than planned due to poor grazing conditions. The unfavourable weather in 2023 had a big impact on animal performance and costs, as cattle were indoors for longer.

Based on the group report from PastureBase Ireland, the monitor farms with over 20 grass measurements grew 10.6 t grass DM/ha in 2023. To support this level of grass production farmers used 161 kg N/ha across the year. Soil fertility across the farms has increased since the inception of the programme with a big emphasis on correcting soil pH in the last 12 months. Nevertheless, all farms still have at least 20% of the farm sub-optimal for soil fertility. Almost three-quarters of programme farms have incorporated white clover into their swards through reseeding and over-sowing and 40% of farms have established red clover silage swards to reduce N inputs and increase silage production and feed value.

Carcass performance on Dairybeef 500 farms

In dairy-beef systems, ensuring high levels of individual animal performance from arrival on-farm until finishing is key to maximising carcass output. Obtaining maximum carcass weight at a reduced age is one of the main drivers of profitability, while it will also reduce the carbon footprint of beef produced. Irish agriculture is obliged to reduce greenhouse gas emissions by 25% by 2030, as set out in the Climate Action Plan. One of the many strategies to achieve this target is the reduction in the finishing age of animals on beef farms by up to three months by 2030 relative to

2018. Slaughter performance for steers, heifers and bulls were analysed for 2022 and 2023 across all Dairy beef 500 farms. Variance was found between farms and between years.

Average carcass weight for dairy-sired steers declined by 9.6 kg between 2022 and 2023 (Table 4). Finishing age also reduced by 15 days to 24 months. Carcass conformation score did not change. Beef-sired steers followed a similar trend to dairy cross steers, with a 12.1 kg lighter carcass, a 12-day reduction in finishing age and similar carcass conformation for 2023 compared to 2022.

Table 4. Dairy and dairy × beef steer slaughter performance on Dairybeef 500 farms

Year	Carcass weight (kg)	Number	Conformation score	Slaugther age (months)	Price (€/kg)	Carcass value(€)
Dairy × Dairy Steers						
2023	298.0	863	O-	24.0	4.84	1441
2022	307.6	764	O-	24.5	4.63	1425
Difference	-9.6	+99	N/A	-0.5	+0.21	+16
Beef × Dairy Steers						
2023	299.3	243	O=	22.7	5.05	1511
2022	311.4	248	O=	23.1	4.84	1507
Difference	-12.1	-5	N/A	-0.4	+0.21	+3.7

Mirroring the performance of steers, average carcass weight for heifers was 5.3 kg lighter in 2023 than in 2022. However, this reduction in weight was not associated with a younger age. In fact, average slaughter age of heifers was one month older in 2023. Furthermore, carcass conformation score reduced by one grade from O+ in 2022 to O= in 2023.

Table 5. Beef × dairy beef heifer slaughter performance on Dairybeef 500 farms

Year	Carcass weight (kg)	Number	Conformation score	Finishing age (months)	Price (€/kg)	Carcass value(€)
2023	252.4	107.0	O=	21.5	5.20	1312
2022	257.7	205.0	O+	20.5	4.84	1247
Difference	-5.3	-98	-1 grade	+1.0	+0.36	+65

Bull carcass weight had the biggest drop, whereby on average they were 24.5 kg lighter in 2023 than in 2022. Again, similar to heifers, this reduction in weight was not associated with a younger finishing age, rather an increase in age of 20 days. Carcass conformation remained the same, with an average grade of O= recorded in both years.

Table 6. Dairy × dairy bull slaughter performance on Dairybeef 500 farms

Year	Carcass weight (kg)	Number	Conformation score	Slaughter age (months)	Price (€/kg)	Carcass value(€)
2023	289.4	308	O=	21.5	4.70	1360
2022	313.9	267	O=	20.8	4.60	1443
Difference	-24.5	+41	N/A	+0.7	+0.1	-84

Summary

The overall performance of cattle on the DairyBeef500 monitor farms dropped in 2023. This can be attributed to poor weather conditions leading to late turn out to pasture in spring and early housing in autumn. With a number of the farmers at a stocking rate close to 170 kg organic nitrogen, changes to the nitrogen excretion rates on males >12 months will mean a reduction in output from these farms otherwise these farms will require a nitrates derogation.

Johnstown Castle Winter-Milk Herd

Herd Profile

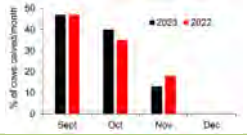
- Split-calving herd:
  - 90 autumn-calving cows
  - 50 spring-calving cows
- No cow recycled between seasons
- Same genetic selection criteria:

High fertility (>€100)	High milk solids (>35 kg)
Positive for milk kg	Functional cows

May, 2024	JC Aut.	JC Spr.	Nat. Ave.
EBI	225	240	178
Milk	80	68	52
Fertility	100	112	77
Carbon	-3	7	7
Calving	39	45	31
Beef	2	-5	-7
Maintenance	3	8	13
Management	1	0	1
Health	3	5	6

Autumn Calving & Fertility

- 10-wk breeding season starts 12th Dec
- Calving season starts 12th-15th Sept
- Mean calving date 8th Oct



5-year average 2020-24	JC Aut.	Target
21-d submission rate (%)	81	>90
Preg. rate to 1st service (%)	56	60
6-wk calving rate (%)	78	>80
10-wk empty rate (%)	13	<10
Calving interval (d)	370	<370
Replacement rate (%)	23	20-22

Cumulative Milk Production

5-year average 2019-23	JC Aut.
Milk yield (kg)	7,540
Fat (%)	4.52
Protein (%)	3.66
Milk solids (kg)	616
Body weight (kg)	604
Milk solids (kg/kg BW)	1.02
Concentrate fed (kg)	1,602

Take Home Messages

- Focus on high EBI cow that can also deliver from pasture
- Strict breeding management rules are critical
- Be mindful of concentrate feeding level

Pasture Management

Spring

- Turnout: ~1st Feb or earliest weather window

First rotation grazing targets	
End of Feb	33%
St. Patrick's day	66%
Early April	2nd rotation

- Short grazing bouts when needed, 2-3 hr after milking to help achieve grazing targets
- Winter forages adjusted based on grass supply & removed ASAP

Summer

- April–Aug: grass wedge

Summer grazing targets	
Pre-grazing yield (kg DM/ha)	1400-1600
Avg. Farm Cover (kg DM/ha)	600-700
Cover/LU (kg DM/LU)	160-180

- 1st cut silage: early, target high quality

Milking cow:	Dry cow:
72–76% DMD	64–67% DMD

Autumn

- Maximise pasture in diet and compliment with a high energy, 15% CP concentrate
- Freshly calved cows can struggle on heavy autumn covers

