# Environmental and Economic Modelling of the Impact of Adjustments in the Maximum Stocking Rates Permitted under Ireland's Nitrates Derogation

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## Glossary

| | |
|---|---|
| ACP | Agricultural Catchments Programme |
| AD | Anaerobic Digestion |
| AFBI | Agri-Food and Biosciences Institute |
| ASSAP | Agricultural Sustainability Support and Advisory Programme |
| C | Carbon |
| CAP | Common Agricultural Policy |
| $CH_4$ | Methane |
| $CO_2$ | Carbon Dioxide |
| CSO | Central Statistical Office |
| DAFM | Department of Agriculture, Food and the Marine |
| DM | Dry Matter |
| EPA | Environmental Protection Agency (Ireland) |
| FAS | Farm Advisory System |
| FSDN | Farm Sustainability Data Network |
| GAP | Good Agricultural Practice |
| GHG | Greenhouse Gas |
| ha | hectare |
| IOT | Internet of Things |
| K | Potassium |
| LESS | Low Emissions Slurry Spreading |
| LU | Livestock Unit |
| MACC | Marginal Abatement Cost Curve |
| MoSt GG | Moorepark St Gilles Grass Growth Model |
| MGM | Market based Gross Margin |
| MTR | Medium Term Review |
| N | Nitrogen |
| NFS | National Farm Survey |
| $NH_3$ | Ammonia |
| NAP | Nitrates Action Plan |
| $N_2O$ | Nitrous Oxide |
| $NO_3^-$ | Nitrate |

| | |
|---|---|
| $NO_2$ | Nitrite |
| NFS | Teagasc National Farm Survey |
| NUE | Nitrogen Use Efficiency |
| NFS | National Farm Survey |
| OrgN | Organic N |
| P | Phosphorus |
| PBHDM | Pasture Based Herd Dynamic Milk Model |
| WFD | Water Framework Directive |
| R&D | Research and Development |
| SR | Stocking Rate |
| S.I. | Statutory Instrument |
| TAMS | Targeted Agricultural Modernisation Scheme |
| TB | Tuberculosis |
| UAA | Utilised Agricultural Area |
| UCD | University College Dublin |

# 1 Executive Summary

The Department of Agricultural, Food and the Marine (DAFM) requested that Teagasc carry out 'Environmental and economic modelling to ensure that the impact of any adjustment in the maximum stocking rates permitted under Ireland's Nitrates Derogation is well understood' as part of a broader request to undertake research and analysis in support of i) the formulation of the national Nitrates Action Programme for the period 2026-2029 and ii) the Government's discussions with the European Commission and fellow Member States .on securing an extension to Ireland's Nitrates Derogation.

The analysis relies on data from the Teagasc National Farm Survey (NFS) on Irish dairy farms only given that most farms in derogation are dairy farms. There are farms other than dairy farms that are in derogation, but the NFS does not have a representative sample of such farms and thus our analysis in this report is limited to dairy farms only. The analytical approach used involves applying potential changes in nitrates policy to this dataset. Ideally nitrates policy changes considered would be evaluated using NFS data for 2025, but such data are not yet available. In their absence NFS data for the three most recently available years (2021, 2022 and 2023) are used to account for the volatility of dairy farm incomes in Ireland in recent years.

To address the challenges of compliance with reduced organic stocking rate limits under the Nitrates Directive, a range of strategies and scenarios for sustainable dairy farming have been explored. These include renting additional land, exporting slurry, and contract rearing of heifers, reducing dairy cow numbers, and reducing the crude protein content of concentrates fed on Irish dairy farms. The analysis conducted looked at each adjustment in isolation. Farmers who have to adjust their farm operations to remain compliant with changed maximum organic stocking rates will likely adjust along multiple dimensions (rent in land, export slurry, outsource heifer rearing, reduce cow numbers). The adjustments under each scenario analysed and associated adjustment costs should not be interpreted as "predictions" but as indicative of the costs that would be incurred if farmers could only adjust in such a constrained manner. Thus, the costs estimated are likely to be more than costs farmers are likely to incur if changes to maximum allowed organic stocking rates are introduced.

Based on the European Union (Good Agriculture Practice for the Protection of Water) Regulation 2022 and Statutory Instrument (S.I.) 42 of 2025 and using data from the Teagasc NFS from 2021, 2022 and 2023 it is estimated that approximately 49% of dairy farms in Ireland and 65% of national milk production was produced on farms that had an organic nitrogen stocking rate of >170 kg/ha. Similarly, it is estimated that approximately 15% of dairy farms in Ireland and 24% of national milk production was produced on farms that had an organic nitrogen stocking rate of >220 kg/ha. A separate but related analysis examines the potential impact of the evolution of the average Irish dairy farm on N leaching using the MoSt-PBHDM model in conjunction with 19 years of weather data from Met Eireann Moorepark synoptic station.

**Renting additional land** (Scenario 1) on dairy farms with organic stocking rates >170 kg/ha resulted in a requirement to rent 15 hectares of additional land (23% increase in farm area) and a reduction of €10,928 (15%) in family farm income on the farms (7,609) affected. This will result nationally in a requirement to rent in an additional 112,983 hectares of land on dairy farms. Renting additional land to maintain an organic nitrogen stocking rate <220 kg/ha required the renting in an average of 6 hectares of additional land (11% increase in farm area) and a reduction of €4,590 (5%) in family farm income on the affected farms (2,258). This will result nationally in a requirement for 18,168 hectares of additional land to be rented in by dairy farms. The cost of renting additional land rented in to achieve compliance is based on rental prices paid by dairy farmers in each region, recorded in the NFS.

**Exporting slurry from dairy farms** (Scenario 2) to reduce organic nitrogen stocking rate to 170 kg/ha required the export of 94 tankers of slurry from all animals on the farms (1.1 million litres) and these activities are estimated to lead to a reduction of €18,841 (19%) in family farm income on the affected farms (7,609). Exporting slurry from the dairy farms to maintain an organic nitrogen stocking rate of <220 kg/ha required the export of 52 tankers of slurry (0.59 million litres) and a reduction of €10,393 (9%) in family farm income on the affected farms (2,258). On many farms because of the limited number of days during which animals are housed slurry volumes produced are insufficient to allow the export of slurry to be a strategy that guarantees compliance with changed organic N stocking rate limits.

**Contract rearing dairy heifer replacements and removing non-dairy cattle from the farm** (Scenario 3) so as to reduce organic nitrogen stocking rate to 170 kg/ha resulted in a reduction of €11,136 (14%) in family farm income on the affected farms (7,609). Contract rearing dairy replacement animals to maintain a nitrogen organic stocking rates <220 kg/ha resulted in a reduction of €9,465 (8%) in family farm income on the affected farms (2,258). If farms that contract rear dairy heifers and remove all non-dairy animals were to add additional dairy cows to their farm operation so as to farm up to the maximum stocking rate permitted the additional income could offset much but not all of the costs of this scenario.

**Reducing dairy cow numbers** (Scenario 4) so that all dairy farms had an organic nitrogen stocking rate of less than 170 kg/ha required an average reduction of 27 cows/herd on those farms required to initially farming at an Organic N stocking rate in excess of 170 kg/ha. This reduction in dairy cow numbers resulted in a reduction (on average) of €43,555 (39%) in family farm income on the affected dairy farms (7,609). This would result nationally in a reduction of 203,719 cows (14%) and a reduction in national milk production of 1.2 billion litres (15%). Limiting all dairy farms to an organic nitrogen stocking rate of 220 kg/ha required an average reduction of 15 cows/herd and a reduction of €25,328 (19%) in family farm income on the affected farms (2,258). This would result nationally in a reduction of 33,023 cows (2.5%) and a reduction in national milk production of 0.2 billion litres (2.5%).

**Reducing crude protein content of concentrate feed (Scenario 5)** fed to dairy cows will reduce annual nitrogen dairy cow excretion. The level of reduction in excretion will depend on dairy cow milk yield. Annual nitrogen exertion rates (kg N/cow) for Band 1 dairy cows are 79, 78, and 76 kg N/cow for cows fed concentrate with an average crude protein content of 15%, 14% and 13%, respectively. Annual nitrogen exertion rates for Band 2 dairy cows are 90, 89, and 87 kg N/cow for cows fed concentrate with an average crude protein content 15%, 14% and 13%, respectively. While the annual nitrogen exertion rates for Band 3 dairy cows are 103, 100, and 98 kg N/cow for cows fed concentrate with an average crude protein content of 15%, 14% and 13%, respectively.

Analysis in the report demonstrates that while reducing crude protein reduced nitrogen excretion, on a stand-alone basis it does not facilitate compliance for a substantial number of farms. As a compliance strategy it needs to be used in conjunction with one or more of the other measures that farmers can use to achieve compliance. In this summary we concentrate from this point onwards on the first four compliance strategies: renting additional land, exporting slurry from dairy farms, and contracting rearing of dairy heifer replacements and reducing dairy cow numbers.

Comparing 2019 to 2023 **nitrogen leaching** from dairy farms (1 metre depth) has reduced from an average of 15.1 kg/ha to 14.4 kg/ha. The reduction at the higher organic nitrogen stocking rates has been greater; 19.6 kg/ha in 2019 to 18.0 kg/ha in 2023 for organic nitrogen stocking rates of 180 to 240 kg/ha.

Not considered in this analysis is the wider impact of a dairy herd reduction on the Irish agri-food sector. A smaller national milk pool would lead to underutilisation of processing capacity, potentially increasing unit processing costs and negatively impacting farm milk prices. Considering Ireland's significant dairy export capacity, valued at €6.5 billion in 2024 (DAFM, 2025), each 1% milk volume reduction would equate to a €65 million loss in export revenue. A 15% reduction in dairy exports would translate to a reduction in dairy export value of close to €1bn. Deferred or cancelled expansion plans in the dairy processing sector could result in job losses and decreased investment. Furthermore, a reduction in dairy cow numbers would decrease the supply of dairy-origin calves, impacting beef production and potentially increasing meat processing costs. Beef farmers specialising in calf rearing would face income pressures.

## Interpretation of the Results

The primary purpose of this research is to provide policymakers with a robust understanding of the challenges and financial burden that regulatory changes concerning organic stocking rate present for the wider Irish dairy farming sector. Like all research, the study has limitations. A limitation of the study is that to make the research tractable, it is assumed that a farmer applies an individual measure to achieve compliance, when more than one measure is likely to be used by the farmer faced with a requirement to reduce their farms organic N stocking rate. Thus, the estimates of compliance costs associated with the scenario analysed should be interpreted as setting boundaries on the space within which compliance incurred by Irish dairy farms will fall if farmers have to reduce their farm's organic N stocking rate.

By analysing and quantifying the scale and cost of the compliance scenarios outlined above, this study aims to provide policy makers with information on the scale of adjustment and costs that might arise as the result of possible changes in stocking rate limits and thus this work should contribute to informed policy development. However, it is imperative to recognise that **this analysis does not provide farm-specific recommendations.** Individual farmers must conduct thorough assessments of their own operations and seek professional advice to determine the most appropriate compliance measures for their individual farm circumstances and context.

## Implications for Dairy Farms

**Scenario 1- Renting additional land:** This provides a pathway to compliance by allowing farmers to dilute individual farm nitrate leaching across a larger farm area. This approach is particularly appealing in regions where the concentration of dairy farming is lower and where land availability permits expansion of the dairy farm's land area. However, renting land can be expensive and challenging, particularly in areas with intense competition for agricultural land. This scenario also requires careful planning to avoid unintended consequences, such as increased transportation GHG emissions, disruption of existing land-use patterns and adverse impacts for other farm systems.

**Scenario 2 - Exporting slurry from dairy farms:** This represents a practical solution for redistributing excess nitrogen from dairy farms to areas where it can be effectively utilised, such as arable farms. This scenario benefits both the dairy farm exporting the slurry and the tillage or other farm type in receipt of the slurry. The latter gains access to a cost-effective source of organic fertiliser, while the exporting farm reduces its organic N stocking rate. However, exporting slurry requires substantial investment in farm infrastructure and equipment, such as storage facilities and transport machinery. Despite its potential, this scenario must be carefully monitored to ensure that nitrogen overload does not shift from dairy farms to tillage land or other grassland farms, creating new environmental challenges in other farm systems. Exporting slurry from grassland farms that are already deficient in soil phosphorus and potassium could further exacerbate soil fertility status and exporting farm would need to consider such a strategy in the context of overall farm nutrient management planning.

**Scenario 3 - Contract rearing of dairy heifer replacements:** This is a viable strategy to achieve regulatory compliance, reducing the risk of on-farm nitrate leaching by outsourcing the rearing of young breeding stock to specialised contract rearing farms. This allows dairy farmers to focus on milk production, while maintaining compliance with nitrogen limits. Contract rearing offers a win-win solution: it reduces environmental pressure on dairy farms and creates economic opportunities for other farmers providing the contract rearing service. However, widespread adoption requires the establishment of robust agreements that clearly define responsibilities, costs, and performance expectations. Regional collaboration between dairy farms and contract rearing farms can also help optimise resource use and minimise logistical challenges.

**Scenario 4- Reducing dairy cow numbers:** On dairy farms exceeding the nitrogen limit, **reducing dairy herd sizes** is a direct and effective strategy to reduce nitrate leaching. By decreasing the number of cows, nitrogen excretion is reduced. However, this approach comes with significant economic implications for farmers, as lower cow numbers directly affect milk production and, consequently, farm income. Additionally, the reduction in stocking rate could result in reduced grass utilisation on grassland farms resulting in further reductions in profitability. This approach to compliance would also create downstream effects for the broader dairy industry, including milk processors, as well as upstream effects for input suppliers to dairy farms.

## Wider Implications

**Scenario 1 - Renting additional land:** Dairy farmers acquiring additional land would be able sustain milk production, but this could adversely affect the beef and tillage sectors. Increased demand for rented land would drive up land rental prices, potentially displacing non-dairy farmers and potentially also leading to speculative land market behaviour. While landowners renting farmland would benefit from increased income, monitoring and enforcement would be required to ensure compliance with environmental objectives.

**Scenario 2 - Exporting slurry from dairy farms:** Exporting slurry from dairy farms offers a potential solution to maintain milk production on dairy farms in the face of reduced organic N stocking rate limits, but this strategy alone may not fully achieve compliance on many farms due to the outdoor nature of the Irish grass-based production system. As a strategy it could help drystock and tillage farmers improve their income performance, since receipt of slurry could reduce their dependence on chemical fertiliser inputs. However, increased slurry transport would involve additional costs, and monitoring would be required to prevent the emergence of new environmental risks. This scenario would foster increased interdependence between farm systems and promote circular economy practices (including a possible future Anaerobic Digestion sector), but it would necessitate careful management of logistics and nutrient application.

**Scenario 3 - Contract rearing of dairy heifer replacements:** Raising dairy replacements on non-dairy farms could help preserve milk production volume while achieving compliance without the requirement to rent in additional land. However, the strategy would create a production system in competition with traditional beef production systems, potentially reducing overall beef output. This scenario would diversify income for non-dairy farmers and promote inter-farm collaboration, but it would require new contractual arrangements, enhanced biosecurity measures to mitigate risk of TB and other diseases, and specialised training for farmers rearing dairy replacements. This would also require increased monitoring of nitrates compliance on the farms receiving these livestock.

**Scenario 4 - Reducing dairy cow numbers:** A dairy herd reduction would have important knock-on impacts on the wider agri-food sector. A smaller national milk pool would lead to underutilisation of existing milk processing capacity, potentially increasing unit processing costs and negatively impacting farm milk prices. Considering Ireland's significant dairy export capacity, valued at €6.5 billion in 2024, each 1% milk volume reduction would equate to a €64 million loss in export revenue. Deferred or cancelled expansion plans in the dairy processing sector could result in job losses and decreased investment. Furthermore, a reduction in dairy cow numbers would decrease the supply of dairy-origin calves, impacting beef production and potentially increasing meat processing costs. Beef farmers specialising in calf rearing would face income pressures if the reduction in the supply of calves from the dairy herd increased calf prices. On the other hand, the land market would remain relatively unaffected, and no new monitoring requirements would arise.

## Implications for Advisory Services

Across all scenarios, the role of **advisory services** is critical. Tailored guidance and technical support can help farmers identify the most suitable strategies for their specific circumstances and ensure effective implementation of solutions. Expanding the capacity of agricultural advisory services and fostering closer collaboration between researchers, policymakers, and practitioners will be essential for scaling up sustainable practices. For example, advisory services can provide farmers with tools and training to monitor nitrogen management more accurately, empowering them to make informed decisions that balance productivity and environmental goals.

## Implications for Research

**Research and innovation** must also play a central role in supporting compliance efforts. Continued investment in technologies such as precision farming tools, nutrient sensors and data management platforms can improve the efficiency of nitrogen use and reduce waste. Pilot programmes and case studies that show successful implementations of sustainable practices can serve as valuable models for replication and building farmer confidence in these approaches. Additionally, integrating nitrogen management goals into broader sustainability initiatives, climate action plans and biodiversity conservation strategies, can create synergies and amplify impact.

## Nitrate Leaching

A modelling analysis using the average of 20-years of weather data from Moorepark synoptic weather station and farm data from the Teagasc NFS indicates that the steady increase in stocking rates (SR) since 2013 contributed to a projected rise in N leaching, peaking in 2018. However, this peak is primarily linked to increased fertiliser use and concentrate feeding rather than SR alone. In more recent years, despite continued SR increases, the model suggests a stabilisation—and by 2023, a decline—in N leaching, largely attributable to changes in management practices, particularly reduced fertiliser application. The recent EPA Early Insights Nitrogen Indicator publication suggests that reduced nitrates concentrations nationally in 2024 are likely. A closer examination of these trends indicates that the most significant reductions in Nitrate leaching are expected on farms with higher organic nitrogen stocking rates. This suggests that those farms most at risk of exceeding nitrogen limits are also making the greatest efforts to mitigate their environmental impact. This perspective provides crucial insights into both the challenges and successes in reducing Nitrate leaching, helping inform the most effective pathways for compliance with the current and potential future organic N stocking rate limits.

