Animal & Grassland Research and Innovation Centre

Moorepark

National Dairy Conference 2022

Turning Challenges into Opportunities

Tuesday 6th December, 2022 Rochestown Park Hotel, Cork.

Thursday 8th December, 2022 Mullingar Park Hotel, Co. Westmeath.

Teagasc

Agriculture and Food Development Authority

Dairy Research Ireland

funded by Irish Dairy Farmers

National Dairy Conference 2022

Proceedings

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Agriculture and Food Development Authority

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Joe Patton

Head of Teagasc Dairy Knowledge

On behalf of Teagasc, I welcome you to the National Dairy Conference 2022- 'Turning Challenges into Opportunities'. This time 12 months ago we had to abruptly cancel plans for an attended conference event due to a COVID wave, so we are especially looking forward to having everyone 'in the room' today to discuss and debate the issues at hand.

In the 12 months just passed, some monumental challenges have emerged for Irish agriculture and indeed the wider economy. Most immediate have been the consequences of war in Ukraine, including rapid input price inflation, plus uncertainty around supply chains for fertilizer, fuel and feed. A relatively strong milk price this year has protected farm margins to a fair extent against these cost pressures, however, dairy farmers are all-too-aware of the risks that market volatility can bring to their business over the longer term. Despite the altered price-cost environment at present, meeting best practice targets around pasture utilisation, animal health and welfare, breeding for high EBI and controlling costs, remain the key drivers of farm profitability. Today's conference will feature messages on these key themes from researchers, advisers and leading dairy farmers.

This year also saw agreement on a target 25% reduction in greenhouse gas emissions from Agriculture by 2030, as part the Government's Climate Action Plan. While there is no doubt that this is a very challenging target, it is a positive development to now have a defined goal for the sector. The Teagasc MACC outlines a pathway for the initial steps on the journey, and with new research emerging, more mitigation options will be added to the mix. It has been encouraging to see growing adoption of proven measures at farm level such as protected urea and reduction of chemical N through use of clover. Wider adoption is needed in the short timeframe and this will be a key target for the SignPost programme and wider Teagasc dairy programme in the coming year. Working with farmers, discussion groups and industry partners, we aim to progress in areas such as clover sward management, the EBI carbon index, and use of high DBI genetics.

The measures contained within the Fifth Nitrates Action Programme (NAP) 2022-25 also announced this year, place renewed focus on farm nutrient management practices, and establish cross-links between water quality, climate and biodiversity goals. This creates a new suite of challenges for the dairy industry. The appetite for science-based solutions to these issues was clear from the level of attendance and engagement at this year's Johnstown Castle Open Day, Ballyhaise Open Day, as well as the many clover and grassland management events rolled out through the year. Today's conference will build on those messages and will outline the practical steps that can deliver economic and environmental win-wins on the ground.

With the scale of challenges outlined, it is testament to the resilience of dairy farmers that the production of milk continues to an excellent standard on Irish dairy farms. Every day, from 17,000 family farms across the country, high quality milk is sent for processing into a range of dairy products destined for a diverse market. Our conference will hear from food industry and nutrition experts as to the value of these products in the human diet, and the potential evolution of market demands in the coming years.

Finally, I would like to thank all our speakers and those who have helped to deliver the conference programme. Special thanks to our dairy farmer contributors Liam, Michael, Peter and Sean, whose willingness to share their experience and insight with their peers is much appreciated.

Nitrogen strategy on clover swards - what does the research say?

Deirdre Hennessy

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

Summary

- White clover is a legume. It can fix atmospheric N and make it available for grass growth
- Fixed N can replace chemical N fertiliser, especially in the summer period (May to August)
- White clover will allow Irish farmers to continue to grow large quantities of grass at lower rates of chemical N fertiliser application.

Introduction

Grass-based milk production systems are heavily reliant on nitrogen (N) availability for pasture production. Sources of N in grazed grassland include chemical N fertiliser application, animal return (dung and urine patches, slurry, manure), atmospheric deposition (this is small; approximately 6 kg N/ha per year), background N (N stored in the soil and released through mineralisation) and, if clover is present in the sward, biological N fixation. Sown pastures in Ireland generally consist of perennial ryegrass (*Lolium perenne* L.) which requires chemical N fertiliser application to maximise productivity. In the last 10-15 years, the use of chemical N fertiliser has received a lot of focus, particularly in terms of the negative impact of N on water quality as well as gaseous emissions. More recently, the increased cost of chemical N fertiliser has also resulted in an increased focus on reducing its use. Incorporating clover in grassland swards must be accompanied by a reduction in chemical N fertiliser use to reduce nitrous oxide emissions and contribute to reducing agricultural greenhouse gas emissions.

Reducing chemical N fertiliser input

In Ireland, perennial ryegrass swards receiving 250 kg N/ha can grow 13-14 t DM/ha, sustaining stocking rates of ~2.5 livestock units/ha (O'Donovan *et al.*, 2020). Restrictions in N fertiliser use are of concern as reducing N fertiliser input can reduce grass production (Enriquez-Hidalgo *et al.*, 2018). Analysis by Ruelle *et al.* (2022) concluded that pasture-based milk production systems in Ireland stocked at 2.5 cows/ha and receiving ~250 kg N/ha were self-sufficient in terms of grass-grown for spring to autumn grazing and winter feed. Reducing chemical N fertiliser input reduced farm feed self-sufficiency. Ruelle *et al.* (2022) concluded that for every 50 kg N/ha reduction in chemical N fertiliser from 250 kg N/ha, stocking rate would have to be reduced by 0.18 LU/ha for systems to remain self-sufficient. To maintain herbage production in an environment with reduced chemical N fertiliser application, farmers must consider other options, including optimising soil fertility, optimising slurry use, and introducing white clover to their grassland (Dillon *et al.*, 2020).

Role of white clover

White clover (Trifolium repens L.; hereafter referred to as clover) is the most important legume species in grazed grassland in Ireland. Clover grows well in association with grass, is tolerant of grazing, promotes high dry matter (DM) intake, has high nutritional quality and can grow over a wide range of climatic conditions (Whitehead, 1995). In addition, there are herbage production and milk production benefits associated with the inclusion of clover in grass swards. Perennial ryegrass-clover swards can make an important contribution to the future sustainability of ruminant production systems in Ireland and

Western Europe (Peyraud *et al.*, 2009). The capacity of white clover to fix atmospheric N and make it available for plant growth allows farmers to reduce chemical N fertiliser application, which is beneficial in reducing nitrous oxide (a greenhouse gas) emissions and emissions associated with the manufacture and transport of chemical N.

Sward white clover content

To achieve maximum benefits of clover inclusion in the sward, an average annual clover content of approximately 20% is required. Sward clover content varies across the year. It is low in spring, and contributes little to the DM intake of dairy cows. Clover needs a soil temperature of about 8°C for growth (compared to about 5°C for grass). Sward clover content increases from approximately 0-5% in February to a peak of 35-50% in early September and then declines (Figure 1).

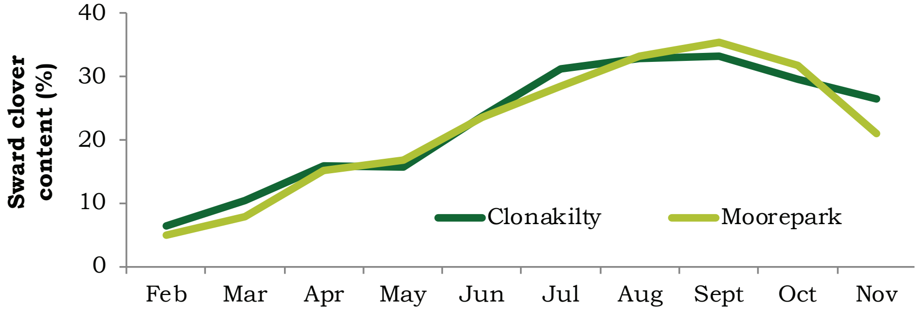

Figure 1. *Annual sward white clover content at Moorepark (eight years) and Clonakilty (four years)*

Benefits of white clover

Nitrogen fixation

Clover is a legume; this means it has the capacity to fix atmospheric N and make it available for plant growth. This occurs through a symbiotic relationship whereby rhizobia bacteria in the soil infect clover root hairs forming nodules. The clover supplies the bacteria with energy from photosynthesis to fix N which the bacteria makes available to the clover plant for growth. In frequently grazed swards (8-10 times per year), up to 250 kg N/ha per year can be fixed when zero chemical N fertiliser is applied.. The rate of N fixation is influenced by the N fertiliser supply to the sward and the sward clover content. Generally, as N fertiliser application rate increase, N fixation declines (Figure 2).

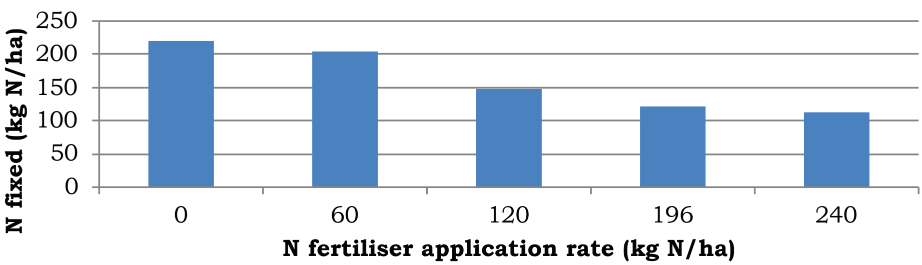

Figure 2. *Nitrogen fixation (kg N/ha) on grass clover swards receiving 0, 60, 120, 196 and 240 kg N fertiliser/ha over three years*

Source: *Enriquez-Hidalgo et al. (2018)*

Herbage production

Incorporating clover into grazed grassland can increase herbage production, particularly at lower N application rates. Research from Clonakilty Agricultural College found that incorporating clover (average clover content 23%) into intensively managed swards increased annual herbage production by 1.5 t DM/ha relative to grass-only swards (where both sward types received 250 kg N/ha). Research at Moorepark shows that grass-clover swards receiving 150 kg N/ha grew the same quantity of herbage as grass-only swards receiving 250 kg N/ha (13.4 t DM/ha) over an eight year period.

Milk production

Grass-clover swards tend to have higher quality in mid-season compared to grass-only swards as clover content increases from May onwards. Clonakilty and Moorepark research both show increases in milk production and milk solids production ($P<0.05$) from grass-white clover swards compared to grass-only swards (Table 1).