Autumn grazing targets	
Max pre-grazing yield (kg DM/ha)	1,800
Peak Avg. Farm Cover (kg DM/ha)	950
Area closed by early November (%)	75
First ensiled forages in diet	1st Nov
Closing Avg. Farm Cover (kg DM/ha)	650 (10th Nov)

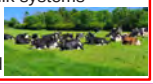
Pasture Production - 2023

- Covers measured weekly throughout the grazing season
- 174 kg chemical N/ha
- Reduced N on clover swards

Cumulative t DM/ha – Autumn herd	
Grazed	10.7
Silage	2.3
Total	13.0

Take Home Messages

- Grazed pasture drives margin in winter-milk systems
- Grazing targets for each time of year are essential
- Contingency - infrastructure & quality feed



Johnstown Castle winter-milk herd update: Increasing the sustainability of winter-milk

Aidan Lawless[1]; James Dunne[2]; Neil Maher[2]; Joe Patton[2]; Michael Dineen[2]

[1]Teagasc, CELUP, Johnstown Castle, Co. Wexford; [2]Teagasc, Moorepark, Co. Cork

Summary:

- The Teagasc Winter-Milk herd consists of 90 high-EBI (€225) Holstein Friesian cows
- The herd's calving interval is 370 days with a 6-week calving rate of 78%
- Over the last five years, the herd has averaged 7,540 kg of milk, 3.66% protein, 4.52% fat and 616 kg of milk solids with 1,600 kg of concentrate supplement (approximately 1,000 kg during winter-housing and 600 kg during the grazing-season)
- Strict breeding management rules (e.g. 10-wk breeding period and no recycling of cows between breeding seasons) ensures that the herd has an optimal calving pattern to maintain high feed efficiency, reduce annual feed costs and minimise the amount of surplus to contract milk sold during November to February
- At the Teagasc Winter-Milk farm, a strong emphasis is placed on maximising the proportion of high quality grazed pasture in the cow's diet
- Research has demonstrated that current grassland management tools provide a strong framework for winter-milk producers, subject to some slight adjustments
- During the autumn period, pre-grazing yield should be maintained below 1800 kg dry matter/ha, as the freshly calved cow can struggle to achieve adequate intake on heavy autumn covers
- Furthermore, a closing average farm cover of 650 kg dry matter/ha should be targeted to allow a greater opening farm cover in early spring

Other resources & online information

Teagasc National Winter-Milk Open Day 2023: https://www.teagasc.ie/animals/dairy/winter-milk/winter-milk-open-day/

Improving Profit and Sustainability on Winter Milk Farms - Key Management Practices: https://www.teagasc.ie/media/website/publications/2019/Booklet-2019---Improving-Profit-and-Sustainability-on-Winter-Milk-Farms.pdf

Email: michael.dineen@teagasc.ie; aidan.Lawless@teagasc.ie; james.dunne@teagasc.ie

Lower Carbon Footprint and

Context

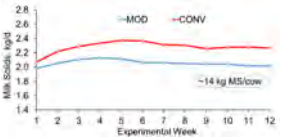
- National and European Union policy;
  - ➢ Reduce Agri. emissions by 25% by 2030
  - ➢ Increase tillage sector to 400,000 ha
  - ➢ Produce more native grown legumes and grains
  - ➢ Improve overall protein self-sufficiency
- EU currently imports **71%** of high-protein feed use ingredients
- Concerns:
  - ➢ GHG emissions and deforestation
  - ➢ Price volatility, food security and geopolitical disruptions
  - ➢ Food product marketability

Carbon Footprint and Protein Self-Sufficiency

- Imported protein ingredients typically higher C footprint and lower protein self-sufficiency
- Maize silage typically higher C footprint
- Indoor feeding experiment over 2 winters

Ingredient, kg DM/cow	CONV	MOD
Grass silage	4.5	13.5
Maize silage	9.0	-
Home-grown conc. *i.e. field beans & native barley*	2.5	7.0
Imported hi-pro conc. *i.e. soybean meal & maize*	4.5	-
Total DMI	20.5	20.5

	CONV	MOD
Milk yield (kg/d)	27.9	25.9
Fat (%)	4.67	4.58
Protein (%)	3.52	3.40
Milk solids (kg/d)	2.22	2.06



- MOD diet reduced milk production performance
- Number of potential causative factors (i.e. concentrate ingredients, maize silage exclusion)

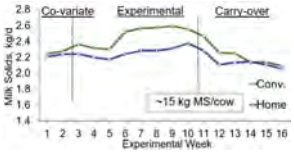
Higher Protein Self-Sufficiency

Replacement of Imported Protein Ingredients

- Isolate the protein source as the only difference between diets (i.e. same forages)
- 8-wk indoor feeding and 5-wk carry-over periods

Ingredient, kg DM/cow	Conv.	HG
Grass silage	7	7
Maize silage	7	7
Imported hi-pro conc. i.e. soybean meal & maize distillers	7	-
Home-grown conc. i.e. field beans & rapeseed meal	1.2	8.2
Total DMI	22.2	22.2

	Conv.	HG
Milk yield (kg/d)	30.5	28.6
Fat (%)	4.29	4.25
Protein (%)	3.57	3.50
Milk solids (kg/d)	2.38	2.20



- Home-grown protein ingredients reduced milk production
- Likely due to inadequate metabolizable protein/AA supply

Future Research

- Potential solutions to overcome inadequate metabolisable protein/amino acid supply;
  - ➢ Rumen-protected amino acids
  - ➢ Alternative base forages
  - ➢ Alternative hi-protein ingredients
  - ➢ Feed technological processing methods

Take Home Messages

- Home-grown diets can:
  - ➢ ↓ carbon footprint of our milk
  - ➢ ↑ EU protein self-sufficiency
  - ➢ Support the tillage sector
- However, reduced milk production performance was observed

The effect of lower carbon footprint and higher protein self-sufficiency winter-milk diets on milk production

Neil Maher[1]; Aidan Lawless[2]; James Dunne[1]; Joe Patton[1]; Michael Dineen[1]

[1]Teagasc, Moorepark, Co. Cork; [2]Teagasc, Crops, Environment and Land-use Programme, Johnstown Castle, Co. Wexford

Summary:

- During the winter-feeding period, the demand for high-protein feed ingredients increases because of inadequate protein supply from conserved forages.
- Currently, there is a major deficit in the supply of these ingredients, with the EU agricultural sector importing the majority of its requirements (~71%).
- Several experiments have been undertaken investigating the inclusion of home-grown or EU-grown protein sources (e.g. field beans and rapeseed meal) in Irish winter-milk diets.
- Initial life cycle assessment modelling indicated that carbon intensity per hectare and per kg of milk was reduced when cows consumed the home-grown protein ingredients but animal performance was reduced (~0.17 kg of milk solids/day) when compared with cows fed standard protein ingredients.
- The reduced performance was likely due to inadequate metabolisable protein/amino acid supply.
- It is important to note that the experiments investigated the full replacement of imported protein ingredients.
- The practice currently used in the industry is to use some inclusion of home-grown protein sources in tandem with inclusion of imported soybean, resulting in satisfactory animal performance.

