Teagasc
Agriculture and Food Development Authority

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National DAIRY CONFERENCE 2024

Wednesday, 27 November

Limerick Racecourse

Conference Programme

9.45am	**Welcome** *Teagasc Chairman, Liam Herlihy*	
9.50am	**Opening Address** *Teagasc Director, Frank O'Mara*	
10.00am	**Session 1: Achieving grazing system objectives in real-world conditions**	

Future metrics for pasture production and utilisation
Aine Murray, Teagasc Moorepark Research

Putting grazing targets into practice on my farm
Michael Carroll, dairy farmer Limerick

Keeping grass in the diet in difficult spring weather conditions
Donal Patton, Teagasc Ballyhaise

11.15am ***Tea/Coffee break***

11.40am **Session 2: Nutrient use on dairy farms-improving margins at low environmental impact**

Protected urea – effects on pasture production and emissions mitigation
Patrick Forrestal, Teagasc Johnstown Castle

Priority actions for dairy farmers on water quality management
Pat Dillon, Teagasc

My approach to farming for better nitrogen efficiency
John Macnamara, dairy farmer Limerick

1.00pm ***Lunch***

2.00pm **Afternoon Workshops**
All workshops are repeated 3 times during the afternoon at 2.00pm, 2.45pm and 3.30pm.

Workshop 1	*Trends in TB, reducing risk for dairy herds* *Speakers: Damien Barrett, Niamh Field & Derek O'Donoghue*
Workshop 2	*Meeting herd feed requirements this winter and next spring* *Speakers: Aisling Claffey, James Dunne & Kevin Stagg*
Workshop 3	*Clover 150 – Lessons learned from 2024 and planning for 2025* *Speakers: Michael Egan, Joseph Dunphy, Robert & Denis O'Dea*
Workshop 4	*Controlling dairy production costs in 2025* *Speakers: Patrick Gowing, Nora O'Donovan, Jerome & Brian Desmond*
Workshop 5	*Successful use of sexed semen in Irish dairy herds* *Speakers: Stephen Butler, Stuart Childs & John McCarthy*
Workshop 6	*Managing young calves for better health outcomes* *Speakers: Ian Hogan, Emer Kennedy & Deirbhile Browne*

National Dairy Conference 2024

Robust Dairy Farming for Future Challenges

Limerick Racecourse

Wednesday 27th November, 2024

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Welcome from Teagasc Kerry-Limerick Advisory Region

Majella Moloney
Regional Manager, Teagasc Kerry/Limerick Advisory Region

On behalf of the Teagasc Kerry/Limerick Region, together with my staff, I am happy to welcome attendees to the 2024 National Dairy Conference. "Robust Dairying for the Future Challenges" is the theme for this year's event. This is very appropriate as the conference aims to deliver some solutions to these challenges.

The Kerry/Limerick region is synonymous with top class dairy farming due to the mild climate and long growing season allied with top quality free draining soils. The region is a significant national producer of milk, with a dairy cow population of over 220,000 cows. The collaboration with three joint programmes, Kerry Dairy Ireland, Dairygold, and North Cork Creameries enables our region to extend world class Teagasc dairy research onto our dairy farms. An end of year conference such as this one, while casting a glance back at the year coming to an end, is laser focused on planning for the years ahead. Building a resilience and adaptability into our dairy farming will be the main features that will serve our industry well for the years to come. The main conference in the morning, complemented by the after lunch workshops can assist dairy farmers in creating a robust enterprise, which will be well placed to withstand the undoubted challenges of the years to come. Finally, welcome to Kerry/Limerick region, we are very pleased to be this year's host and that this year's conference provides you with a learning opportunity to help you prepare for the future.

Welcome from Teagasc Dairy KT Department

Joe Patton
Head of Dairy Knowledge Transfer, Teagasc

On behalf of the Teagasc Dairy team, I would like to welcome you to this year's Teagasc National Dairy Conference. The theme for the event is "Robust Dairy Farming for Future Challenges". This year started as another tough one for dairy farming, with poor spring grazing conditions, slow growth in early summer, and low milk prices. Concerns around costs and regulatory changes also exacerbated negative sentiment. Thankfully, we have seen an upswing for dairy farms in the latter part of the year, driven by recovering milk production and rising milk prices, favourable weather, and an improved cost base. Our initial estimates would show a potential 80% increase in farm margins relative to 2023, which is a welcome development, albeit from a low base. Such volatility in family farm incomes underlines however, the need for resilient systems and careful control of farm finances.

This year saw continued progress on uptake of technologies on dairy farms. We have seen for example a huge shift to sexed semen and use of high dairy beef merit AI bulls. This in time will address a key sustainability issue for the sector. Dairy farmers have played a big part in helping to reduce year-on-year sectoral greenhouse gas emissions by almost 3%, primarily due soil nutrient and fertilizer usage.

Long-term challenges for the sector need to be addressed, in particular on how high performing dairy systems can incorporate best-practice environmental and water quality measures into their routine management. This must be achieved while maintaining progress in areas such as animal performance, health and farm profitability.

Our conference today will take a forward look at these key issues. Attendees will hear from a mix of researchers, advisers and leading farmers in the morning plenary sessions. The content will focus on real-world issues and solutions for dairy farmers. The afternoon will run in practical workshop format, where attendees can choose topics of most interest to them. The workshops have an informal style to allow for plenty of questions, debate and discussion. We encourage you to take full part in the discussion.

New science is always of interest but nothing beats hearing the experience of farmers who have been putting new ideas and technologies into practice. Teagasc are delighted to have Limerick farmers John Mcnamara, Michael Carroll, Robert& Denis O'Dea, and Cork farmers Jerome and Brian Desmond presenting at the conference. Their input and insight will be a highlight of the day and we sincerely thank them for their participation.

10.00am Session 1: Achieving grazing system objectives in real-world conditions

Session 1 Speakers

Dr. Áine Murray – Teagasc, Moorepark Research Centre

Dr Áine Murray is the clover farm systems research officer based in Teagasc Moorepark. Áine is currently researching grass-only vs. grass-clover swards with reduced nitrogen inputs and their effects on herbage, milk production and nitrogen use efficiency on the Moorepark research farm. Following on from her PhD studies based in Clonakilty on clover incorporation into grassland systems and a post doctorate in nitrogen mineralisation in grassland systems.

Michael Carroll – Farmer Speaker

Michael farms 91ha near Granagh, Co. Limerick, with the help of his father Martin and Ollie O'Brien who works fulltime with them. The milking block consists of 55ha of very mixed land type. There is also 36ha of out block for replacements, silage and a small beef enterprise. Michael was the joint winner of the Nutrient Management Category of the Sustainable Grassland Farmer of the Year 2023. He places great emphasis on grass management and gets cows to grass as much as possible on the shoulders of the year with a network of roadways and a multitude of access points. In what was a challenging 2023, the 145 cows delivered 503kgs of milk solids to Dairygold feeding 630kgs of meal. They will deliver similar solids in 2024 but with a meal input closer to 800kgs due to the lower growth this year. Family is very important to Michael, and when not farming he will be with his wife Stephanie and their 3 children. He also enjoys hurling with the Granagh/Ballingarry Junior B's alongside his brothers Pat and John.

Dr Donal Patton – Teagasc Research Officer, Ballyhaise College

Dr Donal Patton is the Research officer based in Ballyhaise College Co. Cavan. The dairy research project in Ballyhaise has been focused on profitable dairy production systems on heavy clay drumlin soils since 2005 and Donal has been involved since 2008. The current trial is looking at the transition to clover systems within the context of soil types present at the site. Donal has worked on a number of previous trials looking at stocking rates, calving dates, turnout dates and feed levels and their effects on system performance and profitability.

Future metrics for pasture production and utilisation on dairy farms

Áine Murray[1], Donal Patton[2], Laurence Shalloo[1], Ciaran Hearn[1], Michael Egan[1] and Micheal O'Donovan[1]

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

Summary

- Grazed grass remains the cheapest high quality feed that can be offered dairy cows. Achieving grazing targets will ensure that grazed grass intake is maximised in the diet.
- Current grazing metrics are achievable on farms when stocking rate is appropriate for farm pasture production.
- Grass and feed budgeting will allow farms to tailor grazing targets to individual farm conditions and will provide confidence around achieving grass targets.
- Silage of high quality should be budgeted for the spring and supplemented in February as dictated by the farm feed budget and spring rotation plan
- Stocking rates on farms should be set based on whole farm pasture growth in order for the farm system to be financially robust and self-sufficient for feed.
- Grass clover swards have a major role to play in maintaining annual herbage production and farm productivity in lower N scenarios.

Introduction

After difficult prolonged periods during the past two grazing years in many areas of the country, many farmers are wondering whether the standard grazing targets are appropriate and achievable on farm within the context of a changing climate. With climate change predictions, it is likely that we will experience increasing numbers of either prolonged rainfall or drought-like events. Dairy farmers will need to be able to insulate their systems to these events and create resilient grazing systems that still allow high levels of grazed grass utilisation. At the same time, we must ensure that the overall system remains robust by building and retaining forage buffers on the farm in the form of grass silage. Grazed grass and clover swards are still the cheapest high-quality feed source available in our grazing systems; indeed the cost gap between grazed grass and grass silage or purchased concentrate has increased over the past number of years due to increased fuel and feed prices, and rising contractor charges.

Since the abolition of dairy quotas, and the expansion of the national dairy herd, farmers have taken the opportunity to increase farm productivity per hectare. One way in which farmers have achieved this is through increased stocking rates on farm and in particular on milking platforms. At the same time, there has been a downward trend in pasture production measured on farms since 2019 (PastureBase Ireland). This has occurred where feed demand at the animal level has actually increased as there has been a significant increase in milk yield per cow in the form of increased milk volume yields coupled with increases in fat and protein percentages. This has led to high pressures on our grazing systems at particular times of the year when grass growth can no longer meet the high daily pasture demand set by stocking rates. With an increasing number of challenging weather events, either from excessive rain or prolonged dry periods, farmers are forced to supplement grazed grass at a higher frequency, for more prolonged periods, and with greater levels of supplementary feed. The question asked by some are around whether the grazing targets are still achievable in our changing climate in 2024 and beyond?

Total annual herbage production

How have you decided your stocking rate for your farm? National farm survey figures show that for 2023 stocking rate was static at 2.13 LU/ha for dairy farms in Ireland. To be self-sufficient in terms of herbage production for this whole farm stocking rate, the farm needs to be capable of growing 12 to 14 tonnes of DM production based on current concentrate feed levels and national average milk yields. When stocking rate is not decided based on a farms potential to grow grass, cow performance suffers as potential animal dry matter intakes will not be achieved.

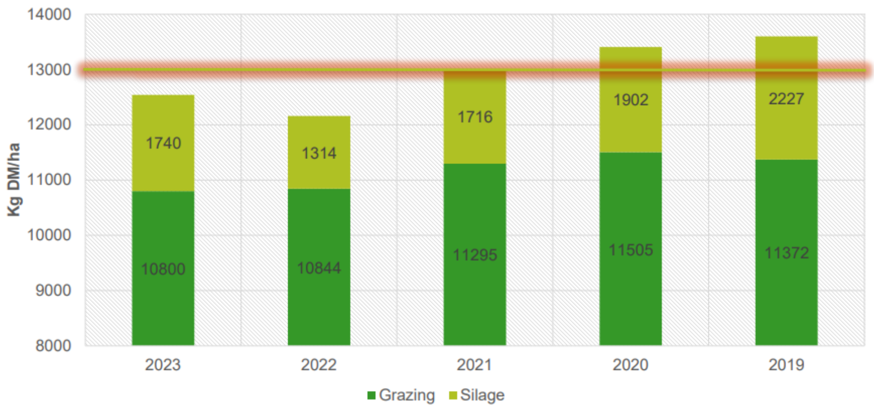


Figure 1. *Total herbage production of farms recording minimum 30 covers across Ireland on PastureBase Ireland (2019-2023).*

Regardless of soil type and location, farms should be targeting the maximum days at grass possible, and managing cow intake at grass in order to achieve good animal performance and high grass utilisation. In order to achieve this, a total feed budget should be carried out for the farm to allow the farm stocking rate to be matched to grass supply and to allow for planning around feed requirements at different points in the grazing season. This should be followed by a spring and autumn feed budget to facilitate the management of the feed deficits in the shoulders. This allows better decisions to be made for the farm, thus facilitating individual grazing targets to be met. Current grazing targets are still achievable on farms and the principles behind why the targets are there are still very important to our grazing systems. However, some stocking rates are not allowing farms to be self-sufficient in terms of what they can support within their farm gate. This has led to higher levels of off farm supplementation being required. It also creates pressure during the mid-season when we see the greatest fluctuations in grass growth. It creates a situation where there is increased days during the grazing season when supplement must be fed.

Table 1. Whole farm herbage production stocking rate (SR) budget based on national average milk yields for 2023 of 431 kg of milk solids per cow

Level of concentrate supplement (kg/cow)	Grass allocation DM/cow/per day	Grass grown required (tonnes)	10 tonne grown (SR)	12 tonne grown (SR)	14 tonne grown (SR)	16 tonne grown (SR)
600	16	6.4	1.6	1.9	2.2	2.5
1000	14	5.8	1.7	2.1	2.4	2.7

Autumn targets

As silage area comes back into the grazing platform after first and second cut silage crops, stocking rates will decrease for the grazing platform. This will help with building autumn covers for the final rotation to maximise grazed grass intake for the remainder of the grazing season. Peak average farm cover should be targeted at approximately 1,000 to 1,100 kg DM/ha based on a feed budget carried out to suit each farm. Farms that are still stocked at >3.5 LU/ha in the August September period will struggle to build farm cover as growth at this time of year will not be greater than demand as seen in Figure 4 below. Some farms on very heavy soil types that struggle to keep cows out full time in October and November, can build to a somewhat lower peak cover in September (900-1000kg DM per ha). However, it is still important to try to extend grazing into November period; and for spring grass to the 60:40 rule where possible.

The main points we need to keep in mind with our autumn grazing are as follows:

- Autumn closing rotation is the beginning of the next grazing season
- What you do in the last rotation will influence spring grazing decisions
- Depending on milking platform stocking rate you may need to start building farm cover from the beginning of August (SR >3 LU/ha)
- Build farm cover to a level that you are comfortable with on your farm if grazing conditions turn unfavourable
- Letting peak autumn cover get too high may impact spring grass availability
- 60:40 rule – graze 60% area in October, 40% of area in November
- **Target 650-750 kg DM/ha AFC 1st of December**

Spring targets

Grazed grass is far more valuable to our cows as a feed source in the spring than the autumn for milk production. Cows will benefit far more from consuming grazed grass than silage to manage body condition score at this crucial time of year. Silage supplementation in February and early March has little effect on milk production at that point or for the remainder of the lactation. However, beyond this period there is significant impact of silage supplementation on milk production for the lactation. Therefore, your spring grazing targets should prioritise this. Opening at a cover of more than 1,000 kg DM/ha is important to ensure you will have enough grass for the first rotation. If opening cover is low, silage supplementation should be prioritised in the February period when it has proportionally less on milk production. Some level of silage supplementation is hard to avoid during the spring period. In terms of labour, it is also more efficient to supplement silage in the February period while the majority of cows are still calving than March. A silage budget should be carried out on farms as part of a feed budget and good quality (>75% DMD) silage should be reserved in the yard for this. Calving start date and compactness has a very large impact on the herd demand and the ability to meet the targets. Herds that calve too early will have a much higher demand and will result in big requirements for both forage and concentrate feed in the spring. Managing calving date should be included in the planning process for spring management.

- Open at AFC +1000 kg DM/ha
- 30% area grazed 1st March? +7 to 14 days depending on farm type
- 60% area grazed 17th March? +7 to 14 days depending on farm type
- Finish the first rotation by 7th – 10th of April? +7 to 14 days depending on farm type

Spring rotation planner

The spring rotation planner (SRP) has been used successfully on many farms over the last 20 years to get grazing started while setting up the farm for second rotation. In recent years, many farmers have questioned its usefulness due to erratic spring weather events. While spring weather has become more variable with more severe extremes, changes in stocking rate and calving pattern are also causing farmers to question the SRP. A key point here is to revisit the growth pattern of your farm (Grass reports - growth curve PBI) in spring and look for the date when you are on average hitting your demand comfortably. That is your end date on your SRP and can range from early April to early May depending on growth rates and demand. Getting this date right is the key to setting the farm and the cow up to capitalise on high quality grass in early summer. If you are not measuring grass yet a good way to identify if this is a problem on your farm is to review protein % on your co-op report in April and May. Where farmers tend to finish 1st rotation too early silage will have to be fed in April to hold rotation length. Where this is a regular occurrence, you will see protein % will stagnate in April and recover in May if grass is being well managed at that point. If the opposite is the case and first rotation is being finished too late protein will improve in April as grass will not be limiting but will stagnate in May as pre grazing yields get too high.

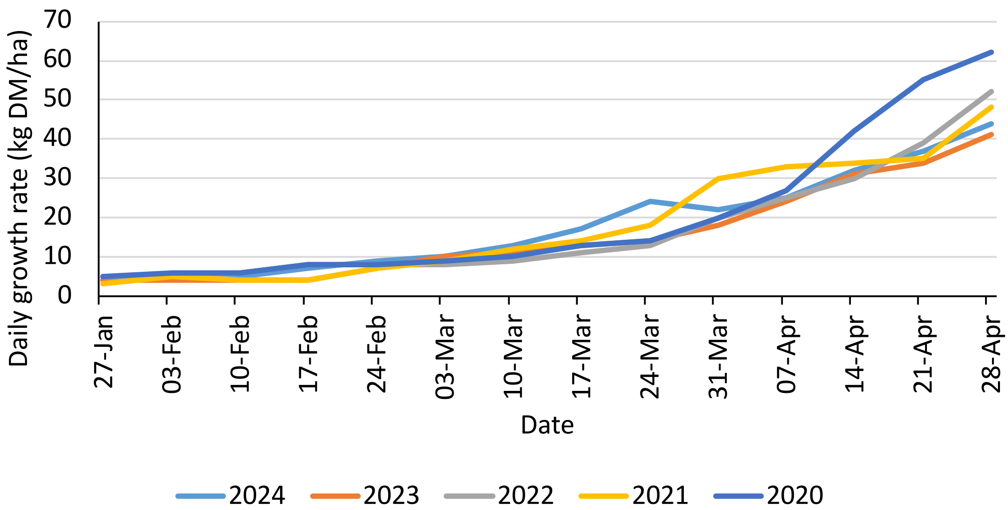


Figure 2. *Spring daily growth rate of farms recording minimum 30 covers across Ireland on PastureBase Ireland (2019-2023).*

While the SRP is the tool that will allow you to set up the second rotation on the farm, a grass budget (PBI farm management) will help you ensure that the cow is on a rising plane of nutrition while doing so. The key to success is making sure both work together in unison.

Spring grazing planning:

- Decide on magic day based on data not tradition
- Start with 600 AFC on that date in budget and work back
- If silage required front load it in first 6 weeks

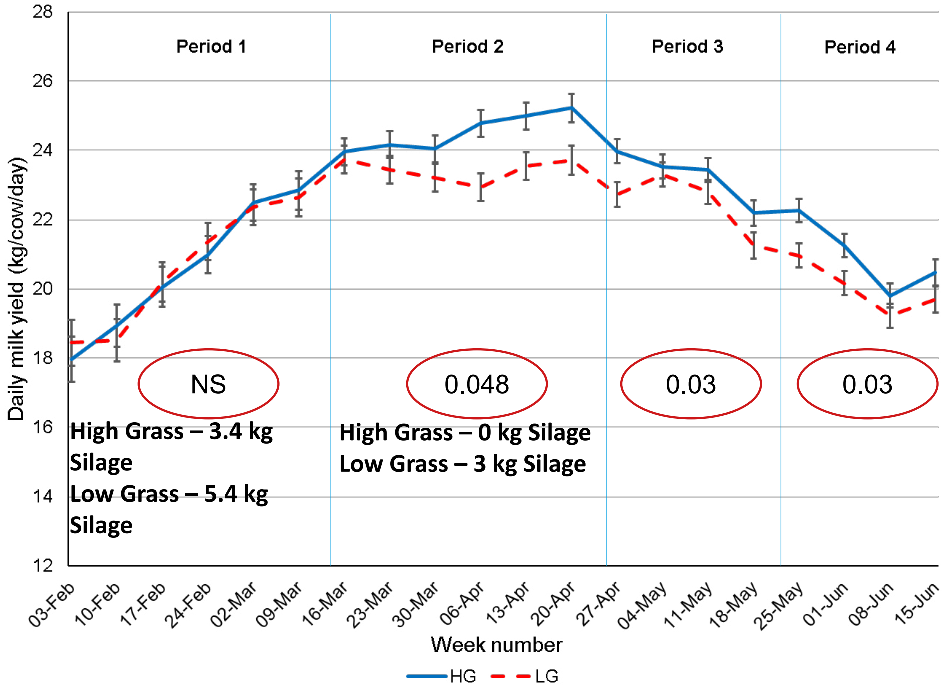


Figure 3. *Effect of timing and level of silage supplementation in the spring on daily milk yield*

Summer grazing targets

Mid-season stocking rate needs to be set at an appropriate level for farms based on average growth rate for the summer season and the requirement for the farm to produce forage for the winter period. This should be determined by grass demand. Demand is defined as SR x Grass allocation. For example, grass allocation of 18 kg DM/cow per day would be a demand of 18 multiplied by the stocking rate of 3 cows/ha is a mid-season demand of 54 kg DM/day. Setting demand at a higher level of over 60 kg DM/day reduces your opportunities to take out higher quality surpluses for silage; while these can be expensive they may be required in the diet to fill deficits that occur in the grazing season. Taking out pasture surpluses within rotation in response to high daily pasture growth will keep cows grazing the ideal pre-grazing cover of 1,400 kg DM/ha the majority of the time. This will further increase grass utilisation and productivity during the mid-season.

- 1400 kg DM/ha pre-grazing cover
- Demand and allocation sets stocking rate
- Take out surplus bales for high quality silage budget for following spring

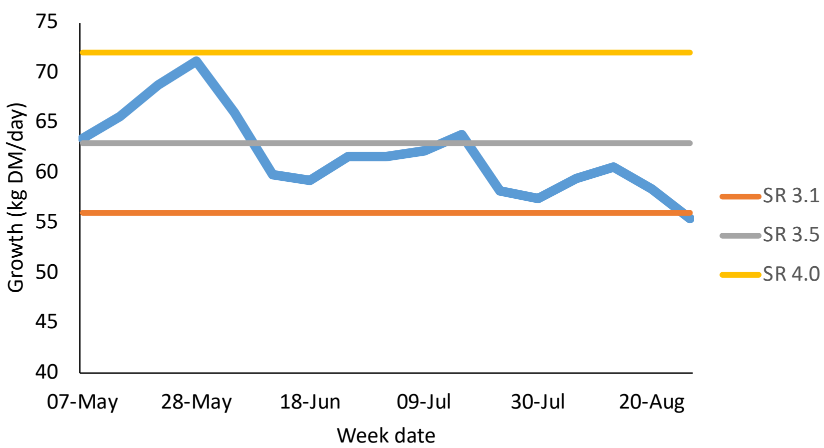


Figure 4. *Mid-season growth for farms recording minimum 30 covers across Ireland on PastureBase Ireland (2019-2023) with 3 demand lines based on stocking rate (SR).*

Clover- essential for pasture growth in a lower N environment

There has been much discussion on the future role of white clover in our grazing systems, particularly in light of declining annual pasture tonnage yields in recent years. Analysis of PBI and plot-level data would indicate that a contributor to lower herbage production has been reduced N application rates, often preceding or in the absence of clover in swards at farm level. Perennial ryegrass swards have a high nitrogen requirement; while perennial ryegrass/white clover systems can maintain pasture production and increasing animal performance at reduced chemical nitrogen applications in the system. With 20% white clover inclusion in perennial ryegrass swards, white clover can biologically fix up to 100 kg N/ha reducing the swards reliance on chemical nitrogen sources. White-clover perennial ryegrass systems can help further insulate our grazing systems due to their nature as lower cost systems with higher outputs (+30 kg MS/ha) through increased animal intake.