Table 1. Effect of white clover inclusion on milk and milk solids yield in the Moorepark and Clonakilty grazing experiments

Moorepark experiment	Grass-only 250 kg N/ha	Grass-clover 250 kg N/ha	Grass-clover 150 kg N/ha
Milk yield (kg/cow)	6,108	6,498	6,466
Milk solid yield (kg/cow)	460	496	493

Clonakilty experiment	Grass-only 250 kg N/ha	Grass-clover 250 kg N/ha
Milk yield (kg/cow)	5,222	5,818
Milk solid yield (kg/cow)	437	485

Nitrogen use efficiency

Nitrogen use efficiency (NUE) is hugely important in grazing systems as N is a key nutrient lost from these systems. It is influenced by many factors including N fertiliser application rate, quantity and crude protein content of concentrate fed, and N removed from the system in milk and meat. The farm-gate NUE of a farm systems experiment undertaken at Teagasc, Moorepark from 2013-2016 was examined using a farm-gate N balance model. The experiment compared herbage and milk production from a grass-only sward receiving 250 kg N/ha per year (Grass250) and grass-clover swards receiving 150 kg N/ha per year (Clover150). Each treatment was stocked at 2.74 cows/ha. The N inputs were purchased concentrate, fertiliser and replacement animals, and the N outputs were milk and livestock. The N fixed by the clover was not included. The NUE of the systems increased from 37% on Grass250 to 55% on Clover150 due to the reduction in N fertiliser application and the increase in milk production on that treatment.

Long term research at Moorepark

Eight years (2013-2020) of research at Moorepark comparing the standard grass-only grazing system receiving 250 kg fertiliser N/ha with a grass-white clover system receiving 150 kg N/ha have been completed. Both systems were stocked at 2.74 cows/ha. The chemical N fertiliser application for each treatment is shown in Table 2. Cows were assigned to their respective system post-calving each spring and remained on that system until housing in late November each year.

Table 2. Nitrogen fertiliser application strategy by rotation on grass-only swards receiving 250 kg N/ha and grass-white clover swards receiving 150 kg N/ha		
Date (rotation)	Grass 250	Grass-white clover 150
Mid-late January	28	28
Mid-March	28	28
April (2nd rotation)	33	28
Early-May (3rd rotation)	30	9
Late -May (4th rotation)	30	9
June (5th rotation)	17	9
Early-July (6th rotation)	17	9
Late-July (7th rotation)	17	9
August (8th rotation)	17	9
Mid-September	33	12

Herbage production was similar on the two sward types despite the 100 kg/ha reduction in N fertiliser used on the grass-clover swards. Approximately 75 kg DM/cow more silage were fed during lactation to the grass-clover cows, mostly in autumn. Neither system was self-sufficient in terms of herbage production due to the high stocking rate. Milk and milk solids yield were greater on the grass-clover system compared to grass-only. Reduced N fertiliser input and an increase in milk production contributed to increased net profit in the grass-white clover system compared to the grass-only system (Table 3). Average sward clover content was 22%.

Table 3. Average animal and sward production on grass-only swards receiving 250 kg N/ha and grass-white clover swards receiving 150 kg N/ha from 2013-2020			
	Grass-only 250 kg N/ha	Grass-white clover 150 kg N/ha	Difference
Stocking rate (cows/ha)	2.74	2.74	-
Annual herbage prod. (t DM/ha)	13.8	13.5	-0.3
Silage conserved (t DM/cow)	1.00	0.98	-0.02
Silage fed during lactation (kg DM/cow)	259	333	+74
Average sward clover content (%)	-	22.0	-
Milk yield per cow (kg)	6,068	6,331	+243
Milk solids yield per cow (kg)	490	510	+20
Concentrate fed (kg/cow)	438	438	-
Nitrogen use efficiency (%) (2013-2016)	40	58	+18
Net profit (€/ha) (2013-2016)	1,974	2,082	+108

N fertiliser application strategy on grass-clover swards

In high stocking rate systems (>2.5 cows/ha), it is necessary to apply similar levels of N fertiliser on grass-clover swards as on grass-only high N systems until April, as in Table 2. Clover makes a small contribution to the sward herbage mass in the early part of the year due to requirement for higher temperature for growth. Applying similar levels of N fertiliser is necessary to ensure adequate availability of herbage for early spring grazing. From May onwards, N fixation is actively occurring and supplying the clover component of the sward directly with N. In addition, the N stored in the organic component of the soil is higher in established grass-clover swards due to the addition of decomposing clover parts to the organic matter. This results in more N being released from the soil for grass growth through mineralisation. Chemical N fertiliser can be reduced by at least 100 kg N/ha on established grass-clover swards from May onwards. Some chemical N fertiliser (12-15 kg N/ha) is required for application in September to help build cover for the autumn.

Conclusion

Incorporating white clover into grassland swards is an effective way of maintaining herbage production when chemical N fertiliser application is reduced. Reducing chemical N application reduces nitrous oxide emissions. Grass-clover swards receiving 150 kg N/ha have similar or greater herbage production than grass-only swards receiving 250 kg N/ha. The Moorepark long-term clover research shows that milk solids production is greater on grass-clover swards compared to grass only-swards.

Acknowledgements

The authors wish to acknowledge the funding provided by the Irish Dairy Levy administered by Dairy Research Ireland.

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Increasing milk production efficiency from pasture-based diets

Michael Dineen

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Summary

- Ruminant production systems must maximise their use of human inedible feeds
- Lower pre-grazing yields and including white clover increases milk production efficiency
- Concentrate supplementation should be used to fill feed deficits.

Introduction

Our global population surpassed 8 billion people on the 15th of November 2022 and is projected to peak at 10.4 billion by 2100. As a result, the world will have to produce more food in the next 50 years than we have produced in the thousands of years since civilization began. While global demand for dairy products will increase, the demand for human-edible plant resources will also concurrently rise, potentially reducing the availability of these resources and the associated arable land for livestock production. Therefore, to maintain a significant contribution to net food production, ruminant production systems should maximise their reliance on the unique ability to convert human inedible resources into human edible food. To achieve this, a clear focus on pre-grazing yield, the inclusion of white clover (WC) into grazing swards and optimizing concentrate supplementation is required.

Pre-Grazing Yield

Organic matter digestibility (OMD; i.e. the amount of nutrients digested) is a crucial factor affecting milk production efficiency from pasture. Pastures with high OMD have high metabolisable energy and metabolisable protein value and can often lead to increased dry matter intake. Experiments performed at Teagasc Moorepark have indicated that lower pre-grazing yield results in higher OMD (Fig 1.) with a more marked effect being demonstrated as the grazing season progresses. Lower pre-grazing yield swards that have higher OMD have also been associated with higher milk yield, milk protein production and milk protein concentration. Therefore, by maintaining optimal pre-grazing yield, through management practices such as grassland measurement, increased milk production efficiency from pasture can be achieved.

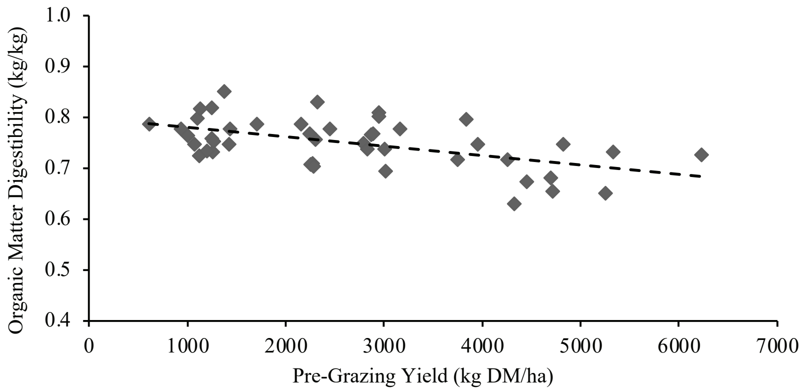

Figure 1. *The effect of pre-grazing yield on organic matter digestibility (Garry, 2018)*

White Clover

The inclusion of WC into perennial ryegrass (PRG) swards can dramatically reduce the system's reliance on chemical nitrogen (N) fertilisers (-100 kg of N/ha) while simultaneously increasing milk production efficiency (+48 kg of milk solids/cow) and economic profitability (+€305/ha), when sward clover content is >20%. Experiments utilising lactating dairy cows in France and sheep in Ireland have demonstrated increased OMD when WC is included in the sward. Increased dry matter intake (DMI), when cows consume PRG-WC swards, has also been widely observed.

Concentrate Supplementation

In pasture-based systems, when growth rate is lower than herd demand, concentrate supplementation is required to fill the feed deficit. In addition, the use of concentrate supplementation has been adopted to increase the milk production of pasture-fed cows. In the latter scenario, the economic effectiveness of concentrate supplementation can be variable, as a wide range of milk response (calculated as the difference in milk produced between non-supplemented and supplemented treatments divided by supplement DMI) has been reported in the literature (0.3 to 2.4 kg of milk/kg of supplement DM). Linear increases in milk production up to 10 kg of concentrate supplemented per day have been reported, whereas other studies have reported diminishing responses at levels greater than 3 kg/day. Factors such as pasture allowance, pasture chemical composition, level of pasture substitution, concentrate level, concentrate ingredients, negative associated effects, stage of lactation and genetic merit of the cows have been suggested to contribute to this variation in milk response. Ultimately, milk response is a crucial factor influencing the profitability of concentrate supplementation. In an economic analysis ranging across a number of different scenarios and prices, the most profitable pasture-based system generally fed circa 500-600 kg of concentrate/cow/year. Thus nationally, there are opportunities to reduce concentrate supplementation while at the same time increase the profitability of milk production. This will also maintain Ireland's ability to produce nutritionally superior dairy products from home-grown pasture and further increase the proportion of human inedible feeds in the lactating dairy cow's diet.

Conclusion

High pasture inclusion levels in dairy cow diets can support an environmentally friendly system of milk production and a resilient business model for the producer. Maintaining lower pre-grazing yields, including white clover into swards and optimizing concentrate supplementation are key factors to increase the milk production efficiency of pasture-based systems.

Meeting the challenges of lower chemical N use on my farm

Michael Gowen
Dairy farmer, Kilworth, Co. Cork

Summary

- Clover incorporation leading to nitrogen fixation from the atmosphere, has replaced the chemical nitrogen removed from the farm system
- Soil fertility has to be correct with pH ≥ 6.3-6.5 and P and K indexes need to 3+ for best establishment of clover
- Reseeding has been the most effective method of clover incorporation but it is a slow process so some over-sowing will be necessary to complement it.

Introduction

I farm with my family near Kilworth in Co. Cork. We farm a total of 70.5ha which is 4 blocks. The milking platform is 33ha. I milk 125 cows approximately each year and carry some in calf heifers and calves on the farm with some of the in calf heifers going into a contract rearing arrangement just this year for the first time. The stocking rate on the whole farm is 2.5 LU/ha while the stocking rate on the milking platform is 3.76 cows/ha. In 2021, the herd averaged 488 kgs of Milk solids sold from just over 560 kg of meal fed and will do 520kgs of milk solids this year.

Changing direction

In the past, I would have used every kg of chemical nitrogen allowed to me. However, in the last few years with the increased focus on water quality and emissions, a change in tack was warranted. Having seen all the good work being done in the research centres on clover, I decided that I needed to start down this road in advance of any regulation changes forcing me to do so. This would allow me to adapt to the new changes more quickly and also give me time to make any necessary adjustments to the way I manage the farm.