Other resources & online information

Teagasc National Winter-Milk Open Day 2023: https://www.teagasc.ie/animals/dairy/winter-milk/winter-milk-open-day/

TResearch Winter 2023 article (pp. 34-35): https://www.teagasc.ie/media/website/publications/2023/TResearch-Winter-2023.pdf

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

Dietary focussed Methane Mitigation

- **Bovaer® (3-NOP)**
  - Reduces methane when offered throughout the day
  - No effect on animal performance

Supplementation	↓ CH_4
Beef – TMR	30%
Dairy – Silage	22%
Dairy – AM/PM	6%

- **RumenGlas (CaO_2)**
  - Research and refinement ongoing
  - Does not need to be offered throughout the day

Supplementation	↓ CH_4
Beef – AM/PM (low)	16%
Beef – AM/PM (high)	28%[1]
Dairy – AM/PM (high)	12.5%[2]

[1]Reduced DMI when fed in a coarse ration, no reduction when fed in a pelleted ration
[2]Reduced milk yield and DMI

- **Oils and Seaweeds**
  - Natural origin
  - Difficult to include in a nut

Supplementation	↓ CH_4
Linseed oil (4%)	19%
Rapeseed oil (2.5%)	8%
Rapeseed cake (14.5%)	8%
Brown seaweed (2%)	4%
Brown SW Extract (2%)	8%

Take home messages

- Daily methane production can be reduced by **30%** during **housed period**.
- A research priority is the delivery of methane mitigating supplements **at pasture.**

Reducing Methane from Winter-Milk Cows

Methane Reducing Feed Additive

- Enteric methane emissions are a by-product of feed digestion within the rumen
- 3-NOP is a feed additive that can inhibit enteric methane production
- The indoor-feeding period offers an opportunity to incorporate 3-NOP into the diet of Irish dairy cows

Experimental Design

- 2-wk covariate and 7-wk experimental periods
- 44 cows/treatment
- 3-NOP added as Bovaer (231g/cow – 0.8% 3-NOP)

Ingredient, kg DM/cow	Control	Additive
Grass silage	7	7
Maize silage	7.2	7.2
TMR concentrate	6	6
Parlour and GreenFeed concentrate	2	2
3-NOP, g/cow/day	-	1.8
Forage proportion, %	64	64
Total DMI	22.2	22.2

Results

	Control	Additive	
Milk yield (kg/day)	29.9	30.4	
Protein (%)	3.50	3.55	
Fat (%)	4.61	4.64	
Milk solids (kg/day)	2.42	2.48	← 2% increase
Methane (g/day)	452	335	← 26% reduction
Methane (g/kg MS)	190	136	← 28% reduction

Take Home Messages

- A number of solutions currently available to reduce enteric methane production
- Promising outcome for methane reducing feed additive in Irish Winter-Milk systems
- Further solutions are required

Evaluating the potential of 3-nitrooxypropanol to reduce enteric methane emissions of winter-milk cows

N. Maher[1]; A. Lawless[2]; B. Lahart[1]; H. Costigan[1]; C. Dwan[1]; M. Dineen[1]

[1]Teagasc, Moorepark, Co. Cork; [2]Teagasc, CELUP, Johnstown Castle, Co. Wexford

Summary:

- Enteric methane represents 62.5% of Irish agricultural green-house-gas emissions and given targets of reducing agricultural emissions by 25% by 2030, assessing means to reduce enteric methane emissions is vital.
- The objective of this study was to investigate the effect of 3-nitrooxypropanol (3-NOP) on enteric methane production of Irish winter-milk cows.
- The treatments consisted of cows fed a diet containing 78 mg of 3-NOP/kg of DM or cows fed a control diet containing no 3-NOP.
- The winter-diets consisted of 32% grass silage, 32% maize silage and 36% concentrate.
- Cows fed 3-NOP had 26% lower methane production (g/cow/day) and 28% lower methane intensity (g/kg of milk solids) when compared with cows fed the control diet.
- Overall, the results are promising for methane mitigation during housed periods; however, assessment of other strategies will be needed for Irish dairy systems.

Other resources & online information

Teagasc National Winter-Milk Open Day 2023: https://www.teagasc.ie/animals/dairy/winter-milk/winter-milk-open-day/

3-NOP experiment: https://www.teagasc.ie/news--events/daily/dairy/promising-results-from-methane-reducing-feed-additive-in-irish-winter-milk-system.php

Email: michael.dineen@teagasc.ie; aidan.lawless@teagasc.ie; hazel.costigan@teagasc.ie; ben.lahart@teagasc.ie

Multispecies Swards – Johnstown Castle Dairy

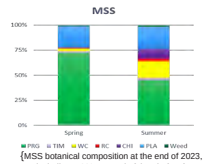
Johnstown Castle Spring Milk Production

- PRG with 10% white clover (GC) vs. MSS 6-species mixtures (MSS)
- MSS mixture (2019) included perennial ryegrass (AberChoice, AberGain), timothy (Presto), white-clover (AberHerald, AberAce), red-clover (AberChianti), chicory (Puna II), and plantain (Tonic)
- Seed weight: 72% grass, 20% legume, 8% herb

Key Performance Indicators (2020 to 2023)

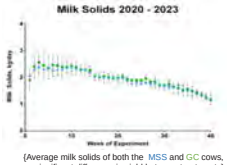
	Herbage grown T DM/ha	Grazed T DM/ha	Chemical N kg/ha	Conc. kg/cow	Kg MS/cow
PRGWC 2020	15.2	11.2	234	790	535
MSS	13.7	11.3	82	847	535
PRGWC 2021	15.2	11.6	155	761	534
MSS	13.7	11.5	64	832	538
PRGWC 2022	12.9	9.9	144	1012	556
MSS	12.9	10.2	54	1014	559
PRGWC 2023	12.6	9.7	116	927	539
MSS	10.7	8.7	31	923	527

Botanical Composition:



{MSS botanical composition at the end of 2023, including a 30% reseed of the platform}

Results:



{Average milk solids of both the MSS and GC cows, no significant difference in yield between treatments}

Take Home Messages

- MSS grew an average of 12.8 T DM/ha from 2020-2023, receiving on average 58 kg of chemical N
- MSS produced a similar milk yield of similar compositional quality to cows grazing the GC sward

Challenges:

- Silage conservation, lower DM = longer wilt required
- Quantifying the non-production advantages of MSS v GC
- Persistency of herbs, herbicides/weed control