## Need for a Coordinated Approach

Finally, **long-term planning** is essential to ensure that compliance efforts are not only effective but also sustainable over time. The success of these scenarios will depend on their ability to adapt to evolving environmental regulations, market dynamics, and societal expectations. A coordinated approach that integrates multiple strategies can provide flexibility and resilience, allowing farmers to respond to changing conditions while maintaining compliance. Policymakers, industry stakeholders, and farmers must work together to develop a comprehensive roadmap that balances environmental goals with economic viability, ensuring a sustainable future for the dairy sector.

In conclusion, achieving compliance across the Irish dairy farm sector with Organic nitrogen stocking rate limits under the Nitrates Directive is a complex challenge that requires a multifaceted approach. Renting additional land, exporting slurry, contract rearing of heifers, reducing dairy cow herd sizes, and reducing the crude protein content of concentrate feeds used on Irish dairy farms each offer pathways to or towards compliance, but their success hinges on targeted supports and policies.

## Key Takeaways for Policy Makers

### Changes in Nitrates Policy Require Farm-Level Adaptation

The transition to a banded system based on dairy cow milk yield has altered stocking rate calculations on Irish dairy farms, subsequent regulatory changes to stocking rates for young cattle have also had an impact on the calculated organic N stocking rates of Irish dairy farms. These changes, which were based on the latest scientific research and evidence, have presented compliance challenges on some Irish dairy farms. The reduction of the derogation limit from 250 kg N/ha to 220 kg N/ha in many areas has also added to the scale of the compliance challenge for a substantial number of dairy farms.

### There are trade-offs associated with achieving compliance with lower organic nitrogen stocking rate limits.

**Renting additional land (Scenario 1):** This measure spreads nitrogen over a larger dairy farm area and allows dairy farmers to maintain their level of milk production, but as a solution, it is costly for the dairy farmer and increases land market pressures for farmers in general who require rented land for their system. The magnitude of the negative impact on farm income would depend on the price of the rented land and the profitability of milk production.

**Exporting slurry from dairy farms (Scenario 2):** This measure would help farmers to maintain their dairy herd size, but it could be complicated logistically to operationalise. Additionally, it shifts the environmental concern with nutrient balances from one farm to another.

**Contract rearing of dairy heifer replacements (Scenario 3):** This measure lowers on-farm nitrogen on dairy farms but creates a new dependency for dairy farming on another farming system.

**Reducing Dairy Cow numbers (Scenario 4):** This measure is a direct way for the dairy farmer to achieve compliance but has an adverse impact on farm level milk output and farm income. There are also knock on consequences for downstream economic activities (milk processing) and associated production systems (beef).

### Economic Implications on Dairy Farms

**Scenario 1- Renting additional land**: This strategy offers the potential to maintain herd size, while complying with nitrogen limits. It creates an additional land cost for the farmer, which would reduce farm profitability (depending on the rental prices of land, relative to the profitability of the milk produced using it). As with the slurry export strategy, there is an element of uncertainty, land may not easily be available, or may be available at elevated rental prices, which could limit the feasibility of this option.

**Scenario 2 - Exporting slurry from dairy farms:** This strategy avoids the need to reduce herd size by managing organic nitrogen limits by exporting slurry so that it is spread on other farms. However, this involves additional slurry transport and handling costs and involves the export of highly valuable P and K which are required to grow high yields of grass, which would reduce dairy farm income. There is also an element of uncertainty with this strategy, as it depends on the availability and engagement of potential slurry importing farms.

**Scenario 3 - Contract rearing dairy heifer replacements:** This strategy helps to maintain dairy herd size, without exceeding nitrogen limits. But it involves additional costs for dairy farmers as they have to pay for the outsourcing of rearing of replacements, reducing their overall dairy farm profitability. Outsourcing the rearing of replacements may introduce management challenges which could have an impact on production efficiency.

**Scenario 4- Reducing dairy cow numbers:** This strategy leads to a direct reduction in milk production, milk revenue, and income on dairy farms. While reducing cow numbers would lead to lower variable costs (e.g., feed and veterinary expenses), fixed costs remain relatively unaffected, reducing overall farm profitability. There is a potential loss of economies of scale, leading to an increase is the cost per litre of milk produced on the farm.

While all of the measures suggested to achieve compliance are costed in annual terms in the report, these are not once off costs as they recur each year and more closely represent a recurring annual economic cost.

## Adaptation on Dairy Farms to changed Nitrates Regulations will have Consequences for Other Farming Sectors

**Scenario 1- Renting additional land**: Increased land rental demand may increase land rental prices and negatively impact drystock and tillage farmers.

**Scenario 2 - Exporting slurry from dairy farms:** Slurry exports could move the pollution risks from slurry exporting farms to slurry importing farms.

**Scenario 3 - Contract rearing of dairy heifer replacements:** A shift to contract heifer rearing on some drystock farms could be disruptive for the existing beef production system, given that currently suckler farms produce animals which later go to finishing farms.

**Scenario 4- Reducing dairy cow numbers**: Reduced number of dairy cows would be reflected in a reduced supply of dairy calves being raised to beef and would be reflected in reduced beef production nationally.

## Environmental Considerations

The measures outlined could be used by dairy farmers to achieve compliance, but this study cannot conclude definitively whether this would result in improved water quality, since only the monitoring process can demonstrate actual improvements.

# 2 Introduction

The Department of Agricultural, Food and the Marine (DAFM) requested that Teagasc carry out 'Environmental and economic modelling to ensure that the impact of any adjustment in the maximum stocking rates permitted under Ireland's Nitrates Derogation is well understood' as part of a broader request to undertake research and analysis in support of i) the formulation of the national Nitrates Action Programme for the period 2026-2029 and ii) the Government's discussions with the European Commission and fellow Member States .on securing an extension to Ireland's Nitrates Derogation.

## 2.1 Context and Policy Background:

Nitrogen and phosphorus pose a water quality risk as they can leach into groundwater and run off into surface waters, leading to excessive algal growth through eutrophication. This process depletes oxygen in water, which can cause harm to aquatic life and biodiversity. Nitrates also represent a risk to human health when nitrate levels exceed safe drinking water limits. The EU's Nitrates Directive aims to protect water resources and ensure compliance with broader environmental and public health goals. Without proper management, agricultural activity can lead to excessive nutrient levels in water and contribute to a decline in the overall quality of water as determined by the Environmental Protection Agency (EPA)

In Ireland, the Nitrates Directive is implemented through the Good Agricultural Practice for the Protection of Waters Regulations and the Nitrates Action Programme (NAP). It is the primary agricultural strategy within Ireland's River Basin Management Plan, aimed at mitigating water pollution from agricultural sources, specifically from nutrients like nitrogen. Ireland's first Nitrates Action Programme, mandated by the Nitrates Directive, was initiated in 2006. Subsequent amendments of the Programme followed: in 2010, 2014 and again in 2018, and most recently, the fifth Nitrates Action Programme ratified and legally enacted through the Good Agricultural Practice (GAP) for Protection of Waters Regulations (S.I. No. 113 of 2022) as amended by S.I. 42 of 2025.

Additional measures, which are not included in the GAP regulations, are included in the fifth Nitrates Action Programme. These include the establishment of a Register of Chemical Fertiliser Sales, initiatives to enhance compliance with the Directive, and the evaluation of the Agricultural Sustainability Support and Advisory Programme (ASSAP).

These regulations, aimed at reducing the environmental impact of agriculture, mandate more stringent controls of agricultural activity. Attention is focused on nitrogen (N) and phosphorus (P) farm animal excretion rates, slurry management and soil health. In Ireland, dairy farming is the most intensive form of pasture-based agricultural system. Ireland currently has been granted a derogation under the Nitrates Directive, allowing the application of livestock manures at higher rates than the standard limit of 170 kg of organic nitrogen per hectare on grassland farms. This derogation is principally of relevance to dairy farming given that dairy farms typically operate at a higher stocking rate than other grassland systems. There are however some non-dairy farms currently operating under a derogation. For farmers in receipt of a derogation, a limit of 250 kg of organic nitrogen was allowed. However, the organic N stocking rate limit was reduced to 220 kg of organic nitrogen with effect from January 2024 for most of the country. Further changes were also made to the organic N stocking rate calculations at farm level.

### 2.2 Objective and Scope:

This research serves three principal purposes:

- Investigates the impact of reducing the maximum organic nitrogen stocking rate per hectare to both 170 kg and 220 kg on dairy cow numbers, milk production and farm profitability.
- Investigates mitigation measure (renting additional land, exporting slurry, contract rearing dairy replacement animal and reducing concentrate crude protein) to allow dairy farms greater than 170 kg of organic nitrogen to continue to farm at current levels of output.
- Evaluate the impact of policy change on nitrate leaching.

This research first explores the extent of the impact of recent change in nitrates regulations for the Irish dairy farm population. The research then explores the scale and estimates the associated costs of farm level adaptation strategies available to Irish dairy farmers in response to possible the new regulatory requirements that reduce the maximum organic N stocking rate limits permitted.

The research uses Teagasc National Farm Survey (NFS) data to establish the position of each dairy farm, taking account of the revised organic nitrogen limits and stocking rates (nitrogen coefficients for each animal type). These NFS farms are used as the basis to evaluate four primary options that farms can implement to achieve or move towards achievement of compliance with the changed organic nitrogen stocking rates. The first three compliance scenarios (renting additional land, outsourcing dairy heifer replacement rearing and removing non-dairy cattle from the farm, and the exporting of slurry) are means to achieve or move towards achieving compliance with reduced stocking rate limits that reduce or negate the need to reduce milk production. The fourth option of reducing the dairy cow herd size would while reducing a farm's organic N stocking rate would also lead to reduced milk production and income per farm. A fifth scenario examines the impact of reducing crude protein in concentrate feed used on dairy farms in Ireland. This measure is not found to be capable of ensuring compliance with changed nitrates regulations on a stand-alone basis but would be an important element of reducing a farm's organic N stock rate in conjunction with one or more of the other compliance strategies outlined. Hence the focus in this report is on the first four scenarios outlined.

The analysis of each scenario addresses specific operational, logistical, and economic challenges which compliance with these policy changes create. For instance, reducing herd size can help farmers comply with the new nitrogen limits, but may lead to significant reductions in milk production and income. While renting additional land can dilute the stocking rate, it introduces added expenses, potential difficulties in securing land, and can have ripple effects on other farming sectors due to increased competition for farmland. Outsourcing heifer rearing and exporting slurry are two strategies that might allow farmers to balance compliance with maintaining current milk production levels, though they too involve logistical complexities and regulatory considerations.

The evolution of nitrogen (N) leaching from representative NFS dairy farms has been simulated over time, both at the national average level and across different organic N stocking rates. The objective of this part of our analysis is to examine how farms have adjusted to recent regulatory changes and whether these adaptations have influenced overall N leaching trends.

### 2.3 Report Structure:

Section 3 of this report provides a summary of the pre-existing and revised nitrates regulations. Section 4 summarises the various strategies that could be pursued by dairy farmers to achieve compliance with the revised regulations. Section 5 examines the impact of moving from the pre-existing nitrates regulations to the current regulations. It does so by examining the implications based on an analysis of the dairy farms in the Teagasc NFS as a means to understand the consequences for the entire dairy farm population. Section 6 then examines the consequences of the actions that could be taken by farmers to ensure continued compliance with possible lower organic N stocking rate limits (compliance scenarios). It does so by exploring four different scenarios or strategies to achieve compliance. The scale and the cost of these measures is also explored. Section 7 provides a discussion of the results obtained in Section 6, examining their feasibility. Section 8 presents the possible evolution through time of N leaching from representative NFS dairy farms. Section 9 discusses the wider implication of the compliance scenarios on the broader agri-food sector. Section 10 concludes. Further supporting material is contained in the Appendix.

# 3 Policy Context

## 3.1 EU Nitrates Directive and Compliance:

The Nitrates Directive (Council Directive 91/676/EEC) aims to protect water quality across Europe by preventing nitrate pollution caused by agricultural activities, particularly from livestock manure. The Directive requires EU member states, including Ireland, to set limits on the application of organic fertilisers and implement measures to mitigate nutrient loss to water bodies. The following is a summary of the measures included in S.I. No. 113 of 2022 as amended by S.I. 42 of 2025, which are of relevance for in this analysis. These include

- Livestock excretion rates (Banding)
- Review of technical tables (N content in slurry)
- Crude protein in concentrates fed.
- Livestock excretion rates for young animal (S.I. 42 of 2025).

## 3.2 The regulatory measures introduced by the review of the Good Agricultural Practice for the Protection of Waters Regulations (SI No 113 of 2022)

### *3.2.1 Livestock excretion rates*

From January 2023 the organic N excretion rate for a dairy cow changed from a standard common value of 89 kg N/cow to a graduated or banded system, which is based on the milk yield of the cow. The milk yield is calculated for individual farms based on the most recent year's data on their farm's average milk cow yield or a rolling three-year average of their farms milk yields. The bands are summarised in Table 1. The banding is then used to allocate an organic N excretion rate per animal, which is set out in Table 6 of S.I. 113 of 2022 (see Table A1 in the Appendix). The rationale for this change is that cows producing more milk require more energy and protein in their diet to support the synthesis of milk components such as protein, fat, and lactose. As milk yield increases, the volume of feed and protein consumed also increases, leading to a greater intake of nitrogen. The total nitrogen excreted increases with milk yield due to the increased volume of feed consumed and the associated nitrogen intake.

Table 1: Annual Excretion Rates for Dairy Cows

| Band | Milk Yield kg | Organic Nitrogen |
|---|---|---|
| 1 | < 4,500 | 80 kg N/cow |
| 2 | 4,501 – 6,500 | 92 kg N/cow |
| 3 | > 6,500 | 106 kg N/cow |

Source: Table 6 S.I. 113 of 2022

### *3.2.2 Review of technical tables*

Technical tables play a critical role in legislation by providing structured, precise, and actionable information to support compliance with environmental standards. Technical tables set out specific criteria in relation to slurry storage capacity and nutrient management, storage periods for livestock manures and periods when application of fertilisers to land is prohibited. The technical tables have been updated to include the most up to date Teagasc Green Book information on macro and micro-nutrient advice.

### *3.2.3 The regulatory measures introduced by the review of the Good Agricultural Practice for the Protection of Waters Regulations (S.I. 42 of 2025).*

Amendments to S.I. 113 of 2022 were introduced in 2025, these amendments have been accepted and published as S.I. 42 of 2025. Changes introduced through the amendment are:

- Revised nutrient excretion rates for calves to reflect their lower nutrient output. Nutrient excretion rates for other cattle aged less than 1 year and for 1-2 year old cattle are also updated to reflect the latest Teagasc research.
- Recognition of the lower nitrogen excretion rate achieved by dairy farmers who opt to manage crude protein in the concentrates fed to their cows across the year.
- The maximum crude protein content allowed in concentrates fed to cattle aged two years and over at grass between 15 April and 30 September, is reduced from 15% to 14%, and this requirement now applies to all farmers.
- The maximum stocking rate on farms granted a derogation under the Nitrates Directive to be reduce to 220 kg N/ha in areas where the EPA (Environment Protection Agency) have identified a need for nitrate reduction measures as a priority to improve water but that were not considered under the European Commission's criteria for the two-year review of water quality that took place in 2023. For these additional areas, the lower stocking rate limit will apply with effect from December 2025.

# 4 Description of Scenarios to Achieve Nitrates Compliance

Having established the position of each dairy farm with respect to the revised nitrate limits and stocking rates, the aim of this research is to examine a number of different strategies, which farmers might adopt to satisfy the regulatory requirements. In our analysis these strategies are analysed and evaluated on a stand-alone basis. In reality, dairy farmers who have to change their farm business plan to be compliant with a changed nitrate limit would, depending on their individual farm circumstances and context, implement more than one compliance strategy. The scenarios analysed in this report wherein farms are assumed to exclusively implement one or other compliance strategy is used for analytical purposes only. These scenarios are outlined in Table 2

Table 2: Analytical scenarios examined and their scope.

| Scenarios | Description |
|---|---|
| 1. Rent Additional Land | Evaluate the viability of renting additional land to dilute production intensity, looking at land availability, rental costs, and associated management changes. |
| 2. Export Slurry | Analyse the option of exporting slurry, focusing on the volumes involved, logistics, potential partnerships, and regulatory considerations |
| 3. Remove all Non-Dairy Livestock and Contract Rear Replacement Heifers | Assess the feasibility and potential challenges of rearing heifers on external farms, considering, the numbers required, logistics, costs, and impacts on farm management |
| 4. Reduce Dairy Cow Numbers | Examine the practical and economic implications of lowering dairy cow numbers to meet the nitrogen limit |
| 5. Feed low protein concentrate feed | Analyse the impact of reducing crude protein in concentrates fed to dairy cows |

The following approach is adopted to assess the implications of the scenarios:

- Calculation of the previous Organic N stocking rate of the farm (89 kg N/cow)
- Calculation of the new Organic N stocking rate based on banding and additional Mid Term Review measures for excretion rates on other livestock.
- Calculation of the additional land requirements to remain under 170 kg N/ha, 220 kg N/ha and 250 kg N/ha
- Calculation of the different de-stocking options to remain under 170 kg N/ha, 220 kg N/ha and 250 kg N/ha
- Contract rearing of replacement dairy stock and removal of all other livestock from the farm except dairy cows.
- Calculate additional slurry produced under new rules and the amount of slurry that needs to be exported to remain under 170 kg N/ha, 220 kg N/ha and 250 kg N/ha.
- Reduction in the number of dairy cows required to remain under 170 kg N/ha, 220 kg N/ha and 250 kg N/ha.
- Generate costs associated with each scenario.

## 4.1 Assumptions

There are a number of assumptions associated with each scenario, and they include:

- That for each scenario, it is the only measure adopted on the farm to achieve any organic N stocking rate reduction required. In reality, farmers may choose a mix of different measures to remain compliant with the analysed Organic N stocking rate limits.
- Additional land, where required, is assumed to be available.
- We assume the price of the additional land that is rented in by dairy farms is based on what is currently paid by dairy farmers for land rented in that region as recorded by the NFS.
- We assume that contract rearing options are freely available, at a cost to the dairy farmer, and that where applicable dairy farmers can source another farm to contract rear replacement heifers.
- We assume that slurry exporting options are available at a cost and that farmers can find farms ready and willing to import additional slurry without breaching the Organic N stocking rate limits of the farm receiving the slurry exports.
- We assume that the K and P in slurry exported by dairy farms can be replaced at zero cost by the slurry exporting dairy farmer.