11.40am Session 2: Nutrient use on dairy farms- improving margins at low environmental impact

Session 2 Speakers

Dr. Patrick Forrestal – Teagasc, Johnstown Castle Research Centre

Patrick Forrestal is a Senior Research Scientist in the Soils, Environment and Land Use Department of Teagasc. Patrick grew up on a mixed livestock and arable farm. His research programme and team focuses on the development and extension of practical and economic soil, nutrient management and agronomic solutions to support Irish agricultural production systems while addressing water quality, greenhouse gas and ammonia challenges. With his team he has published more than 50 scientific papers providing, for example, the scientific evidence for new loss reduction solutions under Irish conditions and the basis for agriculture to receive emission inventory credit for solutions implemented by farmers.

Prof. Pat Dillon – Teagasc Director of Research

Pat has responsibility for the four Programmes in the Teagasc Research Directorate; Animal & Grassland Research and Innovation; Crops, Environment and Land Use; Food; Rural Economy and Development. These Programmes operate across six Teagasc research centres. In addition to research departments, these Programmes also include the Knowledge Transfer (Specialist) Departments and the Pigs, Horticulture and Forestry Development Departments. He joined the research staff in Teagasc in 1990. He was Head of the Animal Production Research Centre in Moorepark. He is internationally recognised as a leading scientist in sustainable, pasture-based livestock production and brings a wealth of experience in technology development and industry engagement to the role.

John Macnamara – Dairy farmer, Co. Limerick

John and his family are farming together in the parish of Knockainey Co. Limerick. They farm 116ha, 78ha on the milking block and 38ha on the outside farm which is 6 miles from home. John is a member of the local Teagasc Bulgaden Discussion Group and the Teagasc Clover 150 group. There is significant emphasis on reducing chemical nitrogen with incorporating clover within the groups. John has won multiple awards in his farming career such as FBD Macra Young Farmer of the Year in 2005, Grassland Farmer of the Year 2018 and NDC & Kerrygold Quality Milk Awards winner in 2023. John's father won Farmyard of the Year in 1969 and 40 years later they won the same title again. He is also the chairman of the Grass 10 Group. Family and community play a huge role in the Macnamara's farming life.

Protected urea – effects on pasture production and emissions mitigation

Patrick J. Forrestal

Teagasc, Environment, Soils and Land Use Department, Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford.

Summary

- Across multiple sites and years, there was no difference in grass yield from using protected urea versus CAN as fertilizer N type
- Grass production was reduced by using 100% standard urea application
- Protected urea reduces greenhouse gas emissions compared to CAN, and ammonia emissions compared to urea.

Effects of fertiliser nitrogen type on herbage production

In a multi-site experiment conducted over two years Forrestal *et al.* (2017) reported that grassland plots fertilised with urea+NBPT had the same herbage yields and nitrogen (N) recovery as calcium ammonium nitrate (CAN) fertilised plots. Nitrogen recovery in the herbage was lower for urea plots. A trial by Krol *et al.* (2020) found that herbage yields of plots fertilised with NBPT or NBPT+NPPT protected urea matched CAN herbage yield performance. Subsequently, a multi-year grazed plot research study conducted by Murray *et al.* (2023) at four sites again found that herbage yields from Urea+NBPT treated grazed plots matched CAN yields. However, lower yields were detected when using standard urea. Field trials conducted by Teagasc at Johnstown Castle, Co. Wexford in 2024 found no significant difference in the herbage production from plots fertilised with CAN, standard urea and urea protected by NBPT, NBPT+NPPT or 2-NPT (Figure 1). The site suffered wet and saturated conditions spring and soil moisture restriction over the summer.

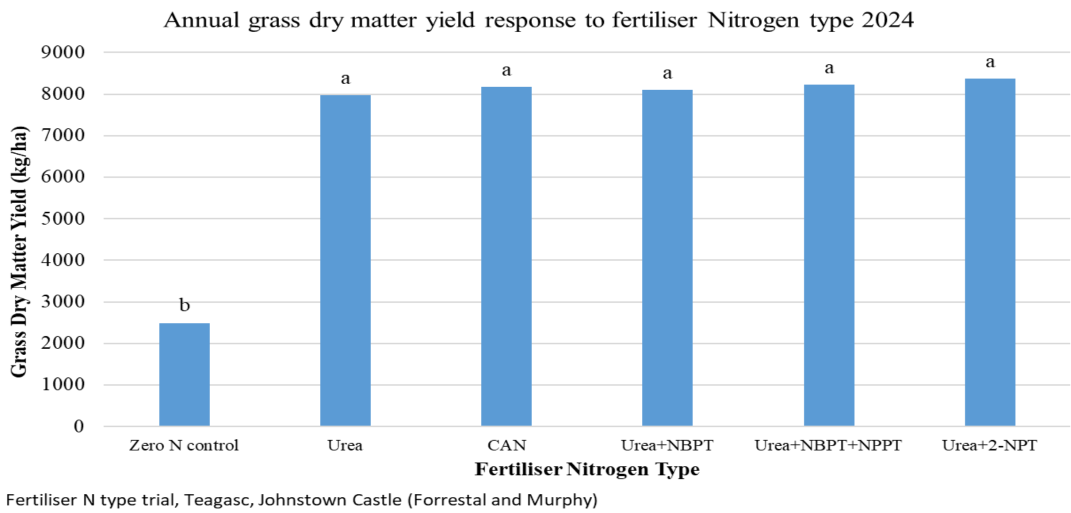


Figure 1. *Effect of fertiliser nitrogen source on grass dry matter yield in 2024. Treatments with differing lettering are significantly different at ($P \leq 0.05$).*

Effects of fertiliser nitrogen type on emissions

Although herbage yield response to different fertiliser N types is similar in Irish grassland there are important differences in emissions of the greenhouse gas nitrous oxide (N_2O). The N_2O emission factor of urea based fertiliser is approximately 70% lower compared with CAN (Harty *et al.*, 2016). Additionally, recent research has shown that ammonium-N has an N_2O emission factor that is 66% lower than the emission factor for nitrate-N highlighting the role of nitrate in grassland emissions (Rahman and Forrestal, 2021) (Figure 2a and b, respectively).

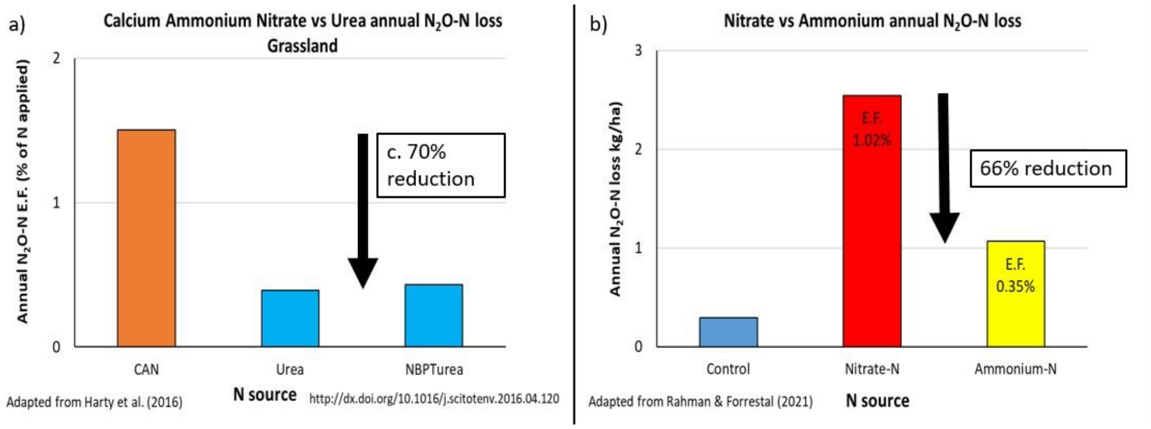


Figure 2. ***a.*** *The effect of calcium ammonium nitrate (CAN) compared to urea and urea protected with NBPT on the nitrous oxide (N_2O) emission factor in Irish soils.* ***b.*** *the effect of zero N, nitrate only and ammonium only fertiliser N on N_2O emissions and emission factors.*

Acknowledgements

I recognise the team of students, post-docs, technicians, researchers and collaborators referenced below along with the funding support of the Irish Department of Agriculture, Food and the Marine.

References

Forrestal, P.J., Harty, M.A., Carolan, R., Watson, C.J., Lanigan, G.J., Wall, D.P., Hennessy, D., and Richards, K.G. (2017). Can the agronomic performance of urea equal calcium ammonium nitrate across nitrogen rates in temperate grassland? Soil Use and Management 33:243-251. https://doi.org/10.1111/sum.12341

Harty, M.A., Forrestal, P.J., Watson, C.J., McGeough, K.L., Carolan, R., Elliot, C., Krol, D.J., Laughlin, R.J., Richards, K.G., and Lanigan, G.J. (2016). Reducing nitrous oxide emissions by changing N fertiliser use from calcium ammonium nitrate (CAN) to urea based formulations. Science of the Total Environment 563-564: 576-586. http://dx.doi.org/10.1016/j.scitotenv.2016.04.120

Krol, D.J., Forrestal, P.J., Wall, D., Lanigan, G.J., Sanz-Gomez, J., and Richards, K.G. 2020. Nitrogen fertilisers with urease inhibitors reduce nitrous oxide and ammonia losses, while retaining yield in temperate grassland. *Science of the Total Environment*, 725: 138329. https://doi.org/10.1016/j.scitotenv.2020.138329

Murray, Á., Gilliland, T.J., Delaby, L., Patton, D., Creighton, P., Forrestal, P.J., McCarthy, B. 2023. Can a urease inhibitor improve the efficacy of nitrogen use under perennial ryegrass temperate grazing conditions? The Journal of Agricultural Science. 161, 230-240. https://doi.org/10.1017/S0021859623000126

Rahman, N. and Forrestal, P.J. (2021). Ammonium fertiliser reduces nitrous oxide emissions compared to nitrate fertiliser while yielding equally in temperate grassland. Agriculture - Special issue on nitrous oxide emission mitigation 11: 1141. https://doi.org/10.3390/agriculture11111141

Improving Water Quality with Particular Focus on the Munster Blackwater River Catchment

Pat Dillon[1], Michael Dineen[2], Jesko Zimmermann[3], Laurence Shalloo[2] and Pat Tuohy[2]

[1]Teagasc, Head Office, Oak Park, Carlow, Co. Carlow, Ireland; [2]Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland; [3]Teagasc, Department of Agri-Food Business and Spatial Analysis, Rural Economy and Development Programme, Co. Dublin, Ireland

Summary

- Water quality in Ireland is relatively good in a European context but there are significant opportunities for improvement
- The primary actions required at farm level to reduce nutrient loss to water are; increased slurry storage capacity, reduced point source loss from yards and roadways, increased use of over-winter green cover on tillage farms and greater efficiency in the use of organic manures from intensive farming systems
- A river water catchment approach will optimise Ireland's ability to target mitigation strategies, which are pertinent to the specific catchment taking cognisant of the current ecological status, known pressures and range of farming systems
- An intensive extension advisory programme will be required to assist farmers to change management practices at farm level to improve water quality using the 8-Actions for Change
- To be successful, the 'Better Farming for Water' campaign will require strong collaboration with existing water quality programmes such as ASSAP, Farming for Water EIP, Waters of LIFE, Blue Dot Catchments, ACP, as well as, impactful stakeholder engagement

Introduction

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. A strong and healthy aquatic ecosystem offers vital goods and services, such as the provision of drinking water. Whilst water quality in Ireland is good in a European context, water quality has not improved in recent years. Encouraging improvements are being made in some catchments; however, these are being offset by declines in water quality in others.

The Water Framework Directive (WFD; 2000/60/EC) requires EU Member States to achieve at least good status in all surface water and groundwater bodies by 2027. Good or high ecological status is important for sustaining healthy aquatic ecosystems to support abundant communities of fish, insects and plants. Currently, just over half of Irish surface waters bodies (rivers, lakes, estuaries and coastal waters) are achieving at least good status.

The Nitrates Directive (91/676/EEC), in place since 1991, aims to protect surface water from pollution by agricultural sources and to promote good farming practice. The current (5th) Nitrate Action Programme (NAP) covers the period from 1st January 2022 to the 31st of December 2025. The NAP regulations contain specific new measures to protect surface waters from nutrient pollution arising from agricultural sources, such as dairy cow banding (linking milk yield to organic N excretion), reduced chemical N allowances, shorter organic and chemical fertiliser spreading periods and an increased requirement for soiled water storage. Ireland, like a number of other EU countries, has availed of a derogation from the maximum limit of 170 kg/ha of livestock manure N (organic N) as provided in the Nitrates Directive. Ireland was granted a derogation from the Nitrates Directive from 1st January 2022, but requiring a two-year review of water quality in 2023. This review resulted in a number of areas of the country having a reduction in the derogation limit to 220 kg/ha of organic N, while other areas remained at 250 kg/ha of organic N from 1st January 2024. There are currently approximately 7,000 grassland farmers availing of a derogation from the Nitrates Directive. While the levels of nitrate and P loss to water is highest in the areas with the more intensive agriculture, it is important to realise that sub-optimal water quality is a problem throughout the country and that agriculture is not the only pressure affecting water quality.

In 2024, Teagasc launched the 'Better Farming for Water; 8-Actions for Change' campaign. This is a 7-year (2024-2030) national multi-actor campaign focused on improving water quality in Ireland. The campaign was initiated at the request of the Minister for Agriculture, Food and the Marine, Charlie McConalogue TD, and forms part of a wider whole of government approach to improving water quality. The 'Better Farming for Water' campaign is building on existing water quality programmes such as ASSAP, Farming for Water EIP, Waters of LIFE, Blue Dot Catchments and others as part of the campaign to improve water quality. This requires the creation of strong collaboration between these initiatives and the 'Better Farming for Water' campaign. The purpose of this paper is to outline the actions required at farm level as part of the 'Better Farming for Water' campaign to improve water quality with particular focus on the Munster Blackwater River Catchment.

Role of agriculture in supporting water quality

Agriculture is the dominant land use in Ireland, accounting for approximately 70% of the land use; therefore, it is not surprising that agriculture has been identified as one of the main threats to water quality in Ireland (EPA, 2024a). Figure 1 shows the pressures affecting water quality by source and water body type, with agriculture the greatest, followed by hydro-morphology, urban waste water and forestry (EPA, 2019). Table 1 shows nationally that agriculture has been identified as the most prevalent significant pressure, impacting over 1,000 waterbodies or approximately 62% of all waterbodies 'at risk' of not achieving the environmental objectives under the Water Framework Directive (EPA, 2024a). In two thirds of the water bodies where agriculture is a significant pressure, additional pressures have also been identified. Over 80% of the waterbodies that have been identified 'at risk' from agriculture are river waterbodies. Notably, in rivers that are impacted by agriculture, nitrate concentrations from 2010-2023 were lower when compared with all rivers (EPA, 2024b; EPA, 2024c).

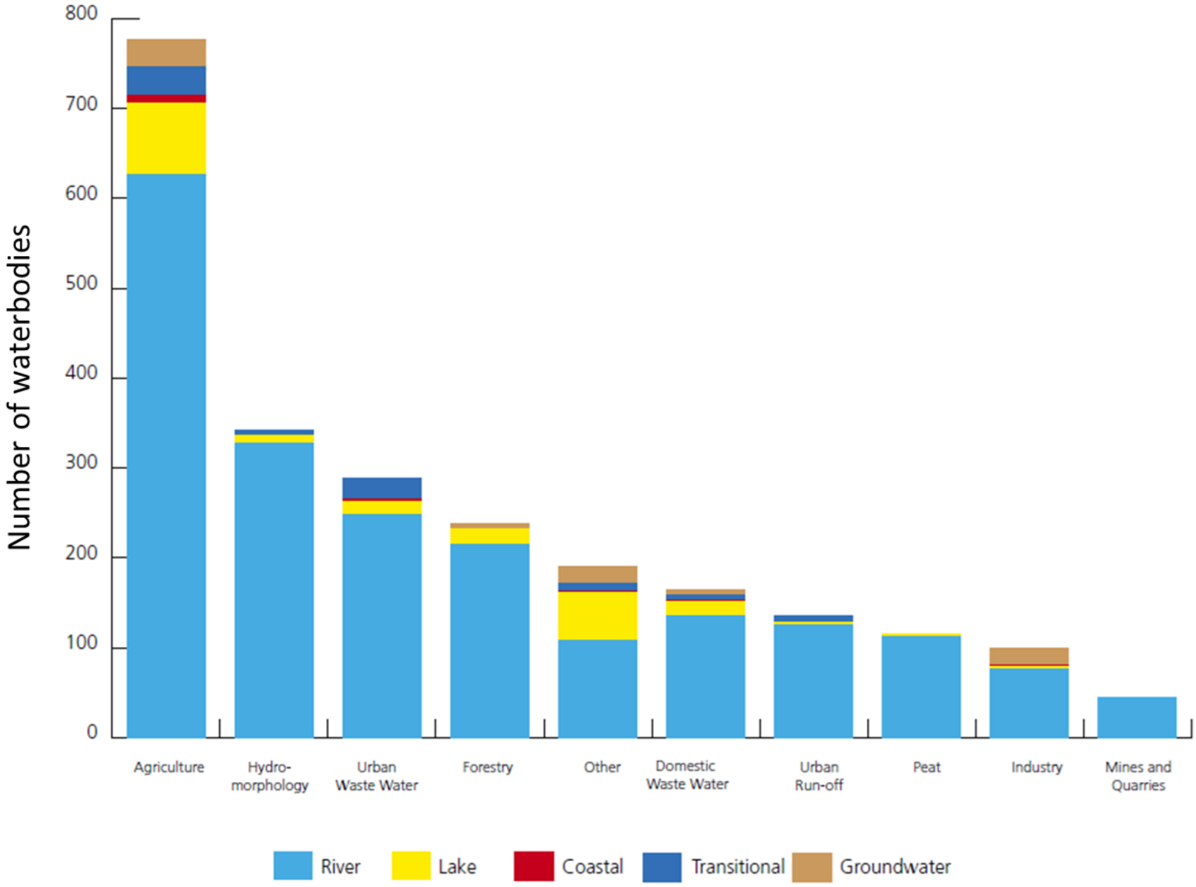


Figure 1. *Pressures influencing the water quality of waterbodies in the Republic of Ireland (Adapted from; EPA, 2019)*

The most common water quality issue arising from agriculture is the loss of excess nutrients (N and P) and sediment from agricultural systems (EPA, 2024a). Nutrient loss can come from point sources such as farmyards, or from diffused sources such as spreading of chemical and organic fertilisers. Excessive N and P can contribute to eutrophication of surface waters, impacting aquatic species through plant growth and associated fluctuation in oxygen concentration in water. Sediment can impact the physical quality of aquatic habitats, for example, clogging gravels for spawning trout and salmon. Both P and N play a role in eutrophication, however, excess P is typically the main issue for rivers and lakes and management of excess N for groundwater, estuaries and coastal waters.

Table 1. Number of 'at risk' waterbodies with agriculture as a significant pressure (EPA, 2024a)

Waterbody type	No. waterbodies	No. at risk waterbodies	No. waterbodies with agriculture identified as a significant pressure	% at risk waterbodies with agriculture identified as a significant pressure
River	3,192	1,337	843	63
Lake	812	142	85	60
Transitional	196	60	40	67
Coastal	112	16	7	44
Groundwater	514	94	48	51
Total	4,826	1,649	1,023	62

The risk of P loss is highest on poorly draining soils and subsoils. In these settings, overland flow pathways deliver sources of P into watercourse networks with excess rainfall. The overland flow of water carries the P and sediment into drains and surface waters. In grassland, applied P accumulates in soil close to the surface. When there is a lot of rainfall on heavy soil types or when the soil is saturated in the first place, most of the water will "run-off" the surface. Consequently, the water is moving in or on the soil where P is most concentrated. This "run-off" carries both dissolved P and P attached clay particles. Fertiliser, including slurry, spread on wet or frozen soils followed by heavy rain will add to this loss.

Conversely, the risk of N loss is more likely to occur from free draining light soils. Loss typically occurs where excess N fertiliser is applied above the crop requirement, especially when crop growth conditions are poor. When this happens, excess N in the form of nitrate in the soil, not utilised by the grass or crop, may be leached into shallow groundwater during heavy or prolonged rainfall, discharged into connected river systems and travels onward to the estuaries and coastal waters. Mitigation actions are best targeted at controlling loss at source and reducing the N surplus. The N surplus can be reduced by increasing N output from the farm and/or decreasing the N input to the system in the form of feed and/or fertiliser. Murphy *et al.* (2023) showed that reducing N surplus/ha on free draining soils on pasture-based systems reduced nitrate leaching to water. The lag time between the implementation of measures to reduce nitrate leaching and reduced groundwater nitrate concentrations needs to be also considered. Fenton *et al.* (2011) has estimated that in Irish soil types it will require between 7 and 21 years to achieve good water quality.

Excess loss of fine sediment can impact the condition of ecological habitats and fish spawning grounds, as well as being reservoirs and transport media for P. Typical sources of fine sediment include run off from farm roadways and bare ground, erosion of riverbanks at cattle access points and river channel maintenance. Mitigation options include livestock exclusion, fencing and stabilising vegetation on riverbanks.

Recent trends in water quality

The EPA classifies the water quality of our surface waters (rivers, lakes, estuaries and coasts) and groundwater every three years. The last report was published in 2021 for the 6-year period 2016 to 2021 (EPA, 2021a), the next report will include year's 2022, 2023 and 2024. Surface waters are classified by their ecological status (biology, water quality and hydromorphology combined) and chemical status (level of harmful chemicals). Waterbodies are classified into five quality or status classes; High, Good, Moderate, Poor and Bad.

The European Communities Environmental Objectives (Surface Waters) Regulations 2009 set out the environmental quality standards that are required to maintain a healthy aquatic ecosystem. The environmental quality standard for good status for P is 0.035 mg/l of P. Ireland does not have a statutory standard for N in rivers. The EPA guideline is 8 mg/l of NO_3 (1.8 mg/l of N) for having good ecological health for rivers and subsequent good ecological status downstream in marine waters. This guideline river value is used, together with statutory P and ammonium standard, to assess the nutrient condition of rivers. When two of these nutrients fail to reach their respective standards then good nutrient status are deemed to have not been met. Additionally, the EPA uses a mean of 2.6 mg/l as Dissolved Inorganic Nitrogen (DIN) as N in fresh waters that discharge from rivers into estuaries.