Soil fertility

Managing soil fertility on the farm is critical to growing high levels of grass and clover. The pH is > 6.5 in all but one of the paddocks. I am fortunate in that from having had pigs on the farm in the past, our P and K indexes are very good with only two paddocks in index 3 for K. All other paddocks are Index 4 for both P and K and this is a big benefit to me in establishing clover on the farm.

Establishing clover

I have established clover in two ways. I have sown clover when reseeding, of which I do approximately 10% every year. However to get the farm in clover as quickly as possible, I am also over-sowing clover. This year I have oversown 15% of the milking platform. It is tricky to manage the over-sown ground given it has to be grazed regularly at lower covers and I have made the mistake of taking on too much area for over-sowing in one year in the past. This creates the problem of several paddocks all needing grazing at the same time to allow the clover to flourish which is difficult to do in practice. With area out for reseeding and stocking rate high during the summer means that grazing high levels of over-sown area could result in the cows running out of grass due to grazing too many low covers. Consequently, some of my over-sowing hasn't worked out as I couldn't get to all the ground at the right stage and feed the cows as well. This is a lesson learned. I have over-sowed some of this ground for a 2nd time already and have had greater success establishing it through better management of smaller areas. A combination of 10% reseeding and 15% over-sown done well over the next couple of years should see the whole milking platform in clover by 2025.

Managing clover

The biggest challenge I found was that while I knew it was the right thing to do in terms of reducing nitrogen, going and doing it was another story. I knew that I would be able to establish clover in the sward but managing it was another question. However, there are commercial farms that have done it and are making a success of it and this combined with the success in the research centres down through the years gave me the confidence to at least try it. It is seeing this on-farm experience that give me the confidence that I will overcome any potential knowledge gaps to make a success of it on my farm. Table 1 below shows the performance of the paddocks on my farm under varying management strategies. It highlights to me the performance that can be achieved through clover incorporation and I have reduced the chemical nitrogen use on the farm significantly. This is a big financial saving to the farm allowing me to reduce my input costs. Importantly, this saving has come with no reduction in herd performance. I am also contributing to reduced N loss to water and I am reducing nitrous oxide emissions.

Table 1. Data to 15/11/2022 showing the effect of various nitrogen strategies on grass growth on the Gowen farm in 2022

	Area (ha)	No. of Grazings	Grazing (kg DM/ ha)	Silage (kg DM/ ha)	Total (kg DM/ ha)	Total N kg/ha	Chem N kg/ ha	Chem P kg/ha	Chem K kg/ha
Grass only	9.3	7.2	10,249	1,080	11,329	198	186	3	34
Clover-Spring N	2.0	8.0	12,413		12,413	79	39	0	20
Clover-Zero chemical N	8.9	9.4	12,234		12,234	36	3	0	39
Clover-Spring N &half rate summer	9.2	9.0	11,291	370	11,661	161	121	1	33
2022 Spring reseeds	3.6	8.0	10,496		10,496	108	87	19	68

Conclusion

Managing clover will be a challenge but it is a challenge that is achievable. There is an ever increasing amount of information coming from research centres and learnings from commercial farms putting the advice into practice that farmers can learn from to make clover on their farms a success.

Meeting the challenges of lower chemical N use on my farm

Sean O'Donnell
Dairy farmer, Ballina, Co. Mayo

Summary

- Incorporation of clover is helping to reducing chemical nitrogen (N) input on the farm
- Targeting the most fertile areas of the farm will increase chances of success with both over-sowing and reseeding
- Heavier land can make clover sward management more challenging but we are targeting the more suitable areas of the farm for now with good success
- Good farm infrastructure is key for grass and grass clover swards alike.

Introduction

I farm near Ballina in Co. Mayo. We farm a total of 100ha. There are two milking platforms which comprise of 70ha. We milk 210 cows across the two farms. The stocking rate on the whole farm is 2.3 LU/ha while the stocking rate on the milking platform is 3 cows/ha. In 2021, the herd averaged 485kg of milk solids produced from just over 750kg of meal fed and will do in or approximately 495kgs of milk solids this year. The soil type on the farm is mixed with approximately one third heavy, one third medium type soil and the remainder is dry.

Changing direction

Like many dairy farms, we had been using a significant proportion of our chemical N allowance in the past. However, not only has this allowance reduced, it could be subject to further reduction in the future, so we need to reduce our reliance on chemical nitrogen. This has become even more pertinent with the dramatic increase in the cost of fertiliser as one of our key objectives is to maintain a low cost base and with fertiliser being one of the main costs to the business, any reductions that can be achieved will be significant at current prices

Grazing Infrastructure

As the farm is heavy we have invested heavily in infrastructure to allow us to graze the wetter sections of the farm while minimising the risk of damage. Despite this investment, there are parts of the farm that will probably be very challenging for the establishment of clover due to being too wet. For now we will focus on selecting the most suitable areas of the farm based on soil type, soil fertility and ease of access.

Establishing clover

In the last few years we have made a concerted effort on incorporation of clover on the farm. Initially, we did a lot of over-sowing. We tried to do much in our early attempts which meant that we didn't hit the right pre-grazing yields at the right time or the right residuals subsequently and so it was a bit hit and miss. We have also done some reseeding but with limited success as we were reseeding some of the heavier ground which has lower pH. This year we have targeted some of the dry ground with much higher success rate.

Future objective

The plan is to use the clover incorporation to reduce chemical nitrogen use on the farm. We have managed to do this to date having reduced the nitrogen from 235kg N/ha (total) in 2020 to 215kg N/ha in 2021 and will finish 2022 at 200kg N/ha (170 kg N/ha of chemical N). However, we have ambitions to go further. The plan long term is to reduced total N application to 160 kg N/ha which will be made up of 120 kg N/ha of chemical N and the balance coming from slurry and soiled water applications.

Conclusion

Clover has the capacity to reduce chemical N inputs on farms. Incorporation and management of clover will be an important skillset for all dairy farmers to establish in order to replace reduced chemical N allowances which will in turn have positive impacts at meeting both environmental and financial challenges on farms into the future.

Greenhouse gas mitigation potential of chemical N fertiliser

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Summary

- Nitrous oxide makes up 25% of greenhouse gas (GHG) emissions from agriculture. Quantity and type of nitrogen (N) fertiliser are important factors in determining total emissions from this source
- A reduction of 30% in chemical N use and a switch to 100% N in protected urea form can reduce the agricultural sector's emissions by 5.4% (1.25 Mt CO_2-eq). Greater biological fixation of N (clover) will be required to maintain sward productivity
- Changes in N use are accounted for in the national inventory, however the scale of impact for the industry depends on widespread adoption of these practices at farm level.

Introduction

The agriculture sector as a whole accounted for 37.5% of national GHG emissions in 2021 (EPA, 2022a). Over recent years, farmers have taken steps to drive further carbon efficiency per unit of output, as evidenced by a declining carbon footprint (kg CO_2-eq/kg product) of food product from Ireland. However, taking the agricultural sector as a whole, the increase in agricultural output in recent years has contributed to increased overall GHG emissions. In July 2022, the Government agreed ceilings for emissions from each sector of the economy that deliver a pathway towards a 51% reduction by 2030. The ceiling for the agriculture sector will require a cut of 25% (5.76 Mt CO_2-eq) in its emissions by 2030 compared to 2018 levels. Implementation of both methane and nitrous oxide emissions reduction measures will be required to meet this target. This will be a significant challenge for agriculture without affecting livestock numbers, as current technologies available to Irish farmers can't reach that yet. If the targets are to be met with current livestock numbers, it will require development of new technologies, but also more ambition around adoption of existing mitigation options. This paper evaluates the impact of reducing reliance on synthetic N fertiliser and increasing use of protected urea in achieving sectoral GHG emission targets.

How are GHG emissions calculated?

The national inventory is an accounting system, overseen by the Environmental Protection Agency (EPA), which accounts for the total GHG emissions released within the border of Ireland during a given year. The EPA report national GHG emissions across a number of sectors, one of which is agriculture. In contrast to other sectors which are dominated by carbon dioxide, the Irish agricultural sector is dominated by methane and nitrous oxide, contributing over 90% of total agricultural GHG emissions. Figure one provides an overview of the GHG emission sources from the agricultural sector reported in the national inventory.

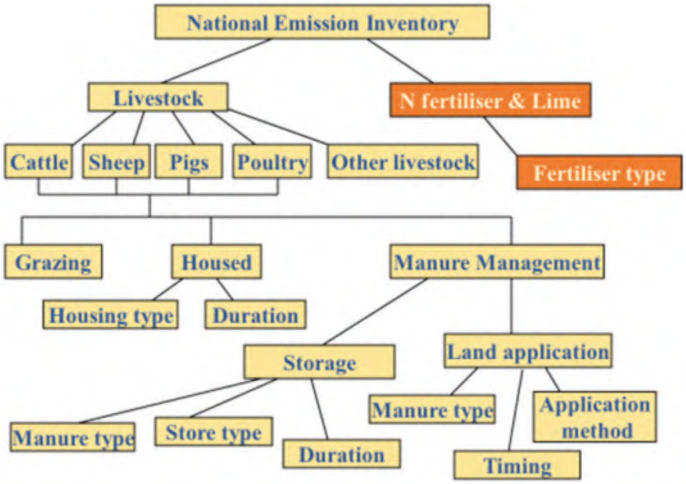

Figure 1. *Overview of agricultural greenhouse gas emission sources in the national inventory*

How are emissions from chemical nitrogen fertiliser accounted for in the national inventory?

While methane receives much more media attention and commentary, it is important to note that nitrous oxide made up 25% of total agriculture emissions in 2021 (EPA, 2022a). Nitrous oxide is a potent GHG, with a global warming potential 265 times that of CO_2, therefore its mitigation is a key objective for the agricultural industry. The main sources of nitrous oxide emissions from agricultural sector are the application of chemical N fertilisers, the deposition of urine and dung during grazing, and manure management (storage and spreading).

Chemical N releases nitrous oxide into the atmosphere when applied to land. Therefore, the reduction in the quantity of chemical N used will lead to a decline in total GHG emissions from the agricultural sector. The type of chemical N fertiliser used also impacts the quantity of nitrous oxide emissions released following application; protected urea emitting 73.5% less nitrous oxide emissions per kg N applied than calcium ammonium nitrate. In addition to direct nitrous oxide emissions, synthetic N fertilisers also emit carbon dioxide following the application of urea fertiliser, and indirect nitrous oxide from ammonia emissions and nitrate leaching. To calculate fertiliser related emissions the EPA records the quantity and type of chemical nitrogen used in the country in a given year. The national fertiliser usage in 2018 is presented in Table 1 as it is the base year for the Climate Action Plan reduction target of 25%.