### 4.2 Caveats

We acknowledge that some of these measures have implications for other farming sectors. Apart from destocking of dairy cows, all of the other scenarios may affect other sectors in the following way:

- **Rent Additional Land:** this may have unintended consequences on farms that already rent land, and, as demand for land increases in some areas, the price of land will increase. Where dairy farms rent additional land which had previously been rented to other farmers, this will reduce the size of these other farms and will impact on the profitability of farms who lose rented ground.
- **Remove all Non-Dairy Livestock and Contract Rear Replacement Heifers:** this option will also have a knock-on effect on the stocking rate of contract rearing farms and may result in additional non-dairy farms requiring a derogation. Farms already involved in other enterprises, such as dairy calf to beef enterprises, may switch to contract rearing, which will have implications for dairy farms dependent on these farms to currently rear their dairy calves.
- **Export Slurry:** As with contract rearing, this scenario will also have consequences for farms importing slurry, by increasing the organic N stocking rate of the receiving farm. As with the contract rearing scenario, slurry importing farms will still need to remain compliant with current stocking rate limits under the Nitrates Directive.

# 5 Impact of moving from Pre-existing Policy to Current Policy

## 5.1 Data Used for the Analysis

The National Farm Survey (NFS), conducted by Teagasc, serves as a comprehensive and representative dataset of Irish farms capturing a wide range of economic and environmental data, and information on farm management practices (Dillon et al., 2024). Its primary objective is to monitor the financial and operational conditions of different farm types in Ireland, including dairy, cattle, sheep, and tillage farms. The Teagasc NFS is part of the Farm Sustainability Data Network (FSDN), an EU-wide system aimed at collecting data on farm incomes and business activities (European Commission, 2024).

To ensure representativeness, the NFS uses a stratified sampling technique, dividing farms into various strata based on farm type, size, and geographic location. This method enables the survey to reflect the diversity of farming practices across the farm population in Ireland accurately, capturing small, medium, and large operations. For dairy farms specifically, the NFS gathers detailed data on among other things, herd size, milk production, stocking rates, input usage, and environmental practices, making it a valuable resource for analysing trends and assessing the impact of policy changes on the economic, environmental and social sustainability of agricultural activities.

Because it is designed to mirror the structure of the national farm population, the NFS provides policymakers, researchers, and industry stakeholders with reliable insights into the broader economic and environmental conditions affecting Irish dairy farmers. This representative sample is essential for evaluating the effects of regulatory changes and guiding decisions that support sustainable agricultural practices.

## 5.2 Organic N Stocking Rate calculations

In this study, the organic N stocking rate of the farm is calculated by assigning each animal type an organic N excretion rate. Total annual organic N is calculated by summing the N produced by each animal on the farm based on the livestock excretion rates in Table A1 in the Appendix. Livestock types included in total N calculations are dairy cows, suckler cows, calves, cattle 1-2 years, cattle > 2years, ewes, rams, sheep 1-2 years, sheep > 2 years. Total N is then divided by the farm size to give an organic N stocking rate as follows:

$$Total\ annual\ nitrogen\ Kg/\ Utilised\ Agricultural\ Area.$$

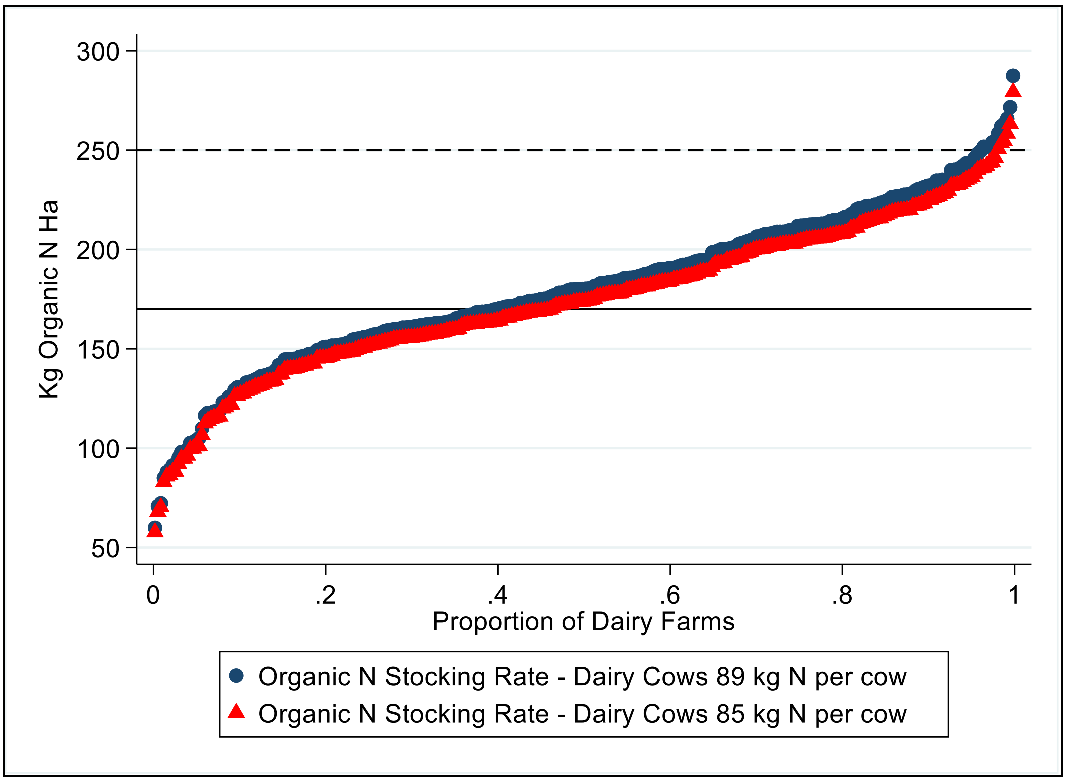
Where Utilised Agricultural Area (UAA) represents the area under crops and pasture plus the area (unadjusted) of rough grazing. It is the total area owned, plus area rented, minus area let, minus area under remainder of farm.

Where Utilised Agricultural Area (UAA) refers to grazing, and silage and other crop areas of the farm and excludes common land (commonage).

### 5.3 Interpretation of Stocking Rates under Previous Policy

Under previous policy rules, a single organic N excretion rate for dairy cows was in place. This was 85kg N/cow up until 2022 and from 2022-2023 the organic N produced by a dairy cow was 89kg N/cow. In Figure 1, we present a comparison of Organic N Stocking Rate distribution of dairy farms under the rules applying prior to 2022, based on livestock numbers in 2023. The Nitrates Directive limit of 170 kg N/ha is represented by the solid horizontal line and the upper limit of 250 kg N/ha for derogation farms is represented by the dashed line. National Farm Survey data for 2023 is used to determine the distribution of Irish dairy farms with respect to their organic N stocking rates. Under these rules prevailing until 2022, 52% of farms had an organic N stocking rate > 170 kg N/ha based on dairy cows' excretion rate of 85 kg N/cow, this increases to 58% when excretion rates per dairy cow were 89 kg N/cow. See Table 7.

Figure 1: Distribution of Organic Stocking Rate across Irish Dairy Farm Population in 2023 before the 5th NAP rules including Banding and Mid Term Review




Source: Derived based on data from the Teagasc National Farm Survey.

### 5.4 Interpretation of Stocking Rates under Current Policy

From January 2023, the organic N excretion rate per dairy cow changed. Previously there was a common standard figure for the number of kg N produced by all dairy cow (89 kg/cow in 2022). With the introduction of banded stocking rates, there are three different N excretion values for dairy cows, depending on the farm's average milk yield per cow (80, 92 and 106 kg N/cow) as shown in Table 1 (Government of Ireland, 2022a) . We will refer to these as Band 1, Band 2, and Band 3. The average milk yield of the cow (measured in kg) is calculated as total milk sold in litres multiplied by 1.029. Based on the new excretion rates for dairy cows, higher yielding cows in Band 3 (≥6,500 kg/milk/yr.) have a higher N co-efficient; lower yielding cows in Band 1 (< 4,500 kg/milk/yr.) have a lower co-efficient.

Most of the dairy cow population are in Band 2 (≥4,500 but < 6,500 kg/milk/yr.). This means that for some farms, even with no change in land area or animal numbers, the organic N stocking rate may go up or down depending on the average yield of the herd in the most recent year or the average of three preceding years. Changes to the nitrates excretion rates increase the total nitrogen loading on farms in Band 2 by 3 kg N/cow and Band 3 by 17 kg N/cow and reduce the total nitrogen load on farms in Band 1 by 9 kg N/cow as compared to the 89 kg N/cow excretion rate used in 2022.

An additional amendment to rules for some farms granted a derogation has reduced the upper limit of organic N from 250 kg N/ha to 220 kg N/ha, which requires a reduction of 30 kg N/ha. However, some areas in Ireland are not currently subject to the reduced organic N limit of 220 kg N/ha, as indicated by the areas shown in white in Figure 5. In these areas, derogation farms can continue to operate at an upper limit of 250 kg N/ha in 2025. The maximum stocking rate for farms, under the Nitrates Directive remains at 170 kg N/ha.

Additional amendments to the Organic N stocking rate calculations were introduced under the Mid Term review of the Fifth Nitrates Action Programme (NAP). These amending regulations have been implemented by S.I. 42 of 2025 (Government of Ireland, 2025). Revised nutrient excretion rates for calves reflect their lower nutrient output, especially in their first 90 days of life. Nutrient excretion rates for other cattle aged less than 1 year and for 1-2 year old cattle were also updated to reflect the latest Teagasc research. These additional measures in terms of stocking rate calculations are presented in Table 3

Table 3: Revised Nutrient Excretion Rates

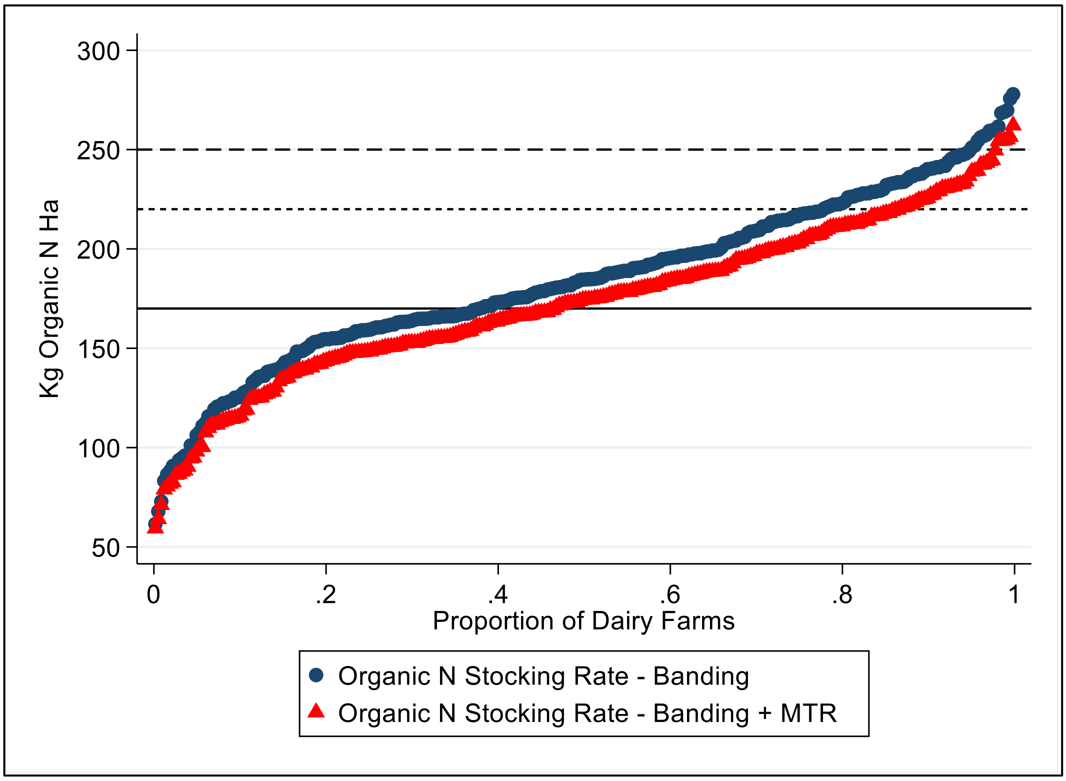
| Livestock Type | Total Nitrogen | Total Phosphorus |
|---|---|---|
| | kg/year | kg/year |
| **Calves 0 – 3 months*** | 1 | 0.1 |
| **Calves 4 – 12 months*** | 20 | 2.8 |
| **Cattle 1-2 years Female** | 55 | 8 |
| **Cattle 1-2 years Male** | 61 | 9 |

Source: European Union (Good Agricultural Practice for Protection of Waters) (Amendment) Regulations 2025.

* Note that for Calves 0-3 months and Calves 4-12 months of age the nutrient excretion rates are not kg per year but kg per relevant time period (3 months or 9 months).

Under the previous policy rules, organic N stocking rates were driven by livestock numbers only. Under the new rules, including banding and the amended regulations, the organic N stocking rate of a farm is driven by both animal numbers and the milk yield of the dairy cows on the farm. Figure 2 presents a comparison of the organic N stocking rate distribution under banding and banding plus mid-term amendments for all dairy farms based on 2023 NFS data. The horizontal dashed line represents the previous limit of 250 kg N/ha, which currently applies to farms in receipt of a derogation in some areas. The horizontal short-dashed line represents the new upper limit for derogation farms of 220 kg N/ha, which applies to farms in receipt of a derogation in areas where that new reduced limit (220 kg N/ha) applies; the solid horizontal line represents the Nitrates Directive limit for all farms of 170 kg N/ha.

Figure 2: Distribution of Organic Stocking rate across Irish Dairy Farm Population in 2023 under 5th NAP rules including Banding and Mid Term Review




Source: Derived based on data from the Teagasc National Farm Survey.

### *5.4.1 Organic N Stocking Rates distribution in 2023, by percentile*

In recent years, several changes have been made to the calculation of the organic N stocking rate. Up to and including 2022 the excretion rate for dairy cows consisted of a single figure, 85 kg N/cow until 2021 and 89 kg N/cow in 2022. From January 2023, the organic N excretion rate for dairy cows was banded to milk production per cow. Table 4 presents the average kg N/ha for dairy farms in 2023, under different stocking rate calculations at each percentile of the NFS dairy farm distribution of organic N per hectare.

Table 4: Organic N Stocking Rates for each decile of dairy farm population under different Stock Rate calculation rules

| Percentile | Stocking Rate (85) | Stocking Rate (89) | Stocking Rate Banding | Stocking Rate Banding + MTR |
|---|---|---|---|---|
| | Organic N per ha | | | |
| **10** | 126 | 130 | 125 | 116 |
| **20** | 145 | 150 | 155 | 143 |
| **30** | 155 | 161 | 164 | 153 |
| **40** | 164 | 170 | 173 | 164 |
| **50** | 173 | 180 | 185 | 174 |
| **60** | 184 | 190 | 195 | 184 |
| **70** | 200 | 206 | 209 | 198 |
| **80** | 208 | 216 | 223 | 212 |
| **90** | 225 | 232 | 240 | 227 |

Source: Derived based on data from the Teagasc National Farm Survey 2023.

Note: SR (85) based on **S.I. 610 of 2010**; SR (89) based on **S.I. 113 of 2022**; SR Banding based on **S.I. 113 of 2022**; SR Banding + MTR based on **S.I. 42 of 2025.**

### *5.4.2 Trends in Organic N Stocking Rates greater than 170 kg N/ha*

The Nitrates Directive limit of 170 kg N/ha applies to all farms. Farms operating at an organic N stocking rate greater than 170 kg N/ha are mostly derogation farms with most farms currently having an upper limit of 220 kg N/ha. There is a small percentage of farms greater than 170 kg N/ha that are not in derogation who may be exporting slurry to bring their total organic N produced on the farm under regulatory limit. In this study we examine the impact on farms that are most affected by recent policy changes, i.e. farms with an organic N stocking rate greater than 170 kg N/ha.

Table 5 shows the trends over time in the number of farms with an organic N stocking rate in excess of 170 kg N/ha. The first column "SR >170 (85)" is calculated for stocking rates where all dairy cows had a single organic N excretion for dairy cows of 85kg N/cow (this was the case from 2010 until 2021). In 2022 this rate increased to 89 kg N/cow "SR >170 (89)". From January 2023 banding was introduced which attributed different organic N excretion rates to dairy cows, this is shown in column three "SR >170 Banding". The final (rightmost) column in Table 5 shows the progression from Banding to amendments introduced in the Mid Term Review (MTR). Readers should note that calculations are based on NFS data for specialist farms from 2010 -2023 when some of these policy changes were not in place, therefore the calculations are hypothetical from a policy perspective but based on actual stock numbers in these years.