The latest EPA Water Quality in Ireland report (EPA, 2021a) covering the period 2016-2021, found that 54% of our surface water had satisfactory (≥ good) ecological status. The assessment indicated that the primary challenge facing our water was the presence of too much P and N, leading to increased eutrophication in these waters.

During 2021-2023, 42% of Irish rivers had concentrations higher than 8 mg/l NO_3 (1.8 mg/l N), and 27% had concentrations greater that the 0.035 mg/l of P (Figure 2); both are having a negative impact on the ecological status of these rivers (EPA, 2024b). High N concentrations are mostly in areas of free draining soil in the south and south east, while high P concentrations are typically found in areas with poorly draining soils. Agriculture also can contribute to the diffuse loss of sediment, pesticides and pathogens to waters, which also contribute to the overall pressures and factors that need to be taken into account when attempting to reduce the impact of agriculture on water quality.

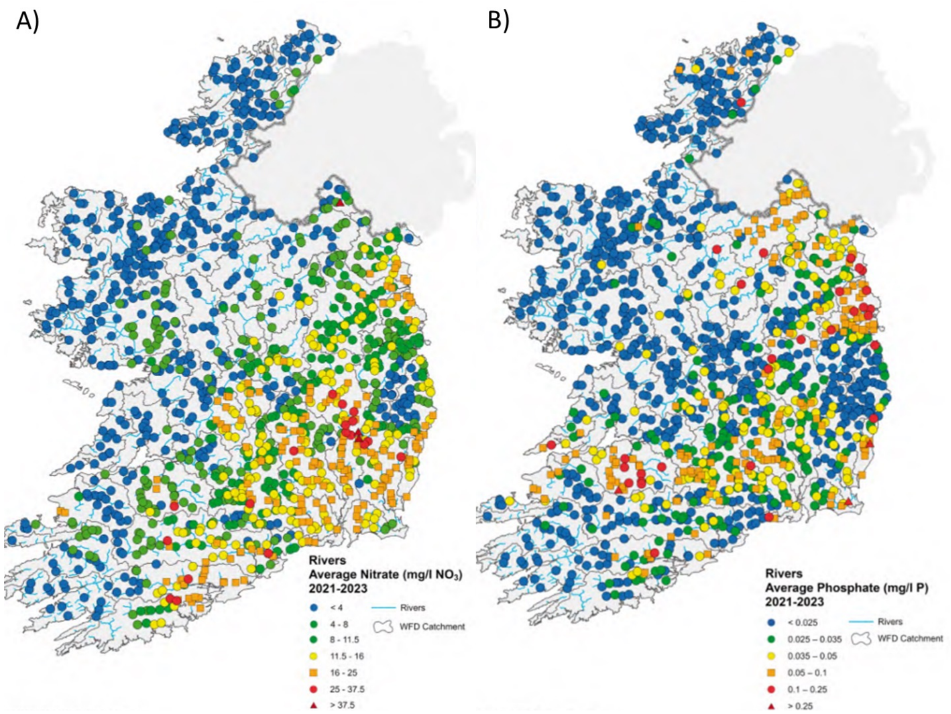


Figure 2. *Average A) nitrate and B) phosphate concentrations (mg/l) at Water Framework Directive river sites for 2021 to 2023 (EPA, 2024b)*

River catchment ecological status and N reduction requirements

Eight water catchments (Slaney, Barrow/Nore, Suir, Blackwater, Lee/Bandon and the Boyne) have been prioritised for the 8-Actions for Change as part of the 'Better Farming for Water' campaign. Table 2 shows the ecological status of these catchments based on monitoring cycle 2016 to 2021; additionally the trends in the ecological status of the Munster Blackwater River Catchment over the last 5 monitoring cycles is also shown. Based on the most recent monitoring cycle (2016-2021) there is large variation in the ecological status of the catchments ranging from 67% in the High/Good status for the Bandon/Ilen to 32% for the Boyne. Water quality in recent years in the Munster Blackwater River Catchment has reduced; however, currently 66% of the surface water bodies are in the High/Good status. Also the deterioration in water quality has not been associated with an increase in the proportion of surface water bodies in the Poor and Bad category suggesting that reversal of this decline in water quality can be easily achieved.

The general reduction in the ecological status of surface water bodies in recent years can be related to 2018/2019 period, which was associated with the severe drought in 2018 resulting in significant increase in N surplus on farms.

Within the 8 river catchments there was large variation in the ecological status of the surface water, there was known differences in pressures influencing the water quality and there were a range of farming systems. This highlights the importance of a specific river catchment approach to improving water quality, which is in agreement with Osawe *et al.* (2024) as they recommended that mitigation actions should be targeted at the catchment level.

Table 2. Ecological status of surface water bodies for the 8 river catchments prioritised in the 'Better Farming for Water' campaign

Catchment	Monitoring Cycle	Status					High + Good
		High	Good	Moderate	Poor	Bad	
Munster Blackwater	2007-2009	24	62	10	4	1	86
Munster Blackwater	2010-2012	22	62	12	3	0	84
Munster Blackwater	2010-2015	17	54	22	8	0	71
Munster Blackwater	2013-2018	12	65	17	6	0	77
Munster Blackwater	2016-2021	12	54	29	4	0	66
Bandon/Ilen	2016-2021	18	49	25	7	1	67
Barrow	2016-2021	4	32	41	23	0	36
Boyne	2016-2021	3	29	36	32	0	32
Lee	2016-2021	21	41	33	2	2	62
Nore	2016-2021	3	38	37	21	1	41
Slaney	2016-2021	11	51	32	6	0	62
Suir	2016-2021	2	34	41	22	1	36

In 2021, the EPA carried out an analysis to identify the catchments where N concentrations were too high to support healthy ecosystems, or at least Good Ecological Status under the Water Framework Directive (EPA, 2021b). The EPA calculated the reductions in N load required in major river catchments discharging water to marine water. The standard required was < 2.6 mg/l of dissolved inorganic N concentration in the upper reaches of estuarine waters that discharge into the marine environment. Therefore, if nitrate concentration in the streams and rivers throughout the contributing catchment are maintained at less than 2.6 mg/l as N, then the statutory dissolved N standard will be achieved in the marine waters. An analysis was carried out in 18 catchments, but for the purpose of this paper only the 8 catchments that are part of the 'Better Farming for Water' campaign are discussed.

The average N concentration in two of the catchments was at or below the 2.6 mg/l N (Lee and Suir); four of the catchments were between 2.9 and 3.4 mg/l (Bandon, Boyne, Blackwater and Nore) and two catchments were greater than 4 mg/l N (Barrow and Slaney; Table 3). The greatest N load reduction is required in the Barrow and Nore and the lowest in the Lee and Suir. The annual N load (in tonnes) is calculated by multiplying the concentration of N by the river flow summed over the whole year. Some catchments may have a large N load, but the concentration may be sufficiently diluted by the greater river flow that the environmental harm is much reduced.

Greater than 80% of the source in all eight catchments was from agriculture. The proportion of N coming from arable farming was greatest in the Barrow (28%) and Slaney (27%) catchments. The annual load reduction in N required to achieve the water quality targets range from 0.3 kg/ha in the Lee catchment to 50.8 kg/ha in the Slaney catchment. The proportion of N reduction required to achieve the water quality target varied from 1% in the Lee catchment to 53% in the Barrow catchment. There was significant year-to-year variation in the load reduction targets, with the largest reduction targets in the 2018 to 2019 period. The EPA is currently updating this report; indications are that the levels of load reductions in the Slaney and Barrow are not as great as indicated in this paper.

Table 3. Mean nitrate concentration discharging to marine waters (mg/l N), catchment N load (tonnes N), catchment load reduction required (tonnes N), N reduction (kg/ha N) and proportion of N reduction required (%) for the period 2012 to 2019 based on critical source areas (Adapted from; EPA, 2021b)

Item	River N, mg/l	Load of N, t	Load reduction required, t	N reduction required, kg/ha	N reduction required, %
Barrow	4.9	5,960	3,183	42.0	53*
Bandon	3.1	2,392	370	4.3	15
Blackwater	2.9	7,782	939	9.5	12
Boyne	3.3	4,924	833	23.1	21
Lee	2.3	3,917	24	0.3	1
Nore	3.4	4,525	1,027	14.9	23
Slaney	4.8	6,847	981	50.8	46*
Suir	2.6	6,829	244	2.4	4

**More recent information from the EPA indicates that these N reduction requirements will be lower*

Recent trends in fertiliser use and soil fertility

Table 4 shows that there was a significant decrease in the trends in fertiliser sales over the period 2017 to 2023. Fertiliser N sales has reduced from 369,089 tonnes in 2017 to 280,569 tonnes in 2023; a reduction of 88,520 tonnes or a 24% reduction. Phosphorus sales reduced from 41,893 tonnes in 2017 to 30,762 tonnes in 2023; a reduction of 11,131 tonnes or a 27% reduction. Potassium reduced from 108,694 tonnes in 2018 to 81,956 in 2023; a reduction of 26,738 tonnes or a 25% reduction. Lime sales increased from 737,118 tonnes in 2017 to 1,019,002 tonnes in 2023; an increase of 281,884 tonnes or a 38% increase.

Table 4. Chemical N, P, K and lime sales for the 2017 to 2023 (CSO, May 2024)

Item, tonnes	2017	2018	2019	2020	2021	2022	2023
Nitrogen	369,089	408,495	367,364	379,519	399,164	343,193	280,569
Phosphate	41,893	46,387	42,672	44,259	46,068	34,240	30,762
Potash	108,694	120,267	114,288	118,016	122,922	93,614	81,956
Lime	737,118	1,028,738	762,867	887,320	1,333,100	1,386,915	1,019,002

Table 5 shows the trends in fertiliser application rates, concentrate fed and stocking rate over the period 2017 to 2023 based on National Farm Survey data (NFS, 2024). Since 2020 the application rate of N, P and K across all farms have reduced by 21% (16.5 kg/ha), 25% (2.3 kg/ha) and 22% (5.3 kg/ha), respectively. On dairy farms the application rates of N, P and K have reduced by 19% (34.7 kg/ha), 28% (3.8 kg/ha) and 25% (9.3 kg/ha), respectively. On beef farms the application rates of N, P and K have reduced by 25% (14.3 kg/ha), 26% (1.8 kg/ha) and 27% (4.6 kg/ha), respectively. On sheep farms the application rates of N, P and K have reduced by 34% (14.9 kg/ha), 35% (2.3 kg/ha) and 34% (5.1 kg/ha), respectively. Over the same period the application rates of N on tillage farms have increased by 2% (1.7 kg/ha), while the application rates of P and K have reduced by 17% (3.7 kg/ha) and 8% (4.6 kg/ha), respectively. Although the percentage reduction in fertiliser use was slightly lower on dairy farms compared to drystock farm, the absolute reductions were much greater i.e. the reduction in N fertiliser use on dairy farms was almost 2.5 times greater than that on beef farms (34.7 versus 14.3 kg/ha N). The reductions in chemical N on tillage farms was much less than that on grassland farms.

Table 5. Trends in fertiliser application rates, concentrate fed and stocking rate over the period 2017 to 2023 based on National Farm Survey data (NFS, 2024)

Item	2017	2018	2019	2020	2021	2022	2023
Dairy							
N Fert, kg ha	171.9	184.1	176.2	178.2	165.4	156.0	143.4
P Fert, kg ha	12.8	13.7	13.7	13.6	13.6	11.0	9.8
K Fert, kg ha	34.0	36.3	36.0	36.9	36.4	29.4	27.7
Concentrated fed, kg/LU	1,023	1,368	1,132	1,135	1,153	1,216	1,207
Stocking Rate (Dairy Forage Area)	2.11	2.10	2.12	2.09	2.11	2.15	2.13
Average Farm Size, ha	60	61	62	65	64	65	65
Cattle							
N Fert, kg ha	56.6	64.0	55.1	56.3	63.3	43.4	41.9
P Fert, kg ha	7.2	7.2	6.6	6.8	8.1	5.4	5.0
K Fert, kg ha	17.2	17.2	16.4	17.3	20.4	13.0	12.7
Concentrated fed, kg/LU	115	128	118	122	137	177	176
Stocking Rate (Cattle Rearing)	1.30	1.30	1.33	1.29	1.30	1.22	1.20
Stocking Rate (Cattle Finishing)	1.42	1.46	1.42	1.38	1.42	1.39	1.45
Average Farm Size, ha	34	35	35	35	35	35	35
Sheep							
N Fert, kg ha	41.1	56.8	41.9	44.3	47.1	25.6	29.4
P Fert, kg ha	6.2	7.6	7.1	6.5	7.6	4.3	4.2
K Fert, kg ha	14.1	17.4	16.0	14.9	17.7	8.9	9.8
Concentrated fed, kg/LU	531	494	392	381	409	359	375
Stocking Rate (Mid-Season Lowland)	1.72	1.69	1.61	1.57	1.62	1.49	1.48
Average Farm Size, ha	48	49	48	45	45	45	44
Mixed Livestock							
N Fert, kg ha	118.0	148.7	97.6	63.3	116.7	69.0	74.2
P Fert, kg ha	11.8	12.4	19.5	9.0	18.0	9.2	12.6
K Fert, kg ha	27.1	26.4	44.4	21.1	38.8	22.8	32.0
Concentrated fed, kg/LU	1,141	1,409	746	623	903	806	757
Average Farm Size, ha	74	77	95	68	92	67	95
Tillage							
N Fert, kg ha	112.1	121.8	110.0	99.8	102.1	90.8	101.5
P Fert, kg ha	20.1	22.3	20.2	21.7	22.0	16.0	18.0
K Fert, kg ha	59.3	62.6	62.6	59.6	62.9	48.3	55.0
Average Farm Size, ha	60	62	62	64	68	70	73

Tables 6 and 7 show the P, K and pH analysis for soil samples presented for analysis in 2023, from both all farms and dairy farms. On all farms the proportion of soil samples that were categorised suboptimum for P (Soil Index 1 to 2) was approximately 50%; the proportion on dairy farms was 45%. On all farms the proportion of soil samples that were suboptimum (Soil Index 1 and 2) for K was 44%; on dairy farms 43%. In terms of soil pH, 54% of soil samples on all farms were suboptimum (pH < 6.2) for soil pH and 49% of sail samples from dairy farms were suboptimum for pH. Across all farms only 14% of soil samples were optimum for all three tests; on dairy farms 35% of soil samples were optimum for all three tests.

Table 6. The proportion of both all farms and dairy farms in the differing soil P and soil K Indices for 2023

Item, % of farms		Soil Index			
		1	2	3	4
P Index	All farms	23	27	25	25
	Dairy farms	20	25	25	29
K Index	All farms	11	33	28	28
	Dairy farms	11	32	27	29

Table 7. The proportion of both all farms and dairy farms in the differing soil pH levels for 2023

Item	Soil pH level				
	< 5.5	5.5-5.9	5.9-6.2	6.2-6.5	> 6.5
All farms	13	23	18	17	29
Dairy farms	9	20	19	21	31

Munster Blackwater River Catchment

The Munster Blackwater River Catchment comprises 28 subcatchments with 158 river water bodies, no lakes, three transitional and one coastal water body, and 18 groundwater bodies. There are no heavily modified or artificial water bodies in the Munster Blackwater River Catchment. A total of 68% of surface water bodies were of Good or High Ecological Status in the 2016 to 2021 monitoring period. The Munster Blackwater River Catchment consists of a total area of 3,310 km^2.

The Blackwater rises on the southern side of Knockanefune in the Mullaghareirk Mountains (border between Cork, Kerry and Limerick) and flows south to Rathmore where it is joined by the Cullavaw River and the Owentaraglin River. The Blackwater continues eastwards to Banteer where it is joined by the Allow River from the north and the Glen River from the south. On its route east, the Blackwater is joined by the Awbeg after flowing through Mallow and eastwards to Fermoy. Downstream of Fermoy, the river is joined by its tributaries, the Rivers Funshion, Ariglin and Owennashad. The Blackwater becomes tidal, before turning abruptly south at Cappoquin where the Glennafilla River joins from the northeast. The tidal Blackwater is joined by the Finisk River and the Bride River from the west downstream of Villerstown. The Goish, Licky, Glendine and Tourig Rivers drain the lands adjacent to the estuarine part of the catchment, and the Blackwater then flows past Youghal and out to sea through Youghal Harbour.

Figures 3 and 4 shows the Pollution Impact Potential-Phosphorus (PIP-P) and Pollution Impact Potential-Nitrogen (PIP-N) maps, respectively, for the Munster Blackwater River Catchment. The more intensive the colour the higher the risk of P or N loss in that area. In the west of the catchment, risk of P loss is much greater (Rank 1, 2 and 3) due to the presence of heavy poor draining soils (Figure 3). In these areas, P loss occur where water flowing over land potentially carrying P or sediment is likely to enter a watercourse, like a stream, river or lake. In the eastern part of the catchment, the risk of N loss is much greater (Rank 1, 2 and 3) due to the presence of free draining soils (Figure 4) where water tends to drain away down through the soil.

Figure 5 shows the 28 individual subcatchments within the Blackwater River Catchment. Table 8 shows the proportion of land cover that is cultivated and proportion of farms that have an organic loading greater > 170 and ≤ 170 kg N/ha for each of the subcatchments in the Blackwater River Catchment. The average proportion of cultivated land in the Blackwater River Catchment is 10.7%, ranging from 0.4% for subcatchment Funshion_SC_010 to 34.7% for subcatchment Blackwater [Munster]_SC_100 (Figure 6). On average, 21.2% of farms had an organic loading > 170 kg N/ha; it ranged from 5.1% in subcatchment Blackwater [Munster]_SC_010 to 42.9% for subcatchment Bride[Waterford]_SC_010. Figure 7 shows the individual farm organic N load (kg N/ha) for the Blackwater River Catchment.

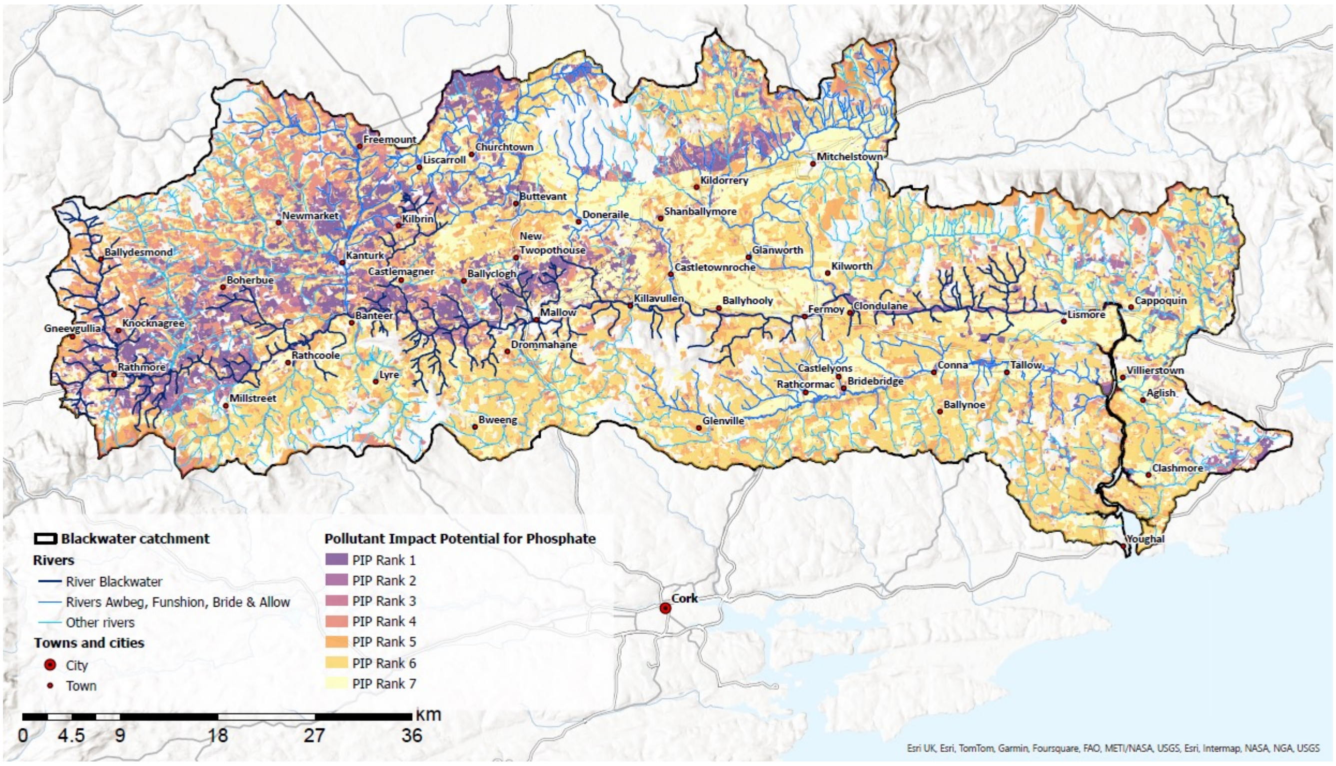


Figure 3. *Pollution Impact Potential for Phosphorus (PIP-P) map for the Munster Blackwater River Catchment. Data sources: WFD catchments, WFD Subcatchments, WDF River Waterbodies, PIP-PN maps (EPA, 2024d). Towns and cities (adapted from CSO, 2016)*

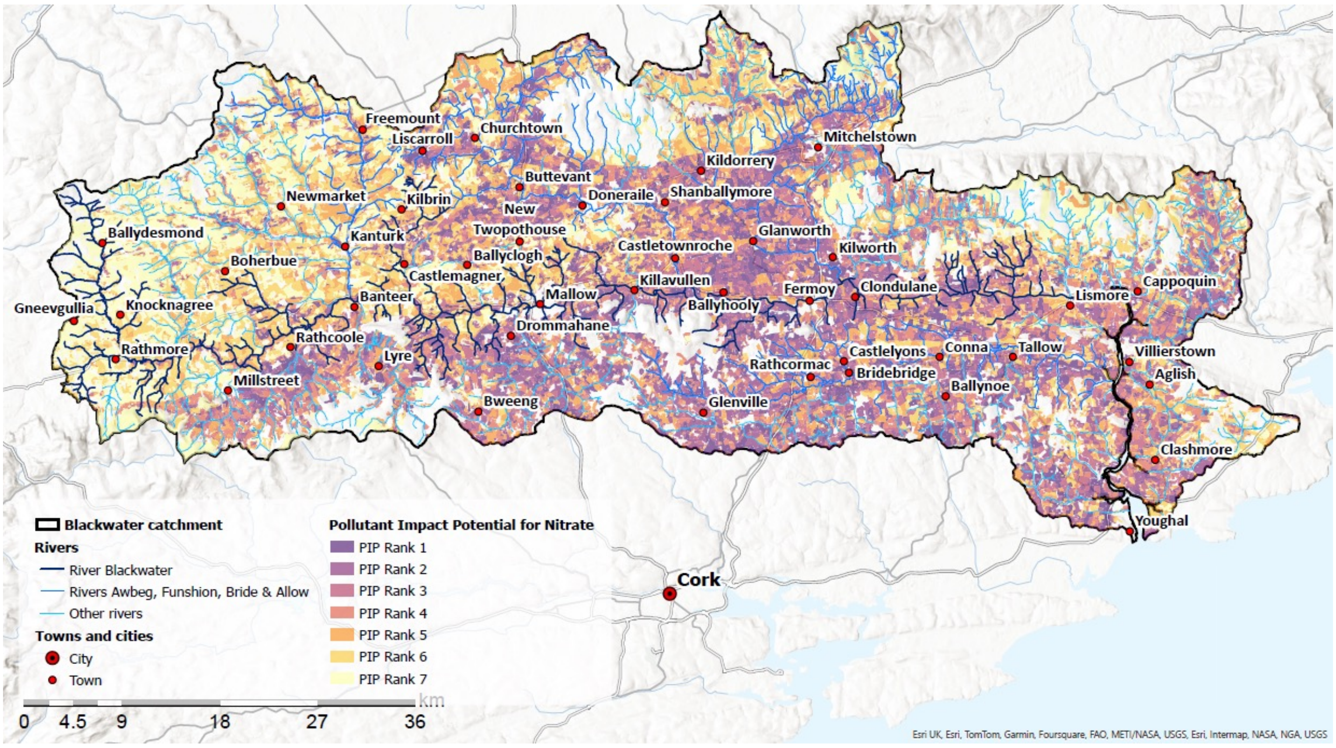


Figure 4. *Pollution Impact Potential for Nitrate (PIP-N) map for the Munster Blackwater River Catchment. Data sources: WFD catchments, WFD Subcatchments, WDF River Waterbodies, PIP-N maps (EPA, 2024d). Towns and cities (adapted from CSO, 2016)*