Table 1. National fertiliser compound statistics in 2018 (EPA, 2022)

	Tonnes N	Proportion
Ammonium sulphate	1,881	0.5%
CAN	147,340	36.1%
NK mixtures	3,134	0.8%
NPK mixtures	198,050	48.5%
NP mixtures	1,969	0.5%
Other straight N compounds	863	0.2%
Urea	51,991	12.7%
Protected urea	3,265	0.8%
Total	408,493	

The impact of reducing synthetic N fertiliser and increasing use of protected urea

An analysis was conducted to evaluate the impact of reducing chemical N levels nationally and adopting protected urea. All GHG emissions associated with synthetic fertiliser in the national GHG inventory report were consider. The emission sources included were direct N_2O emissions following application, CO_2 emissions following the application of urea fertiliser, and indirect N_2O from ammonia emissions and nitrate leaching. The methodology applied is consistent with the national inventory methodology.

The analysis was completed based on two scenarios. In Scenario 1, chemical N levels applied to pastures were reduced by 30% based on 2018 profile of fertiliser use nationally and then the industry moved to displacing CAN and compounds with 100% protected urea. In Scenario 2, it was assumed that the industry first moved to displacing CAN and compounds with 100% protected urea and then reduced fertiliser levels applied to pastures by 30% nationally. Synthetic N fertiliser use on arable land was reduced by 15% for both scenarios. In all scenarios, it was assumed that most of the chemical N fertiliser reductions was achieved through the incorporation of clover into pastures thus allowing the fixation of atmospheric N.

The analysis shows (Table 2) that whether you move to protected urea first or reduce overall chemical N first, you end up at the same place in terms of the overall emissions reductions i.e. a reduction in emissions from 2.3 Mt CO_2-eq associated with fertiliser use to 1.05 Mt CO_2-eq, or 5.4% of the required 25% reduction in emissions from the agricultural sector. However, the order of the movement has a dramatic impact on the advantages associated with reduced chemical N versus a movement to protected urea. The advantage financially as well as from an emissions perspective suggests that the focus at farm level across pasture-based systems should be to move to protected urea based N fertiliser at first and then focus on the N reductions. A Teagasc report published in 2021 (Dillon *et al.*, 2020) that looked at different fertiliser reductions has shown that a reduction in chemical N at farm level would result in a reduction in profitability. Therefore, clover has a key role in replacing chemical N removed at farm level and thus ensuring that there is not a reduction in profitability. Research by McClearn *et al.* (2020) has shown that the establishment and maintenance of clover will increase profitability by approximately €300 per hectare. The successful industry wide reduction of chemical N will be based on widespread establishment of clover on Irish farms.

Table 2. Effect of reducing chemical N fertiliser applied to pastures by 30% and displacing calcium ammonium nitrate (CAN) and compounds with protected urea

	Fertiliser (t N)	Protected % N	Total Mt CO_2-eq	Mt CO_2-eq saved
Baseline	408,493	0.8	2.3	-
Scenario 1				
Reduce fertiliser 30%	294,945	0.8	1.63	0.67
Protected urea	294,945	74.5	1.05	1.25
Scenario 2				
Protected urea	408,493	76.2	1.47	0.83
Reduce fertiliser 30%	294,945	74.5	1.05	1.25

Why concentrate on chemical N when methane makes a bigger contribution to greenhouse gas emissions?

The agricultural sector has some technologies in the toolbox that when implemented will provide wins in terms of reducing total emissions. Using protected urea and reducing reliance on chemical N fertiliser through improved nutrient use efficiency and the incorporation of clover into swards are technologies that can be readily implemented. Methane emissions are more difficult to reduce but technologies like improved breeding, reducing age at slaughter and feed additives will all help to reduce methane emissions.

Conclusion

A reduction in the reliance on chemical N by reducing total N used by 30% and a 100% switch to protected urea will reduce total GHG emissions from Irish agriculture by 5.4%. The likelihood of this reduction will be dependent on whether the industry has a strong movement toward protected urea reducing the impact of chemical N reductions. It is recommended that the first step is to move to increase use of protected urea followed by a reduction in chemical N usage.

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Management and housing guidelines to achieve excellent calf welfare

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Summary

- Irish farmers have a good reputation in terms of animal welfare it is now more important than ever that this is retained
- Ensure adequate space allowance (1.5m^2/ calf) in calf sheds
- Make sure calf housing is fit for purpose
- Maintain high hygiene standards – housing and equipment
- Good colostrum management is a must for healthy calves.

Consumers are becoming increasingly concerned about animal welfare, wanting food purchases to be produced in an ethical and sustainable manner. Presently, most consumers in Ireland believe farm animal welfare standards are high, particularly on dairy and beef farms. The Irish public are becoming more interested in the living environment of animals, requesting more information on farming practices in general, and how welfare friendly they are. The post-quota increase in stock numbers at farm level and heightened interest among consumers towards animal welfare, has created a need to ensure farm animal welfare, and particularly that of calves, is at a high standard on all farms.

In a recent Teagasc Moorepark survey, almost three quarters of farmers rated welfare on their farm as very good. Over 80% of farmers, from the study, also rated their calf husbandry skills as very good. One area which can impinge on high welfare standards is a heavy workload, such as at peak calving, where issues with labour availability and time to adequately tend to calves can arise. Peak calving also coincides with high numbers of calves on the farm and space allowance may be compromised, leading to issues associated with poor calf health.

This paper outlines key areas and practices which can be focused on this coming spring/ calving season to promote excellent calf welfare.

Housing

A potential area for concern is the quantity of housing available for calves, particularly if calves need to be retained on farms for a longer period before they can be transported off farm. Current EU specifications require a minimum space allowance of 1.5 m^2 for calves <150 kg and under 19 weeks old. Interestingly, in the recent Teagasc Moorepark study, the majority of dairy farmers were not concerned with having to retain non-replacement calves for longer, with almost half being extremely or very prepared if this happened. This may be because, based on the recommended EU specifications, only 10% of calf houses were overcrowded.

In the survey where farmers had sufficient space for calves (both space allowance and cubic air capacity), they were more likely to have healthier calves. Surveyed farmers generally kept calves in groups of <12 calves/pen; smaller group sizes are encouraged as it is associated with reduced respiratory issues and improved welfare. Calf houses should be standalone so that airspace is not shared with older animals, as older animals tend to carry and transfer pathogens to young stock. This can threaten calf health, particularly in relation to respiratory infections.

Another key component of calf management is hygiene and maintaining clean and dry bedding areas. A slope of 1 in 20 is recommended for calf house flooring, however very few Irish farms have a sufficient floor slope. Poor drainage can cause dirty and saturated bedding, leading to increased bacterial growth, which can cause higher rates of calf illness and compromise welfare. Inadequate and infrequent cleaning, particularly of feeding equipment, is a huge issue in calf rearing; hygiene management can minimise the transmission of infectious agents among calves. For example, additional survey work carried out by Teagasc Moorepark, on Irish dairy farms, showed that the two dirtiest pieces of feeding equipment on farms were a teated bottle and stomach tubes. Colostrum is generally fed to new-born calves with this equipment; as the calf's immune system is not developed at birth, using feeding equipment with such a high bacterial load immediately exposes them to a higher risk of infection. Below are some guidelines which can help improve calf health and welfare with regard to housing:

Housing check list

- Space allowance of $1.5m^2$ / calf.
- No sharing of airspace with older animals; i.e. keep calves in a separate house.
- Well ventilated, but draught free house.
- Solid divisions between pens – minimise disease spread.
- 1 in 20 slope on floors.
- Deep bed of clean straw to allow calves to nestle and keep warm.

Calf management

As the calf does not have a developed immune system when born, it is essential that calving pens are spotlessly clean to minimise the risk of spreading disease and infection. Colostrum is the most important factor in calf health and vitality. Where poor colostrum management practices are used, calves are more likely to have failure of passive transfer. This leads to increased rates of illness and mortality, as well as slower growth rates and reduced productivity in the lactating herd. The following is a six point reminder to ensure excellent calf nutrition in the first week of life:

The Calf 1-6 Rule

- **First milking:** calves should only be fed high quality colostrum/biestings (i.e. first milking >22% on Brix refractometer (Figure 1)).
- **Feed within two hours of birth:** all calves need to be fed their first colostrum feed within 2 hours of birth, as this is when the maximum amount of antibodies can be absorbed from colostrum.
- **Feed three litres:** all calves should be fed three litres of high quality colostrum.
- **Four feeds of transition milk:** following the first feed of colostrum the calf should get at least four more feeds of transition milk (milkings two to six).
- **Five litres of transition milk:** all calves should be getting at least five litres of transition milk per day.
- **Feed six litres of high quality whole milk or milk replacer:** by one week old all calves should be offered six litres of milk, either high quality (i.e. not waste) milk or milk replacer split into at least two feeds.

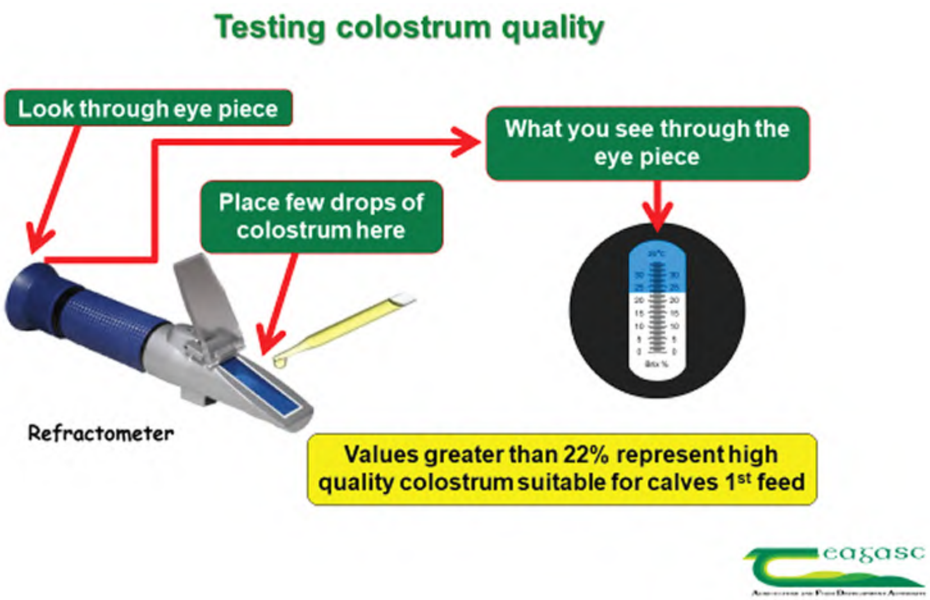

Figure 1. *Testing colostrum quality using a Brix refractometer*

As well as adhering to good colostrum and transition milk management, it is important that all calves are provided with fresh water and concentrate from birth as this will help encourage rumen development. Feeding management practices should be standardised across all calves on the farm. Catering for all aspects of nutrition and feeding sufficient milk during early life not only helps promote high welfare standards, but also improves calf growth and vitality.

Acknowledgements

This work was funded by Teagasc Core Funding and Dairy Research Ireland (Dairy Levy).