Table 5: Percentage of Dairy Farms in excess of 170 kg N/ha 2010-2023

| Year | SR >170 (85) | | SR > 170 (89) | | SR >170 (Banding) | | SR >170 (Banding + MTR) | |
|---|---|---|---|---|---|---|---|---|
| | % of dairy farms | % of National Milk supply | % of dairy farms | % of National Milk supply | % of dairy farms | % of National Milk supply | % of dairy farms | % of National Milk supply |
| **2010** | 27 | 40 | 33 | 45 | 30 | 44 | 20 | 32 |
| **2011** | 29 | 40 | 33 | 45 | 33 | 45 | 22 | 33 |
| **2012** | 33 | 42 | 37 | 46 | 37 | 47 | 28 | 37 |
| **2013** | 39 | 48 | 45 | 54 | 42 | 53 | 33 | 43 |
| **2014** | 41 | 46 | 47 | 54 | 45 | 55 | 35 | 45 |
| **2015** | 42 | 50 | 50 | 59 | 50 | 60 | 36 | 46 |
| **2016** | 48 | 59 | 52 | 63 | 54 | 66 | 43 | 56 |
| **2017** | 49 | 59 | 57 | 65 | 59 | 69 | 48 | 59 |
| **2018** | 46 | 61 | 52 | 66 | 54 | 70 | 45 | 62 |
| **2019** | 49 | 62 | 52 | 67 | 54 | 70 | 43 | 59 |
| **2020** | 48 | 62 | 51 | 65 | 54 | 68 | 46 | 61 |
| **2021** | 49 | 63 | 53 | 67 | 58 | 72 | 48 | 63 |
| **2022** | 51 | 64 | 55 | 68 | 60 | 75 | 49 | 64 |
| **2023** | 52 | 66 | 58 | 72 | 60 | 75 | 51 | 67 |

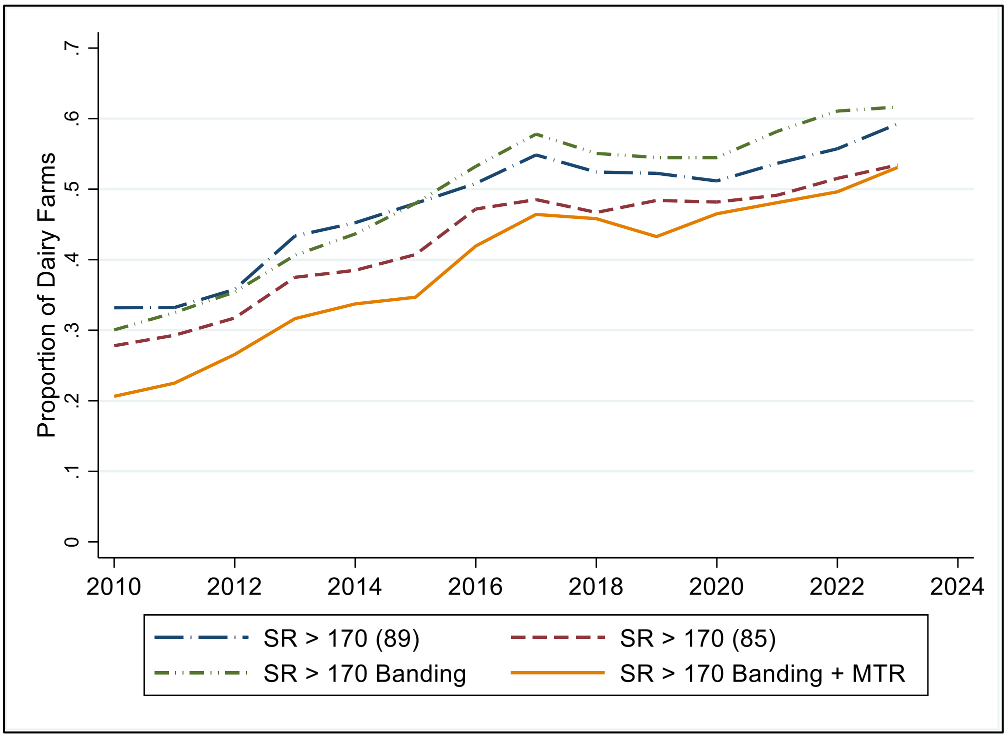
Source: Derived based on data from the Teagasc National Farm Survey 2010-2023.

Note: SR > 170 (85) based on **S.I. 610 of 2010**; SR > 170(89) based on **S.I. 113 of 2022**; SR > 170 Banding based on **S.I. 113 of 2022**; SR > 170 Banding + MTR based on **S.I. 42 of 2025.**

The data show a notable increase in the proportion of farms with stocking rates in excess of 170 kg N/ha between 2010 and 2017 and a slowdown in the rate of increase in subsequent years. Overall, in 2023 under organic N stocking rates including banding and Mid Term Review amendments, 51% of Irish Dairy farms were operating at stocking rates in excess of 170 kg N/ha.

Figure 3 presents a visual representation of these developments. The graph shows increasing trends in the percentage of Irish dairy farms operating at organic N stocking rates greater than 170 kg N/ha. The graph shows that the gap between farms > 170 kg N/ha under a Banding + MTR and farms > 170 kg N/ha under dairy cows at 85 kg N/ha has narrowed over time. Recall, the banding + MTR calculation is driven by two parameters, animal numbers and milk yields, whereas the original stocking rate calculation was only driven by animal numbers. This shows how milk yields per cow have increased, on these farms over time and how (with banding) this is reflected in the calculated stocking rate.

Figure 3: Trends in Organic N Stocking Rates greater than 170 kg N/ha 2010 -2023.




Source: Derived based on data from the Teagasc National Farm Survey.

Table 6 shows the farm level characteristics of dairy farms with an organic N stocking rate greater than 170 kg N/ ha (calculated using Banding + Mid Term Review). For the characteristics summarised in Table 6 we have used mean (average) levels. There is a distribution around these mean levels, in Table A4 in the Appendix the median and average (arithmetic mean) levels for these farm characteristics are reported. The median can serve as a superior indicator of the central tendency than the average (arithmetic mean), this is the case where there are outliers within the sample.

Table 6: Summary Statistics for Dairy Farms in excess 170 kg N/ha at the MTR Stocking Rate 2021-2023

| Year | 2021 | 2022 | 2023 | 2021-2023 Average |
|---|---|---|---|---|
| UAA size (ha) | 67 | 66 | 68 | 67 |
| Dairy Cow Numbers | 115 | 113 | 118 | 115 |
| Total Cattle Numbers | 224 | 218 | 216 | 219 |
| kg Milk per Cow | 6,013 | 5,971 | 5,665 | 5,879 |
| kg Concentrate per Cow | 1,232 | 1,344 | 1,277 | 1,285 |
| Chemical N per ha | 203 | 196 | 170 | 189 |
| Organic N per ha | 211 | 212 | 204 | 209 |
| Family Farm Income €/ha | 1,823 | 2,781 | 928 | 1,834 |
| Percent of Farms in Derogation | 74% | 72% | 72% | 73% |

Source: Derived based on data from the Teagasc National Farm Survey.

### *5.4.3 Trends in Organic N Stocking Rates greater than 220 kg N/ha*

Table 7 shows the percentage of farms with an organic N stocking rate > 220 kg N/ha. In 2024, the upper limit for farms in derogation reduced from 250 kg N/ha to 220 kg N/ha for most areas. Under banding and with the Mid Term Review amendments, 13% of Irish dairy farms were operating in excess of 220 kg N/ha. Over the period 2010 to 2023 there has been an increase in the proportion of dairy farms operating at an organic stocking rate of > 220 kg N/ha.

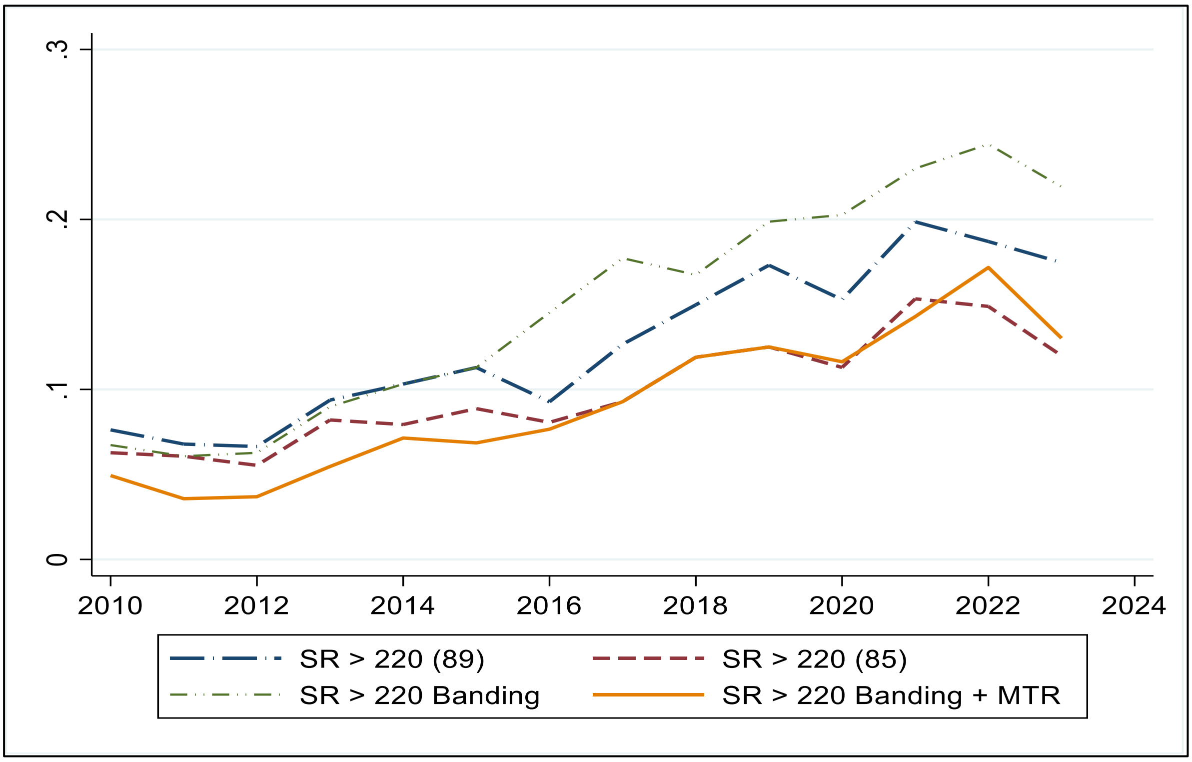
Table 7: Percentage of Dairy Farms at organic stocking rate in excess of 220 kg N/ha

| Year | SR >220 (85) | | SR > 220 (89) | | SR >220 (Banding) | | SR >220 (Banding + MTR) | |
|---|---|---|---|---|---|---|---|---|
| | % of dairy farms | % of National Milk supply | % of dairy farms | % of National Milk supply | % of dairy farms | % of National Milk supply | % of dairy farms | % of National Milk supply |
| **2010** | 6 | 9 | 7 | 10 | 6 | 10 | 5 | 7 |
| **2011** | 6 | 9 | 7 | 10 | 6 | 10 | 4 | 6 |
| **2012** | 6 | 8 | 7 | 10 | 7 | 10 | 4 | 7 |
| **2013** | 9 | 12 | 11 | 13 | 10 | 14 | 6 | 10 |
| **2014** | 9 | 11 | 12 | 14 | 11 | 15 | 8 | 11 |
| **2015** | 10 | 12 | 12 | 15 | 12 | 15 | 8 | 10 |
| **2016** | 9 | 11 | 10 | 13 | 15 | 20 | 8 | 12 |
| **2017** | 10 | 13 | 13 | 18 | 18 | 26 | 9 | 14 |
| **2018** | 12 | 18 | 16 | 22 | 16 | 27 | 12 | 20 |
| **2019** | 14 | 19 | 19 | 25 | 20 | 31 | 13 | 20 |
| **2020** | 12 | 16 | 16 | 22 | 20 | 29 | 12 | 17 |
| **2021** | 16 | 20 | 20 | 28 | 23 | 36 | 14 | 23 |
| **2022** | 16 | 20 | 19 | 26 | 24 | 35 | 17 | 27 |
| **2023** | 12 | 17 | 18 | 25 | 21 | 32 | 13 | 21 |

Source: Derived based on data from the Teagasc National Farm Survey.

Figure 4 presents a visual representation of these developments. The graph shows an increasing trend in the percentage of Irish dairy farms operating at organic N stocking rates greater than 220 kg N/ha.

Figure 4: Percentage of Dairy Farms at Organic Stocking Rate in excess of 220 kg N/ha.




Source: Derived based on data from the Teagasc National Farm Survey.

Table 8 shows average (arithmetic mean) statistics for the dairy farms with an organic stocking rate >220 kg N/ha (calculated using Banding + Mid Term Review). As discussed above arithmetic mean as a measure of central tendency can be affected by the presence of outlier or extreme values, median value analogues of the arithmetic mean values presented in Table 8 are presented in Table A5 in the Appendix to this report.

Table 8: Summary Statistics (Average) Dairy farms in Excess 220 kg N/ha at MTR Stocking Rate

| Year | 2021 | 2022 | 2023 | 2021-2023 Average |
|---|---|---|---|---|
| UAA size (ha) | 69 | 68 | 70 | 69 |
| Dairy Cow Numbers | 139 | 135 | 141 | 138 |
| Total Cattle Numbers | 252 | 250 | 247 | 250 |
| kg Milk per Cow | 6,239 | 6,048 | 5,859 | 6,053 |
| kg Concentrate per Cow | 1,347 | 1,447 | 1,316 | 1,377 |
| Chemical N kg per ha | 235 | 214 | 194 | 213 |
| Organic N kg per ha | 249 | 249 | 236 | 245 |
| Family Farm Income per ha (€) | 2,149 | 3,223 | 1,094 | 2,259 |
| Percent of Farms in Derogation | 86% | 86% | 87% | 86% |

Source: Derived based on data from the Teagasc National Farm Survey.

### 5.4.4 Banding and the Distribution of Milk Yields

Based on the population weights associated with the National Farm Survey sample, the number of dairy farms in each band and the percentage of the overall dairy farm population represented by the NFS sample of specialist dairy farms are presented in Table 9. The percentage of farms in Band 3 declined in 2023 due to a drop in milk yields. This decline in yields likely stems from a combination of factors, including low milk prices, high feed costs, poor grazing conditions during the autumn of 2023, and policy changes. Future NFS data will reveal if this decline in yields was a one-off reaction to climatic and market forces or a reaction to policy changes.

Table 9: Hypothetical* Distribution of Irish Dairy farms by Band 2021, 2022 & 2023

| | Year | 2021 | 2022 | 2023 |
|---|---|---|---|---|
| Band 1 | Number of Farms | 2,283 | 2,332 | 2,897 |
| | % Farms | 14% | 15% | 17% |
| | Average SR (kg N/ha) | 138 | 151 | 147 |
| | % Milk Supplied | 7% | 8% | 9% |
| Band 2 | Number of Farms | 11,704 | 11,109 | 11,307 |
| | % Farms | 77% | 72% | 75% |
| | Average SR (kg N/ha) | 174 | 173 | 177 |
| | % Milk Supplied | 77% | 72% | 81% |
| Band 3 | Number of Farms | 1,288 | 1,862 | 1,014 |
| | % Farms | 9% | 13% | 8% |
| | Average SR (kg N/ha) | 206 | 214 | 192 |
| | % Milk Supplied | 16% | 20% | 10% |

Source: Derived based on data from the Teagasc National Farm Survey.
*Note: Banding only came into effect in January 2023 so figures for 2021 & 2022 are hypothetical and for illustration.

### Dairy Farm Population and Derogation

Based on the population representivity of the NFS, Table 10 shows the number of NFS dairy farms in derogation in 2021, 2022 & 2023

Table 10: Number of NFS dairy farms in Derogation 2021 2022 & 2023

| Year | 2021 | 2022 | 2023 |
|---|---|---|---|
| Derogation | 6,679 | 7,107 | 7,507 |
| Non-Derogation | 8,596 | 8,196 | 7,711 |
| Total | 15,275 | 15,303 | 15,218 |

Source: Derived based on data from the Teagasc National Farm Survey.

As a validation exercise, we compare the population of NFS dairy farms estimated to be in derogation based on Teagasc NFS data with DAFM data on the actual farm population applying for and being granted derogations. These data are presented in Table 11. According to DAFM 6,426 derogation applications from dairy farms were approved in 2021, whereas NFS estimates based on national weights of the representative sample indicate that the number of such farms is 6,679.

Table 11: Comparison of the number of dairy farms in Derogation, NFS & DAFM

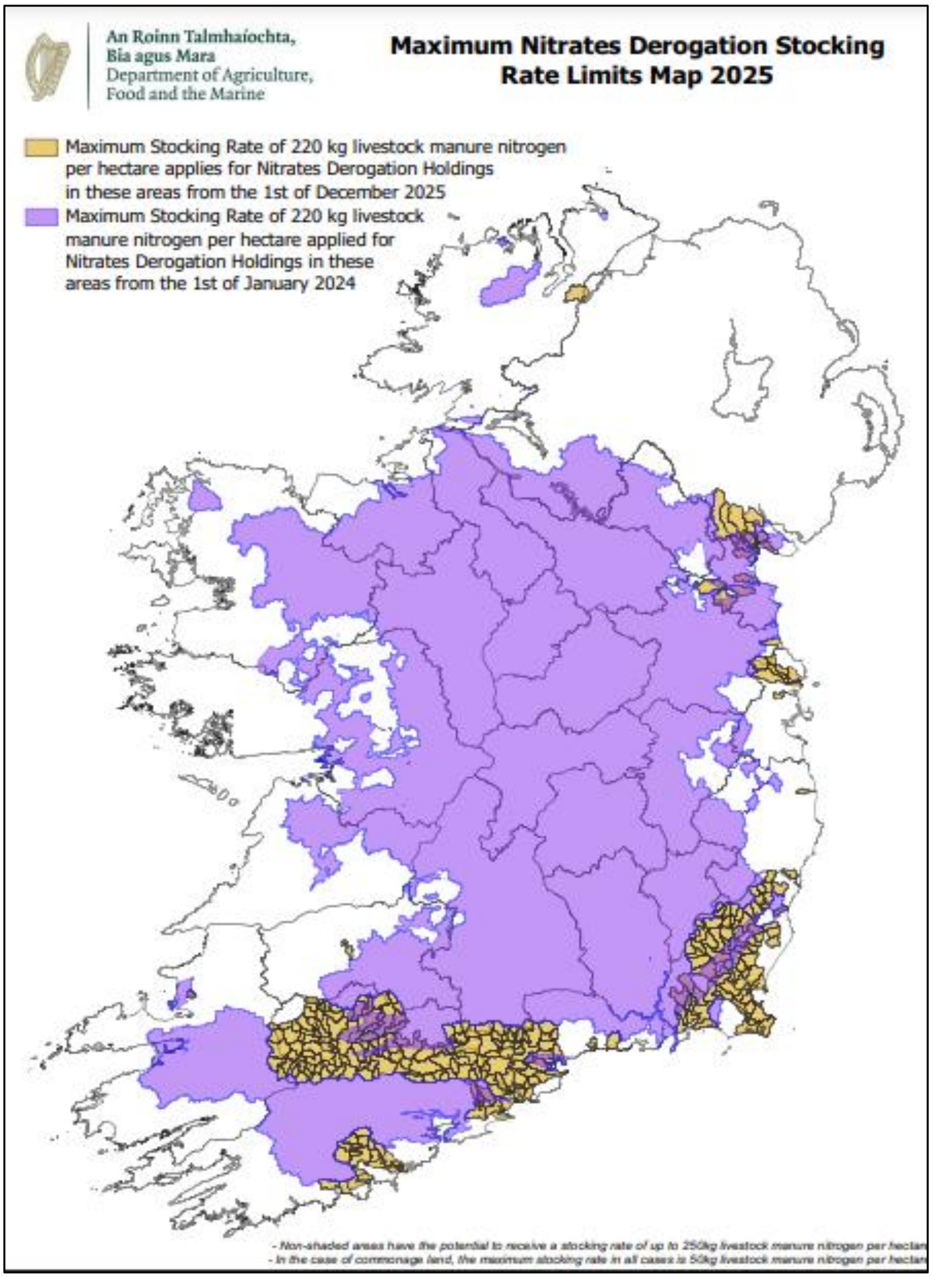
| Source | 2021 | 2022 | 2023 |
|---|---|---|---|
| **DAFM Applications received** | 6,814 | 6,726 | 7,298 |
| **DAFM Approved Derogation Applications** | 6,426 | 6,389 | 6,747 |
| **NFS estimate of farms in Derogation** | 6,679 | 7,107 | 7,507 |

Source: Derived based on data from the Teagasc National Farm Survey & DAFM published data.