Experiment 2024-2025

Introduction

- Objective: to evaluate multispecies swards in an intensive grazing system that is self-sufficient for forage and demonstrates best practice in environmental sustainability
- 7.55 ha of PRG with 10% clover vs. 7.55 ha 6-species mixtures. Stocking rate of 2.37 LU per ha
- Both farmlets established in 2019, with a 30% reseed of each sward type in 2023

Additional work

Field lysimeter study:

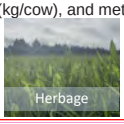
- Evaluate the effect of sward type and urine application on nitrogen losses across a range of soil types

Life Cycle Assessment:

- Evaluate the environmental impact of both sward types in a spring-calving dairy production system

Methodology

- Cows: 36 high EBI (€ 240) HF cows, national average €178
- Measurements include: target pre-grazing herbage dry matter (DM) (kg DM ha-1), post-grazing residual height (cm), herbage allowance (kg DM cow-1), milk solids (kg/cow), milk yield (kg/cow), and methane (g/cow)



Current Performance 2024

	Grass-clover	Multi-species
Milk yield kg/cow		
MS kg/cow		
Conc. kg/cow		
Herbage grown kg DM/ha		
Chem. N kg/ha		
Current average farm cover		
Silage produced to date		

An evaluation of multispecies and grass-clover swards in a dairy grazing platform

Orla Mattimoe[1], [2]; John Finn[1]; Michael Dineen[3]; Aidan Lawless[1], Karina Pierce[2] & Bridget Lynch[1]

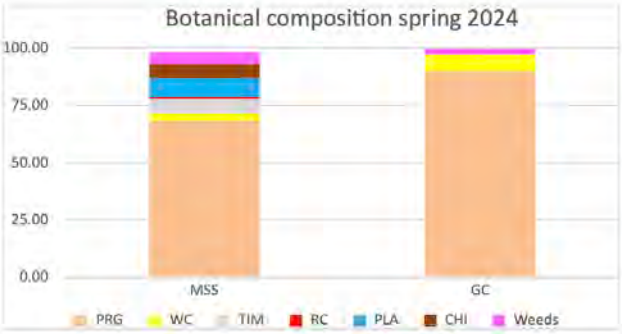
[1]Teagasc, Crops, Environment and Land-use, Teagasc, Johnstown Castle, Wexford, Ireland; [2]School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4, Ireland;
[3]Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland

Summary 2020 - 2023:

- Reduced reliance on chemical nitrogen (N) fertiliser and minimising N loss to the environment are some of the greatest challenges facing pastoral dairy production systems today.
- Irish dairy farmers have become increasingly interested in the use of multispecies swards to reduce both their chemical input and environmental impact.
- This study compared the herbage and milk production of two groups of Holstein Friesian cows grazing either a grass-clover sward (GC) containing Perennial Ryegrass and White Clover or a multispecies sward (MSS), containing Perennial Ryegrass, Timothy, White Clover, Red Clover, Plantain and Chicory.
- The GC and MSS swards were established on separate farmlets in autumn 2019, and the experiment was carried out across the full grazing season (February to November) from 2020 to 2023 inclusive.
- Grazing was managed on a rotational basis, using target pre-grazing herbage dry matter (DM) (kg DM ha-1), post-grazing residual height (cm), and herbage allowance (kg DM cow-1). The weekly grazing wedge was determined by farm cover (herbage DM kg ha-1) using the PastureBase Ireland software.
- The two treatments produced a similar milk yield of similar compositional quality across the first four years of the study despite the MSS treatment receiving a reduced chemical nitrogen input.
- Across the four year period, the MSS treatment grew an average of 12.8 T DM/ha, receiving on average 58 kg of chemical N. The GC treatment grew an average of 13.9 T DM/ha receiving on average 162 kg of chemical N.

Continuing experiment 2024 - 2025:

- This experiment will continue in 2024 and 2025 with the objective of evaluating multispecies swards in an intensive spring calving grass based production system that is self-sufficient for forage.
- The GC and MSS farmlets will be stocked at 2.37 LU/ha with 30% of each farmlet (7.55 ha) reseeded in 2023 with similar herbage and cow key performance indicators being measured
- The botanical composition of the swards in early 2024 were as follows



- Additional environmental parameters will be measured including enteric methane measurements using GreenFeed Technology. A life cycle assessment will be completed with multiple year's data.
- It is also planned to conduct an evaluation of the effect of sward type and urine application across a range of soil types using in the infield lysimeter facility at the Environment Research Centre in Johnstown Castle over the coming years.

Other resources & online information

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

Email: orla.mattimoe@teagasc.ie; bridget.lynch@teagasc.ie; aidan.lawless@teagasc.ie; michael.dineen@teagasc.ie; john.finn@teagasc.ie

Acknowledgements:

Thank you to the dairy farm staff in Teagasc, Johnstown Castle for their assistance with this experiment and the technical laboratory staff in Teagasc Johnstown Castle and Moorepark for feed and milk analysis.

Complete a Fodder Budget

Winter Fodder Requirements 2024 - 2025				
	A	B	C	(A x B x C)
Animal Type	No. Stock	No. months (Include 4 – 6 week buffer)	No. Bales per month	Total Silage Required
Dairy Cow			1.75	
Suckler Cow			1.70	
0 -1 year			0.90	
1 -2 year			1.35	
> 2 year			1.70	
Ewes			0.17	
Total SILAGE BALES required				
Total tons PIT SILAGE required (Total bales / 1.1)				

- ❑ Complete a fodder budget today & assess current stocks
- ❑ Tons Silage = (length x width x height in metres) / 1.4
- ❑ Don't over estimate 2nd cut silage potential yields
- ❑ Put a plan in place – act sooner rather than later

Building Fodder Stocks

Complete a fodder budget
Know your requirements

Maximise silage - own farm
Maximise grass growth – N, P, K, S

Finish animals at grass
Reduce grass/fodder demand

Buy silage bales
Preferably locally

Short term rent
6 – 8 week period

Forage crops
Access/Shelter/Balance Diet/Nitrates

Contract cropping – Maize/Beet/Whole Crop
Agreement in advance

Buy beet
Machinery to handle

Ensuring you have enough fodder for winter 2024-2025

Pearse Kelly[1]and Gordon Peppard[2]
[1]Teagasc, Grange; [2]Teagasc, Kilkenny

Summary:

- Following a wet start to 2024 and a prolonged winter housing period, silage and fodder reserves on many farms were completely exhausted this spring. Grass growth to date in 2024 has been poor with further supplementary feeding of fodder taking place in recent weeks on some farms.
- It is essential to know how much fodder is required in order to make a plan. Complete a fodder budget for your farm and include a 20 – 25% buffer to take into account the possibility of a prolonged winter feeding period again this year.
- Every opportunity to harvest silage should be made for the remainder of this grazing year. Plan for second cuts as normal on all fields that are not required for grazing. A third cut may also be targeted on some fields in September. On grazing ground, any extra grass grown should be cut and saved as high quality baled silage.
- Can some stock be finished off grass? Is it an option to finish some animals from grass with/without concentrates this autumn, thereby reducing the grazing demand in the back end of the year and more importantly reducing the winter fodder requirement.
- Can silage bales be sourced locally in order to enhance the silage stock on farm? Buying locally can be of great benefit if you have knowledge of the farm that the bales came from.
- Renting land for a 6 to 8 week period where you can fertilise the ground in order to cut a crop of silage maybe an option in parts of the country. Sourcing land in close proximity to your home farm is key.
- Where silage is going to be tight next winter, in some instances the growing of forage crops like forage rape maybe an option? These crops may be an option in fields that are planned for reseeding next year.
- In some of the tillage areas of the country, linking up with a tillage farmer to purchase whole crop silage, maize silage, grass silage, beet etc. on contract may be an option. If going this route, it would be important for all parties to complete a contract cropping agreement in advance so that everyone knows their obligations.

Other resources & online information

Website: https://www.teagasc.ie/animals/managing-fodder-this-winter/

Email: pearse.kelly@teagasc.ie; gordon.peppard@teagasc.ie

Advisory, Education & Policy

FARMING FOR A BETTER FUTURE

Teagasc Advisory and Training Services - independent, professional and research-backed

Ger Shortle

Manager, Teagasc Wicklow/Carlow/Wexford Advisory Region

Introduction:

The 2024 Johnstown Castle Open day - Farming for a Better Future – builds on the great success of the 2022 Open Day and Teagasc Advisory and Training Services are doing our utmost to make this year's event an even greater success. Our staff are on hand to inform, explain and guide you through the wide range of Open Day topics.

Through our nationwide network of 50 offices Teagasc provides services to all of Ireland's 130,000 farmers, including 40,000 direct clients. The primary purpose of the advisory service is to improve the competitiveness of the agri-food sector, support sustainable farming and the environment and encourage diversification of the rural economy.

Teagasc has a unique model which combines research, advice and training in one organisation. Internationally this model is seen as very effective in serving the needs of farmers by getting the latest information from research to them quickly. Our network of Signpost Farms show the way to achieving a sustainable and resilient 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.

How we deliver advice

The Teagasc advisor is the central and key component of the Teagasc Advisory Service and of the Agricultural Knowledge and Innovation System (AKIS) which aims to ensure that relevant people in the farming and agri-food sectors get connected, and that knowledge is shared between everyone who uses and produces it.

Our advisory service is delivered in many ways, from one-to-one consultations, to discussion groups, in-person meeting webinars and courses. Depending on the type of annual contract, each client can avail of office and phone consultations and on-farm visits when needed. Discussion Group, facilitated by an advisor work well for many farmers who value them as an excellent way to learn and exchange knowledge with other 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. Everyone, clients and non-clients can attend farm walks, demonstrations and other public events, like this Open Day where the latest information is disseminated

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

Our Range of Services

We offer advisory support on a broad range of services covering schemes, animal and crop production, environment and business. 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 used across the industry. While for those who want to look at alternative enterprise development can avail of our Options Programme. 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. Our Transferring the Family Farm Clinics are used by hundreds of farming families each year to help them plan for succession, inheritance and retirement.

Come and see us at the Knowledge Transfer Village where you can chat with an advisor, teacher or education officer who can help you on journey towards a better farming life.

ACRES Tranche 1: Some timely reminders for common actions

To avoid problems down the road it's essential that you are familiar with your ACRES plan and know what your approved actions and the relevant deadlines are. Correct and timely implementation of the actions will reduce the risk of penalties and delays in payments.

Some of the most common actions are listed below but your plan may include others.

Extensively Grazed Pasture

- Mowing/Topping can be carried out after 1st July
- Watercourses must be fenced to exclude bovines
- Max chemical nitrogen 40Kgs/Ha/year

Low Input Grazing

- Extensively managed with low inputs of fertiliser
- Plot should have less than 30% Ryegrass
- Late mown meadow bonus if harvesting from 1st July to 31st August for chosen plots

Hedgerow/Tree planning

- Planting of trees/hedgerow across all approved actions now extended to 31st March 2025

Soil Sampling

Valid soil samples (Taken after 01/01/2022) to be uploaded to ACRES system before 31/12/2024

Cover/catch Crops

Cover crops or catch crops can have many potential benefits but results can be very variable depending on many variables. Among the main potential benefits are:

- reduced leaching of nitrogen
- reduced run-off of phosphorus and soil particles
- increased soil carbon
- increased organic matter
- improved yields
- reduced fertiliser requirement

Key advice for success with cover/catch crops:

- Choose species carefully.
- Carefully consider your rotation, seed cost, benefits required, sowing method.
- Include a legume for nitrogen.
- Early sowing is important. At the latest sowing must be done before mid-September
- Late sowing = poor growth = small benefits
- Destroy/incorporate stemmy material early – slow breakdown
- Early incorporation of leafy material less critical
- For the ACRES cover crop action a mixture of cover crop species must be used.

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. Irelands 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 E.U. Water Framework Directive of achieving 'Good Status' for all waters.
- The River Basin Management Plan for Ireland sets out Irelands plan to achieve good status
- The ASSAP service is available to farmers in 190 Priority Areas for Action (PAA's) 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 PAA's 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

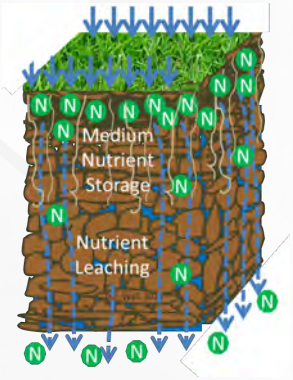


Figure 2: Nitrogen that is not used up by grass/ plant is available to leached to groundwater/ streams during heavy rainfall

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.

Farming for water: River Slaney Project

Introduction:

This Tirlán initiative is a collaborative project bringing together expertise from Teagasc, the Local Authorities Water Programme (LAWPRO), and ifac. It is designed to enhance water quality across the Slaney River Catchment area and is closely aligned with the European Innovation Partnership (EIP) 'Farming for Water'. It aims to enhance water quality across all farming enterprises – dairy, grain and drystock – and in the winder communities through which the River Slaney flows.

A target of the project is to transform the Slaney from one highlighted by the Environmental Protection Agency (EPA) water testing programme as a 'catchment of concern' to one that provides best practice in how partnerships and collaboration can deliver real and meaningful changes and improvements that work for farmers, local communities, and the wider environment together. Realising the required improvements in water quality is seen as key to securing the Nitrates Derogation from 2026 onwards.