Table 8. **Individual subcatchment proportion of cultivated land, proportion of farms > 170 kg organic N/ha and proportion of farms ≤170 kg organic N/ha**

Name - Subcatchment ID	Cultivated Land	> 170 kg N/ha	≤ 170 kg N/ha
Awbeg[Buttevant]_SC_010 - 18_13	5.1	28.9	71.1
Awbeg[Buttevant]_SC_020 - 18_20	19.1	22.2	77.8
Blackwater[Munster]_SC_010 - 18_12	0.4	5.1	94.9
Blackwater[Munster]_SC_020 - 18_6	0.4	10.2	89.8
Blackwater[Munster]_SC_030 - 18_3	3.4	14.2	85.8
Blackwater[Munster]_SC_040 - 18_9	0.8	7.6	92.4
Blackwater[Munster]_SC_050 - 18_4	2.6	10.9	89.1
Blackwater[Munster]_SC_060 - 18_2	17.3	10.3	89.7
Blackwater[Munster]_SC_070 - 18_7	6.5	11.1	88.9
Blackwater[Munster]_SC_080 - 18_23	10.0	27.1	72.9
Blackwater[Munster]_SC_090 - 18_21	27.7	23.1	76.9
Blackwater[Munster]_SC_100 - 18_10	34.7	18.2	81.8
Blackwater[Munster]_SC_110 - 18_14	10.8	24.3	75.7
Blackwater[Munster]_SC_120 - 18_28	15.2	28.1	71.9
Blackwater[Munster]_SC_130 - 18_5	26.0	18.9	81.1
Blackwater[Munster]_SC_140 - 18_24	4.7	19.6	80.4
Bride[Waterford]_SC_010 - 18_11	5.5	42.9	57.1
Bride[Waterford]_SC_020 - 18_25	14.6	24.1	75.9
Bride[Waterford]_SC_030 - 18_19	18.6	31.1	68.9
Brogeen_SC_010 - 18_1	3.0	9.4	90.6
Crinnaghtane_SC_010 - 18_16	2.1	9.5	90.5
Dalua_SC_010 - 18_18	1.0	11.0	89.0
Dalua_SC_020 - 18_26	2.6	26.9	73.1
Finisk_SC_010 - 18_15	9.5	31.1	68.9
Funshion_SC_010 - 18_17	0.5	15.8	84.2
Funshion_SC_020 - 18_22	6.5	24.1	75.9
Goish_SC_010 - 18_27	12.4	21.2	78.8
Tourig_SC_010 - 18_8	20.6	29.1	70.9
Average	10.7	21.2	78.8

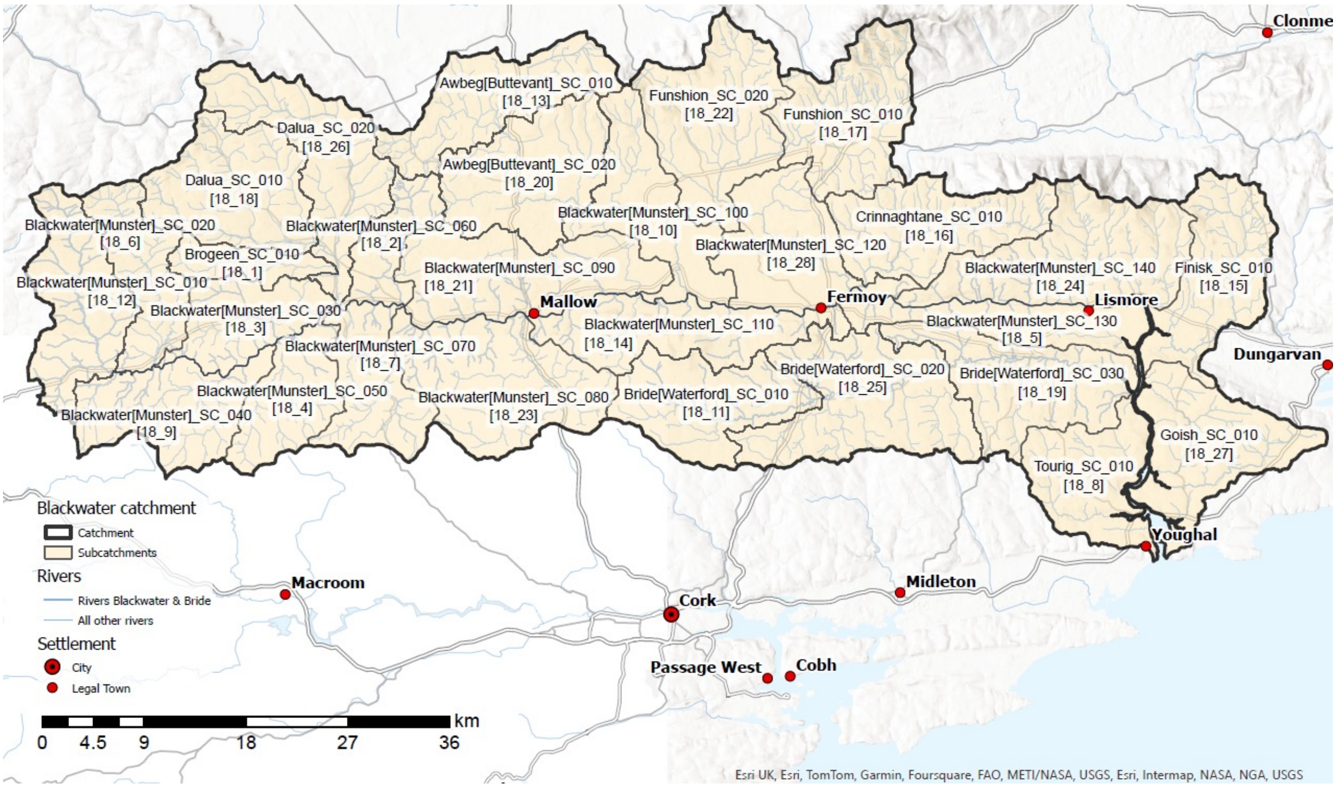


Figure 5. *The 28 individual subcatchments within the Munster Blackwater River Catchment. Data sources: WFD catchments, WFD Subcatchments (EPA, 2024d)*

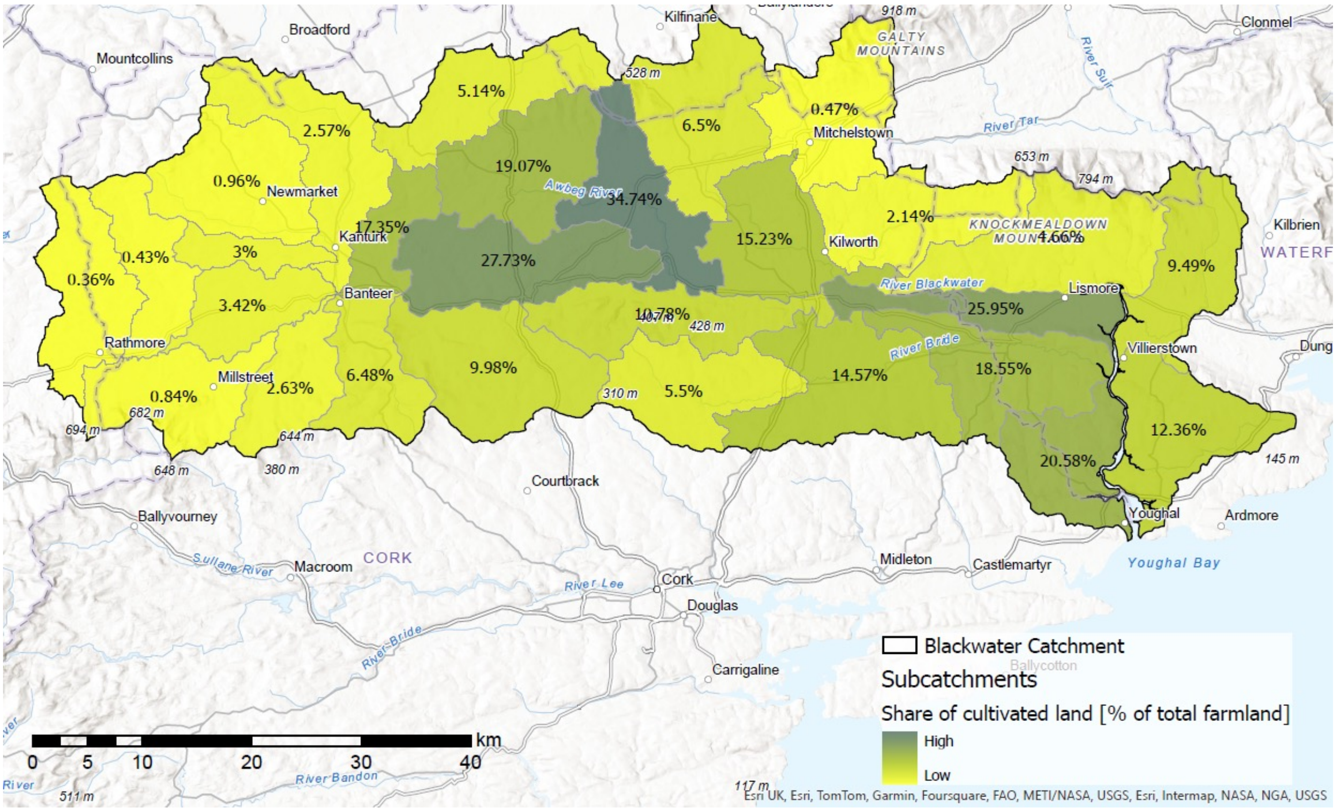


Figure 6. *Proportion of cultivated land in each of the individual Munster Blackwater River Subcatchments. Data sources: WFD catchments, WFD Subcatchments (EPA, 2024d); National Land cover map (Lydon & Smith, 2018)*

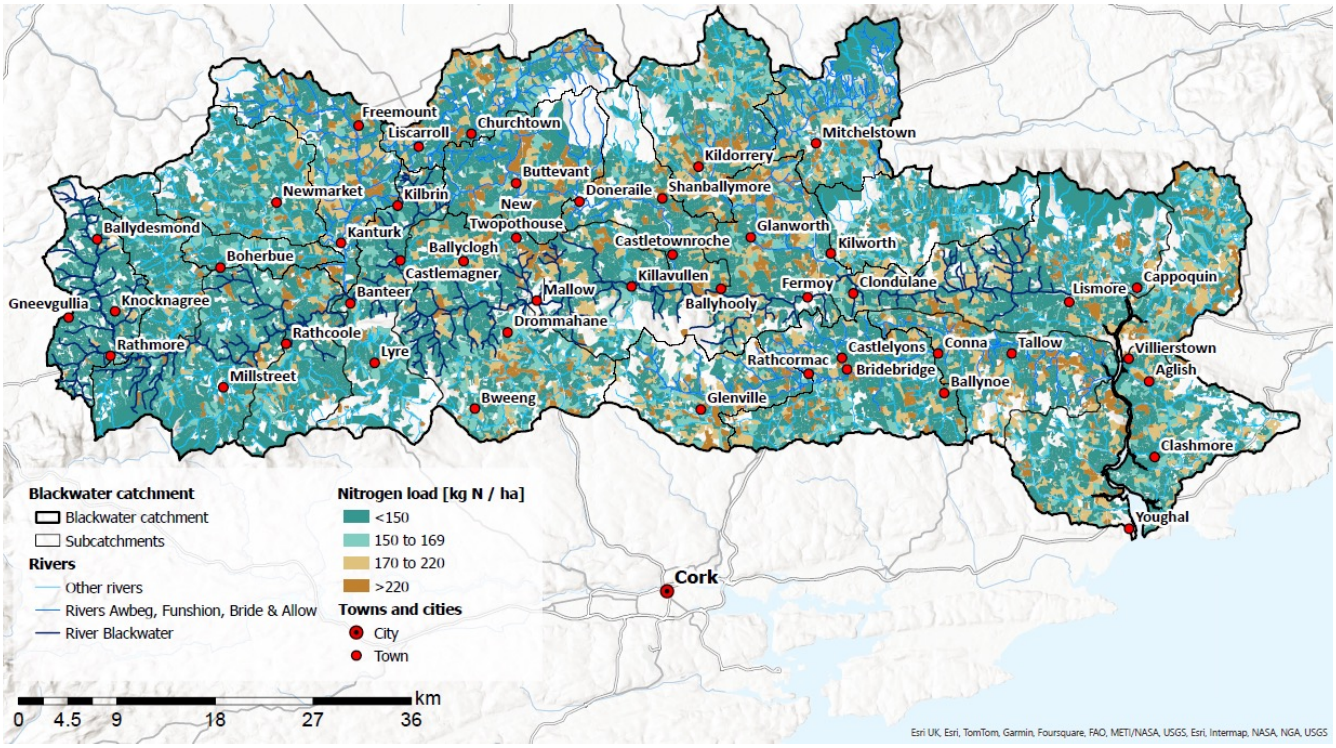


Figure 7. *Individual farm organic N (kg N/ha) loading in the Munster Blackwater River Catchment. Data sources: WFD catchments, WFD Subcatchments, WFD River Waterbodies (EPA, 2024d); Towns and cities (adapted from CSO, 2016); Nitrogen loads (DAFM, 2023)*

Trends in water quality in the Munster Blackwater River Catchment

Figure 8 shows the trends in both ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) for Lismore bridge (Monitoring Station RS18B022600), Tallow bridge (Monitoring Station RS18B050800), Kilcummer bridge (Monitoring Station RS18A051300) and Blackwater u/s (Monitoring Station RS18F051100) from 2007 to 2023. The Lismore bridge monitoring station (RS18B022600) was selected to best represent the trends in in ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) on the main river Blackwater. The Tallow bridge water quality monitoring station (RS18B050800) was selected to best represent the trends in ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) in the river Bride which is a tributary of the Munster Blackwater. The Kilcummer bridge monitoring station (RS18B050800) was selected to best represent the trends in ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) in the river Aubeg which is a tributary of the Munster Blackwater. The Blackwater u/s monitoring Station (RS18F051100) was selected to best represent the trends in ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) in the river Funshion which is also a tributary of the Munster Blackwater.

The average ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) at Lismore bridge were 0.026 (mg/l P) and 3.01 (mg/l N), respectively, in 2023. The trends indicate that ortho-phosphate levels have reduced over the period 2007 to 2023 and the levels in 2023 were less than the national average (0.029 mg/l P). Additionally the level of phosphate concentration are almost low enough to support high water quality status (0.025 mg/l P). The levels of total oxidised nitrogen (mg/l N) were higher than that required to support good water quality (1.8 mg/l N) and there was no indication of any reduction over the period 2007 to 2023.

The average ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) at Tallow bridge were 0.028 (mg/l P) and 4.17 (mg/l N), respectively, in 2023. Similar to the Blackwater the trends indicate that ortho-phosphate levels have reduced over the period 2007 to 2023 and the levels in 2023 were less than the national average (0.029 mg/l P). The levels of total oxidised nitrogen (mg/l N) were higher than that required to support good water quality (1.8 mg/l N), but there were indication that there was a tend reduction over the period 2007 to 2023.

The average ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) at Kilcummer bridge were 0.025 (mg/l P) and 3.07 (mg/l N), respectively, in 2023. Although, ortho-phosphate levels were low in 2023 there are indications that concentrations have increased somewhat over the period 2007 to 2023 and the levels in 2023 were less than the national average (0.029 mg/l P). The levels of total oxidised nitrogen (mg/l N) were higher than that required to support good water quality (1.8 mg/l N), but there were indication that there was a tend reduction over the period 2007 to 2023.

The average ortho-phosphate (mg/l P) and total oxidised nitrogen (mg/l N) at Blackwater u/s monitoring station were 0.024 (mg/l P) and 3.60 (mg/l N), respectively, in 2023. The trends indicate that ortho-phosphate levels have reduced significantly over the period 2007 to 2023 and the levels in 2023 were less than the national average (0.029 mg/l P). Additionally the level of phosphate concentration are almost low enough to support high water quality status (0.025 mg/l P). The levels of total oxidised nitrogen (mg/l N) were higher than that required to support good water quality (1.8 mg/l N) and there was indication that total oxidised nitrogen concentrations reduced over the period 2007 to 2023.

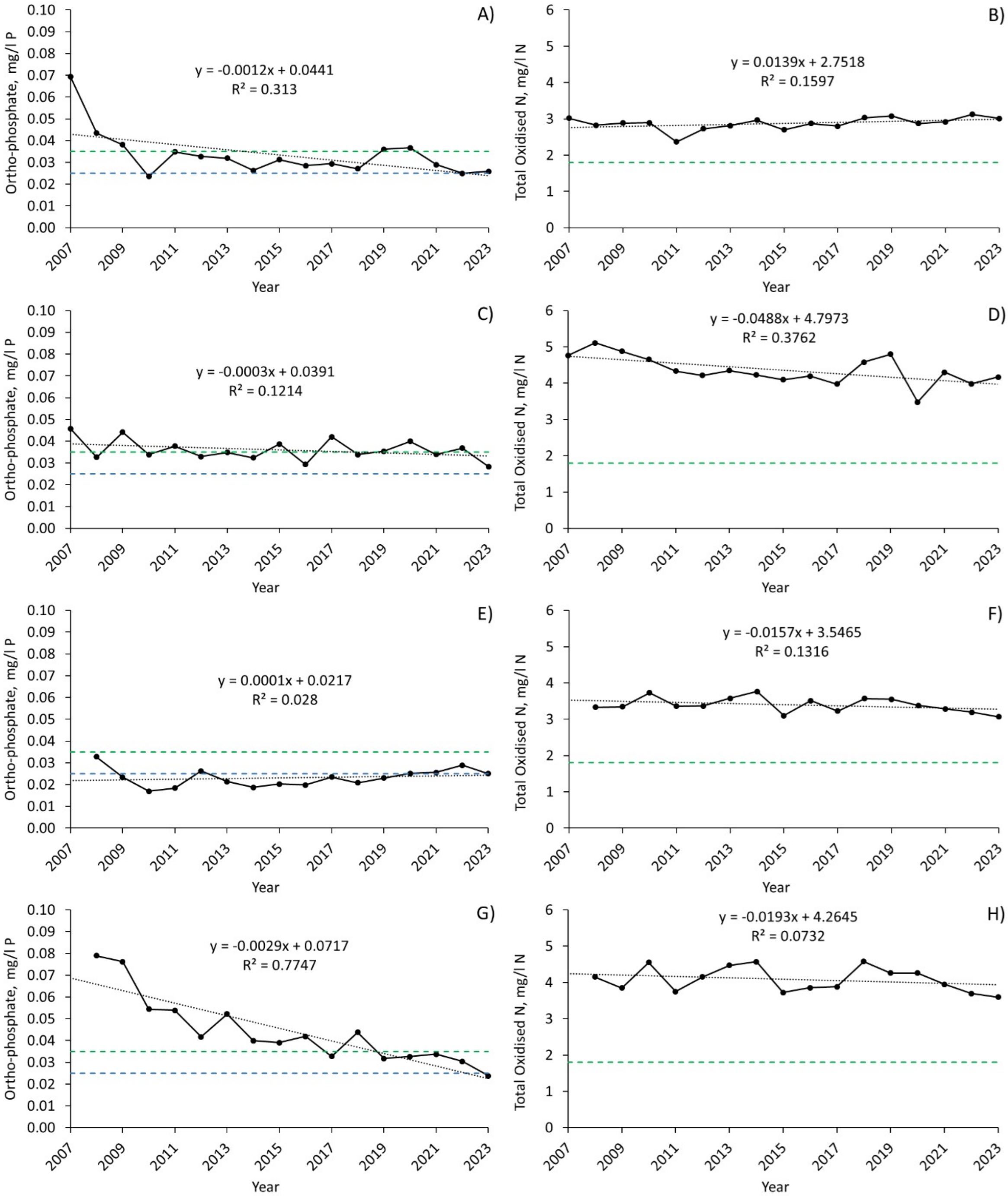


Figure 8. *Average river A) ortho-phosphate (mg/l P) at Lismore bridge, B) total oxidised nitrogen (mg/l N) at Lismore bridge, C) ortho-phosphate (mg/l P) at Tallow bridge, D) total oxidised nitrogen (mg/l N) at Tallow bridge, E) ortho-phosphate (mg/l P) at Kilcummer bridge, F) total oxidised nitrogen (mg/l N) at Kilcummer bridge, G) ortho-phosphate (mg/l P) at Blackwater u/s, and H) total oxidised nitrogen (mg/l N) at Blackwater u/s from 2008 to 2023 (EPA Catchments, 2024). For panels A, C, E and G indicating phosphate concentrations, good river status is represented by the green dashed line (< 0.035 mg/l P) and high river status is represented by the blue dashed line (< 0.025 mg/l P). For panels B, D, F and H indicating total oxidised nitrogen concentrations, good river status is represented by the green dashed line (< 1.8 mg/l N).*

Improving water quality in the Munster Blackwater River Catchment

Ireland needs to achieve good water quality targets as set by the Water Framework Directive. A vital step in achieving this is by providing technical support to farmers to increase their understanding of the impacts of farming on water quality and the actions to minimise the loss of nutrients and sediment to water bodies.

Dairy

Poorly drained soils have a greater risk of P loss due to low P binding capacity and overland flow pathways. This is depicted in the PIP-P maps (Figure 3) with the western part of the Munster Blackwater River Catchment at greater risk for P loss. While overland flow pathways are the most concerning, there are other sources of P loss such as erosion, leaching and drainage. One of the most effective strategies available to reduce P loss is by implementing a robust field scale nutrient management plan. By tailoring organic and chemical fertiliser P applications based on soil tests and crop demands, adequate levels of plant-available soil P can be achieved, minimising excess P available for loss to the environment. There is scope to improve our management of P, as only 25% of farms nationally are achieving the optimal soil P Index of 3 (Table 6). Soils in Index 4 have excessive levels of P with an increased risk of P loss to the environment. Soils in Index 1 and 2 have reduced herbage production capability, which can lead to other issues such as lower N use efficiency and environmental N emissions. In addition, optimal soil pH and lime application is vital for increasing soil P availability for plant uptake. Ultimately, it is critical that slurry is targeted to low index soils and that manure application is balanced with crop off takes, for example, applying to land that is typically utilized for silage production.