Maximising the beef potential of the dairy herd

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Summary

- Sexed semen and improved survival of dairy cows allows for increased usage of beef in the dairy herd
- Using the Dairy Beef Index to select beef sires, will improve the beef merit of your calves with no increase in calving difficulty
- Commercial Beef Value (CBV) will improve the demand for high beef merit calves.

Introduction

The usage of beef bulls on dairy cows will continue to grow due to the improvements in cow fertility and the increased usage of sexed semen. The number of replacements required is reducing due to cows surviving longer as well as less animals needed for expansion in many dairy herds. In addition, there is increased concerns over calf exports and whether or not these will continue for the foreseeable future. Fifty-seven percent of the national slaughter kill originate from the dairy herd at present, a number which is expected to increase. However, there is a very poor retention of beef farmers in dairy beef systems with only 42% of beef famers continuing to buy calves in each subsequent year. To ensure that there will be beef farmers to rear the increased number of dairy beef calves in the future, dairy farmers need to provide calves to beef farmers that are healthy and of good beef merit, at a price that the beef farmer can make a profit.

Increasing beef bull usage on the dairy herd

Firstly, at the start of the breeding season dairy farmers need to identify the number of replacement heifers they require and use dairy semen accordingly to reach this target. Using sexed semen is the easiest way of increasing beef usage on the dairy herd, but only dairy farmers with high fertile animals should use sex semen to ensure it does not negatively impact herd fertility performance. Although, beef bulls are typically used at the end of the breeding season, dairy farmers should aim to look at using beef bulls earlier in the breeding season on low genetic merit cows (i.e. poorly ranked on the EBI), poorly performing cows and problem cows. Additionally, there is an opportunity to use beef bulls on cows cycling prior to the target breeding season start date. If beef bulls with longer gestation were used up to a week before dairy inseminations, there would be an increased number cows calving earlier in the calving season, with no negative impacts on compactness.

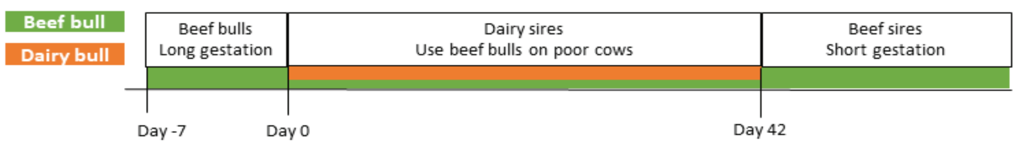

Figure 1. *Breeding season timeline to use beef semen*

Selecting beef sires

Dairy farmers place a large focus on the selection of dairy sires each year. On the contrary, selecting beef sires is often done by picking most easily calved and short gestation sire available. Nevertheless, the selection of the beef bull determines the economic performance of the progeny for the beef farmer and as a consequence the likelihood of them purchasing calves again. The dairy farmer has the power of making their dairy beef calves more of an attractive option by using higher beef merit bulls. The Dairy Beef Index (DBI), available since 2019, enables dairy farmers to pick beef bulls which are easy calving and short gestation, but also higher beef value.

New era for beef breeding

Until now, beef breeding focused on carcass weight, conformation and fat score. Thus, the goal was to breed heavier muscled animals, which receive a high value carcass at slaughter. However, the cost of each extra day it took to slaughter an animal was not considered. Due to new research in Teagasc, the DBI will now include an age at slaughter trait which will identify sires that will have progeny ready for slaughter at a younger age. Age at slaughter will be included in the updated DBI at cost of €1.35/day, which represents the average cost of keeping animal across the year, at a relative emphasis of 6% (Figure 2). Carbon emissions from the dairy and beef herd is becoming a major concern in future years. Although carbon is not a direct economic cost for farmers today, it is possible that farmers will be charged for carbon in the future so the inclusion of a carbon component in the DBI will breed an animal with a lower carbon footprint. It will be the first beef breeding objective in the world to include an age at slaughter trait and a carbon sub-index.

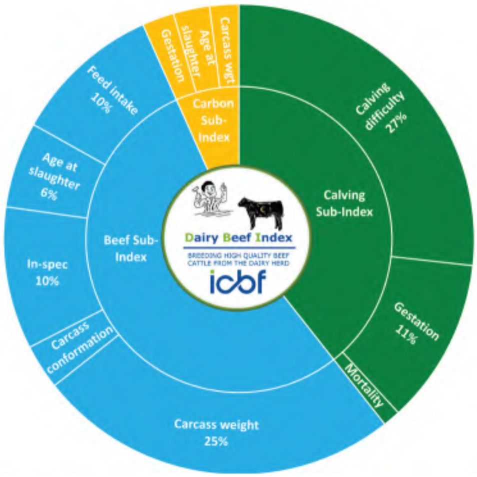

Figure 2. *Traits and their relative emphasis included in the updated DBI*

Commercial Beef Value to drive quality calf demand

The Commercial Beef Value (CBV) is a genetic tool for animals destined for slaughter to predict their beef merit for buyers. It is the first time dairy-beef farmers can control the genetic merit of calves they purchase. Animals with a higher CBV, on average will be heavier, more conformed and younger at slaughter. The introduction of the CBV is both a positive for the beef, more informed at purchasing and dairy farmers, which will get rewarded for higher beef merit animals. This will be available in marts also for animals with a genotype to guarantee correct parentage.

Conclusion

Dairy farmers will need to place higher relevance on beef breeding to ensure they have a saleable calf that is suitable for a beef farmer. Key steps dairy farmers need to take for the next breeding season are to, 1) minimise the number of dairy males, 2) identify poor cows that should be inseminated to beef, 3) use more beef AI, 4) select beef bulls with a high DBI index, 5) use sire advice for beef mating's to minimise calving difficulty and maximise beef potential. Improving beef from the dairy herd will ensure a sustainable integration of both the beef and dairy industry.

My approach to breeding and marketing better beef calves

Liam and Michael Long
Grange, Clonmel, Co. Tipperary

Summary

- My aim is to breed the best beef animal possible without impacting the lactation performance of the dairy herd
- Gestation length is a concern as this will impact on dairy herd performance
- Average calf mortality over the last three years at birth and 28 days is 0.6% and 1.8%, respectively.

Introduction

I farm with my father Michael and brother Michael near Ardfinnan outside Clonmel in Co. Tipperary. We are milking 220 cows on a milking platform of 100ha. We also have 100 0-1s and 100 1-2 year olds. This includes our replacements with the remainder being beef cattle that we carry through to finish. We also have a 7ha block of tillage that is away from the home farm that we cut for whole crop each year and 19ha grassland. We operate a spring calving system and produce approximately 460kg of milk solids from 450kg of meal each year.

Stock bulls were used in the past for breeding. I came home in 2013 and completed an AI course in 2016. We then changed to AI. All dairy replacements are AI bred and we also use a large amount of beef AI throughout the season. We also use one or two Angus and/or Hereford stock bulls towards the end of the breeding season while continuing to AI. Breeding season length on the farm is 12 weeks. Our aim with our dairy replacements is to breed a cow that will last in the herd, have moderate maintenance and produce good milk solids. Our aim with the beef AI is to breed the best beef animal that we can without affecting the performance of the dairy herd.

We keep a very close eye on cows during the calving season and assist if necessary. However, 95%+ of calving be they dairy or beef take place unassisted. I check the camera regularly at night during calving as I hate to lose calves. Our dead at birth figure is quite low at an average of 0.6% for the last three seasons.

When the calf is born, we ensure they get their colostrum and then they move onto whole milk for the remainder of the milk rearing phase. Our calf accommodation can come under pressure quite quickly due to our high six week calving rate and the fact that we keep some beef calves for our beef enterprise.

We have spent a lot of money on infrastructure around the farmyard in the last 5-7 years and the final piece of the jigsaw is the calf housing. It is our plan to build a calf shed that will allow us to keep all our calves. We hope to have this shed built within the next 12-24 months.

In terms of animal health, cows are vaccinated against leptospirosis, IBR and salmonella. Calves are vaccinated for RSV/PI3 pneumonia from a week old to prevent respiratory issues. For the coming spring, cows will be vaccinated against rotavirus, coronavirus and E.coli K99. This is being done as an insurance policy to limit the risk of a scour outbreak, which while not a concern currently, is something that we do not want to have to face.

Our brother Richard who is a DairyBeef500 demonstration farmer, buys 100 calves from us each year. They start to move to Richard at approximately two weeks old. In 2019, a decision was made to look in more detail at the beef AI being used on the farm with a view to improving the quality of the stock being produced.

Table 1 shows the changes in slaughter performance that has been achieved through putting greater emphasis on the beef traits of the AI sires selected. The better genetics chosen facilitated an increased carcass weight for both steers and heifers and this was achieved in a shorter time scale at better grades thus attracting higher prices. The shorter time to slaughter provides a further benefit as it reduces the carbon footprint of beef production and with it emissions from the whole agricultural industry.

Table 1. Slaughter performance of steers and heifers from animals with better beef genetics

Age (months)	Carcass weight (kg)	Average slaughter date	Grade	Fat score	Price (€/kg)	Days on farm
Slaughter performance of steers						
26	287	30/03/2018	0-	3=	3.87	769
23	316	29/01/2022	0+	3+	4.63	655
-3	29	60 days	2	1	0.76	-114
Slaughter performance of heifers						
24	250	31/01/2018	0=	3+	4.07	697
22	281	14/12/2022	0+/R-	3+	4.58	627
-2	31	48 days	1.5	-	0.51	-70

Some continental sires with slightly longer gestation lengths are used only in the early part of the breeding season while the shorter gestation sires only, are used in the latter half. In 2022, more early-maturing (AA and HE) genetics were used. The basis of this decision was twofold. Richard has to finish approximately 40% of his animals before housing in October/November and while only used early in the breeding season, continental sires carrying time prior to calving was impacting on the dairy farming operation.

While the link with Richard is obviously a big benefit to us as an outlet for the calves, I would be very confident that the stock that we are breeding would sell easily either in the yard or in the mart should he ever decide to reduce the number he takes or stop his dairy beef operation. The fact that we can achieve this outcome with no negative impact on the dairy herd makes it an easy decision to breed for better beef during our AI season each year.

A final important point is that using beef AI gives us the scope to target bull type to individual cows in terms of gestation length, calving difficulty and beef merit. The reliability of proofs from AI bulls for these traits is also a big advantage compared to running beef stock bulls only.

Using DBI to produce better beef calves on our dairy farm

Peter and Caroline Robinson

Ballinagore, Co. Westmeath

Summary

- The principles from EBI in terms of using a team of bulls need to be practiced for DBI bull selection
- Our buyers are important to us and so are our cows. Using the DBI information along with our knowledge of individual cows is key to ensuring we deliver on herd performance plus saleable calves
- A calf health plan is key to our business. To ensure we rear healthy calves, Key Performance Indicators are set out each year.