In addition to ongoing work of its Agricultural Sustainability Support and Advisory Programme (ASSAP) team, Tirlán will also develop a tailored Farm Support Service for suppliers in the most challenged areas in the River Slaney Catchment. This advisory service will focus on three primary areas: nitrogen use efficiency; slurry storage; and on-farm profitability.

Teagasc studies have shown that efficient use of nitrogen is essential to achieving maximum crop growth and achieving a greater return on each kilogram of fertiliser you invest in. Planning helps to optimise the use of farm nutrients, maintain and improve soil health, reduce excessive nutrient build up and lessen environmental losses.

The programme has a strong focus on slurry storage and usage to ensure applications can be timed with grass growth rates, allowing for better use of the nutrients contained within and where possible, to replacement of chemical fertiliser.

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 CAP programme which commenced in January 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 (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/

Teagasc is your education and training provider for the agricultural and land-based sectors

Brian Morrissey, Carmel Finlay and Tara Fitzsimons

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

Summary:

- Graduates of Teagasc certificate and advanced certificate courses meet the training qualification to become a "trained farmer."
- Teagasc introduced four apprenticeship programmes in 2023, with certification by QQI.
- The Adult Green Cert programme is offered at Teagasc Regional Education Centres and Agricultural Colleges on a part-time basis.
- The Distance Education Green Cert course has been developed to meet the training requirements of graduates from other non-agricultural award programmes who are interested in farming.
- The Higher Education Links Scheme enables holders of Further Education awards to apply for a quota of higher education courses.
- 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.

Introduction:

Teagasc is the primary provider of accredited further (vocational) education for the agricultural and land-based sectors. Teagasc has a major input into higher education and postgraduate education delivery through its extensive partnerships. Teagasc introduced four new apprenticeship programmes in 2023 and welcomes applications for courses starting in September 2024. Teagasc also has a substantial involvement in providing short courses and continuous professional development across the agricultural, land-based and food sectors.

Become a "Trained Farmer":

National policy has prioritised 'young trained farmers' for various farm schemes and incentives. Graduates of Teagasc training courses meet the training qualification to become a 'young trained farmer'. Measures and schemes include:

- Complementary Income Support for Young Farmers scheme
- National Reserve Scheme – Young Farmer Category
- Young Farmer Capital Investment Scheme under the Targeted Agricultural Modernisation Schemes (TAMS)
- Registered Farm Partnerships/ Collaborative Farming Grant Scheme
- Stamp Duty Exemption on Transfers of Land to Young Trained Farmers
- Capital Acquisitions Tax Relief
- Stock Relief on Income Tax for Certain Young Trained Farmers

It is expected that future CAP reform will have additional benefits for young trained farmers.

Note: educational requirements for schemes are subject to change and applicants are required to meet terms and conditions when applying for various schemes.

New Apprenticeship Programmes

Teagasc introduced four apprenticeship programmes in 2023. These programmes lead to QQI awards at Level 6 and Level 7, as follows:

- Sportsturf Technician (NFQ Level 6 Higher Certificate), 2 year duration
- Horticulturist (NFQ Level 6 Higher Certificate), 2 year duration
- Farm Technician (NFQ Level 6 Higher Certificate),2 year duration
- Farm Manager (NFQ Level 7 Ordinary Bachelor Degree)

Teagasc plans to introduce an apprenticeship programme (Ordinary Level 7 Bachelor Degree) for the equine industry in 2024. This programme will train Assistant Stud Farm Managers to work in the industry. Further updates on apprenticeship training will be published on the Teagasc website.

Careers in the agricultural and land-based sectors

To remain competitive, new entrants to farming, horse production, forestry and horticulture will have to master fresh challenges to progress in the industry. Training with Teagasc will empower you and give you the skills you require to prosper in your chosen career. Courses include:

QQI Level 5 Certificate Courses

- Certificate in Agriculture / Horticulture / Horsemanship/ 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

Adult Green Cert Programmes

The Adult Green Cert programme is offered at Teagasc Regional Education Centres and Agricultural Colleges for students who wish to complete the course on a part-time basis. This course, accredited by QQI, is 2-to-2.5 years in duration. The qualifications gained are the Level

5 Certificate in Agriculture 5M20454 and the Level 6 Specific Purpose in Farming 6S20487. To enter this programme, applicants must be 23 years of age or older when starting. Enquires should be made locally to Teagasc colleges and centres. Subsequently applications are made online through the Teagasc public website: www.teagasc.ie/agriculture-courses/

Distance Education

The Distance Education Green Cert course has been developed to meet the training requirements of graduates from other non-agricultural award programmes who are interested in farming. The course extends over a minimum of 15 to 18 months. The qualifications gained are the Level 5 Certificate in Agriculture 5M20454 and Level 6 Specific Purpose Certificate in Farming 6S20487. Applicants must be a holder of a Level 6 or higher major award in a non-agricultural discipline. Applicants must also have continuous access to a commercial farm in the Republic of Ireland (home-farm or approved nominated farm) to develop proficiency in farm tasks and complete farm-based assignment and projects. They must have access to all farm details, including financial details, on the nominated farm, and are expected to spend time weekly on this farm and be involved in its operation and management. Applications are made online through the Teagasc public website: www.teagasc.ie/agriculture-courses/

Higher Education Opportunities

The Higher Education Links Scheme enables holders of further education awards to apply for a quota of higher education courses. Specific further education courses are linked with specific higher education courses. Applicants for a higher education course, covered by the Scheme, are made through the standard CAO form. Applicants should check details of the higher education Links scheme with the relevant Technological Institute/University. Graduates of Teagasc further education may be eligible for advanced entry to Teagasc linked higher education courses subject to conditions and criteria of the partner higher education institution.

Teagasc Higher Education Partnerships

Teagasc has a longstanding and substantial involvement in higher education provision. There is a wide range of higher-level programmes for the agricultural and land-based sectors available through the Central Applications Office (CAO). Many of these courses are conducted jointly between Teagasc and higher education institutions which allows students access to the best core competencies of each of the partner institutions. Direct recruitment to the courses is through the CAO system with a number of places reserved for mature students and holders of designated further education awards. There are also a number of advanced entry routes which allow Teagasc students to progress from further education into second year of certain higher level programmes. Places are limited and students make applications directly to higher level institutions. Additional information can be obtained on relevant technical university websites.

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

Lifelong Learning & Continuous Professional Development

Teagasc offer a wide range of courses for adults and agri-food sector employees. Please contact your Teagasc Education Officer or your Teagasc Advisory Region or college for advice on courses in your region. Courses are provided subject to demand, and staff resources. Some of the courses include: Farm Safety, Crop Nutrition Management, Discussion Groups, Dairy Production, Grass10 Grazing Management, Forestry, Business, Organic Farming, and Welfare of Animals during Transport.