Farm gate P balance is also important in controlling the amount of surplus P in the farm system. The main imports of P onto a farm are fertiliser and feed with the main exports being milk and meat. If the import of P exceeds the export of P, a P surplus typically occurs which either accumulates in the soil (i.e. build-up) or is lost from the system, principally to water. From 2017 to 2023, P fertiliser imports have reduced on Irish dairy farms by 23%; however, P concentrate feed imports have increased by 18% (Figure 9). As P exports have remained largely static over the period, there has been a reduction in overall P balance by 10%. While this is a positive outcome and ultimately reduces the source of P available for loss, the sustainability of reducing P fertiliser while increasing P imports through concentrate feed needs to be considered nationally and within the Munster Blackwater River Catchment.

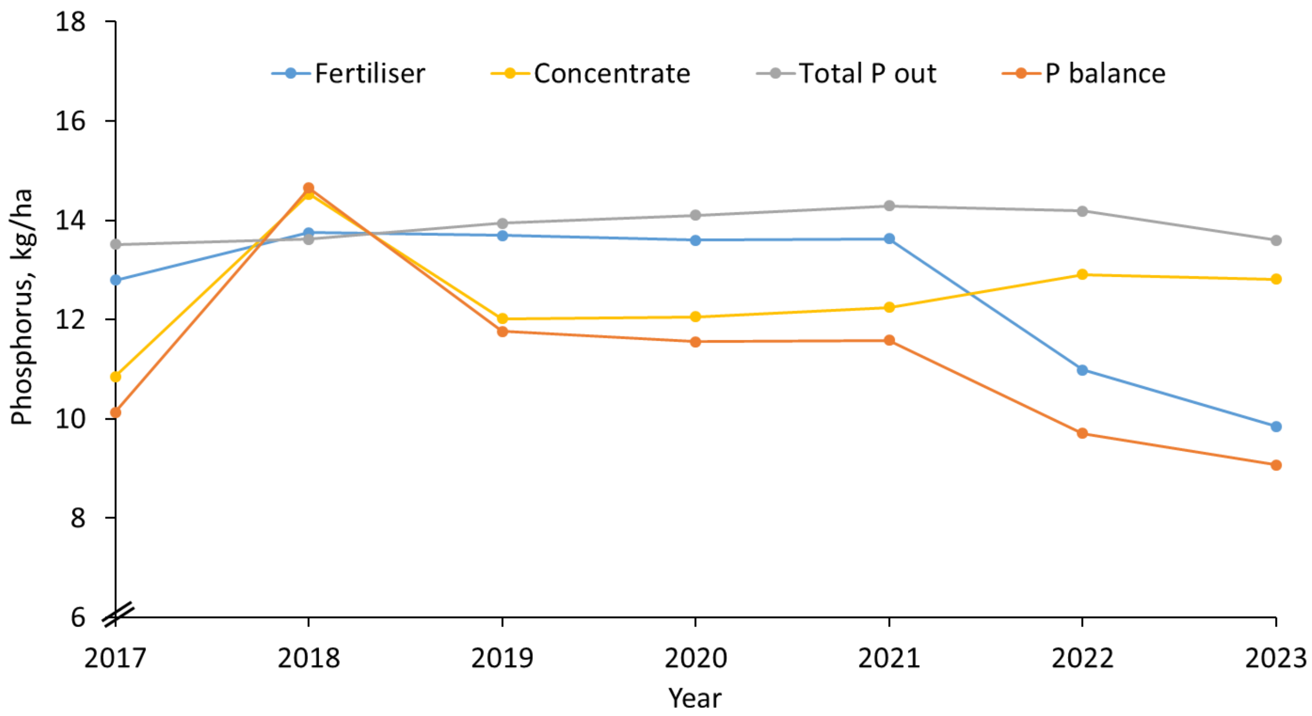


Figure 9. *P fertiliser, concentrate, outputs and balance (kg/ha) on dairy farms from 2017-2023 (NFS, 2024)*

In Northern Ireland, there has been an upward trend in the P balance of all farms from 8.7 kg of P/ha in 2008 to 12.3 kg of P/ha in 2017 (Doddy *et al.*, 2020). This has primarily been driven by an increase in concentrate P purchases from 13.4 kg of P/ha in 2008 to 16.8 kg of P/ha in 2017 with a slight increase in chemical fertiliser P purchases from 3.1 to 4.5 kg of P/ha (Doddy *et al.*, 2020). Although wastewater treatments plants can contribute substantially to P emissions, the trend in Northern Ireland river phosphate concentration over the same period has mirrored that of farm P balance (Figure 10). This highlights the importance of maintaining pasture-based systems that have a low reliance on imported concentrate feed to maintain high water quality in our rivers. Across all farms in the Republic of Ireland, P balance has reduced from 7.8 kg of P/ha in 2018 to 4.5 kg of P/ha in 2023 (NFS, 2024). Both nationally and in the Munster Blackwater River Catchment, the majority of river sites are now achieving good river phosphate concentrations status (Figures 2B, 8 and 10), however, it is crucial we continue the trajectory towards achieving high river phosphate concentrations status through optimizing fertiliser P use and optimizing concentrate feed imports.

Figure 10. *River phosphate concentrations in Northern Ireland (soluble reactive phosphate) and the Republic of Ireland (molybdate reactive phosphate) from 2010-2023 (DAERA, 2024; EPA, 2024b). Good river status is represented by the green dashed line (< 0.035 mg/l P) and high river status is represented by the blue dashed line (< 0.025 mg/l P).*

Adequate slurry storage is also vital so that the correct slurry application levels can be applied during appropriate weather conditions. In the Republic of Ireland, current regulations require 0.33 m^3/cow/week for slurry storage and 0.21 m^3/cow/week for soiled water storage. Preliminary findings are emerging from a Teagasc nationwide monitoring programme, which was established in the first half of 2023, involving 100 dairy farms selected to represent variability in location, climate, scale, stocking density and developmental stage. These findings are suggesting that in winter 2023/2024, slurry tanks collected an average of 0.414 m^3/cow/week, while soiled water tanks collected an average of 0.30 m^3/cow/week in peak months (Tuohy, personal communication). However, the monitoring programme noted that a significant volume of water, estimated at 20-40 L/cow/week (0.02-0.04 m^3/cow/week) equivalent on average, is entering storage tanks. If these rates were to be adopted, slurry storage requirements would increase by approximately 20%, while soiled water storage requirements would increase by approximately 33%, outside of allowances for rainfall runoff. More data is being collected to provide a full understanding of overall volumes collected in this study. It is important that other effective strategies to reduce P loss are utilized such as preventing run-off from yards and roadways, as well as, the implementation of sediment traps.

The critical risk areas for nitrate loss in the Munster Blackwater River Catchment are in the central and east areas due to more free draining light soils. Mitigation actions for nitrate loss are best targeted at controlling loss at source and reducing the N surplus. Similar principals apply, as discussed above for P, around the tailored use of organic and chemical fertilisers. Adequate slurry storage is vital to ensure that maximum nutrient use efficiency can be achieved from organic manures. Adequate slurry storage will support slurry application during conditions when plant demand for N is high and when soils are not saturated, which are also crucial consideration when applying chemical N fertiliser. Ensuring yards are sealed and eliminating point source loss are vital to reduce nitrate leaching. In addition to the Nutrient Importation Storage Scheme outlined below, a separate Nutrient Storage Scheme has been proposed to support farmers with a targeted grant-aid of 60%. The adoption of low emission slurry spreading will also improve N utilization and reduce environmental N emissions.

The inclusion of white clover into perennial ryegrass swards has been demonstrated to increase the milk production efficiency of lactating dairy cows while simultaneously reducing the amount of chemical N fertiliser required, when sward clover content is > 20% (McClearn *et al.*, 2019). By reducing chemical N application, significant reductions in ammonia and nitrous oxide emissions can be achieved especially when the remaining chemical N is applied in the form of protected urea. Reducing chemical N application will also reduce nitrate loses from fertiliser. However, as total N inputs into a system increases, there is an exponential rise in the nitrate N that can be leached, regardless of whether the N input comes from biological N fixation or chemical N fertiliser (Ledgard *et al.*, 2009).

Animal urinary deposits can contribute to the amount of nitrate leached from agriculture. Urinary N is excreted mainly in the form of urea, which can be rapidly mineralised in the soil to ammonium and nitrified to form nitrate. As nitrate is not strongly held in the soil, there is a high risk for it to be leached. Estimates vary in regard to how much of urinary N is leached, with many factors affecting the outcome, such as, soil type, application rate, plant growth rate and weather conditions. In a recent analysis of N loss from grass-based dairy systems, an estimated emissions factor of 26% was used to determine the proportion of urine N that is leached across the full year (Shalloo *et al.*, 2023). In a review of experiments quantifying nitrate loss from urine deposits, Selbie *et al.* (2015) determined that the median nitrate-N loss was 15% of applied urinary N (Figure 11). The experiments within this dataset were mostly focused on autumn applications, when the risk for nitrate loss is greatest. Furthermore, the rate of urine N application was quite high in 40% of the experiment (> 900 kg of N/ha) which is unlikely to be the application rate in Ireland. In the small number of spring and summer experiments, half of the experiments observed nitrate loss of < 5% (Figure 11; Selbie *et al.*, 2015). Further work is ongoing within Teagasc to strengthen our estimate around how much urinary N is typically leached, as there is a wide range reported across many countries.

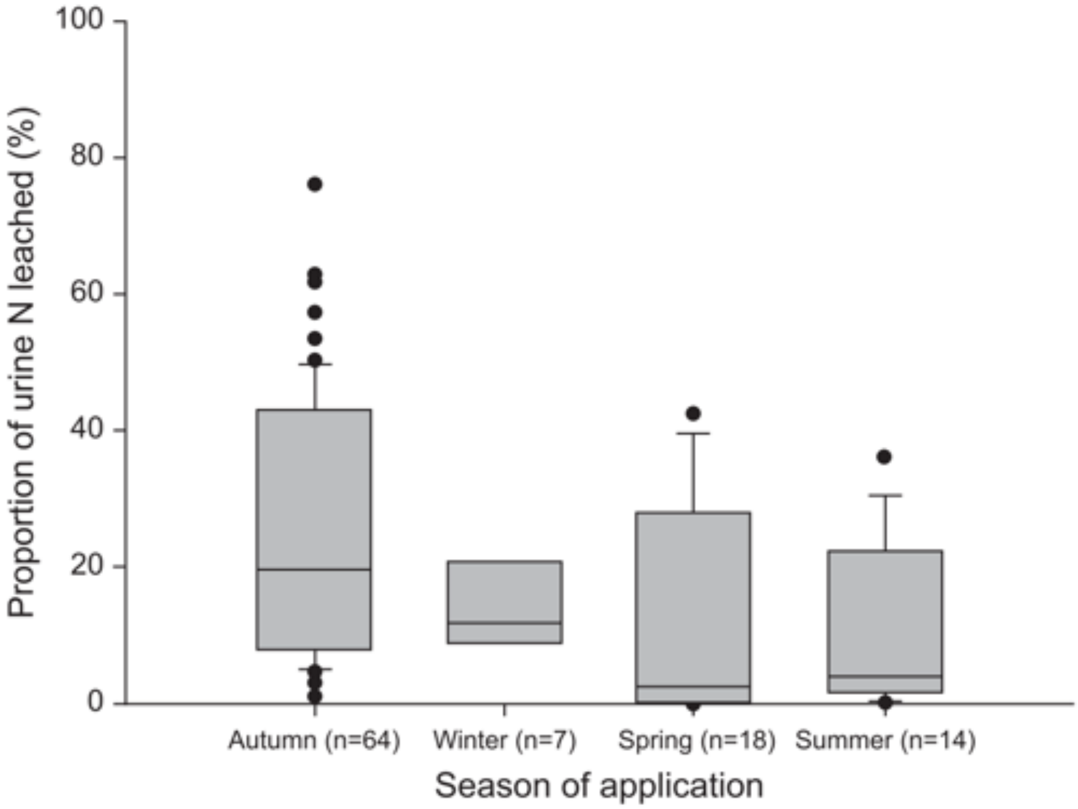


Figure 11. *NO3–N leaching loss by season of application from 22 experiments (103 data points). Losses are reported as a percentage of the urinary N applied. The horizontal line is the median (Adapted from; Selbie et al., 2015).*

Regardless, mitigation actions are required to reduce nitrate loss from urine deposits. Dietary CP (N*6.25) intake is strongly related to urinary N excretion. In pasture-based systems, high CP intake can typically occur during the shoulders of the year due to greater pasture CP concentrations. In a recent study, the average CP concentration of pasture was monitored across 2 grazing seasons on 28 intensive dairy farms (Figure 12). Average pasture CP (mean ± SD) was 18.6 ± 2.9%, with the spring and autumn periods averaging 20.8 ± 3.0% and 21.8 ± 3.0%, respectively. During the shoulders of the year, plant growth rates are lower, reducing the plant's demand for N and its ability to recycle urinary N. In addition, there is typically higher rainfall leading to greater soil water drainage volumes, which can contribute towards greater risk for nitrate loss. It is important to note that during these time periods dietary supplementation is typically required, in the form of moderate to low CP feeds (i.e. silage and concentrate), to support deficits in pasture supply. Altogether, during the autumn when both the cow's and plant's demand for N are low, it is crucial to utilize low CP supplements. However, caution is advised against utilising excessive concentrate supplementation as this can lead to trade-offs resulting in excess concentrate P imports (discussed above), milk of greater carbon intensity and reduce economic resilience. Teagasc are currently exploring other strategies, such as, the use of on-off grazing and plant species that can reduce nitrate loss. Ultimately, a dynamic combination of dietary and management strategies that complement the biological N fixation of white clover will be required to reduce nitrate loss.

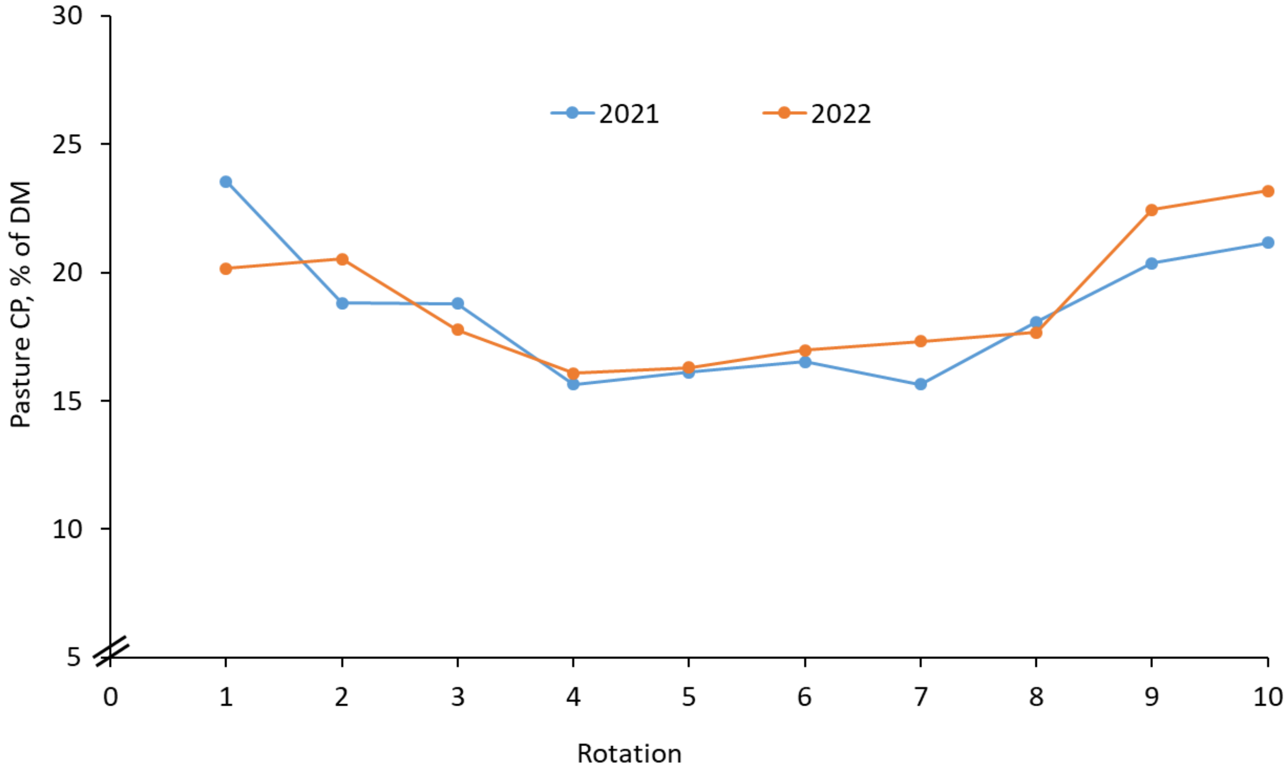


Figure 12. *Average pasture crude protein per grazing rotation on 28 commercial dairy farms across 2021 and 2022 (Van Emmenis et al., unpublished)*

Dry-stock

On intensive beef and sheep farms, the same mitigation technologies such as adequate slurry storage, tailored fertiliser application management and reducing point source loss apply as discussed above. In low-stocked beef and sheep farms the risk associated with N loss is much less but the risks associated with P and sediment loss are equally important. Many low stocked beef and sheep farms are located on heavy soils on the west of Ireland. Additionally, a large proportion of these farms are located in areas of the country where High water quality status is required. High status objective or "blue dot" waters bodies are water bodies which are either currently at High status or have been at High status in the recent past and for which a target of restoring them to High status has been set in the River Basin Management Plan. Sediment loss to water has been identified as a major concern on these farms. If sediment finds its way to the stream, it can settle on the river-bed in slow flow areas, resulting in the loss of macroinvertebrate habitat and spawning ground. Nutrient application followed by significant rainfall on poorly draining and low permeability soils leads to overland flow transporting nutrients to waterbodies. Riparian buffer zones adjacent to a water body can protect it from diffuse loss of nutrients and sediment. Mitigation options to reduce sediment loss include; preventing access by livestock into drains and streams by providing alternative drinking water sources; diverting all surface runoff from farm roadways to a field or soak pit; establishing targeted riparian buffer zones and only carrying out drain maintenance during the months of July to September.

Intensive agriculture – pigs

Today, Ireland has approximately 280 commercial pig farms comprising ~200 sow breeding/ integrated farms with an average herd size of ~700 sows and ~80 specialised finishing farms, and a national output of 3.8 million pigs. In Ireland, the pig industry is concentrated in a small number of counties. In the Munster Blackwater River Catchment, it is estimated that there are approximately 23 pig farms comprising of approximately 19,000 sows or 13% of the national sow herd. It is estimated that these 23 farms produce 378,237 cubic metres of pig slurry. All pig farmers are currently required to have 26 weeks of slurry storage on their farms. Additionally, in recent years there has been a significant increases in the number of pigs produced per sow per year increasing the slurry storage requirements per sow.

Over the past 20 years, the provision of low protein diets and phytase enzyme has greatly reduced the level of N and P exerted, respectively. Teagasc has investigated a number of technologies for using and treating pig manure. Technologies for the treatment of manure such an anaerobic digestion, composting, integrated constructed wetlands, and woodchip biofilters and intermittently aerated sequencing batch reactors have been evaluated, but none of these were found to be cost effective. The role of anaerobic digestion on integrated pig units may be effective in limited scenarios. Thus, land spreading remains the most cost-effective use of pig slurry.

Farmers can make substantial savings by using pig slurry to replace the nutrients supplied by chemical fertilisers. At 4.3% solids, each cubic meter of pig slurry contains approximately 4.2 kg of N, 0.8 kg of P and 2.2 kg of K. The actual value of pig manure as a fertiliser depends on how much chemical fertiliser is replaced, as well as, the cost of the chemical nutrients replaced. The fertiliser value of pig manure at 4.3% solids is currently valued at €7.10 per m^3 when there is a requirement for N, P and K and when the availability of the N to the crop is 50%. This translates into €32 per 1000 gallons. As the solids content increases there will be a corresponding increase in the nutrient content and in the fertiliser value.

Pig slurry can be applied to grassland farms that have stocking rates <170 kg/ha of organic N and on tillage lands. All farmers taking pig slurry onto their farm should be aware of their obligations to ensure compliance with the 'nitrate' regulations. In the Munster Blackwater River Catchment, there are good opportunities to use pig slurry on tillage farms given the proximity of both enterprises. The new Nutrient Importation Storage Scheme which has a 70% grant aid for slurry storage announced as part of Budget 2024 is now available. Having slurry storage on tillage farms increases slurry storage availability to pig farms. Additionally, it increases the window when pig slurry can be allied on tillage farms resulting in greater uptake of N by the growing crop. It also provides tillage farmers with fertiliser at very low costs.

Role of over-winter green cover to reduce N leaching from tillage land

Excessive nitrate leaching to groundwater is often associated with intensive tillage farming, especially in spring sown systems where the land is left fallow over the winter. Two processes for reducing nitrate leaching from tillage land include plant N uptake (via a cover crop) and denitrification influenced by the presence of organic carbon. The role of over-winter green cover (e.g. cover crops) growth as a mitigation measure to reduce nitrate leaching loss during the winter recharged period has been well recognised. A study was carried out at Teagasc Oak Park during three over-winter seasons (2006/2007, 2007/2008 and 2008/2009) after spring cereal crops on a free draining soil that was prone to leaching due to its highly gravelly and sandy texture (Premrov *et al.*, 2012). The experiment included the establishment of three over-winter green covers; Mustard Cover Crop, Natural Green Regeneration of natural vegetation that included weeds, grasses and cereal volunteers and No Green Cover that was achieved by spraying with herbicide each year after harvesting in the autumn. Piezometer were installed in the sand and gravel aquifers to a level of 4 meters below ground level to monitor the groundwater nitrate leaching. Additionally, ceramic suction cups were installed at 0.9 to 1.5 meters below ground level to monitor unsaturated zone nitrate leaching. Regular sampling of groundwater was performed from early November 2006 to March 2009.

There was large variation between years in dry matter biomass harvested (123 to 2,515 kg DM/ha) and N uptake (5 to 60 kg N/ha) over the three years; Table 9 shows the average over the three years. The N uptake of the Mustard Cover Crop was significantly higher than by the Natural Regeneration in all three years. Mean groundwater nitrate-N concentrations over the three years were 18.0, 22.4 and 23.9 mg/l of N for the Mustard Cover Crop, Natural Green Regeneration and No Green Cover, respectively. Mean groundwater nitrate concentrations were significantly lower under the Mustard Cover Crop than the No Green Cover treatment. In conclusion, Mustard Cover Crop and Natural Green Regeneration over-winter green cover reduced nitrate leaching by 25% and 6%, respectively, when compared to No Green Cover. These results are in agreement with other published studies. In summary, the establishment of over-winter green cover (sufficient growth and N uptake) on tillage land during the over-winter recharge period can be a good measure at reducing nitrate leaching loss from tillage land to groundwater.