Background

We farm in Ballinagore County Westmeath. I am married to Caroline and we have four children, Eoin, Luke, Adam and Emily. I took over the home farm in 1994. At that time, there were 17 dairy cows and beef and sheep on the farm. For 13 years, I farmed and worked Monday to Friday in construction. Throughout that time dairy cow numbers increased to 60 cows and bit by bit the beef and sheep enterprises reduced.

In 2007, I took the plunge and went full-time farming. It was very clear early on that 60 cows would not generate enough income for our family. To make farming full-time viable cow numbers grow to 100 cows by 2010. I was looking for opportunities to grow the business but the milking block was completely land locked. Back then, Patrick Gowing was my Teagasc advisor. With a lot of discussion and business planning with Patrick I met with George Walshe to discuss a farm partnership. After a lot of meetings and help from Patrick we went into partnership in 2015. We started with 200 cows and today we have 960 cows. I am also working in partnership with another farmer and there are 260 cows on that farm. I decided that I would keep my 100 cows at home and hire employees to do some of the day-to-day work. For the farms that I am in partnership with my role is mainly managing employees and analysing the business performance. However for my own farm I am very much hands on.

Farm performance

Last year on the home farm the herd produced 554kg milk solids per cow (4.6%f, 3.72%p). Herd EBI is €214 and the replacements are €246. The six week calving rate is at 78%. Creating a good standard of living and implementing processes on the farm to streamline each task to facilitate time off the farm is a key objective of the business. I have been improving genetics and cow performance year on year and I am happy with the current performance.

Breeding decision

Up until two years ago, the key objective was to get as many high EBI replacements as possible to help grow the other herds that I am involved with. We are now in a position where a lot more beef AI can be used. Hol/Fr usage has reduced from nine weeks to three weeks.

We used seven weeks of beef AI/stock bull this year. We made this decision based on our calf buyers. The buyers we had that for the male Hol/Fr calves said each year that they would be interested in AA calves. They favour the AA over the Hol/Fr breed in terms of ease of finish and carcass conformation. In addition, I carried surplus in-calf heifers this year and sold them relatively easy, but there was a lot of work put into them and from year-to-year it can be a variable market for dairy heifers.

I first started to look at the DBI two years ago. I used two AA high DBI bulls. The buyers liked them so I have used a lot of these bulls again this year. My team of Beef AI bulls is too small however. Next year I will use a bigger team of DBI bulls. The heifers are served with Hol/Fr bulls only, so I do not have to worry about difficult calving with heifers. One of the AA bulls I used has a DBI of €149 and €94 of a Beef sub index, with 3% calving difficulty for mature cows. So far, there has been no calving issues. I got caught a good few years ago with a few harder-calving BB AI bulls. It was my own fault, I did not look at his figures and it taught me a lesson. I use sire advice every year for the EBI bull selection, now I know I have to do the same for selecting Beef AI.

Calf rearing

We operate a night calver on each farm and this has been a great help to everyone working here. We are fortunate to have two local farmers who do the night calving and work on the farm part-time throughout the year. All cows get Rotovec 2-3 weeks before calving. Colostrum is fed within two hours of birth for each calf for the most part. Halocur and Bovipast is also given to all calves. This costs over €20 a calf. It keeps calves healthy and it's part of our calf health plan. Calves for sale all stay on whole milk, I find there are no setbacks when keeping them on whole milk. All calves get six litres of milk per day.

Calf and cow accommodation is very important when it comes to calf hygiene. Accommodation on all farms can be cleaned out mechanically. Because of this all calf and cow accommodation is cleaned out every two weeks. We are currently adding an extension to one of the calf sheds. This will give us an additional 100 calf spaces. This will mean that we can accommodate 80% of the total calf births. This is essential to future proof the farm business. We have six calf buyers at present of which four buyers buy 60% of the calves we have for sale and the remaining 40% are sold for export.

Conclusions

Our buyers are important to us and having good quality healthy calves means we have a better chance of having repeat buyers. In summary, we try to make each beef calf leaving the farm a viable option for the buyer to make a margin in their system. If this leads to a win-win then the whole process becomes more sustainable in the long term.

Dairy production costs and projections 2022-23

Adrian O Callaghan[1] and James O Donoghue[2]

[1]Dairy Advisor Teagasc Mallow; [2]Dairy Advisor Teagasc Monaghan

Summary

- Input price inflation is likely to increase the cost of production to €2,218/cow on average based on projected costs from E Profit Monitor data
- Direct costs associated with feeding the cow have increased to 51% of total costs
- Changes in cow numbers should be assessed taking into account cost and source of feed, overhead costs, and implications for labour requirement. Assuming a linear change based on current costs can be misleading.

Introduction

The average unit cost of producing milk has increased since the abolition of quotas. The rate of increase in costs from 2015 to 2017 was 1.9% per year. In the period 2017-2018, this rate increased to 3.4% per year. However over the last 2 years as input price inflation has risen dramatically, the cost of producing milk has increased at a significantly higher rate. Based on data collected from the new Teagasc E Profit Monitor system, the average cost of keeping a cow in 2021 for a spring calving dairy farmer was €1,656/cow (range from €1,198/cow to €2,211/cow). This figure includes the cost of keeping the cow and also her replacement heifer costs.

Projecting a final cost of milk production for 2022-23

To budget forward to examine the costs for 2022 we used the following input cost assumptions:

- Same quantity of inputs as 2021
- Average meal price of €415/t in 2022
- Fertilizer cost increase by 250%
- Contractor cost increase by 50%
- Total variable costs on average increase by 49%
- 10% increase in fixed costs

When these are used in a cumulative projection, average costs is projected to have increased from €1,656/cow to €2,218/cow. This is equivalent to a 33% increase in the cost of production which will equate to an average cost of 37.84c/litre for 2022 excluding owned land and labour. To put this in context, the average Gross Output on Teagasc E-Profit Monitors over the last 5 years (2017-2021) has been 40.88c/litre. It is clear therefore that the final margins achieved on dairy farms in 2022 will have been almost entirely dependent on the higher milk price returned.

Looking forward to 2023 we are likely to see a further increase in concentrate costs while other costs will likely increase at an inflation rate of 8% leading to total costs per cow increasing to €2,331. This underlines the need for dairy farmers to maintain close control on costs despite a seemingly high milk price, to prioritize investment in high return areas such as soil fertility, and to stress-test capital expenditure projects against possible changes to base milk price.

Table 1. Projected costs for 2022						
Spring calving 2021 vs 2022 (projected)						
	Costs/cow			Costs C/L		
	2021	2022 (Proj.)	Diff +/-	2021	2022	Diff +/-
Feed	372	524	151	6.35	8.93	2.58
Fert	158	394	236	2.69	6.73	4.04
Vet	84	93	9	1.44	1.58	0.14
AI	46	51	5	0.79	0.87	0.08
Contractor	149	223	74	2.54	3.81	1.27
Other variable costs	183	201	18	3.12	3.43	0.31
Total variable costs	992	1,486	494	16.93	25.35	8.42
Total fixed costs	664	732	68	11.33	12.49	1.16
Total costs	1,656	2,218	562	28.26	37.84	9.58

Impact of feed budget balance on milk production costs

The projections shown illustrate that the trajectory of production costs has risen steeply. However, in particular the direct costs of feeding the herd (purchased concentrate and forage, fertilizer and contractor) have increased faster than the overall average. In fact in 2022 51% (€1,141/cow) of the cost of production will be associated with direct feed costs. This proportion has increased from 41% in 2021. Therefore, as we look forward and want to control costs, it is essential to manage the feed budget and overall projected feed balance for the farm. This will have the biggest impact on cost structure going forward.

An analysis of 2021 E profit monitor data looks at whole farm stocking rate compared to the purchased feed cost on spring calving herds.

Table 2. Purchased fodder compared to stocking rates					
		Purch conc	Bought in forage	Whole farm SR	Grass utilized
	Kg MS/cow	Tons/cow	Kg DM/cow	LU/Ha	(t/Ha)
Average farmer (n=739)	492	1.05	138	2.33	10.01
No forage purchased (n=321)	486	1.01	0	20.21	9.84
Buying above 200kg DM (n=177)	501	1.15	443	2.47	9.75

Based on this real farm data, some farmers are deciding to stock the farm to buy no imported fodder, while others are stocking beyond the potential grass grown of the farm and purchasing back the additional fodder required. To explore the impact this will have on the cost structure of the farm, we standardized the farm to a 40 Ha block and assumed only cows on the farm. Two stocking rates scenarios were examined i.e. self-sufficient for forage at moderate stocking rate, or the higher stocking rate with additional cows supported by importing feed into the system. Annual pasture growth was assumed to be similar across the scenarios.

If stocked at the moderate SR the farm will carry 88 cows (40 X 2.21). If they run the farm at the higher SR they will carry 98 cows (40 x 2.47). To carry the additional cows no additional grass was grown and in fact grass utilized figures declined from 9.84t/ha to 9.75. The additional costs to keep the 10 extra cows to the feed budget of all cows were 0.14t/ of meal per cow and 443kg DM of purchased forage. This may not appear significant expressed on a 'per cow in the herd' basis, however it is useful to isolate the effect to the extra 10 cows, as these are the cohort creating change in the feed budget (Table 3).

Table 3. Effect of stocking rate and feed input pricing on herd feed cost

	Moderate SR	Higher SR	Per extra Cow
Total cows	88	98	
Purchased meal t as fed	92	113	
Purchased silage tDM	0	42.14	
Feed budget H	€36,960	€55,615	€1,866
Feed budget L	€29,568	€44,492	€1,492

Budget H = Meal €400/t and silage €250/tDM; Budget L Meal €320/t and silage €200/tDM

On the lower stocked farm, each cow was fed 1.01t x 88 cows giving a total meal purchase of 92 tonnes with no additional fodder required. On the higher stocked farm each cow was fed 1.15t or a total of 113t and additional 443 kg DM/ cow or 43t DM was required. Across the two feed market price scenarios shown, annual feed budget cost difference ranged from €14,920 to €18,666, or €1,492 to €1,866 per additional cow. This is before any account is taken of vet, AI and other variable costs, which may be €350 to €400 per extra cow. Labour and costs associated with providing accommodation and slurry storage will vary by farm but must be accounted for. Fixed costs and labour will increase further if higher stocking rate results in significantly more days when buffer feeding pasture is required. Clearly, calculating the economic impact of changes to cow numbers is highly dependent on the assumptions used. However, it is a vital step to clarify the likely economic outcome and risks involved.

Conclusion

The cost of keeping cows on farm have increased dramatically, in particular the costs associated with feeding the cow. When looking at future changes to herd size, it is useful to assess the likely impact on the total inputs, costs and outputs from the farm, rather than assuming a straight line increase based on current average costs.