Teagasc Food Industry Training

Teagasc provides specialist training to the food processing and retail sector in the areas of food safety and quality systems, food legislation, food innovation and new product development. These training programmes are delivered from Teagasc Centres in Ashtown, Dublin and Moorepark, Cork, as well as from other locations around the country or in-company. They address specific industry needs and skills gaps and are developed in consultation with industry. Our training programmes operate to best quality assurance standards. In addition, businesses can avail of assistance from consultants either at Teagasc locations or in-company to address the individual company development needs or for problem solving.

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 kind of measures are also used in the management of college farms, for both livestock and tillage enterprises.

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

What's it like to do a Teagasc Part-Time or Distance Education Green Cert course?

Brian Morrissey, Carmel Finlay and Tara Fitzsimons

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

Summary:

- There are many benefits to completing a Teagasc Part-Time or Distance Education Green Cert.
- A "Green Cert" is an educational award that qualifies the holder as a "trained farmer" for the purposes of Department of Agriculture, Food and the Marine (DAFM) schemes.
- The Adult Green Cert programme is offered at Teagasc Regional Education Centres and Agricultural Colleges on a Part-Time basis.
- The Distance Education Green Cert Programme (for award holders) has been developed to meet the training requirements of graduates from other non-agricultural award programmes who are interested in farming.
- The course content for both the Part-Time and Distance Education Green Certificates is the same, with the latter involving online or blended learning.
- Graduates of these courses are eligible to progress to the Teagasc Higher Education Farm Technician Apprenticeship or apply for entry to linked courses through the Higher Education Links Scheme.

On the Teagasc website at https://www.teagasc.ie/education/contacts/ you can find information on Part-Time or Distance Education courses in your local Teagasc education centre or your nearest college.

Introduction:

There are many benefits to completing a Teagasc Part-Time or Distance Education Green Cert, such as achieving "trained farmer" status. But what does this actually mean, and what is involved in undertaking this kind of training?

Benefits of training with Teagasc:

Teagasc is the leading provider of accredited further education and training for the agricultural and land-based sectors. When you take a course with Teagasc, you receive specialist skills training and gain an in-depth understanding of progressive farming, crop and livestock production systems. Teagasc courses are creative, diverse and lots of fun. During the course, you will meet and work with students from similar backgrounds and develop friendships and networks which will last long after graduation.

On successful completion of your course, you will receive internationally recognised awards. Your QQI qualification will prepare you for your future career in farming, and if you want, it will allow progression into higher education while potentially increase your employment opportunities. In addition, graduating from an accredited Teagasc course qualifies you as a "trained farmer." This is important because national policy has prioritised "young trained farmers" for various farm schemes and incentives.

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.

Taking the first steps

There are a number of steps you can take when planning your education pathway.

1. Consider your long term career plan
2. Identify your education and training requirements
3. Review which courses would meet these needs
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.

Deciding for a Part-Time or Distance Education course

Once you've decided on a course, you can go and find out more about the course and make an application. Here is some information on the Teagasc Part-Time and Distance Education Green Cert programmes.

The Teagasc Adult Green Cert Programmes

The Adult Green Cert programme is offered at Teagasc Regional Education Centres and Agricultural Colleges for students who want to complete the course on a Part-Time basis. This course, accredited by QQI, is 2-to-2.5 years in duration. The qualifications gained are the Level 5 Certificate in Agriculture 5M20454 and the Level 6 Specific Purpose in Farming 6S20487. To enter this programme, applicants must be 23 years of age or older when starting this programme. Enquires should be made locally to Teagasc colleges and centres. Subsequently applications are made online through the Teagasc public website at www.teagasc.ie/agriculture-courses/

Distance Education

The Distance Education Green Cert Programme (for award holders) has been developed to meet the training requirements of graduates from other non-agricultural award programmes who are interested in farming. The course extends over a minimum of 15–18 months. The qualifications gained are the Level 5 Certificate in Agriculture 5M20454 and Level 6 Specific Purpose Certificate

in Farming 6S20487. Applicants must be a holder of a Level 6 or higher major award in a non-agricultural discipline. Applicants must also have continuous access to a commercial farm in the Republic of Ireland (home-farm or approved nominated farm) to develop proficiency in farm tasks and complete farm based assignment and projects. They must have access to all farm details, including financial details, on the nominated farm and are expected to spend time weekly on this farm and be involved in its operation and management. Applications are made online through the Teagasc public website: www.teagasc.ie/agriculture-courses/

What happens next?

So what happens next? Your course application will be processed and if you are offered a place, you can pay the fee. You will receive information about your course, when it will begin, what the requirements are etc. Then you will receive more information about your course, and have an induction session where you will begin your training. Starting a new course can be a challenge, but there are many people you can ask for help, such as your course co-ordinator. Your Learner Handbook will describe your responsibilities as a learner, and the services, supports, and facilities that are available to you.

What is the pattern then?

Then what is the pattern your course will follow? Your course will settle down into a pattern of course work across all subjects, both theory and practical skills, quizzes, practical skills demonstration and practicing, self-directed learning, and Practical Learning Period (PLP). You will also complete different kinds of assessment (examinations, projects, diaries, assignments etc.), and repeat assessments (if required). Towards the end of your course, the course co-ordinator will submit your final assessment results and assessment evidence for External Authentication. All going well, this will be followed by certification of successful learners by QQI, and graduation and receipt of certificates.

What will you study?

The course content for both the Part-Time and Distance Education Green Certificates is the same. The Part-Time Green Certificate course involves classroom and practical instruction. The Distance Education Green Certificate involves classroom and practical instruction and remote or blended learning. The list below gives a sample of what the learner will study on Teagasc Part-time and Distance Education Green Cert programmes:

- Work Practice (home farm) - Level 5
- Principles of Agriculture - Level 5
- Farm Safety and Farm Assurance - Level 5
- Soils and the Environment - Level 5
- Farm Business and Technology - Level 5
- Safe Use of Pesticide Products - Level 5

- Personal Development module* - Level 5
- Electives [choice of electives is at the discretion of the college/ centre] - Level 5
- Work Practice (Home Farm) - Level 6
- Farm Performance Measurement - Level 6
- Farm Management and Business Planning - Level 6
- Sustainable Farming in the Environment - Level 6
- Applied Livestock Breeding & Grassland Management or Crop Production Management - Level 6

Progression

Graduates of these courses are eligible to progress to the Teagasc Higher Education Farm Technician Apprenticeship or apply for entry to linked courses at Institutes of Technology through the Higher Education Links Scheme.

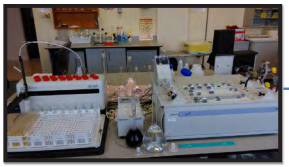
Location and contact details

On the Teagasc website at https://www.teagasc.ie/education/contacts/ you can find information on Part-Time or Distance Education courses in your local Teagasc education centre or your nearest college.