Table 9. Dry matter biomass and N uptake by Mustard Cover Crop and Natural Regeneration Green Cover (average over 2007, 2008 and 2009; Adapted from; Premrov *et al.*, 2012)

Item	Mustered Cover Crop	Natural Regeneration Green Cover
Biomass, kg of DM/ha	1,575	990
N uptake, kg of N/ha	39	22

Conclusion

Increased slurry storage will allow grassland farmers to increase slurry nutrient use efficiency, reduce N surplus per hectare and reduce N loss to water. Slurry application location, timing, application technique and rates are of the utmost importance. The 'location' of slurry spreading (i.e. on paddocks in Index 1 and 2 for P and K and paddocks with high demand for P and K such as silage ground) is crucial. Adopting the correct application timing and technique (i.e. the application of slurry in spring (March/April) using trailing shoe) has been found to increase the N value of slurry threefold compared to spreading in the summer (June) with a splash plate. Grassland farmers need to re-evaluate their slurry storage requirements.

Farmers need to ensure that the farmyard is managed carefully to prevent and minimise point source nutrient and sediment loss to waters. Wastes associated with the feeding and housing of livestock (i.e. slurry and silage effluent, etc.) must have adequate collection and storage facilities. Reduce the soiled area of your yard by regularly cleaning dirty areas, restricting farm 'traffic' to certain parts of the yard and having yard surfaces that are easy to clean. Additionally, reduce the volume of clean water flowing across the yard areas by diverting clean water from shed roofs away from the yard areas. Have gutters and downpipes in good working order and pipe rainwater directly to drains.

In low-stocked beef and sheep farms located on heavy soils in the west of Ireland, risks associated with P and sediment loss are high. Mitigation options to reduce sediment and P loss include; preventing access by livestock into drains and streams by providing alternative drinking water sources; diverting all surface runoff from farm roadways to a field or soak pit; establishing targeted riparian buffer zones and only carrying out drain maintenance during the months July to September.

Tillage land left fallow over the winter is prone to nitrate leaching to groundwater especially on free draining soils. Over-winter green covers have the ability to uptake significant amounts of N over the autumn/winter period. This will result in reducing nitrate leaching loss from tillage land to groundwater during the recharged period.

There is a requirement to increase the nutrient use efficiency of manures coming from intensive agriculture farming enterprises such as pigs and poultry. Farmers can make substantial savings by using pig slurry to replace the nutrients supplied by chemical fertilisers. Pig slurry can be applied to grassland farms that have stocking rates <170 kg/ha of organic N and on tillage lands. The 70% grant aid for slurry storage for tillage could increase the window when pig slurry can be allied on tillage farms resulting in greater uptake of N by the growing crop. It also provides tillage farmers with fertiliser at very low costs.

References

Better Farming for Water; 8-Actions for Change, 2024.

CSO 2016. CSO Settlements Ungeneralised 2015. Source: data.gov.ie. Accessed November 2024

DAERA, 2024. Northern Ireland Environmental Statistics Report.

DAFM, 2023. Anonymous LPIS and N&P data for 2022. Source: data.gov.ie. Accessed October 2024

Doody, D. G., S. A. Rothwell, J. M. Ortega, C. Johnston, A. Anderson, M. Okumah, C. Lyon, E. Sherry, and P. J. A. Withers. 2020. Phosphorus stock and flows in the Northern Ireland food system. RePhoKUs Project Report, October 2020.

EPA Catchments, 2024. Available at: https://www.catchments.ie/

EPA, 2024a. Report series: Impacts of pressures on water quality - Agriculture

EPA, 2024b. Water quality in 2023. An indicators report.

EPA, 2024c. Water quality monitoring report on nitrogen and phosphorus concentrations in Irish waters 2023.

EPA, 2024d. EPA Geo Portal. Water / Water Framework Directive

EPA, 2021a. Water quality in Ireland 2016-2021

EPA, 2021b. Assessment of the catchments that need reductions in nitrogen concentrations to achieve water quality objectives. WFD River Basin Management Plan – 3rd Cycle

EPA, 2019. Water Quality in Ireland 2013-2018

Fenton, O., R.P.O. Schulte, P. Jordan, S.T.J. Lalor, and K.G. Richards. 2011. Time lag: a methodology for the estimation of vertical and horizontal travel and flushing timescales to nitrate threshold concentrations in Irish aquifers. Environ. Sci. Pol. 14:419–431.

Ledgard, S., R. Schils, J. Eriksen, and J. Luo. 2009. Environmental impacts of grazed clover/grass pastures. Irish J. Agric. Food Res. 48:209–226.

Lydon, K. and G. Smith. 2018. National Land Cover Map of Ireland 2018

McClearn, B., T. Gilliland, L. Delaby, C. Guy, M. Dineen, F. Coughlan, and B. McCarthy. 2019. Milk production per cow and per hectare of spring calving dairy cows grazing swards differing in *Lolium perenne* L. ploidy and Trifolium repens L. composition. J. Dairy Sci. 102:8571-8585.

Murphy, D.J., P. Dillon, M. O'Donovan, L. Shalloo, and E. Ruelle. 2024. Nitrate leaching on Irish grassland dairy farms: a review. European Journal of Agronomy 153:127042.

NFS, 2024. Teagasc National Farm Survey 2023.

Osawe, O.W., J. Curtis, and C. O'Donoghue. 2024. Agriculture and water quality in Ireland: new ideas for policy. Biology and Environment: Proceedings of the Royal Irish Academy. 124:1.

Premrov, A., C.E. Coxon, R. Hackett, L. Kirwan, and K.G. Richards. 2012. Effects of over-winter green cover on groundwater nitrate and dissolved organic carbon concentrations beneath tillage land. Sci. Total Environ. 438:144–153.

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

Selbie, D. R., K. C. Cameron, H. J. Di, J. L. Moir, G. J. Lanigan, and K. G. Richards. 2015. The effect of urinary nitrogen loading rate and a nitrification inhibitor on nitrous oxide emissions from a temperate grassland soil. J. Agric. Sci. 152:159–171.

Workshop 1: Trends in TB, reducing risk for dairy herds

Key speakers: Damien Barrett, Niamh Field & Derek O'Donoghue

Herd TB incidence rates are increasing, from 3.72% in 2019 to 5.17% in 2024, resulting in 5,280 affected herds nationally (Q2-2024). Data also shows dairy herds to be at greater risk of breakdown.

This workshop will discuss in detail how to reduce the risk of introducing infection, and will offer insight and advice on managing the herd in the event of a TB outbreak. It will also feature a case study of a TB breakdown from the Salesian College Herd, Pallaskenry. This will bring a real-world example of the impact and management of a prolonged TB breakdown. The main points to be covered are:

What are the main sources of infection for TB-infected herds?

- Understanding the TB skin test and the role of supplementary blood testing in managing breakdowns
- Residual infection in the herd - is it a significant issue for dairy farmers?
- How to improve biosecurity and reduce the risk of transmission of TB from environment and wildlife to the herd

Workshop 1 Speakers

Dr. Damien Barrett – Department of Agriculture, Food & the Marine

Damien is head of the Ruminant Animal Health Programmes division in the Dept of Agriculture, where he has responsibility for statutory ruminant diseases, most notably TB and BVD / IBR. He is also an adjunct associate professor in the School of Veterinary Medicine in UCD. Previous roles in the Dept, include TSE policy, and surveillance. He qualified as a vet from UCD in 1996, he has a number of post graduate qualifications, the most recent of which was a PhD on the epidemiology of Schmallemberg virus in Ireland awarded in 2020.

Dr. Niamh Field – Teagasc Research Officer, Moorepark

Niamh is a dairy herd health research officer based in Teagasc Moorepark. Niamh has a degree in veterinary medicine from UCD and spent four years in large animal clinical practice before joining Teagasc. Having recently completed a PhD focused on Johne's disease, she is now leading three research projects on bovine TB in collaboration with DAFM.

Derek O'Donoghue – College Principal Salesian Agricultural Collage, Pallaskenry

Derek graduated from UCD in 1993 with a Degree in Agricultural Science, specialising in Animal Production. Prior to joining Salesian Agricultural College, Derek worked for more than 19 years with Teagasc where he held roles as a Dairy Adviser, Drystock Adviser, Tillage Adviser and Tillage Specialist. Derek is responsible for the overall management and daily operation of the college and farm, with the farm running a herd of 460 spring calving dairy cows.

Trends in TB, reducing risk for dairy herds

Damien Barrett[1], Niamh Field[2] and Derek O'Donoghue[3]

[1]Department of Agriculture Food and Marine; [2]Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Co. Cork; [3]Salesian College, Pallaskenry, Co. Limerick

Introduction- Current trends in herd TB incidence rates

National trend data on herd bovine TB incidence and reactor numbers has shown an unwelcome increase across 2023 and 2024 (Figure 1, available at *www.bovinetb.ie*). An increasing proportion of TB-restricted herds are dairy herds. There are a number of potential factors why dairy herds may be relatively higher risk of infection, including relatively larger herd scale and having animals in closer air-space proximity at daily milking times. These may contribute to greater animal-to-animal transmission and residual infection risks. There is a significant degree of regional variation in TB incidence rates, with significant clusters of infected herd in the North East, South West and South Midlands in particular.

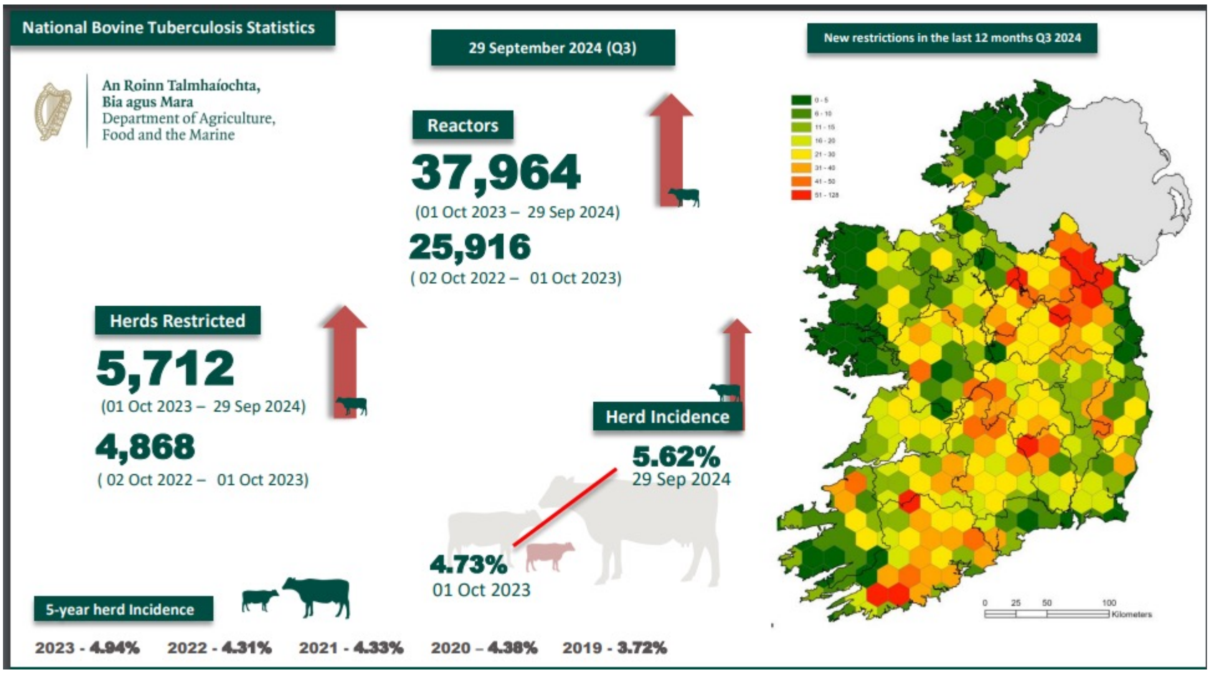


Figure 1. *Trends in Bovine TB incidence rates in Ireland, 2023-24*

How accurate is the TB skin test?

The accuracy of any disease diagnostic test can be defined by two separate but related metrics:

Sensitivity- the ability of the test to correctly identify a truly infected individual as having disease

Specificity- the ability of the test to correctly identify a non-infected animal as not having disease.

Therefore, a test with high sensitivity has a low 'false negative' rate while a test with high specificity has a low 'false positive' rate.

In terms of a single TB skin test, the sensitivity under good testing procedures is approximately 80% while the specificity is around 99.5%. In other words, for every 100 infected animals, the skin test will pick up 80 truly infected animals and 20 will go undetected i.e. false negative. On the other hand, only about 1 in 5,000 skin reactors will be a false negative in real terms. This runs contrary to a commonly held belief that there are a high proportion of 'false positives' on the skin test, which often is linked to the absence of detected lesions for the reactor animal in the factory. However, absence of detected lesions does not mean absence of disease.

In a herd breakdown situation, the sensitivity levels of the TB skin test means there is risk of leaving residual infection behind, which can lead to within herd spread and prolonged, more severe stock losses over time. Repeating the skin test and using a complementary blood gamma interferon (GIF) test will increase the aggregate sensitivity of the testing schedule to over 95%. The specificity of the blood test is lower than the skin test meaning a somewhat higher false positive rate, but in a breakdown scenario this is often a necessary trade-off to improve detection of truly infected animals who have not shown as reactors on the skin test. It also explains why multiple clear tests to restore a herd's trading status are required. The advice for farmers is to be aware of the risk of false negative animals in your herd at a breakdown, and to take all necessary steps to identify and remove residual infection quickly.

Current research on TB

Teagasc are currently leading three new research projects on bovine TB. The single intradermal comparative cervical tuberculin (SICCT) test (skin test) is used to screen all cattle herds for infection annually, with the gamma-interferon test being used also in certain cases to increase sensitivity. Both of these tests rely on the animals' immune system to detect infection.

Physiological stress can lead in immune suppression in animals, and it is hypothesised that it may therefore impact TB test performance. In cattle, calving and early lactation are stressful events which may lead to an increased susceptibility to disease during this period. It also may reduce response to the diagnostic tests. The objectives of the BoviTB project are 1) to determine whether there is an association between the stage of lactation and an animals' bTB test result; and 2) to determine if there is an association between an animal's health and metabolic status and bTB test outcome.

The MetabTB project follows a similar theme. Nutrient deficiencies have significant impacts on immune function. Impaired immune function can increase susceptibility to infection, increasing the risk of bovine tuberculosis (bTB) herd breakdowns and overall bTB incidence. A potential new means of reducing TB incidence relates to improvement of animals' immune status by optimising their nutritional status. The objectives of the MetabTB project are 1) assess the immune, nutritional and metabolic status of herds affected by a bTB breakdown (case subjects) and pair matched bTB free herds (control subjects). This will allow researchers to understand the potential benefits of enhancing the immunity of the national herd through better nutritional and metabolic management at key times of the year. Outcomes from these projects will be directly applicable to the national eradication programme.

Summary actions that farmers can take to reduce the risk of TB in dairy herds

Individual farmers can protect their herd from TB by taking steps to address the risk factors for a breakdown. These include:

- Cull any cattle, which were inconclusive at a previous test no later than the end of the current production cycle. Inconclusive cattle are 12-times more likely to be become reactors at a subsequent test.
- Likewise, cull any cattle which had bovine reactions at a previous TB test, these are 4-times more likely to become reactors at a subsequent test.
- Consider culling any older cattle, which were present at a previous restriction, particularly age cohorts of any infected cattle.
- When sourcing breeding replacements, source cattle from herds which have not been restricted in recent years and buy cattle with a recent test date. Cattle exposed to TB recently may have undetected infection and bring the disease into your herd.
- Ideally breed your own replacements to avoid the potential introduction of disease.
- There is significant genetic variation in TB susceptibility in the dairy cattle population. Make sure to select herd sires that have high breeding values for TB resistance. Values for individual bulls are available on ICBF website or speak to your adviser when picking your bull team.
- If you haven't already done so, locate all badger setts on your farm. Notify the Department of Agriculture, Food and the Marine of any setts you find.
- Fence off the setts and latrines to prevent cattle consuming any grass potentially contaminated with TB bacteria (Mycobacterium bovis).
- Raise water and feed troughs to prevent badgers accessing them.
- Do not feed concentrates on the ground, as badger saliva can contaminate the area, when they eat any leftover feed.
- When selecting bulls for breeding, choose those bulls with greater genetic resistance for TB, based on the health traits sub-index of the EBI.
    - » If your herd is subsequently restricted for TB, this can reduce the number of cattle exposed that become infected.
    - » Many bulls with historically high EBI figures have inferior TB resistance figures, so it is important that the genetic resistance to TB is improved in the national herd.
    - » There are still sufficient bulls with both high EBI and good TB resistance figures. Ensure you identify these bulls to increase both the genetic merit of your herd and increase the genetic resistance to TB within your herd.

- Ensure good quality testing facilities and assistance are available for TB tests to ensure the test is carried out properly. Each animal must be identified and have its skin measured on both days of the test.
    - If the test is not carried out properly, infection may be missed and this may allow the infection to spread widely before the infection is detected at a later test, resulting in many more reactors than if the disease was detected early.
- Wash and disinfect any machinery and facilities which may be shared with neighbours, as the TB bacteria can survive in the environment and lead to new infections.
- Ensure boundary fences are well maintained to avoid mixing with cattle from other herds.
- If you have your young stock contract-reared, ask the rearer to take steps to reduce the risk of TB and have a contingency plan for a TB breakdown in either herd.

Freedom from TB is important from an international trade perspective, and individual farm profitability. However, the control of bovine TB remains a challenge for the dairy industry. Each TB restriction brings significant financial and emotional challenges for those involved. There can be several risk factors involved in any TB outbreak, which makes dealing with the disease more challenging. By addressing each of the risk factors the likelihood and extent of TB breakdowns can be reduced.

Workshop 2: Meeting herd feed requirements this winter and next spring

Key speakers: Aisling Claffey, James Dunne & Kevin Stagg

This workshop will discuss the requirements of the dairy cow in early lactation, with a particular focus on the energy density of the diet and dry matter intake to support milk production. We will examine the importance of forage quality and supplementary feed options, and the relative value of these in meeting potential feed deficits during the coming winter and spring period. We will also address the challenges of feeding the dairy cow in early lactation, during short term periods of adverse weather or poor grass growth, and the knock on consequences of this.

Our aim is that you will leave this workshop understanding:

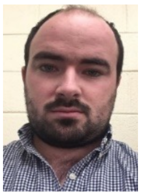
- Nutritional requirements of the spring calving cow in order to optimise herd performance.
- The role grazed grass plays in the diet, with a renewed focus to achieve at least one grazing per day in early lactation.
- How the requirements of the cow can be met when access to grass is impeded in the short term due to adverse weather conditions.

Workshop 2 Speakers

Dr. Aisling Claffey – Teagasc Ruminant Nutritional Specialist, Grange

Aisling recently joined Teagasc as the Ruminant Nutritional Specialist. She completed her PhD in Teagasc Moorepark, in collaboration with UCD, in 2019 and published a number of peer-reviewed papers focusing on her research on autumn and spring grazing management, and pasture allowance in early lactation. Aisling spent five years working in industry as a dairy specialist, with a particular focus on nutrition. Aisling will discuss the energy requirements of the dairy cow in early lactation and meeting these requirements in conjunction with her colleagues, James Dunne, Dairy Specialist and Kevin Stagg, Dairy Advisor.

James Dunne – Teagasc Dairy Specialist



James graduated in 2013 from UCD with a Honours B.Ag.Sci.(Animal and Crop Production). James subsequently went on to complete a Masters in Agricultural Innovation Support through the Teagasc Walsh fellowship programme in collaboration with UCD. He worked as a business and technology dairy advisor in Ballyhaise for 5 years from 2016-2020. In 2020 James joined the Teagasc Dairy KT team as a dairy specialist with a focus on the physical and financial performance of commercial dairy production systems, including issues pertaining to sustainable dairy systems, while also having a particular focus on winter/ liquid milk production.

Dr. Kevin Stagg – Teagasc Dairy Adviser – Kerry/Limerick

Kevin qualified from UCD with a degree in Agricultural Science (general agriculture). After that he completed a PhD in a collaboration between Teagasc and the veterinary college in UCD. The PhD was completed under the supervision of Professor Michael Diskin, Teagasc Athenry and Professor Jim Roche UCD. The thesis focused on factors that affect reproduction in suckler beef cows. Since then Kevin has worked as a dairy adviser with Teagasc in Cork East and for the last number of years as a dairy adviser.

Meeting herd feed requirements this winter and next spring

Aisling Claffey[1], James Dunne[2] and Kevin Stagg[2] and Donal Patton[3]

[1]*Teagasc, Animal and Grassland Research and Innovation Centre, Grange, Co. Meath;* [2]*Teagasc Advisory, Killarney, Co. Kerry;* [3]*Teagasc, Ballyhaise, Co. Cavan*

Summary

- Achieving at least one grazing per day in spring is key to supporting the herds' nutritional requirements.
- If forage is in tight supply on your farm, partition sufficient high quality forage aside for the early lactation cow
- Take cognisance of cow condition, forage quality and feed space if trying to 'stretch' forage this winter

Introduction

Grazed grass, and grass-clover swards in particular, continue to be the cheapest feed resource available to Irish dairy systems, in addition to being a high energy forage source in ruminant feed systems (Doyle *et al.*, 2024). Unfavourable weather conditions at periods in spring, however, can make short term access to grazed grass challenging, resulting in a significant decline in the energy density of the diet if the cow is housed for a period in early lactation as she approaches peak production. The challenges in spring 2024 have also depleted silage reserves on many farms, resulting in potential forage deficits on individual farms over the coming months. It is important that decisions taken over the coming months to manage forage availability do not compromise the herd performance in early lactation.

To understand the importance of grazed grass in underpinning our dairy systems, we must understand the requirements of the dairy cow in early lactation and the energy supplied by the variety of forages and concentrate ingredients that are utilised.

Table 1. The UFL availability per kg/DM of a range of forage and concentrate feed ingredients.

Forage and Wet Feeds Ingredients	UFL/kg DM	Concentrate Ingredients	UFL/kg DM
Grazed Grass (spring)	1.0-1.1	Barley	1.16
Grazed Grass (summer)	0.9-1.0	Maize	1.22
Grass-clover swards	1.0-1.1	Beet Pulp	1.14
Grass Silage 74 DMD	0.84	Soya Hulls	1.05
Grass Silage 68 DMD	0.76	Palm Kernel	0.93
Maize Silage 25 % starch	0.80	Soya	1.18
Brewer's grain	0.92	Maize Distillers	1.16
Eorna/Trafford gold	1.16	Maize Gluten	1.04
Fodder Beet	1.12	Sunflower	0.66

In calculating the energy requirements of the dairy cow, there a number of components to be considered including:

- Maintenance
- Activity level of the animal
- Milk production (kg and constituents)
- BCS gain or loss
- Growth requirements in animals under 40 months
- Gestational requirements in the final trimester
- Negative associative effects (NAE) of increasing concentrate proportion in the diet – as the % of concentrate increases in the diet, this has negative consequences to the digestibility of the total diet, due to rumen pH being altered and rumen microbe efficiency being impaired.