The discrepancies between the NFS representation of the derogation farm total and the actual farm total supplied by DAFM may be due to the population weighting factors used to convert the NFS sample into population equivalents. The dairy farm sample in the NFS is designed to reflect the distribution of dairy farm (economic) size classes and not specifically the number of derogation farms. The primary reason for this difference is attributed to the strata that are used for farm selection, since the NFS dairy farm sample does not use derogation status as a stratum in identifying farms for inclusion in the sample farms. The random sample of farms in the NFS is very close but unsurprisingly does not exactly match the distribution of derogation and non- derogation farms in the actual population. The existence of a small number of grasslands farms other than dairy farms farming under a derogation will also contribute to some of the difference between the NFS estimate of the total population of dairy farms operating under a derogation and the DAFM derogation application and approvals totals.

Figure 5 (Maximum Nitrates Derogation Stocking Rate Limits 2025) shows which areas are under the new upper derogation limits of 220 kg N/ha (purple areas). From the 1st of December 2025 additional areas have been added where the upper organic N limit for derogation farms is 220 kg N/Ha. These additional areas are shown in yellow in Figure 5. Farms in areas shown in white that are farming under a derogation can continue to operate at up to 250 kg N/ha for 2025.

Figure 5: Maximum Nitrates Derogation Stocking Rate Limits Map 2025




Source: Department Agriculture Food and the  Marine (DAFM 2025)

# 6 Scenario Analysis

## 6.1 Introduction to scenario analysis

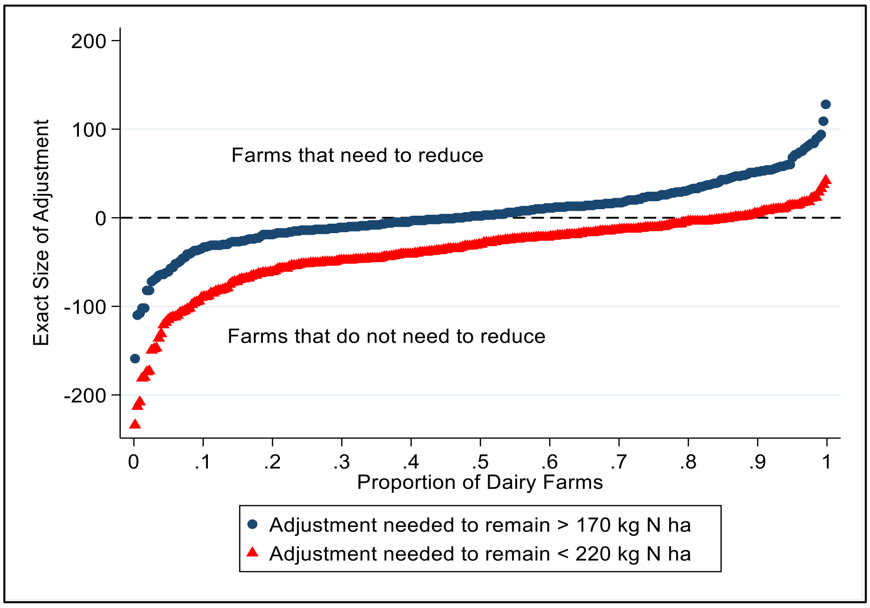
In this section, the four scenarios to achieve compliance, which were described in Section 2, are examined in detail to provide an estimate of the associated cost of their implementation. The fifth measure to reduce nitrate leaching, by reducing crude protein content in concentrate feeds cannot be examined in similar detail due to the absence of data within the NFS on the crude protein content of concentrate feeds used by Irish dairy farmers.

It is important to emphasise that the cost of implementing a scenario for an individual farm will be specific to the circumstances of the individual farm. The methodology used to estimate the cost of each scenario is described in detail. For each scenario, the scale of the action required across the dairy farming population is estimated and having made some necessary assumptions this information in then used to estimate the cost of the scenario. The baseline organic N stocking rate is based on MTR calculations, which have been adopted under the Good Agricultural Practice for the Protection of Waters Regulations amendments (S.I. 42 of 2025).

### *6.1.1 Distributional Graphs*

Throughout the following analysis, sample distributional graphs such as Figure 6, which are unweighted, are used to highlight the range of adjustments that are needed across dairy farms at all levels of production. These sample distributional graphs will show two lines, corresponding to the different organic N stocking rate limits of 170 kg N/ha (Blue) and 220 kg N/ha (Red). The (vertical) y-axis shows the size of the required adjustments (number of additional hectares rented in, and number of tankers of slurry exported, number of cows removed) and the (horizontal) x-axis shows the proportion of the dairy population that are affected by the changes. The x-axis point 0.5 corresponds to the 50th percentile, median, of the whole sample. For farms on the curve with a negative adjustment value, i.e. below the horizontal dashed line, no adaptation or change to farming activities or practices are required to comply with the regulation.

Figure 6: Explanation of distributional graphs



### *6.1.2 Description of Farm Categories*

Throughout the analysis, adjustments required at farm level are examined for the three farm categories described in Table 12. The percentage of the dairy farm populations in each category in 2021, 2022 and 2023 are presented in Table 13. Table 14 presents summary statistics for the farms in each farm category over the period 2021-2023. Table A3 in the Appendix to this report presents the median analogues of these summary average (arithmetic mean) statistics.

Table 12: Definition of Dairy Farms Categories

| Farm Category | Description |
|---|---|
| **Dairy Farm Category 1** | Organic N stocking rate ≤170 kg N/ha |
| **Dairy Fam Category 2** | Organic N stocking rate > 170 kg N/ha and ≤ 220 kg N/ha |
| **Dairy Farm Category 3** | Organic N stocking rate > 220 kg N/ha |

Table 13: Percentage of dairy farms in each farm category

| | Farm Category | | |
|---|---|---|---|
| **Year** | Dairy Farms ≤ 170 (Category 1) | Dairy Farms >170 & ≤ 220 (Category 2) | Dairy farms > 220 (Category 3) |
| **2021** | 52 | 34 | 14 |
| **2022** | 50 | 33 | 18 |
| **2023** | 47 | 40 | 13 |

Source: Derived based on data from the Teagasc National Farm Survey.

Table 14: Summary Farm statistics, by farm category (three-year average for 2021, 2022, and 2023)

| | Farms ≤ 170 (Category 1) | Farms >170 & ≤ 220 (Category 2) | Farms > 220 (Category 3) |
|---|---|---|---|
| Number of Farms | 7,656 | 5,351 | 2,255 |
| % dairy farm population | 49% | 36% | 15% |
| Average dairy cows per farm | 69 | 106 | 138 |
| % of National Milk Produced | 35 | 39 | 27 |
| Average UAA per farm (ha) | 62 | 67 | 69 |
| Average total cattle per farm | 143 | 206 | 250 |
| Average Chemical N kg/ha | 118 | 178 | 215 |
| Average Organic N kg/ha | 137 | 194 | 245 |
| Average Milk Yield kg/cow | 5,333 | 5,805 | 6,053 |
| Average concentrates kg/cow | 1,120 | 1,246 | 1,377 |
| Average Family Farm Income €/ha | 1,261 | 1,654 | 2,259 |

Source: Derived based on data from the Teagasc National Farm Survey.

## 6.1 Scenario 1: Rent Additional Land

*Assumptions:*

*All fixed costs remain in place*

*This is the only measure undertaken on the farm*

*Additional land is available*

*Organic N generated on the farm is evenly applied across the whole farm including rented land*

*The price of additional rented land is equivalent to prevailing regional rates*

### 6.1.1 Methodology

In this scenario, we estimate the additional land dairy farmers require to remaining compliant with the new regulations. Farmers could increase the total grassland area to negate the effect of increases in total annual nitrogen (kg) on the overall stocking rate. The additional land required to remain within the organic limits per ha, is calculated as follows:

$$\frac{Total\ Organic\ N\ produced\ on\ the\ farm \quad - Organic\ N\ limit * uaa}{Organic\ N\ Limit}$$

N limits are calculated as

$$N\ Limits = UAA\ *\ Upper\ Stocking\ Rate\ Limit$$

The upper stocking rate limits are 170 kg N/ha, 220 kg N/ha and 250 kg N/ha for some farms where the upper derogation limit has not been reduced.

The costs of additional rented land are based on the price of rented land reported in the NFS. The price of rented land used for this analysis varies by region and farm system, where typically better-quality land, suitable for dairying or tillage systems, is more expensive.

### 6.1.2 Number of hectares required.

In this scenario, we calculate the additional land required to remain compliant with the Nitrates Directive limits of 170 kg N/ha, 220 kg N/ha and 250 kg N/ha. The calculations are based on 2023 Teagasc NFS data for specialist dairy farms. Table 15 shows the average additional number of hectares required by dairy farms if they wish to remain under 170 kg N /ha or 220 kg N/ha and the percentage of the current farm size that these additional ha represent. The figures are based on the average over the last three years 2021, 2022 and 2023. The 7,609 farms that were stocked at a rate greater than 170 kg N/ha would need, on average, an additional 15 ha to bring their organic N stocking rate below 170 kg N/ha which is 23% increase relative to current farm size. Table A6 in the Appendix presents information on the increase in the volume of land rented in that would be needed to ensure compliance with changed organic stocking rate limits on the median farm renting in additional land. The median farm would need to rent in an additional 11 ha to comply with a 170 kg N/ha limit and an additional 5 ha to comply with a 220 kg N/ha stocking rate limit.

Table 15: Additional ha required to remain below stocking rate limits, Average (2021, 2022 &2023) NFS dairy farms.

| Year | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|
| | To remain ≤170 kg N/ha; across all farms > 170 kg N/ha | | | |
| No of Farms affected | 7,312 | 7,627 | 7,889 | 7,609 |
| Average additional ha per farm | 15 | 16 | 14 | 15 |
| Additional ha % of current farm size | 24% | 25% | 20% | 23% |
| | | | | |
| Cost of additional rented land (€) | 11,851 | 10,559 | 10,428 | 10,928 |
| Additional Rental cost as % of FFI | 13% | 6% | 25% | 15% |
| Cost if rental rate increases 25% (€) | 14,814 | 13,199 | 13,036 | 13,660 |
| Cost if rental rate increases 50% (€) | 17,776 | 15,838 | 15,643 | 16,392 |
| | | | | |
| Total additional ha required | 112,505 | 118,094 | 108,348 | 112,983 |
| | | | | |
| | To remain ≤ 220 kg N/ha; across all farms > 220 kg N/ha | | | |
| Number of Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| Average additional ha per farm | 7 | 7 | 5 | 6 |
| Additional ha % of current farm size | 13% | 13% | 7% | 11% |
| | | | | |
| Cost of additional rented land (€) | 5,229 | 4,804 | 3,613 | 4,590 |
| Additional Rental cost as % of FFI | 6% | 3% | 7% | 5% |
| Cost if rental rate increases 25% (€) | 6,536 | 6,004 | 4,516 | 5,738 |
| Cost if rental rate increases 50% (€) | 7,844 | 7,205 | 5,419 | 6,886 |
| | | | | |
| Total additional ha required | 20,724 | 20,940 | 12,841 | 18,168 |

Source: Derived based on data from the Teagasc National Farm Survey.

In Table 16 we present the increases in land rented in that are required to ensure compliance for the three farm Categories introduced in Table 12. For farms in Category 1, that are farming at or below 170 kg N/ha, no additional land is required. Farms in Category 2 farming at between 170kg N/ha and 220 kg N/ha and farms in Category 3, farming at in excess of 220 kg, renting in additional land is required to ensure compliance if the organic stocking rate limit were 170 kg N/ha. The volume of additional rented in that is required on the average (mean) and median farm to ensure compliance with a 170 kg N/ha and a 220 kg N/ha limit is 21 ha and 18 ha respectively.

If the organic stocking rate limit is 220 kg N/ha only farms in Cateogry 3 have to rent in additional land to ensure compliance. The volume of additional land rented in that is required on the average and median farm smaller at 6 ha and 5 ha respectively.

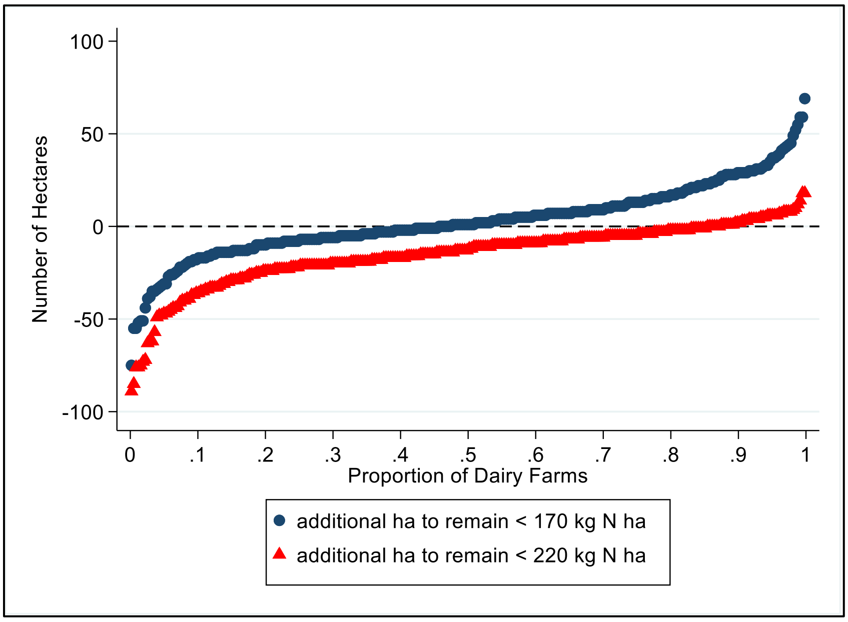
Table 16: Land requirements by Farm Category, Average (2021, 2022 & 2023)

| Farm Categories | All Farms ≤ 170 | Farms>170 & ≤ 220 | All Farms > 220 |
|---|---|---|---|
| Number of Farms | 7,656 | 5,351 | 2,255 |
| Average area farmed (ha) | 62 | 67 | 69 |
| % of milk produced nationally | 35% | 39% | 27% |
| | To remain ≤ 170 for all farms > 170 | | |
| Average Additional Area (ha) | n.a. | 9 | 21 |
| % Increase in farm size | n.a. | 13% | 30% |
| | | | |
| Median Additional Area (ha) | n.a. | 5 | 18 |
| % Increase in farm size | n.a. | 7% | 26% |
| | To remain ≤ 220 for all farms > 200 | | |
| Average Additional Area (ha) | n.a. | n.a. | 6 |
| % increase farm size | n.a. | n.a. | 9% |
| | | | |
| Median Additional Area (ha) | n.a. | n.a. | 5 |
| % increase farm size | n.a. | n.a. | 7% |

Source: Derived based on data from the Teagasc National Farm Survey.

The unweighted sample distribution of additional land required is presented in Figure 7. This distribution shows the range of adjustments across the dairy farm population. Farms operating above zero on the y-axis will need to rent in additional land to remain compliant, while farms below zero on the y-axis would not be required to change their farming activity to remain compliant. This distribution is based on NFS data for dairy farms in 2023 and the baseline organic N stocking rate is banding plus the MTR adjustments.

Figure 7: Land requirements for all farms to the reach 170 or 220 kg N on NFS Dairy Farms in 2023




Source: Derived based on data from the Teagasc National Farm Survey.

The distribution in Figure 7 shows the range of additional land required by farmers. However, as shown in Table 17, most farms require between 0 to 5 ha of additional farmland in order to remain compliant.

Sixty percent of the farms that are currently operating at stocking rates greater than 170 kg N/ha would need between 0 to 5 ha of additional land to bring their stocking rate below the 170 kg N/ha threshold. While 95% of the farms with organic N stock rates that are greater than 220 kg N/ha would need an additional 0 to 5 ha to remain at or below a 220 kg N/ha limit. This has consequences for land demand and land prices, as farmers may be willing to pay higher prices per ha for smaller amounts of land, and because so many farmers require a small amount of land, demand will for land in this scenario will increase when compared to the baseline.

Table 17: Categories of Additional Land Required

| Additional ha required | Adjustments to meet 170 kg N ha Limit on farms > 170 kg N ha | Adjustments to meet 220 kg N ha Limit on farms > 220 kg N ha |
|---|---|---|
| Number of ha | % of Dairy Farms | % of Dairy Farms |
| 0 to 5 ha | 60 | 94 |
| 6 to10 ha | 12 | 4 |
| 11 to 15 ha | 7 | 1 |
| 16 to 20 ha | 4 | 1 |
| > 20 ha | 17 | 0 |

Source: Derived based on data from the Teagasc National Farm Survey.

### 6.1.3 Cost of additional land

The cost of renting in additional land is based on rental prices paid by dairy farmers as recorded in the NFS. In our analysis if a dairy farmer was renting in land during the period 2021-2023 then the cost per ha of additional land rented in under this compliance scenario is assumed to be equal to the rental rate of land already rented in. If the farmer was not renting in land during the period 2021-2023 then the assumed cost of additional land rented-in is set equal to the average rental rate incurred by dairy farmers renting in land in that farm's region. The average rents paid by dairy farmers in the NFS over the period 2021-2023, by region, are shown Table 18.