Implementation of selective dry cow therapy in Irish dairy herds

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Summary

- Selection of cows to be treated with teat sealant alone is very important. Choose cows with less than 100,000 cells/mL throughout lactation and consider using a lower threshold for first lactation cows
- Keeping low SCCs in late lactation is important because a higher SCC in the last milk recording is associated with a higher SCC in the following lactation
- Use of CMT, keeping mastitis records and discarding first strips of milk help achieve lower SCCs
- Cows need to be housed with sufficient space (> 1 cubicle/cow) and in a clean environment (clean cubicles twice/day) to achieve low SCC levels.

Introduction

As of January 2022, EU regulation on veterinary medicinal products that states that antibiotics should not be used as a preventive measure in animal production came into effect in Ireland. Intra-mammary antibiotic treatment of all cows in a herd (blanket dry cow therapy) has been widely used as a method for curing existing infections and to prevent new infections over the dry period. The latter, is not an acceptable approach with the new regulation. To prevent new infections over the dry period, an internal teat sealant is a good alternative to antibiotic treatment in uninfected cows (selective dry cow therapy).

Research

International studies showed that treating low SCC cows (< 200,000 cells/mL) with a teat sealant alone at dry-off was as effective in preventing new dry period infections as using intra-mammary antibiotics combined with teat sealant. However, Teagasc studies in research and commercial herds showed that treating low SCC cows at dry-off with a teat sealant resulted in a higher average SCC in the following lactation compared to treating cows with an antibiotic plus teat sealant (125,100 cells/mL vs 75,700 cells/mL, respectively) and a higher probability of having an infection at calving (18.8% vs 3.4%, respectively). Staphylococcus aureus was causing most of the infections in this study, which is one of the major differences with international trials.

Teagasc studied 21 commercial herds that had implemented selective dry cow therapy to understand the factors most associated with SCC. In that study, cows treated with teat sealant alone had 32,000 cells/mL higher SCC compared to antibiotic plus teat sealant cows (152,000 vs 120,000 cells/mL, respectively). Farmers treated the cows with the lowest SCC in the previous lactation with teat sealant alone. Cows whose last milk recording SCC from the previous lactation was <150,000 cells/mL had 120,000 cells/mL lower SCC compared to cows with >150,000 cells/mL (Figure 1). Cows with lower milk yield in the last milk recording of the previous lactation had lower SCC in the following lactation.

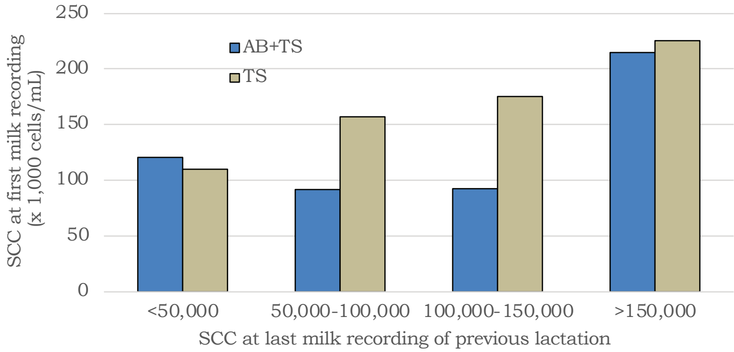

Figure 1. *Average SCC at the first milk recording of the lactation for cows treated with antibiotic plus teat sealant (AB+TS) and teat sealant alone (TS) and according to their SCC in the last milk recording of the previous lactation.*

Farmers were asked to complete a survey about milking and dry period practices to estimate their association with SCC in the following lactation. Farmers that regularly used the California Mastitis Test (CMT) to detect high SCC cows had lower SCCs compared to farmers that did not use it. Farmers that kept records of clinical and subclinical mastitis cases had lower SCC cows compared to farmers that did not keep any records. Farmers that always checked and discarded the first strips of milk before milking the cows had lower SCC compared to farmers that did this seasonally or never.

Farmers that housed their cows in sheds with one or less than one cubicle per cow had higher SCC compared to farmers that housed their cows with more than one cubicle per cow. The recommended stocking rate of the cubicle sheds is 1.1 cubicles per cow. Cows had lower SCC when their cubicles were cleaned/disinfected twice per day compared to once per day.

A second Teagasc study analysed what was the best information to predict which cows will have an infection in late lactation. The analysis included cow SCC throughout lactation, parity and bulk tank data among others. The SCC of the last milk recording was the most significant variable to predict infections in late lactation. Therefore, if a farmer is not milk recording, they could do one milk recording in late lactation to help guide dry cow therapy decisions. However, the benefits of milk recording are best realised when done multiple times throughout lactation.

The Teagasc study also showed that the SCC threshold that maximises correctly classifying infected and uninfected cows was 101,000 cells/mL. The current advice is that cows with < 100,000 cells/mL should be treated with an internal teat sealant alone. However, the SCC threshold for selection of dry cow therapy will depend on the mastitis control situation in each herd and should be tailored accordingly. Additionally, the SCC in infected first lactation cows was lower than in second and greater lactation cows. This means that for first lactation cows, a SCC of approximately 61,000 cells/mL had the best results to correctly classify infected and uninfected cows and could be used for selecting dry cow therapy.

Conclusion

Treating cows with teat sealant alone at the end of lactation can result in higher SCC in the following lactation. The lower the last milk recording SCC, the lower the SCC in the following lactation. Keeping cows housed with more than one cubicle per cow and cleaning cubicles twice per day will help having a lower SCC. Keeping records of clinical and subclinical mastitis, regularly using CMT to detect high SCC cows and discarding the first strips of milk will also contribute to having a lower SCC. Finally, the dry-off procedure is critical if not using antibiotics and therefore, cows need to be dried-off in a clean and dry manner.

Methane mitigation strategies within pasture-based dairy systems

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Summary

- Measured enteric methane output is less than what current models are estimating for dairy cows in Ireland
- Grassland management has a significant impact on enteric methane output
- Feed additives could have a role in reducing enteric methane output in pasture-based systems - further work is required to prolong the efficacy of additives and to make their use practical at the farm level
- The inclusion of the carbon sub-index into the EBI will allow for reductions in emissions to be made through breeding - it may also be possible to directly select for cows with lower methane output within the carbon sub-index in the future.

Introduction

Methane emissions from enteric fermentation are a by-product of feed digestion within the animal's rumen. Within the agriculture sector, methane emissions from enteric fermentation account for 57.4% of agricultural greenhouse gas (GHG) emissions (EPA, 2022). Given that the agricultural sector needs to reduce its GHG emissions by 25% by the year 2030 relative to 2018 levels, developing strategies to mitigate methane will be crucial to meeting Ireland's agricultural climate targets. Teagasc, through VistaMilk, has invested in a comprehensive work programme, which aims to better understand and ultimately mitigate enteric methane output in Irish pasture-based dairy systems. This research has shown that there can be large discrepancies between calculated versus actual enteric methane emissions. A trial conducted across the 2021 grazing season (Figure 1.) demonstrated that the calculated methane output was substantially greater (373 g/day) compared to measured methane (305 g/day). This research will allow for more accurate accounting of methane within the national inventory and will enable policy makers to make better and more informed decisions regarding mitigation strategies for methane in Irish settings.

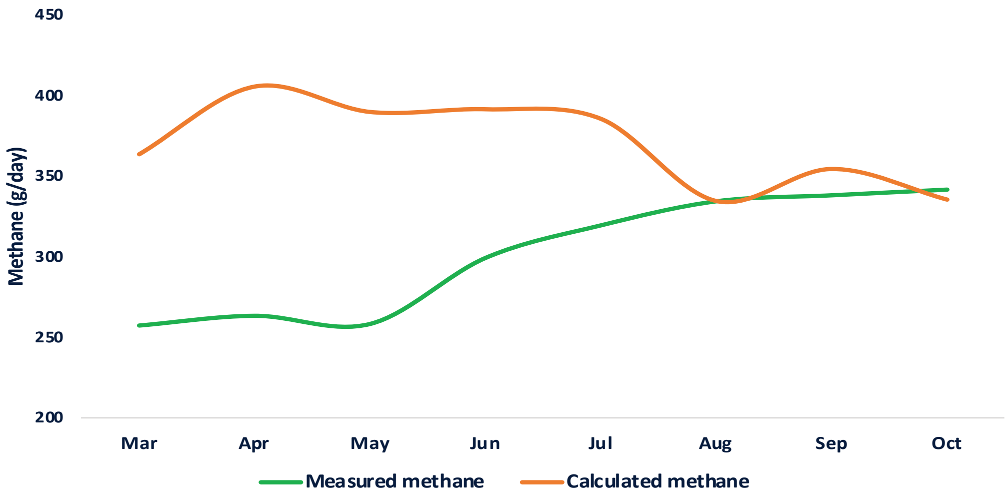

Figure 1. *Seasonal profile of measured and calculated methane emissions in grazing dairy cows*

How can we reduce methane emissions?

Work is ongoing in three areas to reduce enteric methane output, which are summarized as follows:

Grazing management

As demonstrated in Figure 1, there is a seasonal nature to methane output with lower enteric methane emissions observed in the spring period which are related to a decrease in the levels of neutral detergent fibre and an increase in the digestibility of the pasture. This leads to a reduction in the residency time of material in the rumen which means there will be less time for methane to be formed (Moe and Tyrell, 1979). Spring pasture can also lead to reduced ruminal pH levels (McAuliffe *et al.*, 2022), which can inhibit the growth of methanogenic bacteria (Van Kessel and Russel, 1996). Reducing the quantity of silage fed to animals in the spring will further reduce neutral detergent fibre levels and increase the digestibility of the diet. Therefore, getting cows out to grass earlier in the spring, using "on-off" grazing and minimizing silage supplementation will increase the proportion of highly digestible pasture entering the animal's rumen which will in turn lead to reductions in methane output. In the main-grazing season, enteric methane output can be reduced by ensuring swards are highly digestible (Wims *et al.*, 2010). This can be achieved by ensuring cows are grazing the correct pre-grazing covers (~1,400 kg DM/ha).

Feed additives

Feed additives work by altering the rumen environment and inhibiting enteric methane formation. Research internationally has demonstrated feed additives to be effective at reducing methane output when fed to animals in total mixed ration diets indoors (Honan *et al.*, 2021). Within these settings, the additives can be mixed throughout the total mixed ration, meaning they are present in every mouthful of feed that the animal consumes. At pasture, the most applicable method of administering additives is through supplemental feeding in the milking parlour twice daily. This potentially limits the efficacy of additives, given their requirement to be constantly present in the rumen. Recent trials with grazing dairy cows have demonstrated approximately 2.5 hours of efficacy following consumption of additives at milking time. During this 2.5 hour period, additives were found to reduce enteric methane output by ~30%. After 2.5 hours, methane levels return to normal with the total reduction across a daily period being ~6-8%. Further work is required to develop technologies which can increase the efficacy of additives over longer periods within pasture-based settings. The practicality of feeding additives on-farm must also be considered. At present, the most practical method of administering additives is to incorporate them into compound feed and feed them through in-parlour feeders during milking. However, such feed is generally formulated to a standardised feeding rate (i.e., 1-2 kg), in which case the daily allowance of the feed additive must also be delivered in 1-2 kg of concentrate. Therefore when concentrate supplementation rate is sporadically increased during periods of low grass availability or during adverse weather conditions, the intake of additive will also increase and as a result may pose problems from a cost and safety perspective. Finally, with all additives the effect on product quality and ensuring there are no residues needs to be continuously monitored and evaluated.