Table 2. The requirements of a 550 kg dairy cow producing 25 kg milk in early lactation at 4.3% fat and 3.4 % protein on 20 % concentrate and 80 % forage diet

Component	UFL/day
Maintenance	6.1
Activity (+ 15 %)	0.90
Milk production	11.5
0.5 BCS loss[1]	-1.4
Neg. Assoc. Effects[2]	0.6
Total required	17.7
UFL required from forage	13.8

[1]The UFL supplied per day as a result of mobilising 0.5 BCS (85 UFL) over the first 60 days of lactation
[2]The NAE of feeding 20 % of the diet as concentrate (3.5 kg DM)

Using the requirements outlined in Table 2, this cow would need to consume 12.5-13 kg DM of spring grass. Alternatively, to provide the same UFL to the cow, she would need to consume 16.5 kg DM of 74 DMD silage, which would not be physically possible due to intake capacity, gut fill and passage rate of silage. This table highlights the need for access to pasture to meet the energy demands of the early lactation dairy cow, or high quality forage and increased concentrates to be supplemented alongside this when pasture is limited. If access to high quality forages is limited on your farm, ensure you partition an appropriate buffer aside for next spring (minimum 300 kg DM/cow).

Managing the diet of dry cows

Opportunities to manipulate the diet over the coming 8-10 weeks will be easier with dry cows that have a lower energy requirement and when workload is reduced on your farm. However, it is important to consider body condition score, forage quality, facilities and workload when making decisions around stretching forage over the winter months. If there are low BCS (< 2.75 BCS) animals within your herd, and you haven't factored in a longer dry period, these animals may want to be grouped separately and given access to high quality forage, or extra meal with lesser quality forages, to ensure they get back on track. It is equally important not to overlook the requirements for weanlings and in-calf heifers to also have access to high quality forage during this period.

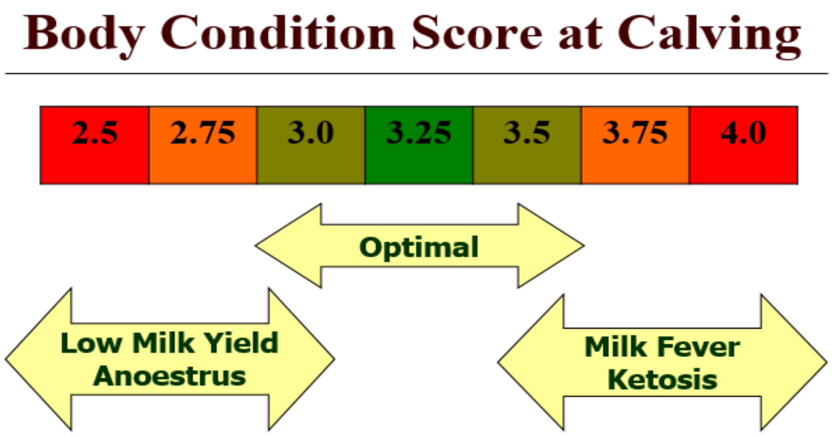


Figure 1. *Aim for BCS of 3.0 to 3.25 at calving*

On the other hand, we want to minimise the risk of cows, that are BCS > 3.25 at dry off or later calving, getting over fat during this period, increasing the incidences of metabolic disorders post-calving. This is also an important consideration to bear in mind if utilising concentrate ingredients to 'stretch' forage deficits on farm. A 1kg DM of concentrate will not directly displace a kg DM of forage, and this substitution effect, if not appropriately controlled through daily forage allocation will result in minimal savings of forage and excess BCS laid down during the dry period, at a significant cost to the farmer.

Conclusion

Grass and grass-clover swards continue to be a cost effective way of maximising energy intake in the early lactation dairy cow. For the majority of milk producers, the energy demands of the dairy cow will be at its highest during March and April, therefore it is critical we maintain an appropriate reserve of high quality forage for this period, and supplement the herd appropriately when access to pasture is limited. Make decisions on overall winter forage security with this spring period in mind.

Workshop 3: Clover 150 – Lessons learned from 2024 and planning for 2025

Key speakers: Michael Egan, Joseph Dunphy, Robert & Denis O'Dea

Legumes, particularly white clover have the potential to play a significant role in offsetting the reduction in N fertiliser use on Irish farms while helping to maintain adequate pasture production at farm level. 2024 has been a very challenging year weather wise with poor growing conditions & many farmers are disappointed with pasture growth (T DM/Ha) on their farms. Clover swards has been particularly affected with cooler soil & air temperatures affecting stolon proportion which delayed clover contributions in the sward until late summer on many farms.

In this session, Joseph Dunphy, Grass10 will be joined Michael Egan, Teagasc Moorepark & dairy farmers Robert & Denis O'Dea from Co. Limerick. The topics for discussion in this workshop will be-:

- Reviewing the pasture grown & nutrient usage on clover150 farms over the last 5 years and lessons learned in the process
- Managing the year to year fluctuations in clover contents & selecting appropriate fertiliser strategies
- Checklist for setting your farm up for high clover contents in 2025

Workshop 3 Speakers

Dr. Michael Egan – Teagasc Senior Grassland Researcher Officer, Moorepark

Michael graduated in 2011 from UCD with an Honours B.Ag.Sci. (Animal and Crop Production) and completed a PhD in Teagasc Moorepark & UCD investigating the effect of including white clover into intensively managed dairy production systems. Since 2015, he has been working as a Grassland Research Officer in Teagasc Moorepark where his main area of research has been optimising grassland management with particular focus on optimising spring and autumn grazing management. Since 2022, he has been working as a legume agronomist, and is the research lead on the area of legume agronomy. Michael is also leading the on farm Clover150 programme, working with over 40 grassland farmers across the country. Michael has an adjunct senior lecture position in UCC.

Joseph Dunphy – Teagasc Grass10, Athenry

Joseph is part of the Grass10 team, and is based out of the Mellows Campus, Athenry, Co. Galway. The Grass10 programme, now in its second four year phase 2020 – 2024, promotes profitable and sustainable milk and meat production from grass on Irish farms. The Grass10 team produce the weekly Grass10 newsletter, the weekly Grass10 Grazing update on the Dairy Edge podcast along with social media updates across their platforms to drive better pasture management on Irish farms.

Robert & Denis O'Dea – Dairy Farmers

Robert and his nephew Denis are dairy farming in Kilteely, Co. Limerick, in partnership. The O'Dea's are milking 259 cows on a 116ha milking platform, with an additional 16ha out farm. Robert joined the Clover 150 Programme in 2020 and in that time he has reduced chemical nitrogen fertiliser from 234kg/ha in 2020 to 153kg/ha in 2023, while growing over 13 T DM/Ha of pasture in 2023. The O'Dea's have 65% of their grazing area with an average of 25% clover are actively working on improving this every year.

Clover 150 – Lessons learned in 2024 and planning for 2025

Michael Egan[1] and Joseph Dunphy[2]

[1]Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Co. Cork; [2]Teagasc, Animal and Grassland Research Centre, Athenry, Co. Galway

Summary

- There is now a successful blueprint for the establishment and management of clover on farms (Clover150 Blueprint), reducing chemical N fertiliser and improving farm gate N surplus
- Spring 2024 clover contents were 8% back on previous years, chemical N fertiliser was increased (+26 kg N/ha) while maintaining herbage production and recovering clover content in autumn
- Now is the time to put a plan in place (autumn closing, soil fertility, early spring grazing to promote clover development and reseeding/oversowing plan to ensure high clover performance in 2025

Incorporating white clover on commercial farms

In 2020, a group of 36 farmers from across the country were enrolled in the 5-year Clover150 programme. The farms included a range of land types, geographical spread, climate conditions and farming enterprises. White clover was established on the farms through a combination of reseeding and over-sowing. In 2020, the Clover150 farms had clover on <10% of their milking platform area and by the end of 2024, 75% of the milking platform area had clover, with an average clover content of 20%. Data from the Clover150 farms (Table 1) shows that chemical N fertiliser application in 2020 was 232 kg N/ha and herbage production was 14.4 t DM/ha. By 2023 chemical N fertiliser application declined by 76 kg N/ha and herbage production was 12.9 t DM/ha, with 12.3 t DM/ha produced by 31st October 2024 with 182 kg N/ha applied. In 2020, farm gate N surplus and NUE were 194 kg N/ha and 31%, respectively. By 2023, the farm gate N surplus had reduced by 54 kg N/ha (to 140 kg N/ha), while farm gate NUE had increased to 36%. A worrying trend on the Clover150 farms is the increase in N/ha derived from purchased concentrate feeds. When clover and N reductions are in place on farm, it is a vital that herbage production must be maintained on farms, highlighting the importance of targeted reductions in the use of chemical N fertiliser on clover paddocks within the farm.

Table 1. Five year on farm performance (2020 – 2024) for the Clover 150 programme.

Year	Average Clover %	Average clover Area %	DM Yield (kg DM/ha)	Nitrogen (kg N/ha)	NUE%	N Surplus (kg N/ha)
2020	10%	<10%	14.4	232	31%	194
2021	12%	45%	14.1	206	33%	180
2022	18%	61%	13.2	159	39%	139
2023	23%	65%	12.9	156	36%	140
2024	20%	75%	12.3*	182	-	-

**Dry matter production until 31/10/2024*

Clover contents 2024

The end of 2023 and the first 6 months of 2024 was challenging in terms of grass growth and grazing conditions on the majority of farms; with 2023 the wettest year (1,510.6 mm), and 2024 the coldest summer (13.9°C) in the last 10 years (Met Éireann , 2024). This placed significant challenges on Irish farmers, and particularly on grass and clover growth. It is widely accepted that clover favours warm, dry, and bright growing conditions, and when deficiencies in these key meteorological factors occur, it significantly impacts the ability of clover to persist in swards. Data from the Clover150 farms shows a significant reduction in sward clover content in spring and early summer 2024 (-8%) compared to the previous 3 years (Figure 1). When this occurs and clover content declines, there needs to be an adaption in on farm management (fertiliser and grazing) to ensure clover content can recover, but also that grass growth does not decline as a result of lower clover content and a reduction in N fixation. This can be seen in the Clover150 farms, when chemical N fertiliser increased from 156 to 182 kg N/ha in 2024 compared to 2023. The majority of this additional 26 kg N/ha was applied up until July when clover content began to recover (Figure 1). This reduction in clover content and increase in chemical fertiliser however resulted in an increase in herbage production YTD (12.3 t DM/ha), with production expected to reach ≈ 13.3 t DM/ha, an increase of 400 kg DM/ha on 2024, with no adverse effect on autumn clover content relative to 2023 (35% and 37%, respectively). It is clear that there will be fluctuations in weather and subsequent clover content from year to year, however adapting to this is vital to herbage production and clover contents.

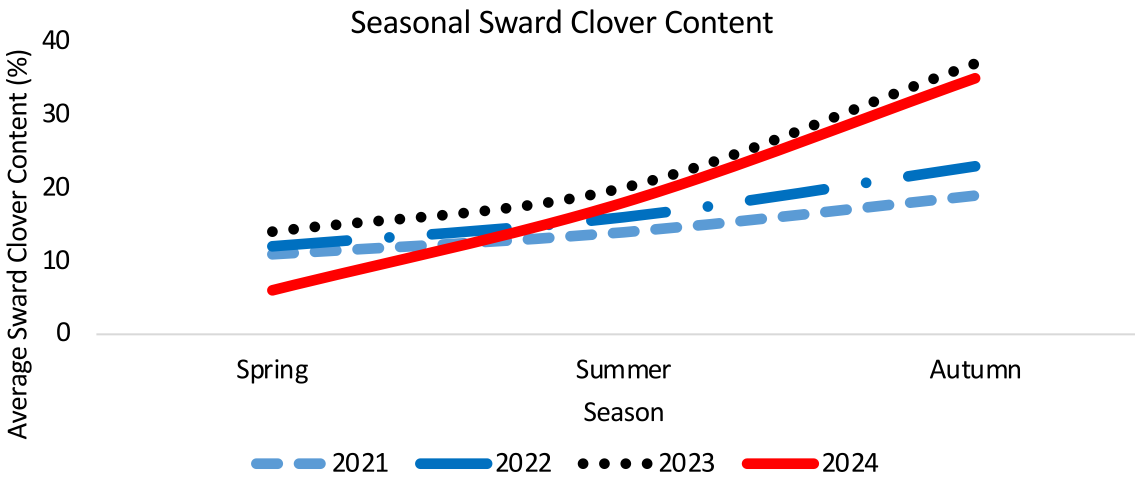


Figure 1. *Seasonal sward clover content on the Clover150 farm from 2021 to 2024*

Table 2. Tailored Nitrogen fertiliser strategy for grass clover swards adjusted for varying sward clover content in April

April Clover content (%)	Feb	Mar	April	May (2 rot)	June (2 rot)	July (2 rot)	Aug.	Sept.	Total
Chemical Fertiliser (kg N/ha)									
Grass sward	24	36	20	32	28	28	21	23	212
5%	20	35	20	20	20	20	20	20	175
10%	20	35	20	15	15	10	15	20	150
15%	20	35	20	15	10	*SW	10	20	130
20%	20	35	20	15	SW	SW	SW	15	105

Checklist for setting your farm up for high clover contents in 2025

Graze high clover paddocks late in your final rotation

Autumn closing date/spring opening farm cover (OFC) can have impact on clover content the following year. It is advisable to graze the most recently established clover swards in late October/early November if grazing conditions allow, to ensure a lower cover on these cohort of paddocks. Grazing late in the autumn allows light down to the base of the sward. The amount of light penetrating the base of the sward directly influences the survival of stolon over the winter. The more stolon that survives the winter, the higher the clover content of the sward and therefore higher N fixation will occur during the following growing season. This emphasises the importance of defoliation management practices to provide favourable conditions for clover to persist. Defoliation management practices, therefore, need to strike a balance between being favourable for clover growth and feeding the herd.

Complete a full set of soil samples for your farm & importance of pH, P & K

It has long been established that soil fertility (pH, P and K) need to be at optimum levels for white clover swards to persist and contribute. The productivity and survival of clover swards are dependent on optimum overall levels of soil fertility and there needs to be a clear focus yearly in the targeted application of P, K and lime. Currently, the soil fertility status of soils in Ireland is sub-optimal; only 18% (20% dairy and 13% drystock) are optimal for P, K and pH (Teagasc, 2023), this will challenge the ability of farmers to establish and maintain the persistency of clovers. White clover does not persist well in low pH soils; a pH of > 6.5 is recommended for grass/clover swards. Potassium is also a pivotal nutrient in plant structure development, root growth and plays a key role in the uptake and efficient use of N. The grass plant is more efficient at competing for K than clover so routine application of K & index 3/4 for K is essential. Optimum soil fertility remains fundamental to the success of clover; below minimum levels greatly diminishes establishment and growth, and makes management to improve sward persistency less effective.

Graze grass - clover paddocks in February

Coming back to the original point on stolon development, grazing grass-clover paddocks early in the 1st rotation with covers of <1,200 Kg DM/Ha will get light to the base of the sward as soil temperatures are improving. However, damage to the sward must be avoided so it is important to be flexible with your grazing plans & aim to graze grass clover paddocks as early as possible when conditions are suitable.

Applying 2,500g/ac of dilute cattle slurry after grazing will replenish N, P & K in the sward and promote early pasture growth.

Identify paddocks for reseeding & over sowing in 2025

Use the winter period to review your PastureBase Ireland data for individual paddocks and identify poorer performing paddocks to reseed with a high clover mix in April 2025. Paddocks with a high weed burden should also be considered. Aim to reseed 10% of your milking platform next April as reseeding is one of the most cost effective on farm investments. Swards with low clover contents/ declining levels of clover % due to competition from grass or due to damage (a consequence of a wet April 2024) should be identified and oversown with 2-2.5 kg/ac of a medium leaf recommended list white clover. Aim to over-sow 10-15% of your farm each year to ensure continued improvements in clover contents on farm.

Workshop 4: Controlling dairy production costs in 2025

Key speakers: Patrick Gowing, Nora O'Donovan, Jerome & Brian Desmond

Controlling the cost of production has always been a vital tool in improving farm profitability. Since 2018, we have seen a significant increase in the cost of production on Irish dairy farms, generally driven by high input prices, particularly in 2022. This was generally matched by increases in milk prices. However, from 2021 to 2024, we have seen massive variability in milk prices while costs have remained high. It is essential to refocus on our costs to get control of our financial business.

This workshop will feature Patrick Gowing, Teagasc Dairy specialist, on trends in costs and showcase a new tool for Teagasc E-profit monitor users to identify areas where your costs may be higher than they need to be. Patrick will be joined by Noreen O Donavan, Teagasc/ Dairygold programme coordinator, and Jerome and Brian Desmond of Crookstown, Co Cork, to showcase how they use this new tool to control costs.

This workshop will demonstrate:

- Trends in farm costs
- High and low margin farms
- New cost control tool for E- profit monitor

Workshop 4 Speakers

Patrick Gowing – Teagasc Dairy Specialist, Dairy KT

Patrick qualified from UCD in 2002 with a B.Agr.Sci. He started his career with Teagasc as a dairy advisor in Sligo/Leitrim for 3 years before working in the same role in Westmeath for 5 years. In 2015 Patrick was selected to lead up the new Teagasc dairy expansion service which was set up to help expanding farmers and new entrants post quota. In that time Patrick completed over 1,000 farm business plans to help farmers in their expansion journey. In 2021 Patrick joined the dairy KT team as a dairy specialist focusing on the areas of farm finance, farm infrastructure and AMS.

Nora O'Donovan – Teagasc Dairy Advisor on the Dairygold Joint Programme

Nora qualified from UCD with a B.Agr.Sci. She started her career as a REPS planner before working as Dairy Advisor in Teagasc, Kerry for over 12 years. In 2023 she took on the role of co-ordinating the Demonstration farms as part of the Dairygold joint programme. The focus of the programme is to reduce agricultural greenhouse gas and ammonia emissions, improving water quality and managing biodiversity on farm, while farming in an economically sustainable manner.

Jerome & Brian Desmond – Dairy Farmers, Co. Cork

Jerome, Brian and family are dairy farming in partnership in Ovens, Co. Cork. The Desmonds are milking 250 cows on a 32 ha milking platform at home, with a second 42 ha milking platform leased 4 miles away. Jerome & Brian are members of the Crookstown Discussion Group where an important emphasis is placed on completing and analysing the Profit monitor annually. Before setting up the second milking block in 2021 they completed a Business plan with Patrick Gowing.

Controlling dairy production costs in 2025

Patrick Gowing[1] and Padraig O Connor[2]

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

Summary

- Dairy production costs have increased consistently since the abolition of quota in 2015. The rate of increase in costs dramatically increased in 2022 and has remained at this new high level for 2023 and 2024. In the same time we have witnessed massive variation in milk price from 2021 to 2024.
- While the average costs have increased the range of the maximum and minimum costs in each cost category have increased as well and we are seeing a wider variation in the cost base of Irish dairy farms.
- Teagasc has developed a new tool to work with the Teagasc Profit Monitor (€PM) called a bill of quantities. This new tool establishes the exact level of inputs required for a farm and this can then be used to compare against inputs on your own farm to help identify areas you may be over spending in.

Introduction

In the period after the abolition of quota, the cost of dairy production was relatively static, increasing by ~ 1.5% per year from 2015 to 2018 and 3.4% per year from 2018 to 2021. However, in 2022 costs increased by 34% due to large increases in input costs. This high cost of production maintained in 2023 with an average cost of production of 37 c/l and is forecast to remain at a similar level for 2024. While looking at the average costs indicates the direction the industry is travelling it does not explain the reality on some farms.

Characteristics of high and low margin farms

While input costs have risen very significantly for all dairy farms in recent years, there remains a high degree of variability in costs and margins across farms within a given year. It is no longer useful to use the average as a comparison, more so to look at the variance within a cost category and explain the variance.

To this end, we recently examined the differences in the top and lowest 10% of farms in €PM, based on 2023 data. Around 700 farms were included in the analysis. These farmers were categorised as farms in discussion groups who complete an €PM. Table 2 shows the physical trends for average, top 10% and lowest 10% of farms, ranked on margin per cow.

Table 2. Physical performance of higher and lower margin dairy farms 2023

Category[1]	Average	Top 10%	Bottom 10%
Net margin[2] per cow	623	1,186	40
Whole farm SR	2.22	2.29	2.13
Milking Platform SR	2.95	2.92	2.96
Cows (average)	152	153	166
Milk Solids/cow	472	511	443
Milk solids per ha	1,047	1,170	943
Concentrate (DM/cow)	1,063	1,105	1,165
Purchased forage/cow (€)	32	35	30
Grass Utilized (t DM/Ha)	9.1	9.9	8.2

[1]Ranked on margin per cow using 2023 €PM data. Data are a voluntary sample of farms and should not be taken to represent national average performance

[2]Margin is operating farm margin (revenue minus direct and overhead costs); does not include own labour, capital repayments, taxation costs, or direct payments

Scale and stocking rates (whole farm and milking platform) were quite similar across the ranking groups. Purchased forage and concentrate levels per cow were similar also, however compared to the lowest 10%, the top 10% of farms sold 68kg additional milk solids per cow (and 227kg per ha). The top 10% most profitable farms utilised an extra 1.7 tonnes of pasture per ha.

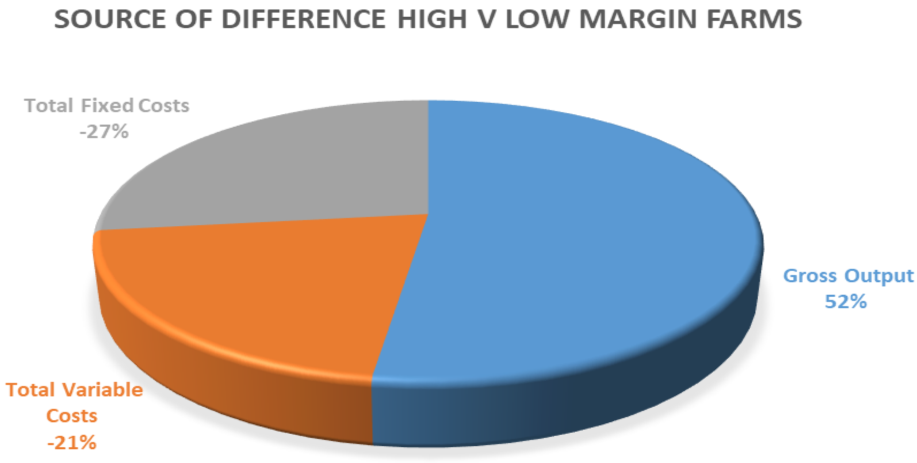


Figure 2. *Source of margin difference between high and low margin dairy farms 2023*

Of the total differential in net margin between high and low ranked farms, 52% was due to greater gross output per cow. Over 85% of this gross output effect was due to milk solids revenue, with a minor proportion due to stock sales and inventory. On the cost side, fixed costs accounted for 27% of the difference (includes paid labour) with variable cost differences accounting for 21% (Figure 2).

Interestingly, while the majority of temporal change in costs on farms has been driven by feed and fertilizer cost increases, the contribution of these major cost categories to the *relative* differences in profit within year is minor at 9% of total (Figure 3). Instead, input cost categories such as contractor, machinery, parlour and veterinary costs, account for a greater proportion of the differentials between high and low margin farms within year.