Table 18: Average rental price of land on dairy farms (€/ha) by region

| | Border | Dub Mideast | Midwest | Midlands | Southeast | Southwest | West |
|---|---|---|---|---|---|---|---|
| 2021 | 672 | 686 | 791 | 687 | 742 | 912 | 573 |
| 2022 | 598 | 636 | 716 | 596 | 668 | 764 | 496 |
| 2023 | 614 | 798 | 710 | 672 | 700 | 817 | 555 |

Source: Derived based on data from the Teagasc National Farm Survey.

Applying the assumed cost per hectare to the amount of additional land rented in that is required, Table 15 shows the cost of the additional renting in of land required by the average farm to achieve compliance with a limit of 170 kg N/ha and a limit of 220 kg N/ha. A sensitivity analysis is also included to assess the impact of possible increases in land prices given the additional demand for small parcels of land by most farms requiring additional land.

The figures presented in Table 15 indicate that for farms renting in land to ensure compliance with a 170 kg N/ha limit that the average cost of renting in the additional land required to ensure compliance would be €10,928 per farm (or 15% of the average family farm income on those farms). The average costs of compliance with the 220 kg N/ha limit are lower because of the lower level of additional land rented in that is required to ensure compliance. On average the cost is estimated at €4,590 per farm. Table A6 in the appendix presents information on the costs on the median farm renting in additional land to ensure compliance with either a 170 kg N/ha or 220 kg N/ha limit. As shown in Table 16 the volume of additional rented-in land required to ensure compliance on the median farm is smaller than the volume on the average farm and the corresponding costs, presented in Appendix Table A6, are also lower.

#### *6.1.4 Advantages of this scenario*

- Maintains current herd size and milk production.
- Provides a long-term solution for compliance.
- Potentially increases farm asset value over time.

#### *6.1.5 Limitations of this scenario*

- Availability of suitable land is uncertain and varies regionally.
- Farmers may not be able to rent the exact quantity of land required and may have to rent a set block which will exceed their requirement and increase costs.
- Increases operational complexity if additional land rented in is not contiguous with existing farm. Increasing dairy farm fragmentation would increase costs of production and undermine low-input grass-based production systems.
- Farmers may not be able to access land nearby which increases the risk of slurry not being applied to rented land. This may have negative environmental consequences.
- Additional demand for land among affected farmers will have an inflationary effect on agricultural land prices. This magnitude of this inflation is difficult to predict and would affect cost to dairy farmers of renting in additional land.
- Negative impacts on other sectors depending on additional rented land.
- Increased workload for farmers due to increased farm fragmentation.

## 6.2 Scenario 2: Exporting slurry from dairy farms.

### *6.2.1 Methodology*

***Assumptions:***

***All fixed costs remain in place***

***This is the only measure undertaken on the farm***

***Farmers can locate a farm willing to import slurry***

***The cost of exporting slurry includes transport and spreading***

***All fixed costs remain in place***

***Organic N generated on the farm is evenly applied across the whole farm including rented land***

***The price of transport and spreading slurry exported is €75 per hour***

In this scenario, we calculate the volume of slurry a farm would need to export to remain under different organic N stocking rate limits. Table A2 in the appendix shows the total slurry produced on the farm per week, as defined by Table 2 in S.I. 113 of 2022 for slurry storage capacity required for cattle, sheep, and poultry in $m^3$ per week. Using the data in Table A2 on the amount of slurry produced by each animal type per day and NFS data on the number of days animals are housed (including half days where animals are only housed at night), we calculate the total volume of slurry produced on each farm. Based on S.I. 113 of 2022 recommendations we assume that total N contained in $1m^3$ of cattle slurry has been reduced from 5 kg N to 2.4 kg N.

$$1m^3 = 1{,}000\,l = 1ton = 1000kg$$

$$total\ volume\ slurry\ produced = kg\ slurry\ by\ animal\ type * days\ housed$$

The total volumes of slurry that a farm would need to export to remain below each of the limits 170, 220 kg N/ha is then calculated as:

$$\text{Total volume of slurry to be exported} = \frac{\text{Total Organic N produced on the farm - N}_{\text{limits}}\text{*uaa}}{2.4}$$

Assuming that a typical slurry tanker can hold 11,250 litres of slurry, the total volume of slurry that would need to be exported is converted into tanker equivalents as

$$total\ slurry\ tankers\ to\ be\ exported = total\ volume\ of\ slurry\ to\ be\ exported\ \ (l)/11{,}250$$

In addition to exporting surplus N, farms are also removing P and K from the farm when they export slurry. The quantity (kg) of N, P and K that are removed in each 11,250-litre tanker is given in Table 19.

Table 19: Nitrogen, Phosphorus and Potassium per 11,250 l Tanker

| | kg Nitrogen | kg Phosphorus | kg Potassium |
|---|---|---|---|
| | | | |
| kg nutrients exported per tanker | 27 | 9 | 39 |

Source: S.I. 113 of 2022 & Teagasc Green Book

The cost associated with exporting this slurry is calculated as the nutrient value per tanker, plus the cost of transport and spreading the exported slurry. The nutrient value is based on CSO average prices for N, P and K in 2021, 2022 and 2023 and an assumed DM content of 6.3% (Wall and Plunkett, 2020). Total P and K contained in 1m$^3$ of slurry are 0.08 kg for P based on S.I. 113 of 2022 and 3.5 kg K based on Teagasc Green Book figures (Wall and Plunkett, 2020).

The total cost of slurry per tanker exported is calculated as follows:

$$\begin{aligned} &Total\ cost\ per\ tanker \\ &\qquad = Nutrient\ Value\ + Transport\ \&\ spreading \\ &\qquad - Saving\ of\ Spreading\ on\ Own\ land \end{aligned}$$

### *6.2.2 Quantification of number and cost of slurry tanker journeys required.*

Table 20 shows the number of (11,250-litre) tankers of slurry that would need to be exported from farms in order to remain below stocking rate limits, the cost of exporting this volume of slurry and the overall volume of slurry in tanker equivalents that are produced on the farm and available to export.

Table 20: The average number of tankers of slurry to be exported to remain below Stocking Rate limits on NFS dairy farms in 2023.

| Year | | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|---|
| | | To remain ≤ 170; Across all farms > 170 | | | |
| No. of Farms affected | Farms | 7,312 | 7,627 | 7,889 | 7,609 |
| No. Tankers Exported to be Compliant | Tankers | 97 | 99 | 87 | 94 |
| Total Tankers equivalent produced | Tankers | 83 | 85 | 98 | 89 |
| Cost of Exporting | € | 19,443 | 19,778 | 17,378 | 18,841 |
| Cost as % of FFI | % | 18% | 12% | 27% | 19% |
| Total kg N exported | kg N | 2,629 | 2,674 | 2,350 | 2,551 |
| Total kg P exported | kg P | 876 | 891 | 783 | 850 |
| Total kg K exported | kg K | 3,797 | 3,862 | 3,394 | 3,684 |
| | | To remain ≤ 220; Across all farms > 220 | | | |
| No. of Farms affected | Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| No. Tankers Export | Tankers | 56 | 59 | 39 | 52 |
| Total Tankers produced | Tankers | 96 | 98 | 112 | 101 |
| Cost of Exporting | € | 11,173 | 11,701 | 7,802 | 10,393 |
| Cost as % of FFI | % | 11% | 7% | 8% | 9% |
| Total kg N exported per farm | kg N | 1,511 | 1,582 | 1,055 | 1,405 |
| Total kg P exported per farm | kg P | 504 | 527 | 352 | 468 |
| Total kg K exported per farm | kg K | 2,203 | 2,307 | 1,538 | 2,049 |

Source: Derived based on data from the Teagasc National Farm Survey.

When we examine the average volume of slurry exports required by farms within the three Farm Category definitions, described in Table 12, some farms (Category 1) have the capacity to import additional slurry while still remaining within the upper stocking rate limits. The adjustments in terms of numbers of the average and median number of tankers to be exported to ensure compliance for each of the three Farm Categories are presented in Table 21.

The results in Table 21 show that on average farms in Category 3 do not produce enough slurry on their farms to be in a position to utilise slurry exports as a compliance strategy if the maximum stocking rate is 170 kg N/ha. For the median farm in Category 3 this is also the case, with the volume required to be exported to ensure compliance found to 169% of the slurry available on the median farm. Farms in Category 3 that have an organic N stocking rate > 220 kg N/ha would generally need additional measures to achieve compliance. This outcome reflects the pasture-based nature of the Irish dairy production system where animals spend most of the year outdoors and illustrates the limits of exporting slurry as a nitrates limit compliance strategy. The nature of the Irish production system, with long grass growing seasons and high yields of grass, formed the basis for the granting of derogations from the Nitrates Directive that allow farmers granted a derogation to farm at stocking rates greater than 170 kg N/ha.

Table 20 also present the average  cost of exporting slurry as a stand alone compliance strategy for two organic nitrogen limits of 170 kg N/ha and 220 kg N/ha. On average the cost per farm of this strategy is €18,841 where the stocking rate limit is 170 kg N/ha and €10,393 per farm when the stocking rate limit is 220 kg N/ha. Table A7 in the Appendix present the costs of compliance on the median farm. The costs of using exporting slurry as a compliance strategy are lower on the median farm than on the average farm. If the organic stock rate limit is assumed to 170 kg N/ha the cost of compliance on the median farm is €13,313, while the costs of complying with a 220 kg N/ha limit on the median farm required to adjust farm activities is €7,526 per farm.

Table 21: Adjustments required by Farm Categories, Average (2021, 2022 & 2023)

| Farm Categories | All Farms ≤ 170 | Farms>170 & ≤ 2202 | All Farms > 220 |
|---|---|---|---|
| Number of Farms | 7,656 | 5,351 | 2,255 |
| Average farm size (ha) | 62 | 67 | 69 |
| % of milk produced Nationally | 35% | 39% | 27% |
| | To reach 170 kg N/ha limit | | |
| Average Number of tankers to export | n.a. | 56 | 178 |
| Exports as % of total available (Average) | n.a. | 68% | 175% |
| Median Number of tankers to export | n.a. | 45 | 171 |
| Exports as % of total available (Median) | n.a. | 62% | 169% |
| | To reach 220 kg N/ha limit | | |
| Average Number of tankers to export | n.a. | n.a. | 53 |
| Exports as a % of total available (Average) | n.a. | n.a. | 51% |
| Median Number of tankers to export | n.a. | n.a. | 38 |
| Exports as a % of total available (Median) | n.a. | n.a. | 43% |

Source: Derived based on data from the Teagasc National Farm Survey.

### 6.2.3 Advantages of this scenario

- Enables farms to retain current herd size without acquiring additional land.
- Flexibility in managing excess nitrogen.
- For farms importing slurry and nutrients contained therein there will the opportunity to save on chemical fertiliser expenditure.
- In the event that an Anaerobic Digestion industry develops in Ireland this industry may play a role as an additional importer of slurry from dairy farms.

### 6.2.4 Limitations of this scenario

- Dependent on availability of willing recipients for slurry.
- Transportation and handling costs are significant.
- Logistics can become complicated during peak periods.
- Some farms may already be exporting slurry; this is not accounted for in this analysis.
- Implications for grass growth and utilization resulting from nutrient loss as a result of slurry exported from the farm not accounted for.
- Some farms (particularly those in Farm Category 3) may not have sufficient animal slurries in storage for this strategy to be one that can return them to compliance with reduced organic N limits.
- The consequences of exporting slurry (and the nutrients contained therein) for soil fertility on the exporting farms have not been considered. Farmers exporting slurry may need to consider whether P and K balances on farm are adequate.

### 6.3 Scenario 3: Remove all Non-Dairy Livestock and Contract Rear Replacement Heifers

*Assumptions:*

*All fixed costs remain in place*

*This is the only measure undertaken on the farm*

*Farms willing to contract rear are readily available*

*There are no operational constraints to increasing dairy cow numbers*

#### *6.3.1 Methodology*

In this scenario, we examine the impact of removing all non-dairy cattle and other ruminants from dairy farms and having replacement dairy heifers contract reared as a compliance strategy. By removing suckler cows, calves < 6 months, calves 6 -12 months, cattle 12-24 months, cattle > 24 months, bulls and sheep from the farm, the new stocking rate "*Stocking Rate Contract Rearing*" with just dairy cows and replacement heifers for 3 months as calves on the farm and 3 months when they return to the farm after being contract reared is calculated as follows

$$\begin{aligned} Stocking\ Rate\ Contract\ Rearing \\ &= dairy\ cow + Replacement\ Heifers\ (3\ Months) \\ &+ Replacement\ Heifer\ Calves\ (3\ months) \end{aligned}$$

Excretion rates for dairy cows are based on banding (80, 92 or 106 kg N/cow), excretion rates for replacement heifers are based on MTR rates for female animals 1-2 years (55 kg N/head) and excretion rates for replacement calves are also based on MTR rates for calves < 3 months.

To calculate the costs associated with the scenario we assume an annual dairy cow replacement rate of 25% and calculate the cost of contract rearing these animals for 549 days at a cost of €2 per day as follows:

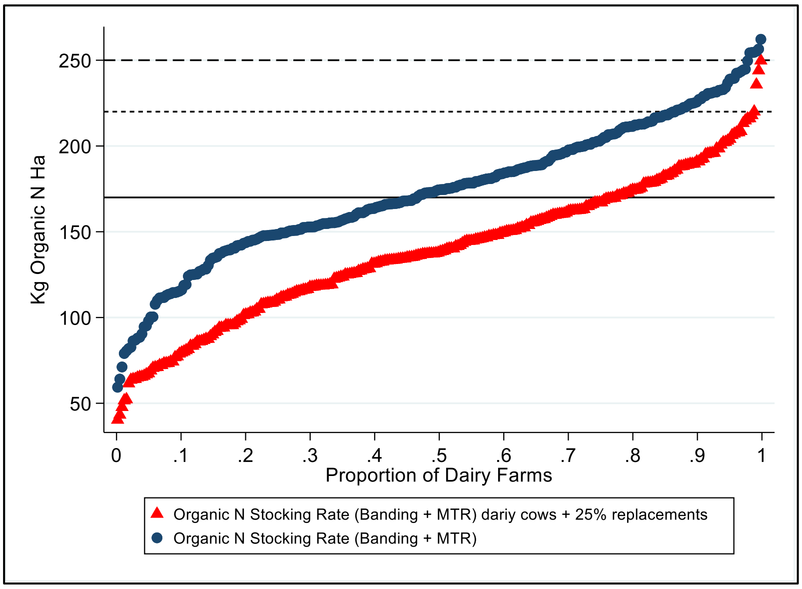
$$cost\ contract\ rearing = dairy\ cows * 0.25 * 549 * €2$$

#### *6.3.2 Changes in the stocking rate*

A comparison of the initial stocking rates of the farms including banding and MTR, and a revised stocking rate calculation with just dairy cows on the farm is presented in Figure 8. Removing all other livestock from the farm and contract rearing replacement heifers reduces the overall stocking rate substantially. Under this scenario there are no farms operating at or above 250 kg N/ha. The number of farms operating at or above 170 kg N/ha has dropped from 51% to 22% of dairy farms. The number of dairy farms operating at over 220 kg N/ha has dropped from 14% to 5%.

As shown in Figure 8, when animals (non-dairy cattle, sheep, and replacement dairy heifers) are removed there is an effective overadjustment in the organic N stocking rate which brings many farms greater than 170 kg N/ha to well below that limit.

Figure 8: Comparison of Stocking Rate Banding + MTR and stocking rate with dairy cows and replacements only (contract rearing), on NFS dairy farms in 2023.




Source: Derived based on data from the Teagasc National Farm Survey.

To compensate for this “overadjustment,” analytically we can assume that dairy cows are added back to the farm’s organic N stocking rate and a new stocking rate calculated which removes all non-milk producing animals and replaces them with additional dairy cows. Additional cows are added to bring the dairy farm up to the stocking rate limit (170 kg N/ha or 220 kg N/ha), after all non-dairy cattle are removed from the farm and replacement dairy heifers are contract reared.

The income from additional dairy cows significantly reduces the overall cost of the contract rearing scenario. Figure 9 represents an adjustment where first all non-dairy animals are removed from the farm, and secondly, where this adjustment is < the upper limit of 170 kg N/ha or 220 kg N/ha (an over adjustment), additional dairy cows are then added. The additional cows added back are calculated as

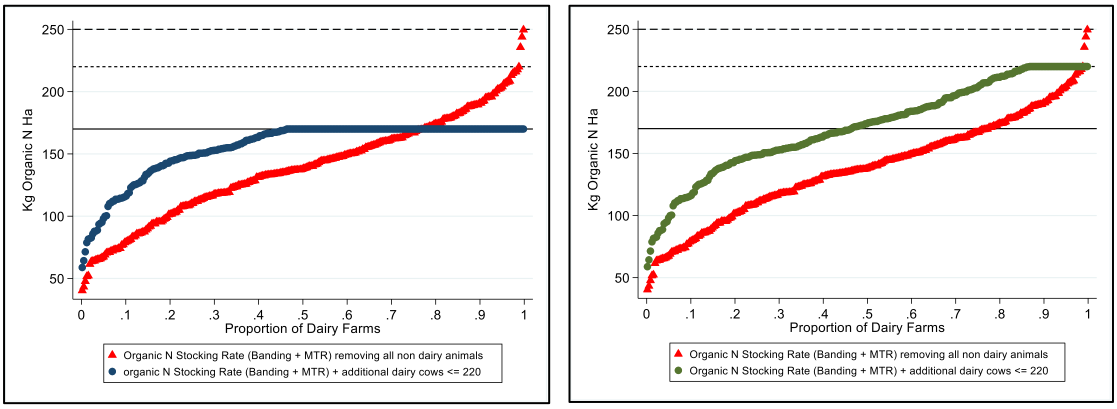
$$(i)\ difference\ in\ total\ N = (Stocking\ Rate - Stocking\ Rate\ Contract\ Rea) * UAA$$

$$(ii)\ Additional\ cows = Difference\ in\ total\ N / \ Coefficient\ per\ dairy\ cow\ (banding)$$

The new stocking rate of the farm after the addition of cows is the same as the stocking rate (banding + MTR) that brings the farm into compliance with the maximum stocking rate limit, but the composition of the farm’s animal herd is changed. On the farms that remove non-dairy animals and contract rear replacement dairy heifers these animals are partially replaced (up to the applicable organic stock rate limit) by dairy cows, assuming that there are no operational constraints (labour or milking facilities) which would prevent the farm from adding additional dairy cows.