Soil, Crop & Slurry Analysis at Teagasc J.C.

Main Points

State-of-the-art analytical equipment used to facilitate research on soil & crop nutrient efficiency and land-use



Lachat flow-analyser used for Morgan's P, K, Mg analysis in soil

Agilent ICP-OES used for mineral analysis in soils, crops & slurry

Bruker FTIR used to develop non-destructive analytical methods for soil & crop nutrient analysis

LECO combustion analyser for C, N and S analysis

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 research soil samples tested annually
- Soil tests include: nutrients, total minerals, %OM, TC, TOC, TN & S, bulk density, soil texture & soil biology
- Approximately 10,000 crop/slurry samples tested annually for up to 15 parameters
- Support research program to identify best practices help improve **Soil Fertility** & **Crop Nutrition,** protect **Water Quality**, improve **Soil Health** and enhance soil and above ground **Biodiversity** benefits

Soil, Crop & Slurry Analysis at Teagasc Johnstown Castle

Linda Maloney-Finn - Laboratory Manager

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

Introduction:

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 around 50 live research projects being conducted by/in conjunction with researchers at Johnstown Castle generating samples for water, greenhouse gas, soil, crop, biodiversity/ecology and microbial analysis.

Research work conducted at Teagasc Johnstown Castle helps in the development of strategies to protect water quality, improve soil health, enhance biodiversity and reduce greenhouse gas emissions from agriculture.

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 to 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

Acknowledgements:

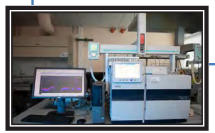
Thank you to the permanent and contract technicians, technologists, field staff, farm staff, general and administration staff who support the research activities at Teagasc Johnstown Castle.

Water, GHG, Soil Microbiome & Ecology Analysis

Main Points

State-of-the-art analytical equipment used to facilitate research on nutrient losses & sequestration, biodiversity and the soil microbiome

Gallery plus analyser used for Water analysis



Bruker Scion Green House Gas Analyser (Methane, Nitrous Oxide and Carbon Dioxide)

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

Support Range of National Projects

Agricultural Catchments Program

Signpost Program

Soil Carbon Observatory

Take Home Messages

- Approximately 20,000 research water samples analysed annually for up to 20 parameters including N, P, nitrates, carbon and BOD
- 50,000+ research gas samples analysed annually to monitor GHG levels
- Support research to develop technologies and practices to protect **Water Quality**, improve **Soil Health**, reduce **Gaseous Emissions** and enhance **Biodiversity**

Water, GHG, Soil Microbiome & Ecology Analysis at Teagasc Johnstown Castle

Linda Maloney-Finn - Laboratory Manager

Teagasc, Environment, Soils and Land-use Research, Johnstown Castle, Co. Wexfordford

Introduction:

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 around 50 live research projects being conducted by/in conjunction with researchers at Johnstown Castle generating samples for water, greenhouse gas, soil, crop, biodiversity/ecology and microbial analysis.

Research work conducted at Teagasc Johnstown Castle helps in the development of strategies to protect water quality, improve soil health, enhance biodiversity and reduce green house gas emissions from agriculture.

Summary:

- All water, gas soil, crop, microbial and biodiversity/ecology samples being 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 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 (N20)
- As well as soil nutrient analysis, soil carbon, 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 sequester carbon.
- The labs are equipped with top of the range analytical equipment. Methods are constantly being adapted to meet the needs to 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

Acknowledgements:

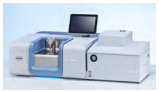
Thank you to the permanent and contract technicians, technologists, field staff, farm staff, general and administration staff who support the research activities at Teagasc Johnstown Castle.

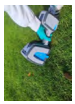
Emerging Soil Analytical Technologies

for fast & cost effective soil analysis

Introduction to new Soil Analytical Technologies

Mid-Infrared Spectroscopy



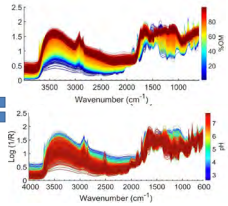


Benchtop
and
Portable Devices

Terra Soil

Irish Soil Map

N = 900



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

X-Ray Fluorescence

Total Elements in soil:
Aluminium, calcium, magnesium, phosphorus, nickel, copper, zinc, manganese, iron, cobalt, lead, chromium and cadmium, among many others.

Take home messages

- ✓ Emerging technologies can reduce the time and cost associated with soil analysis
- ✓ Useful for monitoring large spatial areas
- ✓ Can monitor the soil health & quantify carbon stocks
- ✓ Faster information gathering to aid decision making for soil management
- ✓ No chemical waste is generated
- ✓ Teagasc is assisting in implementing these technologies in Ireland

Emerging Analytical Technologies at Teagasc Johnstown Castle: Mid-Infrared spectroscopy and X-ray fluorescence: fast and cost-effective soil analysis

Felipe Bachion de Santana[1], Rebecca Hall[1], Sifan Yang[1], Longnan Shi[1], Maame Croffie[1], Karen Daly[1]

[1]Teagasc, Soil, Environment and Land use Research Centre, Johnstown Castle, Co. Wexford

Summary:

- National soil analysis requires rapid, low-cost and automatic responses for soil analysis
- Emerging Analytical Technologies such as Mid-Infrared and X-ray can predict several ranges of soil attributes in a few minutes
- Emerging Analytical Technologies are useful for monitoring large spatial areas
- Emerging Analytical Technologies proposed by Teagasc 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 increasing the number of soil analyses without substantial costs
- Faster decision making for soil management
- Can monitor the soil health, quantify carbon stocks
- 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/projects/terra-soil/Pages/default.aspx

Google "Teagasc spectroscopy laboratory". This will give to you more details about both emerging Analytical Technologies.

Email: felipe.bachiondesanta@teagasc.ie; Karen.daly@teagasc.ie

Acknowledgements: Thank you to Courtney Doyle, Patricia Berry, Dr. Anna Fenelon, Dr. Luis Lopez-Sangil, Linda Moloney Finn for their assistance with laboratory sample analysis and organising the resources.

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 available through the Targeted Agricultural Modernisation Scheme (TAMS). 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. 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 (ATV's) are useful machines on farms for travel but they have a high risk of death and serious injury if miss-used.

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 a 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:

http://www.rsa.ie/en/RSA/Your-Vehicle/Vehicle-Standards/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, that meet certain additional requirements.

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. Famers 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: Teagasc: http://www.teagasc.ie/health_safety/ and

H.S.A.: http://www.hsa.ie/

NOTES

Agriculture and Food Development Authority

Contact Details:
Johnstown Castle, Environment, Soils & Land Use Department
Teagasc,
Johnstown Castle,
Co. Wexford
Y35 TC97

Tel: +353 (0)53 9171200

www.teagasc.ie

ISBN: 978-1-84170-702-0