Breeding

The economic breeding index (EBI) has delivered significant improvements in profitability to the Irish dairy industry since its inception two decades ago. This increase in profitability is primarily driven by increased fertility and milk solids output. To date there has been no focus on reducing enteric methane through breeding. Enteric methane models assume the increased productivity of high EBI dairy cows leads to higher energy requirements and thus greater enteric methane output, however, studies undertaken at Teagasc Moorepark show that this is not the case. Measured enteric methane from 2021 indicates that there is no significant difference in daily methane production from elite EBI and national average cows (Figure 2). In fact, the greater productivity of elite EBI dairy cows results in a dilution of their methane emissions and less methane being produced per unit of milk solids which is currently not being captured in the enteric methane models. Further research is required to increase the understanding of these effects, but initial results from 2022 studies are showing a similar trend.

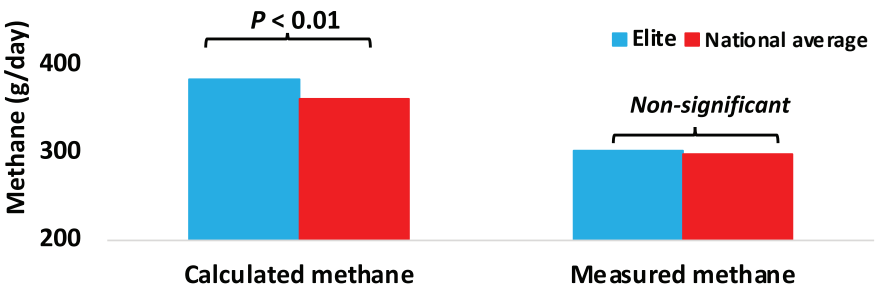

Figure 2. *Calculated and measured methane emissions of elite EBI (€233) and National average EBI (€133) dairy cows*

A new carbon sub-index has been incorporated into the EBI in 2022. This sub-index ranks animals based on GHG emissions and will be linked to EBI through a price per tonne of carbon dioxide. This will put increased emphasis on traits that reduce total GHG emissions and improve profitability (e.g. survival, live weight, and calving interval), while reducing emphasis on traits that increase emissions. The introduction of the carbon sub-index into the EBI will identify more profitable animals while also contributing to increased GHG mitigation. Research has also demonstrated that within a cohort of animals there is variation in terms of enteric methane production, meaning it may be possible to directly select for enteric methane in the future. A key challenge to selecting animals for enteric methane output in pasture-based settings is routine access to a large number of phenotypes to generate breeding values for the trait. Future work will aim to develop methods of ranking animals for enteric methane output on commercial dairy farms, with a view to generating enough data so that we may ultimately be able to genetically select for lower enteric methane production.

Conclusion

Research to date has shown that models used to generate enteric methane output in dairy cows currently overestimate enteric methane emissions. Furthermore, progress has been made in a number of areas to reduce enteric methane output on farm. The most effective methods of reducing enteric methane output on farm at present are through improved grazing management and selection for higher EBI. Further work is required to improve the efficacy and practicality of feed additives within pasture-based settings.

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Milking efficiency of rotary and herringbone parlours

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Summary

- Milking process efficiencies were documented on herringbone and rotary dairy farms through the use of video cameras and infrastructure surveys
- The average total milking process time for the herringbone group was 1 hour 55 mins and 2 hour 35 mins for the rotary group
- The average milking efficiency was 94 cows milked per hour for the herringbone group and 170 cows milked per hour for the rotary group.

Introduction

Milking efficiency is often defined as the number of cows milked per hour, or cows milked per operator per hour. In order to achieve optimum milking efficiency, there must be successful engagement between factors that can have most impact on the milking process such as cows, equipment, and people. Milking is a significant task and accounts for approximately 30% of a dairy farmers daily workload. This paper will describe the times for the milking processes and milking efficiency of a subset of Irish dairy farms across both herringbone and rotary milking systems.

Materials & Methods

Farmers were chosen for inclusion in this study based on their willingness to participate in data recording, to share farm data and who were managing progressive dairy farms that are representative of future Irish dairy farms. Data were collected using both surveys and video cameras. The purpose of the survey was to generate a descriptive profile of all facilities as well as establish the presence of automation on the farms. The cameras were used to collect empirical data from the milking process. Cameras were placed on farms for a duration of one week for two recording periods. Period 1 was from 28/07/20 - 23/10/20 and Period 2 was from 12/04/21 - 19/05/21.

The milking process was then divided into three distinct stages: 1) Set-up Time – 1st cow in holding yard until 1st cluster attached; 2) Milk Time – 1st cluster attached until last cow out of last row/rotation; 3) Clean-up Time – hanging up of 1st cluster until hosing of facilities complete. Total process time was defined as the 1st cow in the holding yard until hosing of facilities was completed. The times presented here are an average of AM and PM milking's.

Results - Infrastructural Survey

Herringbone: The Herringbone group consisted of a sample of seventeen farms. The average herd size for the herringbone group was 180 cows (range 70-364 cows). The average number of milking clusters was 20 units, (range 6-36 units). One farm had a double-up system as opposed to a swing-over system. Automatic cluster removers were installed on 81% of the farms, 41% had automatic feeders, 59% had automatic entry/exit gates, 24% had automatic backing gates and 12% had a rapid exit system installed.

Rotary: The Rotary group consisted of a sample of ten farms. The average herd size for the rotary sample group was 425 cows, (range 275-660 cows). The average rotary farm had 50 units (range 44-64 units). Automatic cluster removers were installed on all of the farms, 70% had automatic teat sprayers installed and 60% had automatic backing gates.

Results – Video Recording

The average total milking process time for the herringbone group was 1 hour 55 mins and 2 hour 35 mins for the rotary group. On herringbone farms, 80% of the total process time was made up of milking with 20% for set-up and cleaning. On rotary farms, 75% of the total process time was made up of milking with 25% for set-up and cleaning.

Figure 1, shows that the milking efficiency key performance indicator (KPI) of cows milked per hour was 80% higher and cows milked per operator per hour was 89% higher for rotary farms compared with herringbone farms. Litres per hour was 50% higher for rotary farms when compared with herringbone farms.

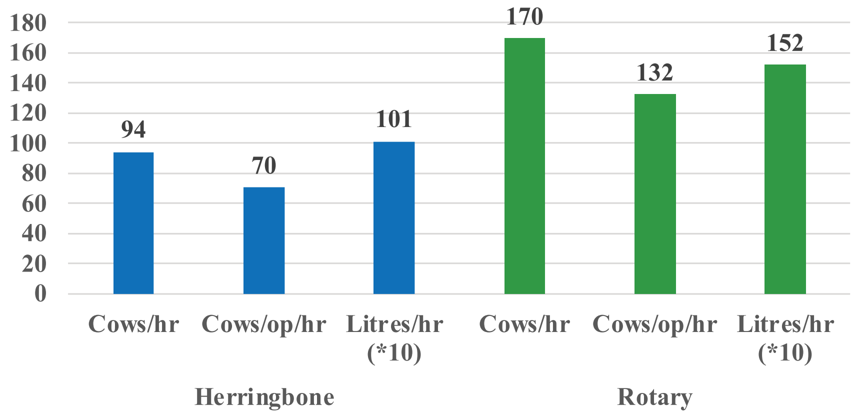

Figure 1. *Milking efficiency key performance indicators for herringbone farms (on left) and rotary farms (on right)*

Conclusion

Rotary farms had longer milking process times and higher cow throughput compared to herringbone farms. The farm-to-farm variability between herringbone and rotary systems warrants further investigation in order to identify the factors that have the largest influence on milking efficiency. The future work of this research project will seek to determine where maximum reductions in milking process time can be achieved.

An Roinn Talmhaíochta,
Bia agus Mara
Department of Agriculture,
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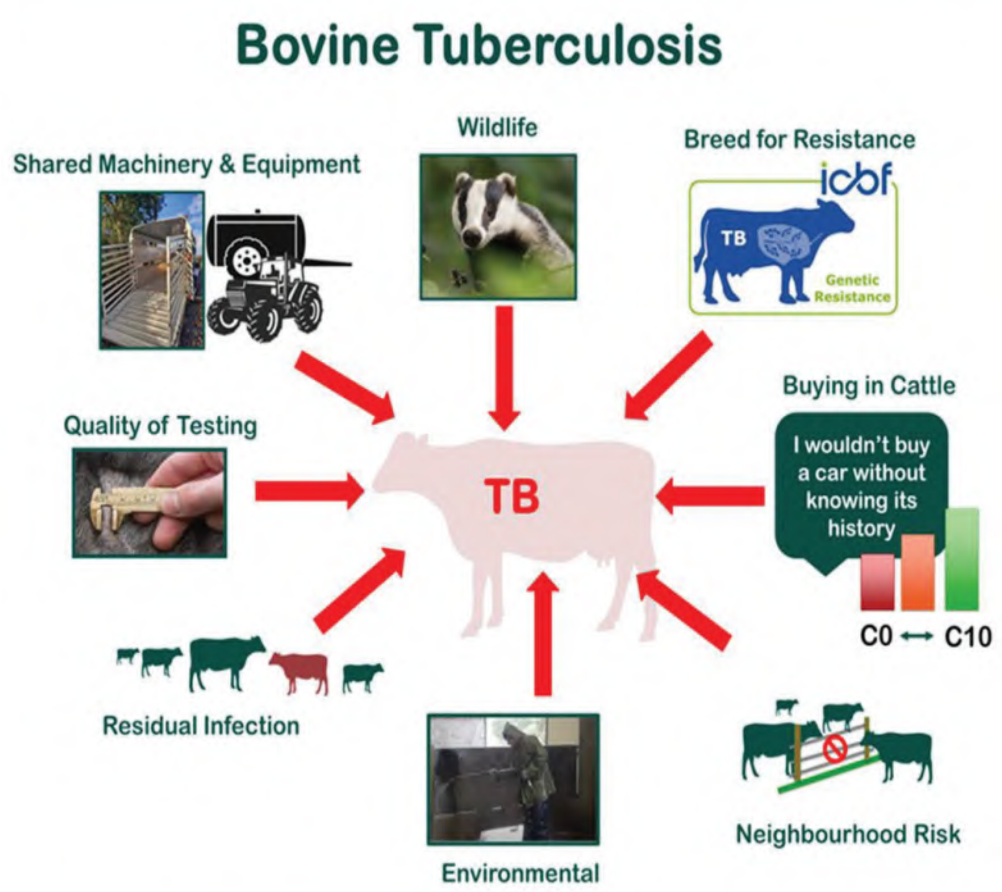


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