Figure 9: Comparison of Stocking Rate (Banding + MTR) adjusted to include additional dairy cows up to SR limits and stocking rate with dairy cows and replacements only (contract rearing)

(a) Maximum SR of 170 kg N/ha (b) Maximum SR of 220 kg N/ha




Source: Derived based on data from the Teagasc National Farm Survey.

### *6.3.3 Total economic cost of contract rearing*

The total economic cost for dairy farms under this scenario depends on whether a farm chooses/is free to add back additional dairy cow after all non-dairy animals are removed and all replacement dairy heifers are contract reared. The total economic cost is calculated as the gross margin of the farm before the scenario is implemented less the gross margin of the farm after it has implemented the contract rearing option.

If additional cows are added so that the farm operates at the maximum organic stocking rate allowed (either 170 or 220 kg N/ha), the costs on the farm will increase due to the cost of the contract rearing service paid by the dairy farmer and the additional direct costs associated with the dairy cows added to the farm operation, these increased direct costs are offset by reduced direct costs associated with the removed non-dairy animals. Farm revenue will reduce due to the destocking non-dairy livestock with this reduction offset by increased revenue from the sale of milk produced by the cows added to the farm.

Changes in inventory value associated with dairy heifer replacements are assumed not to change because of the contract rearing of these heifers. At all times, these animals remain in the ownership of the dairy farmer. The farmer providing the contract rearing service is paid by the dairy farmer, these assets (replacement heifers) remain in the ownership of the dairy farmer. Any changes in the inventory value associated with replacement heifers is assumed to be the same whether these animals are raised on the dairy farm or on the farm of a contract rearing service provider.

Table 22 shows the total economic costs associated with contract rearing replacement heifers and removal of non-dairy animals from the farm and replacing the animals removed with additional dairy cows, on farms above 170 kg N/ha and 220 kg N/ha limits under banding + MTR calculations.

Table 22: Average total Costs of contract rearing including additional dairy cows to remain below SR limits (2021 2022 & 2023)

| Year | | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|---|
| | | To remain ≤ 170; Across all farms > 170 | | | |
| No of Farms | Farms | 7,312 | 7,627 | 7,889 | 7,609 |
| Economic Cost | € | 1,239 | 530 | 1,562 | 1,110 |
| Economic Cost as % of FFI | % | 1% | 0.3% | 3% | 1% |
| | | To remain ≤ 220; Across all farms > 220 | | | |
| Number of Farms | Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| Economic Cost | € | 1,987 | 482 | 1,355 | 1,222 |
| Economic Cost as % FFI | % | 0.8% | 0.3% | 2% | 1% |

Source: Derived based on data from the Teagasc National Farm Survey.

If the additional income arising from the addition of dairy cows is excluded under this scenario, that is farms are assumed to not add additional dairy cows, the costs to the average farm of implementing this strategy, shown in Table 23, are significantly higher than the costs show in Table 22.

Table 23: Average total Costs of contract rearing excluding additional dairy cows to remain below SR limits (2021 2022 & 2023)

| Year | | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|---|
| | | To remain ≤ 170; Across all farms > 170 | | | |
| No of Farms | Farms | 7,312 | 7,627 | 7,889 | 7,609 |
| Economic Cost | € | 16,818 | 8,945 | 8007 | 11,257 |
| Economic Cost as % of FFI | % | 14% | 5% | 13% | 9% |
| | | To remain ≤220; Across all farms > 220 | | | |
| Number of Farms | Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| Economic Cost | € | 14,695 | 7,629 | 6,173 | 9,499 |
| Economic Cost as % FFI | % | 11% | 4% | 9% | 7% |

Source: Derived based on data from the Teagasc National Farm Survey.

The average and median costs of the contract heifer rearing scenario on each of the three farm Categories presented in Table 12 are shown in Table 24 and Table 25. If farms are assumed to be able to add additional dairy cows the average costs of this scenario are low while the costs to the median farm are zero. However, if we exclude the possibility of farms adding additional dairy cows then the costs of this scenario are on average significant. For farms in Category 2 the average costs of this compliance strategy is estimated to be €11,837 per farm, while for farms in Category 3 the average costs is found to be €9,465 per farm. The compliance costs, assuming no additional cows added, are significantly lower than the average costs at

Table 24: Cost of contract heifer rearing scenario by Farm Categories assuming additional dairy cows.

| Farm Categories | | All Farms ≤ 170 | Farms>170 & ≤ 2202 | All Farms > 220 |
|---|---|---|---|---|
| Number of Farms | Farms | 7,656 | 5,351 | 2,255 |
| Number of ha | ha | 62 | 67 | 69 |
| % of National Milk pool | % | 35% | 39% | 27% |
| To remain ≤ 170 kg N/ha limit | | | | |
| Cost of contract rearing | € | n.a. | 1,036 | 1,274 |
| % of family farm income | % | n.a. | 1% | 1% |
| Cost of contract rearing (Median) | | n.a. | 0 | 0 |
| % of family Farm Income | | n.a. | 0 | 0 |
| To remain ≤ 220 kg N/ha limits | | | | |
| Cost of contract rearing (Average) | € | n.a. | n.a. | 1,274 |
| % family farm income | % | n.a. | n.a. | 1% |
| Cost of contract rearing (Median) | | n.a. | n.a. | 0 |
| % of family Farm Income | | n.a. | n.a. | 0 |

Source: Derived based on data from the Teagasc National Farm Survey.

Table 25: Cost of contract heifer rearing scenario by Farm Categories assuming no additional cows.

| Farm Categories | | All Farms ≤ 170 | Farms>170 & ≤ 2202 | All Farms > 220 |
|---|---|---|---|---|
| Number of Farms | | 7,656 | 5,351 | 2,255 |
| Number of ha | ha | 62 | 67 | 69 |
| % of National milk pool | % | 35% | 39% | 27% |
| To remain ≤ 170 kg N/ha limit | | | | |
| Cost of contract rearing (Average) | € | n.a. | 11,837 | 9,499 |
| % of family farm income | % | n.a. | 10% | % |
| Cost of contract rearing (Median) | | n.a. | 4,901 | 2,571 |
| % of family Farm Income | | n.a. | 6% | 2% |
| To remain ≤ 220 kg N/ha limits | | | | |
| Cost of contract rearing (Average) | € | n.a. | n.a. | 9,499 |
| % family farm income | % | n.a. | n.a. | 7% |
| Cost of contract rearing (Median) | | n.a. | n.a. | 3,269 |
| % of family Farm Income | | n.a. | n.a. | 2%3%. |

Source: Derived based on data from the Teagasc National Farm Survey.

## 6.4 Scenario 4: Reduce Dairy Cow Number

*Assumptions:* .

*All fixed costs remain in place*

*This is the only measure undertaken on the farm*

In this scenario we examine the impact of reducing the size of the dairy herd on the farm to remain compliant with regulatory limits for organic N/ha. The baseline organic N stocking rate is based on current regulations, which include banding and MTR adjustments.

### 6.4.1 Methodology

The required reduction in cow numbers, on farms where the organic N stocking rate is in excess of stocking rate limits is determined by the total organic N produced on the farm, the N limit which the farm is required to comply with and the band to which the farm belongs. The reduction in the number of cows required so that a farm remains under the organic stocking rate limit is calculated as

$$\frac{Total\ Organic\ N\ produced\ on\ the\ farm\ \ -\ N_{limits} * uaa}{80}\ if\ in\ Band\ 1$$

$$\frac{Total\ Organic\ N\ produced\ on\ the\ farm\ -\ N_{limits} * uaa}{92}\ if\ in\ Band\ 2$$

$$\frac{Total\ Organic\ N\ produced\ on\ the\ farm\ \ -\ N_{limits} * uaa}{106}\ if\ in\ Band\ 3$$

where $N_{limits}$ are 170, 220 or 250 kg N/ha representing the three stocking rate thresholds analysed.

The costs associated with the destocking of dairy cows are derived from the Market Gross Margin (MGM) per cow which is calculated as follows:

$$MGM\ per\ cow = (Dairy\ Gross\ Margin - total\ subsidies)/Number\ of\ Dairy\ Cows$$

### 6.4.2 Adjustments in the Number of cows

Table 26 shows the required adjustments in the average number of cows so that a farm would remain under an organic N stocking rate of 170 kg N/ha and 220 kg N/ha, based on the organic N stocking rate of the farm (banding + MTR). On average (over the years 2021, 2022 and 2023), if there was no derogation and all dairy farms had to operate under a 170 kg N/ha limit, 7,609 farms would need to reduce dairy cow numbers, with an average reduction in the dairy cow herd of 27 cows per farm. In aggregate these farm level adjustments would represent a 15% cut in the national dairy cow herd. If the upper derogation limit for all dairy farms granted a derogation was reduced from 250 kg N /ha to 220 kg N/ha, 2,258 dairy farms would need to reduce their dairy cow herds, with average reduction required of 15 cows per farm. When the required farm level reductions are aggregated this would represent a 2.3% cut in the national dairy cow herd. Table A10 in the Appendix to this report presents the reductions required on the median farm required to adjust their farming activities to be compliant with either the 170 kg N/ha or 220 kg N/ha limits and the associated costs (income foregone) on the median farm.

Table 26: Average reduction in cow numbers to remain under 170 and 220 SR limits (2021, 2022 and 2023)

| Dairy Cow Reduction | | | | | |
|---|---|---|---|---|---|
| | All farms ≤ 170 kg across all farms > 170 kg N/ha | | | | |
| Year | | 2021 | 2022 | 2023 | Average |
| Number of farms affected | Farms | 7,312 | 7,627 | 7,889 | 7,609 |
| Number of Dairy Cows currently on farm | Cows | 115 | 114 | 118 | 116 |
| Average Reduction in cows per farm | Cows | 28 | 28 | 25 | 27 |
| Reduction in Milk Volume (National) | Bn Litres | 1.2 | 1.3 | 1.1 | 1.2 |
| % Reduction in National Milk Volume | % | 15% | 16% | 14% | 15% |
| Reduction in National Herd | Cows | 202,230 | 210,194 | 198,733 | 203,719 |
| % reduction of national herd | % | 15% | 15% | 14% | 14% |
| | All farms ≤ 220 kg across all farms > 220 kg N/ha | | | | |
| Number of farms affected | Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| Number of Dairy Cows currently on farm | Cows | 139 | 135 | 141 | 138 |
| Average Reduction in cows per farm | Cows | 16 | 16 | 11 | 15 |
| Reduction in Milk Volume (National) | Bn Litres | 0.211 | 0.259 | 0.130 | 0.200 |
| % Reduction in National Milk Volume | % | 4% | 4% | 2% | 3% |
| Reduction in National Herd | Cows | 33,824 | 42,986 | 22,258 | 33,023 |
| % reduction of National herd | % | 2.4% | 3.2% | 1.5% | 2.5% |

Source: Derived based on data from the Teagasc National Farm Survey

Table 27 presents the reductions in in dairy cow numbers required across the three farm categories defined in Table 12 if this reducing dairy cow numbers is the sole strategy employed to ensure compliance with reduced organic stocking rate limits.

Farms in Category 1, farming at or below the 170 kg N/ha stocking rate, are not required to adjust their farm operation. However, the mean and median reductions in dairy cow numbers required on farms in Category 2 and Category 3 are significant. To comply with a 170 kg N/ha limit farms in Category 2 would, on average, have to reduce cow numbers by 17 cows, while farms in Category 3 would have to reduce cow numbers by an average of 51 cows. The magnitude of the average reductions is smaller if the organic stocking rate limit is assumed to be 220 kg N/ha.

The scale of adjustment required on the median farm are also smaller than the average adjustment required, this reflects the fact there are a small number of farms where the required reductions in cow numbers would be very large. These very large reductions affects the calculated average level of reduction required.

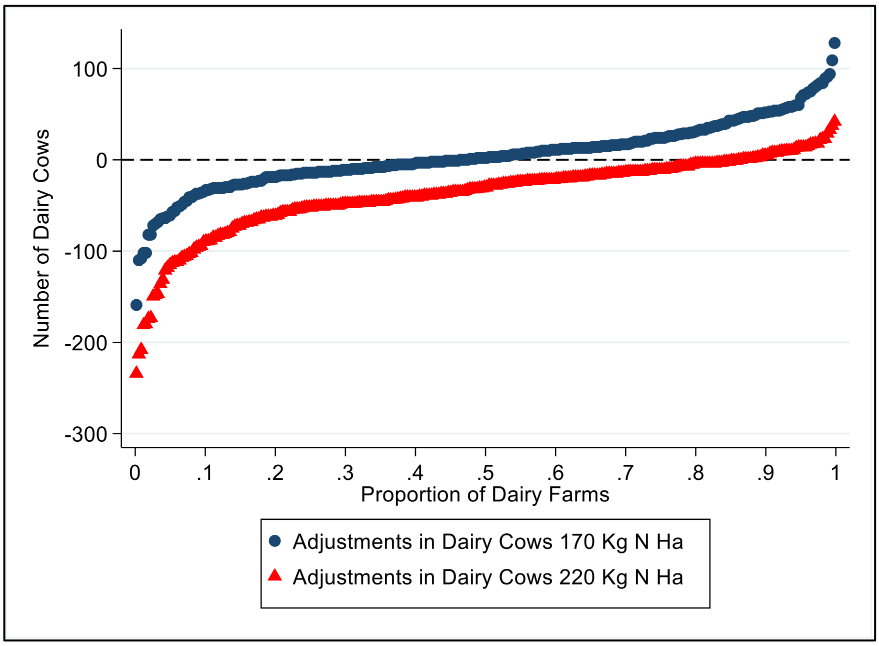
Table 27: Dairy Cow Adjustments by Farm Category three-year Average (2021-2023)

| Farm Categories | All Farms ≤ 170 (Category 1) | Farms>170 & ≤ 220 (Category 2) | All Farms > 220 (Category 3) |
|---|---|---|---|
| Number of Farms | 7,656 | 5,351 | 2,255 |
| Average dairy cows per farm | 69 | 106 | 138 |
| Median dairy cows per farm | 61 | 88 | 125 |
| % of milk produced Nationally | 35% | 39% | 27% |
| | To reach 170 kg N/ha limit | | |
| Average reduction in cow Numbers | n.a. | 17 | 51 |
| % Reduction in current herd (Average) | n.a. | 16% | 28% |
| | | | |
| Median reduction in cow numbers | n.a. | 13 | 49 |
| % Reduction in current herd (Median) | | 15% | 39% |
| | To reach 220 kg N/ha limit | | |
| Average reduction in cow Numbers | n.a. | n.a. | 15 |
| % Reduction in current herd (Average) | n.a. | n.a. | 11% |
| | | | |
| Median reduction in cow numbers | n.a. | n.a. | 11 |
| % Reduction in current herd (Median) | n.a. | n.a. | 9% |

Source: Derived based on data from the Teagasc National Farm Survey.

The unweighted sample distribution of changes in cow numbers is presented in Figure 9. This distribution shows the range of adjustments across the dairy farm population. Farms operating above zero on the y-axis would need to reduce cow numbers to become compliant, while farms below zero on the y-axis do not need to reduce cow numbers to become compliant (and could increase cow numbers and remain compliant). This distribution is based on NFS data for dairy farms in 2023 and the baseline organic N stocking rate is defined as banding plus the MTR adjustments.

Figure 9: Adjustments in Cow Numbers at stocking rate limits of 170 and 220 kg N/ha.




Source: Derived based on data from the Teagasc National Farm Survey

The weighted distribution of the changes in cow numbers that would be required in order for all farms to comply with an organic N stocking rate limit of 170 kg N/ha in 2023 is presented in Figure 10. On average 25 dairy cows would need to be removed on farms that currently exceed the stocking rate 170 kg N/ha limit to achieve compliance (the dashed vertical red line). Figure 10 also shows that while most dairy farms need modest herd size reductions to meet nitrogen limits, a smaller subset of dairy farms may face significant challenges due to the large herd size reductions they would need to make to be compliant with a 170kg N/ha limit

Figure 10: Changes in dairy Cow numbers under a 170 kg N/ha MTR Organic Stocking Rate limit.