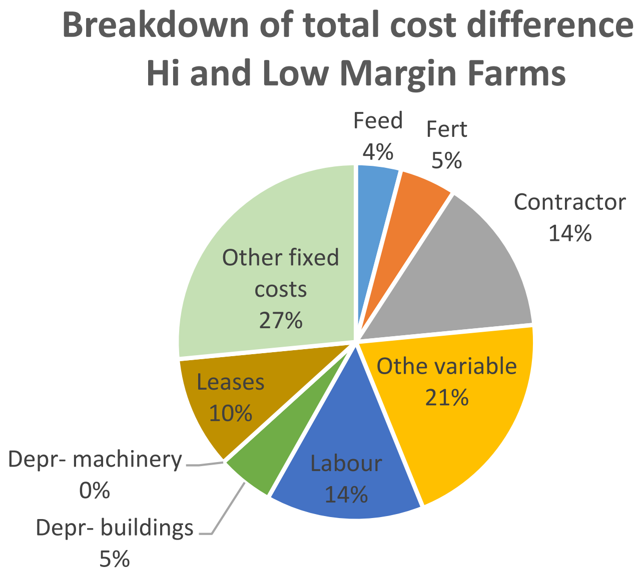


Figure 3. *Source of differentials in production costs for high and low margin farms*

This outcome may seem counter-intuitive given the year-on-year cost trends, but it raises some relevant points. Firstly, the results show that high margin farms tended to have better cost control outcomes across the full range of categories, not just the major items like feed and fertilizer. Differences in consumables and fixed costs like machinery running were more significant than paid labour for example, indicating a need to examine cost control on a category-by-category basis.

More fundamentally, the results underline the premise that differences in pasture utilisation explain much of the variation among farm profit outcomes between farms. Remember, supplement feeding levels and stocking rates for high and low margin farms were similar, but high margin farms delivered much different milk solids and hence extra gross output. The principal source of the extra feed nutrient supply required to deliver the extra milk output by high margin farms was, by definition, more pasture tonnes of higher quality consumed. Therefore we can consider the higher gross output as an end-product of pasture management, rather than assuming a return from extra supplements fed.

Dairy farm Bill of Quantities

As we can see from the above there is massive scope within each cost category to reduce the cost of production. Over €500/cow in additional profit was attributed for by cost control on the higher margin farms.

A saving of €100/cow in costs in 2023 would increase the profitability of the average farmer by 16%. So small changes can have a large impact on farm profitability.

To help identify areas where farmers may be over spending Teagasc have developed a new tool for use with your profit monitor to examine the level of inputs required to run a dairy farm using best practice in each cost category. To establish the bill of quantities a template farm was created based on 120 cows with followers based on 60ha of land. The farm is stocked @ 218kg Org N based on a 92kg Org N cow.

The feed budget was based off growing 13.75t/ha and utilizing 11t/ha of grass @ 80% utilization. To achieve this each cow will intake 4.5t of pasture from the farm in either grazed grass or silage. The average currently on €PM is 3.85t pasture utilized per cow.

The planned feeding rate for the cows is 688kg DM of concentrate and based on this feeding and grass consumed the cows are targeted to produce 472kg MS/cow.

Each cost was also examined and the quantity of inputs required to run the farm for the year was calculated and a price per unit established. This leads to a "shopping list" of inputs required to run the dairy farm.

Each cost can be examined against the bill of quantities. If there is a large variance in costs then the farmer and advisor can do a comparison of the actual inputs the farmer is purchasing against what is required. This will help farmers identify if they are over using any inputs and then they can explore options to reduce this and help maintain costs on farm.

Table 3. Example Input Costs Inventory (Veterinary)

	Product / Service		
Vet General	Vet call outs	Visit	6
Vet General	Antibiotics	Bottle	10
Vet General	Lactating cow tubes	3 Tubes Per Case	90
Vet General	Dry cow tubes	Per Tube	400
Vet General	Teat sealers	Per Tube	480
Vet General	Calcium (Milk Fever)	Bottle (400ml)	10
Vet General	Flutter valve & needle set	I unit	1
Vet General	Syringes and needles	Multiple	1
Vet General	General farm disinfectant	Litres	5
Vet General	Milk & Blood Sampling	Per Sample	10
Vet General	Hoof Pare	Per Cow	48
Vet General	Foot Bath Solution	Litres	374
Vet General	Faecal Sampling	Pooled Sample	5
Vet General	Worm Dose Injection	Litre	0.5
Vet General	Worm Dose Oral	Litres	3.5
Vet General	Fluke Dose	Litres	2.5
Vet General	Pour-on (Lice)	Litres	10
Vet General	Worm dose	Litres	0.5
Vet General	Fluke dose Cows	Litres	15
Vet General	Box of scour tablets (48sachets)	Box	1
Vet General	Arm length gloves	Box	2
Vet General	Iodine	Litres	2
Vet General	Calving Disinfectant	Litres	2
Vet General	Calving lubricant	Litres	2.5
Vet General	Calving Jack Ropes (Pair)	Pair (2 Ropes)	1
Vet General	Herd Test	Annual	1
Vet Vaccines	*Salmonella*	Shot	170
Vet Vaccines	BVD	Shot	170
Vet Vaccines	Lepto	Shot	170
Vet Vaccines	IBR	Shot	170
Vet Vaccines	Rotavirus vaccine	Shot	120
Vet Vaccines	Calves RSV-Pi3- Intranasal	Shot	25
Vet Vaccines	Calves IBR Live injection	Shot	50
Vet Vaccines	Calves Clostridial	Shot	50
Vet Vaccines	Calves RSV-Pi3 - Injectable	Shot	50

Workshop 5: Successful use of sexed semen in Irish dairy herds

Key speakers: Stephen Butler, Stuart Childs & John McCarthy

Dairy sexed semen facilitates targeted breeding of the highest genetic merit females within the herd to produce replacements with increased milk solids production potential delivered with a lower carbon footprint. Similarly, the use of dairy sexed semen can eliminate the production of low value dairy bull calves which are a source of animal welfare concerns. With less dairy straws required to generate the heifer replacements, more females can be bred to high Dairy Beef Index (DBI) sires. This alters the calf crop significantly from one dominated by dairy x dairy breed animals to one that is approximately 70% dairy beef origin.

In this workshop, Professor Stephen Butler will outline the best and most cost effective strategies to employ to integrate sexed semen into dairy breeding for your farm to achieve high conception rates when using sexed semen.

The integration of sexed semen into dairy breeding on Irish dairy farms is important to

- Deliver rapid genetic gain which in turn will deliver better financial returns
- Assist with emissions reduction and
- Address concerns relating to calf welfare

Workshop 5 Speakers

Prof. Stephen Butler – Teagasc, Principal Scientist, Reproductive Physiology, Moorepark

Stephen is a Principal Research Scientist focused on dairy cattle reproduction research in Teagasc Moorepark, Co. Cork. His main areas of research include exploring the genetic basis of sub-fertility, oestrus and ovulation synchronization protocols for seasonal calving systems, the effects of micronutrients on dairy cow reproductive physiology, strategies to utilize sexed semen in dairy herds, and the use of Assisted Reproductive Technologies to accelerate genetic gain in elite genetic merit dairy and beef breeds. He has presented invited plenary session talks at national and international conferences to animal scientists, veterinarians, policy makers and dairy herd-owners.

Dr. Stuart Childs – Teagasc Dairy Specialist

Stuart is a Teagasc dairy specialist based in Teagasc Moorepark. He qualified from UCD with a BAgrSc (Animal Science) and completed a PhD in Animal Science investigating the role of fatty acid nutrition on fertility in cattle. Stuart worked for 10 years as a dairy advisor in the Kilmallock, Mallow and Moorepark areas. Stuart's key focus areas are that of animal breeding and animal health.

Dr. John McCarthy – Teagasc Dairy Advisor Kerry/Limerick Region

John is a Teagasc dairy advisor based in Teagasc, Listowel Co. Kerry. He qualified from UCD with a BAgrSc (Animal and Crop Production) and completed a PhD in the Moorepark Animal and Grassland Research Centre investigating the effect of stocking rate and calving date on Irish dairy farm sustainability. John's key focus is to increase the profitability and sustainability of his local clients

Successful Use of Sexed Semen in Irish Dairy Herds

Stuart Childs and Stephen Butler
Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Co. Cork

Summary

- Sexed semen usage can increase dairy herd genetic gain, which will deliver better financial return to farmers
- Use of sexed semen to generate replacement heifers also facilitates greater usage of beef AI to generate non-replacement beef-cross calves. This will diminish the number of low value dairy bull calves.
- More efficient milk production as a result of better dairy genetics and younger age at slaughter for non-replacement beef-cross calves will reduce the CO_2 emissions associated with milk and meat production.

Introduction

Sexed semen usage in Ireland has increased nearly 4-fold in the last four years, and this trend is expected to continue into the future. While average conception rate to sexed semen is slightly less than conventional semen, the relative conception rate is >90% (i.e., conception rates with sexed semen are >90% as good as those achieved with conventional semen). Sexed semen is a key technology that can bolster the sustainability credentials of the Irish dairy industry:

- Better financial returns through more rapid genetic gain;
- Reduced carbon footprint per kg of product produced from both dairy and beef enterprises;
- Greater societal acceptance from an animal welfare perspective.

Strict guidelines need to be followed to maximise success with sexed semen. Since the advent of sexed sorting technology and commercialisation of sexed semen, conception rate has gradually increased. It is anticipated that this will continue to improve over time, which will further increase the uptake of the technology. In the meantime, farmers have to maximise the performance of the product through strict implementation of the guidelines (Figure 1).

Sire and dam choice

- **Bulls**
  - Pick highest EBI bulls available
  - Use a large team of bulls
- **Dams**
  - **Top 50% of herd based on EBI**
    - Heifers
      - Target live-weight and BCS ≥3.25
      - Cycling regularly
    - Cows
      - Parity 1 to 4
      - >50 days in milk on day of AI
      - BCS ≥3.00
      - Cycling regularly
      - No postpartum disorders or uterine disease

When to use?

- First 3 weeks of the breeding season
- Within first 10 days if possible.

Timing of AI

- 14 to 20 h after heat onset

Fixed time AI

- Costly, but mitigates risk
- Facilitates targeted usage of sexed semen on MSD

Straw handling on day of AI

- Organise sexed straws into one goblet
- Thaw 2 sexed semen straws at a time MAX
- Thaw straws at 35 to 37 °C for 45 seconds
- Load straws into pre-warmed AI guns, keep warm.
- Deposit semen in uterine body
- Complete inseminations within 5 mins

Figure 1. *Guidelines to maximise performance of sexed semen use*

Conventional semen can remain viable for > 24 hours after insemination. The sorting process reduces the viability of sexed semen in the female reproductive tract to less than 24 hours, and hence timing of AI is more critical for sexed semen compared with conventional semen. For maximum success, AI with sexed semen must take place 14-20 hours after the onset of heat (i.e., the first standing mount). The challenge for farmers is knowing the exact time of heat onset and submitting the cow for AI 14-20 hours after. Even in herds where automated heat monitoring technology is available, the optimum time for the AI service may not coincide with availability of the AI technician service.

To overcome such challenges, the use of fixed time AI (FTAI) has a role to play in increasing sexed semen use on Irish dairy farms. The initial cost of this is often seen as prohibitive, but this is counterbalanced by the more compact calving and increase in milk production early in the subsequent lactation; the increase in returns exceed the costs. There are also additional benefits of early-born heifer replacements that are more likely to avoid health challenges during the calf rearing phase. Furthermore, use of FTAI protocols ensure all sexed semen is used at the start of the breeding season, and mitigates any risk of reduced conception rate impacting on 6 week calving rate in the subsequent season. FTAI also allows targeted use of sexed semen on specific females to deliver the best genetic merit replacements.

The recommended FTAI protocols to be used for heifers (Figure 2) and cows (Figure 3) are illustrated below. To achieve successful FTAI, it is critically important that all interventions take place on the appropriate days and at the correct times. Any errors or non-compliance with the protocol can severely impact the fertility of the animal at the time of insemination. Consequently, careful planning and organisation of the protocol is essential. Where timing of AI is dictated by the time of AI technician availability, the timing of the preceding interventions can be scheduled to ensure compliance.

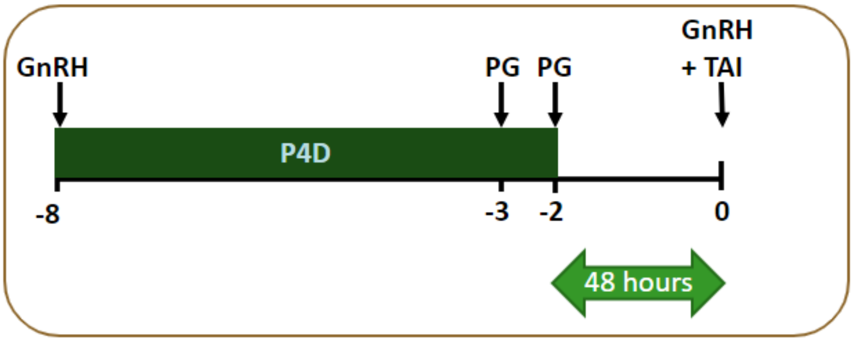


Figure 2. *Recommended 8 day FTAI protocol for dairy replacement heifers*

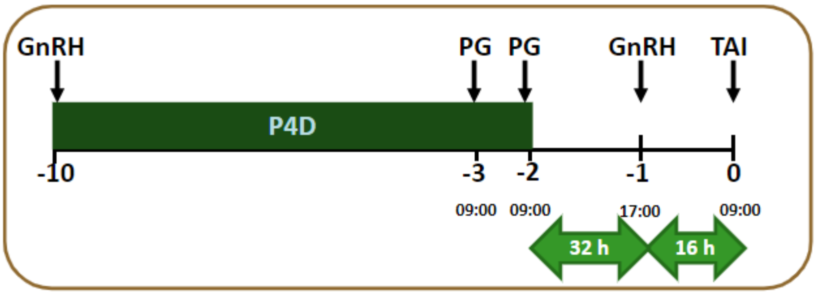


Figure 3. *Recommended 10 day FTAI protocol for dairy cows*

Conclusion

Sexed semen is a relatively new technology in Ireland. In a short period of time, usage has markedly increased and this momentum is expected to continue. This technology provides solutions to several challenges that the Irish dairy sector is currently facing. Through correct implementation of the guidelines, farmers can breed superior genetic merit replacement heifers compared with using conventional dairy semen alone. This will increase herd genetic gain and deliver improved financial returns. Similarly, the carbon footprint of the animal products produced will improve. The change in the calf crop to one that is dominated by beef-cross animals will reduce age at slaughter and thus reduce the emissions of the beef sector and agriculture as a whole. Furthermore, the associated calf crop will be more socially acceptable due to the reduction of animal welfare concerns associated with declining numbers of low value male dairy calves.

Workshop 6: Managing young calves for better health outcomes

Key speakers: Ian Hogan, Emer Kennedy & Deirbhile Browne

Calf scour is one of the most time consuming and stressful challenges that is commonly occurring each spring on dairy farms. Calf scour also adds costs to the business. Identifying the causes of the scour on your farm is the first step towards managing this challenge.

Topics for discussion at this session are:

- Assessing & controlling calf scour
- How to increase calf immunity
- Risk factors for summer scour syndrome

Workshop 6 Speakers

Ian Hogan – Department of Agriculture, Food & the Marine, Research Officer, Limerick RVL

Ian qualified as a vet in 1995 and worked in large and mixed animal practice, before working briefly with Cork DVO and moving to Limerick RVL in 2009. His role there involves carrying out post-mortem examination of submitted animal carcasses, disease investigations and interpreting the results of testing on submitted samples. The RVLs provide an advisory service to farmers through their private veterinary practitioners.

Dr. Emer Kennedy – Dairy Enterprise Leader, Teagasc Moorepark Researcher

Emer is Dairy Enterprise Leader with Teagasc. She obtained her PhD from UCD where she investigated early spring grazing strategies for dairy cows. Since then Emer has gained over 15 years' experience researching calf management, growth, health and welfare of replacement dairy heifers. She has been principal supervisor for 19 PhD and Masters students and is an adjunct senior lecturer with UCC and UCD. Her work currently focuses on colostrum management, assessing calf management and welfare on commercial farms, and post-weaning strategies to maximise growth from pasture.

Deirbhile Browne – Teagasc Dairy Advisor, Kerry/Limerick region

Deirbhile is a dairy advisor with Teagasc in Newcastle West, Co. Limerick since May 2023. She graduated from UCD in 2021 with a degree in Agricultural science (animal & crop production) and secured a place on the Teagasc/UCD Walsh scholarship knowledge transfer master's programme. Deirbhile completed the masters in agricultural extension and innovation and graduated in 2023. Her Thesis was titled "An investigation into the adoption of a selection of the signpost programme 12 steps by dairy farmers in Limerick and Clare". Deirbhile's grew up on a farm in west Clare where she developed her love for agriculture and the outdoors.

Calf scour: Know your enemy

Ian Hogan[1] and Emer Kennedy[2]

[1]*Limerick Regional Veterinary Laboratory, Department of Agriculture Food and the Marine;* [2]*Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Co. Cork*

Summary

- Calf scour is the number one cause of sickness and death in younger calves
- Calf scour contributes to increased workload, stress and cost to farmers
- Cryptosporidia and rotavirus are the most prevalent causes of scour
- Diagnosis of calf scour is crucial to plan its control
- Colostrum management and good hygiene are critical to reducing infection

Scour refers to watery or custard-like faeces. It results from a badly damaged gut, which leads to a loss in function. An intestine that is not functioning properly causes the calf to lose salts and water in the form of diarrhoea. The initial damage to the gut is caused by a variety of infectious agents, including parasites, viruses and bacteria. Once the damage is done, the calf will continue to scour until the intestine has healed. No treatment is available to speed up this repair time. Calf care takes over 20% of the hours needed to run a dairy farm in spring. Research has found that one of the most challenging and stressful aspects of spring calving is managing calf sickness. Farmers also noted that time needed to care for calves increases massively when calves are sick.

What causes scour

A number of infectious agents can cause scour in calves and often more than one of them is involved. Contrary to popular opinion, it is not possible to tell from the appearance of the scour what has caused it. Fresh whole milk or good quality milk replacer given in reasonable portion sizes does not cause scour. Scour is rarely caused by nutritional reasons (over-feeding, poor quality milk replacer) alone and generally will have an underlying infectious cause.

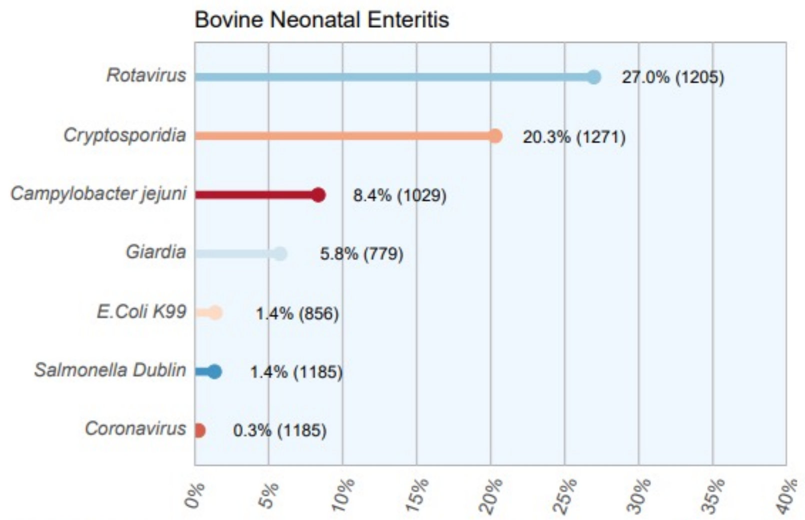


Figure 1. *Findings from Regional Veterinary Laboratories for most common causes of calf scour in spring 2022.*

Rotavirus and Cryptosporidia are by far the most common causes of scour diagnosed in calves in the regional veterinary laboratories. Coccidia cause scour in older calves, *E. coli* K99 is less common and affects very young calves. Bacterial causes of scour such as *Salmonella* are rarer but cause more acute disease.

How to diagnose scour

When performing an investigation of scour on farm it is advisable to submit samples from a number of affected animals. Animals that have been sick for a while are ***not*** suitable candidates for sampling. Ideally three to five scour samples should be collected from ***early scouring and untreated calves***. Faecal samples should only be submitted in screw-top plastic containers.

In addition, blood samples should be submitted to check if there has been adequate colostrum drunk by the calves. Five to ten blood samples should be taken from healthy calves aged less than ten days old, and these samples should not be collected from sick animals.

Image 1. *A screw-top plastic container, ideal for scour samples.*

How should you treat a calf with scour?

Separate the scouring calf

Remove the calf from the group – this helps prevent spread of infection and gives the calf a better chance to recover.

Give oral rehydration solutions

The single most important treatment is to replace the salts and fluids that are lost with scour. Healthy calves need at least 6 litres of good quality milk (or milk replacer) a day and scouring calves need an additional 4 litres of fluid to replace lost fluids. Give one or two extra feeds (2 litres each) of a good quality oral rehydration solution as soon as the calf starts scouring and while it is scouring. These should be given independent of the milk feeds (for example, at lunchtime and, if the diarrhoea is severe, again late in the evening).

Image 2. *A sunken eye due to dehydration in a scouring calf.*

Continue to feed milk

Continuing to feed with milk or good quality milk replacer does not cause, worsen or prolong scour. The milk actually helps the healing of the intestine. Continue to offer scouring calves normal amounts of milk or milk replacer as long as they want to drink. Do not feed diluted milk to calves. Leave suckler calves with their dams.

Products to prevent scour

Vaccines against scour-causing viruses and bacteria have been available for some time; you will need to know the cause of scour on your farm to choose a vaccine. A vaccine against Cryptosporidia has only recently come on the market. An oral dose of Halofuginone is licensed to protect against Cryptosporidiosis. To be of benefit, it should be given as a preventive according to the manufacturer's instructions. However, Halofuginone on its own is unlikely to solve a Cryptosporidia problem if general hygiene is not improved along with the treatment.

Reducing infectious pressure

Even if you have excellent colostrum management, good hygiene is still critical. Keeping the calf comfortable, dry and clean is important through all stages of calf rearing (calving area, calf housing and bedding, and on pasture). Cryptosporidia, in particular, can cause severe diarrhoea even in calves that have received adequate amounts of colostrum, if the hygiene is poor. A variety of housing and feeding systems can be used to successfully rear calves. Some basic hygiene rules are important to follow, no matter what system you use.

- Individual or group calf pens or hutches must be cleaned out between calves.
- Clean, dry bedding is essential wherever your calf is housed. This can be done by cleaning out regularly or by generously topping up a straw bed. Get on your knees: the bed needs to be dry enough so that your knees do not get wet.
- As the calving season progresses there is a tendency for infection to build up. It is important to have your calf housing as clean at the end of the season as at the start.
- Do not forget to keep the feeding equipment clean.

Conclusions

Workload is at its highest on dairy farms in spring. Calf care accounts for over 20% of spring workload. A scour outbreak will significantly increase workload and stress at a time when farmers are already stretched. Also, attracting calf buyers is of upmost importance to dairy farmers. Therefore, prevention is essential. Excellent colostrum management and hygiene are the main factors reducing infectious pressure. Both require time and planning, farmers working solely on their own will struggle to have excellent colostrum management and hygiene. Therefore, having additional help may be required.

Notes

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