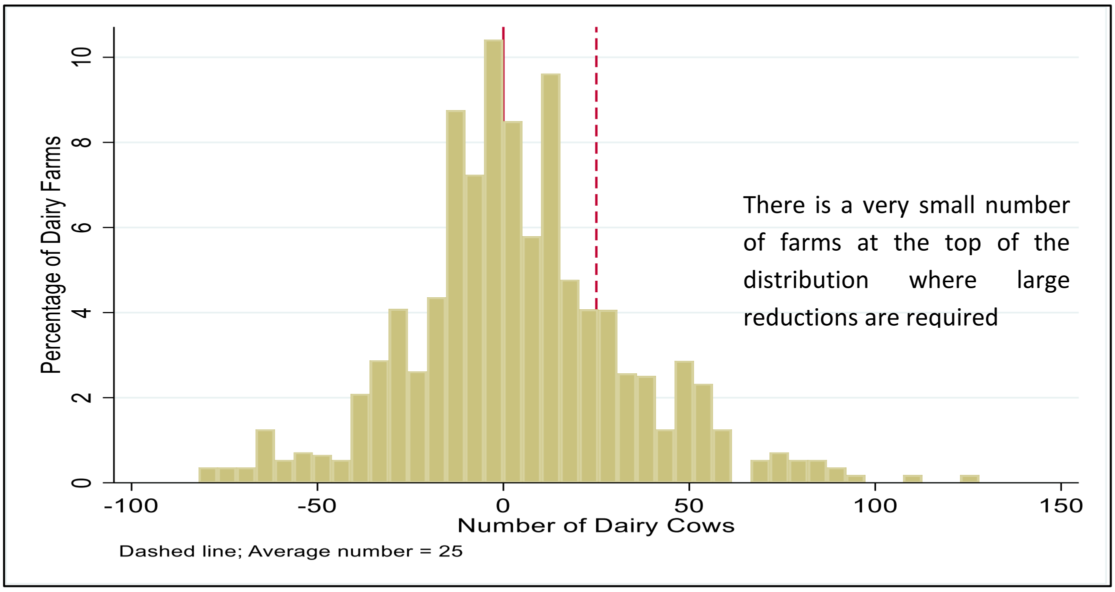
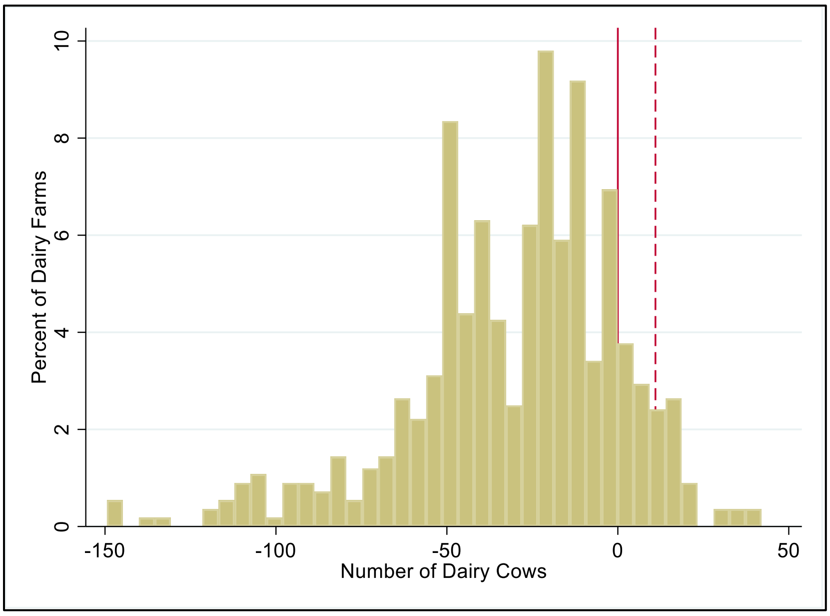



Figure 11 shows the distribution of the number of cows that would need to be removed so that all farms comply with a nitrogen limit of 220 kg N/ha in 2023. The dashed vertical line represents the average reduction in cows across those farms where the stocking rate is currently > 220 kg N/ha.

Figure 11: Reduction in number of cows to remain under 220 kg N/ha 2023.




Source: Derived based on data from the Teagasc National Farm Survey

### 6.4.3 Costs of removing dairy cows

The economic cost of removing cows from the herd so as to remain under various stocking rate limits is defined as the loss of the market gross margin per cow removed, and the market based gross margin (MGM) per cow is calculated as

$$MGM\ per\ Cow = \frac{(Gross\ Output - direct\ costs) - subsidy\ payments}{Number\ of\ dairy\ cows}$$

The average total cost of reducing dairy cow numbers on farms with organic N stocking rates in excess of the various MTR organic N stocking rate limits is presented in Table 28. The cost of removing dairy cows as a compliance strategy on the median farm required to change farming activities to ensure compliance is also shows in Table 28.

On average if the organic stocking rate limit is 170 kg N/ha and the only compliance strategy employed is to remove dairy cows, the average cost is estimated as €43,555 per farm. The economic costs of this strategy on the median farm required to adjust their farm activities is €29,482 euro. If the organic stocking rate limit is 220 kg N/ha the economic cost, while still very large (€25,328), is smaller than those associated with the lower stocking rate limit. On average the economic costs of reducing cow numbers so as to be compliant with a 220 kg N/ha limit would be €25,328, while on the median farm the costs of compliance from using this strategy alone would be €15,618.

It is important to note that the potential loss of future earnings associated with any planned future expansion of the herd are not accounted for in this analysis. It would be difficult to make such an assessment in the absence of knowledge about the scale of the future expansion plans for these farms.

Table 28: Total economic cost of reducing Cow Numbers so as to remain below stocking rate limits (2021, 2022, and 2023)

| Year | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|
| | All farms ≤ 170 kg across all farms > 170 kg N/ha | | | |
| Number of farms affected | 7,312 | 7,627 | 7,889 | 7,609 |
| Average Income reduction per farm (€) | 39,016 | 61,422 | 30,485 | 43,555 |
| Percentage reduction in average FFI | 36% | 35% | 46% | 39% |
| | | | | |
| Median Income reduction per farm (€) | 26,712 | 43,868 | 20,686 | 29,482 |
| Percentage reduction in median FFI | 22% | 22% | 29% | 21% |
| | All farms ≤ 220 kg across all farms > 220 kg N/ha | | | |
| Number of farms affected | 2,153 | 2,614 | 1,982 | 2,258 |
| Average income reduction per farm (€) | 22,722 | 36,132 | 13,762 | 25,328 |
| Percentage reduction in average FFI | 23% | 20% | 13% | 19% |
| | | | | |
| Median Income reduction per farm (€) | 17,135 | 28,816 | 11,483 | 15,618 |
| Percentage reduction in median FFI | 9% | 11% | 6% | 9% |

Source: Derived based on data from the Teagasc National Farm Survey.

### 6.4.4 Advantages of this scenario

- Simple to implement and the only scenario not dependent on other farms.

- Directly reduces nitrogen output and ensures compliance with new organic nitrogen (N) limits.
- Requires no additional land or external arrangements for slurry or heifer rearing.

### *6.4.5 Limitations of this scenario*

- Significant loss of income due to reduced milk production.
- Loss of milk production has implications for the wider dairy industry and related supply chains.
- Fixed costs per (remaining) cow increase, significantly reducing overall farm profitability.
- Negative impact on farm size and production capacity.
- Reducing cow numbers will reduce grass utilisation as grass supply will be greater than grass demand.
- Viability of some dairy farms will be undermined and ultimately it could be expected that many would cease milk production.
- AS with other scenarios analysed farmers' use of this strategy to achieve compliance would be accompanied by other actions such as renting additional land, exporting slurry, and removing non-dairy cattle and contract rearing replacement dairy heifers.
- Given the economic costs in income foregone by reducing cow numbers it is likely that on most farms that have to adjust farming activities to be compliant with a changed organic N stocking rate limit this option would likely only be used when all other opportunities to reduce the farms organic stocking rate are exhausted.

## 6.5 Scenario 5: reducing the maximum crude protein content of concentrates fed to dairy cows.

Based on scientific evidence from research carried out by Teagasc and UCD in Ireland and AFBI in Northern Ireland, there is potential to reduce the organic N excretion rates through reducing the crude protein of the concentrate feed used (Teagasc, 2023a and 2023b). Recent measures introduced (S.I. 42 of 2025) recognise that lower nitrogen excretion rates can be achieved by dairy farmers who opt to manage crude protein in the concentrates fed to their cows across the year. The reductions in the excretion rates are set out in Table 28:

Table 29: Annual Nitrogen Excretion rates for Dairy Cows in herds where the farmer has elected to limit the annual average crude protein in concentrates fed to dairy cows to a maximum of 15% or less.

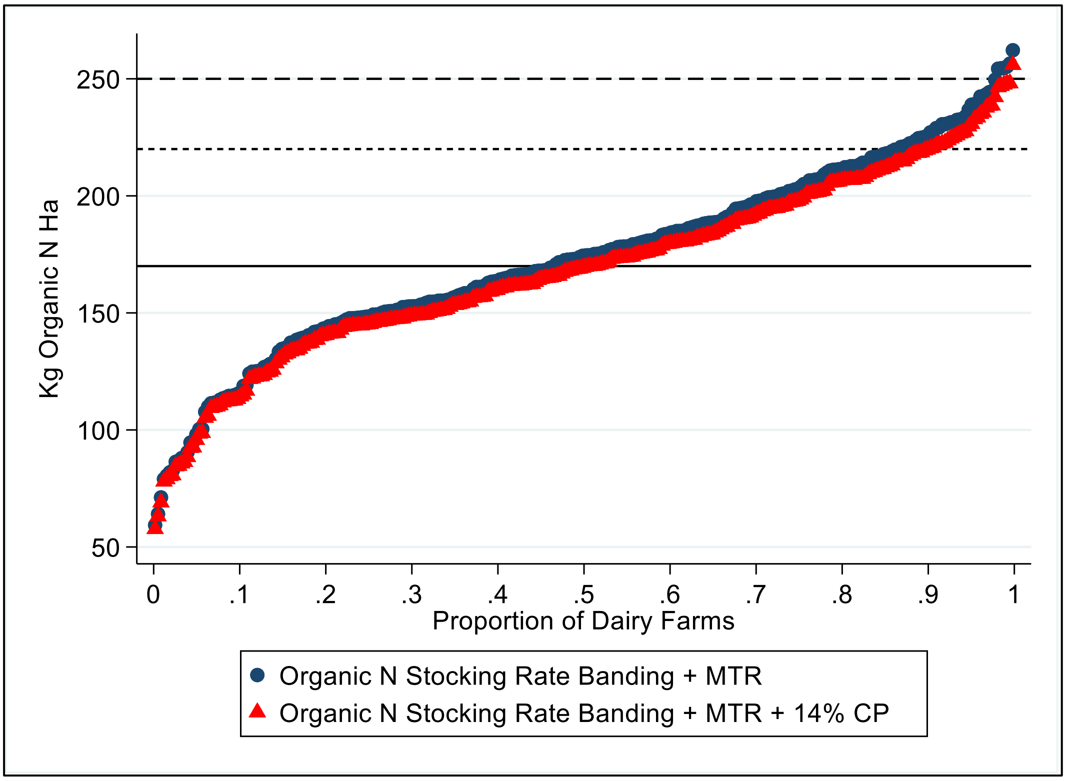
| | Band 1 | Band 2 | Band 3 |
|---|---|---|---|
| **Average crude protein in concentrate fed to dairy cows for the year greater than 14% but less than or equal to 15%** | 79 | 90 | 103 |
| **Average crude protein in concentrate fed to dairy cows for the year greater than 13% but less than or equal to 14%** | 78 | 89 | 100 |
| **Average crude protein in concentrate fed to dairy cows for the year less than or equal to 13%** | 76 | 87 | 89 |

Source : Table 6A S.I. 42 of 2025.

### *6.5.1 Changes in the organic N stocking rate*

A comparison of the organic N stocking rate of dairy farms including banding and MTR, and a revised stocking rate calculation for dairy farms where the crude protein content in concentrates is 14% is presented in Figure 12.

Figure 12: Comparison of Stocking Rate Banding + MTR and stocking rate with CP 14%, on NFS dairy farms in 2023.




Like the contract-rearing scenario (Scenario 3), this scenario where crude protein in concentrates is reduced to 14% reduces the overall organic N stocking rate of each farm. However, as illustrated in Figure 12, this measure on a stand-alone basis is not capable of moving many farms from above the 170 and 220 kg N stocking rate limits to at or below these stocking rate limits. For most farms, other measures such as renting in additional land, contract rearing of replacement heifers or exporting of slurry would need to be considered in addition to reducing crude protein in concentrates feed used, if more than a marginal reduction in farm's organic N stocking rate to below either the 170 or 220 kg N limits is required.

# 7 Discussion

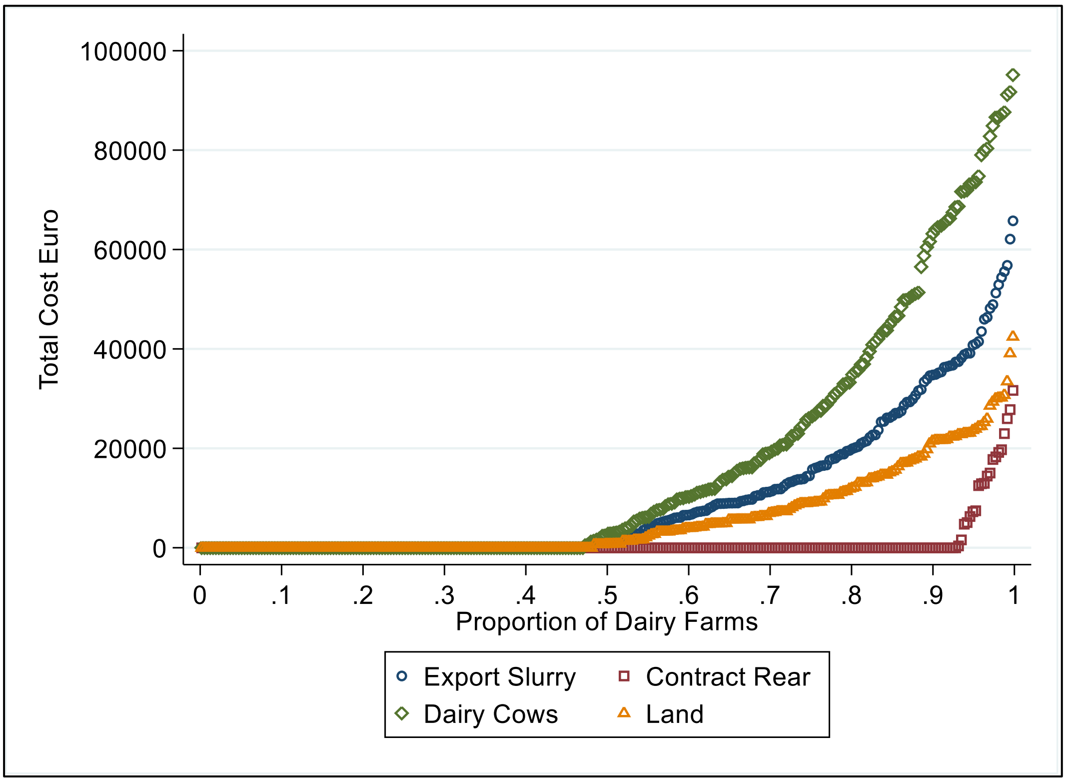
## 7.1 Comparative Analysis of Scenarios:

The scenarios analysed, renting additional land, exporting slurry, and contract rearing dairy heifer replacements and reducing dairy cow numbers as well as reducing the crude protein content of concentrate feeds all present different strategies for achieving compliance with revised nitrates regulations and changed stocking rate limits. The analysis presented looked at each of these strategies and the associated costs if each of these strategies was employed in isolation. Farmers faced with the challenge of adjusting their farm activities to ensure compliance with changed organic N limits will choose strategies suited to their individual contexts and in many instances will choose a mix of the options considered here. The estimated costs of the compliance options when considered in isolation should therefore be considered as setting the boundaries on the likely economic costs that these compliance actions would imply for Irish dairy farmers. In this section we conduct a comparative analysis of these scenarios under the following headings, costs, advantages, limitations, and economic feasibility.

### *7.1.1 Comparison of Total Costs to remain < 170 kg N/ha*

The costs per farm associated with all four scenarios where the maximum stocking rate is 170 kg N/ha are presented graphically in Figure 13. Costs only arise where the farm is calculated as having an organic stocking rate in excess of 170 kg N/ha. Farms with an organic stocking rate less than or equal to 170 kg N/ha no change in farm activities is required for compliance and no compliance costs arises.

Figure 13: Comparison of Total Costs to remain ≤ 170 kg N/ha for All Four Scenarios in 2023.

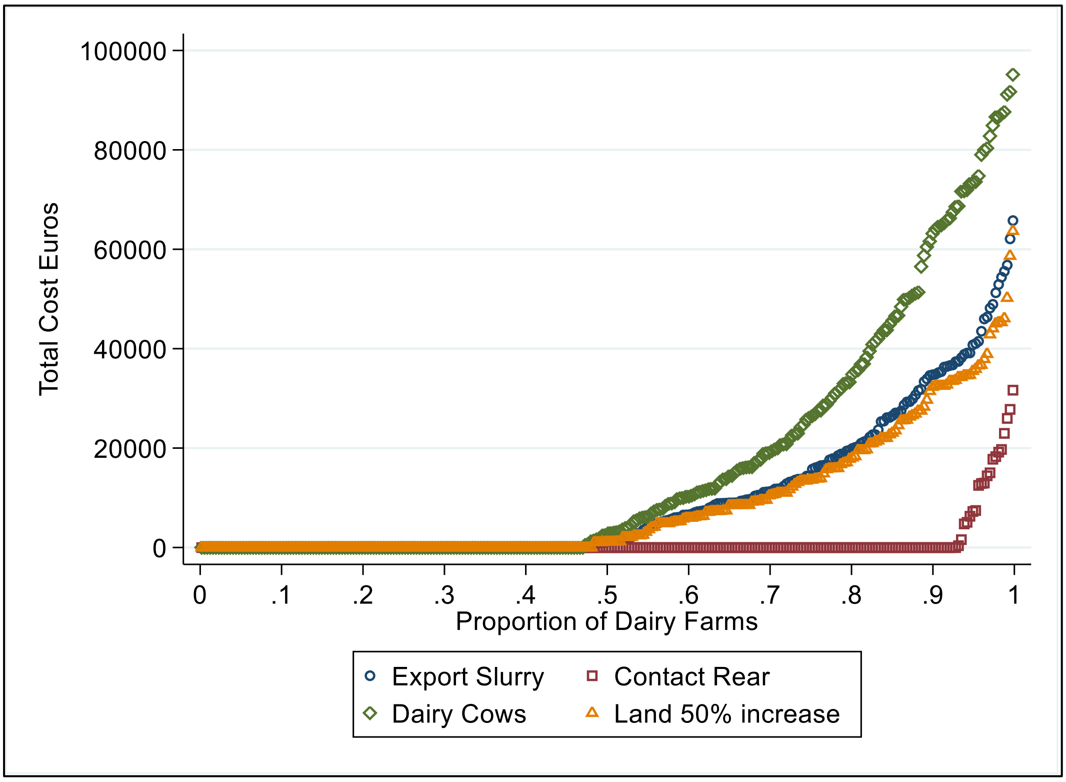



Source: Derived based on data from the Teagasc National Farm Survey.

Figure 13 shows that the most expensive scenario across all farms is the removal of dairy cows (Scenario 4). Exporting slurry is the second most expensive option and renting extra land is the third most expensive scenario. Contract rearing is the least cost option for many farmers except for farms currently operating at very high stocking rates where the costs of rearing replacements become greater than the saving in terms of feeding these animals on farm. On these farms, renting additional land is the least expensive option for achieving compliance with a 170 kg N/ha limit.

In Figure 14, we examine the total costs of all four scenarios if land rental prices were to increase by 50%. This increase would make the renting in more land scenario as expensive as exporting slurry on many farms where adjustments are needed.

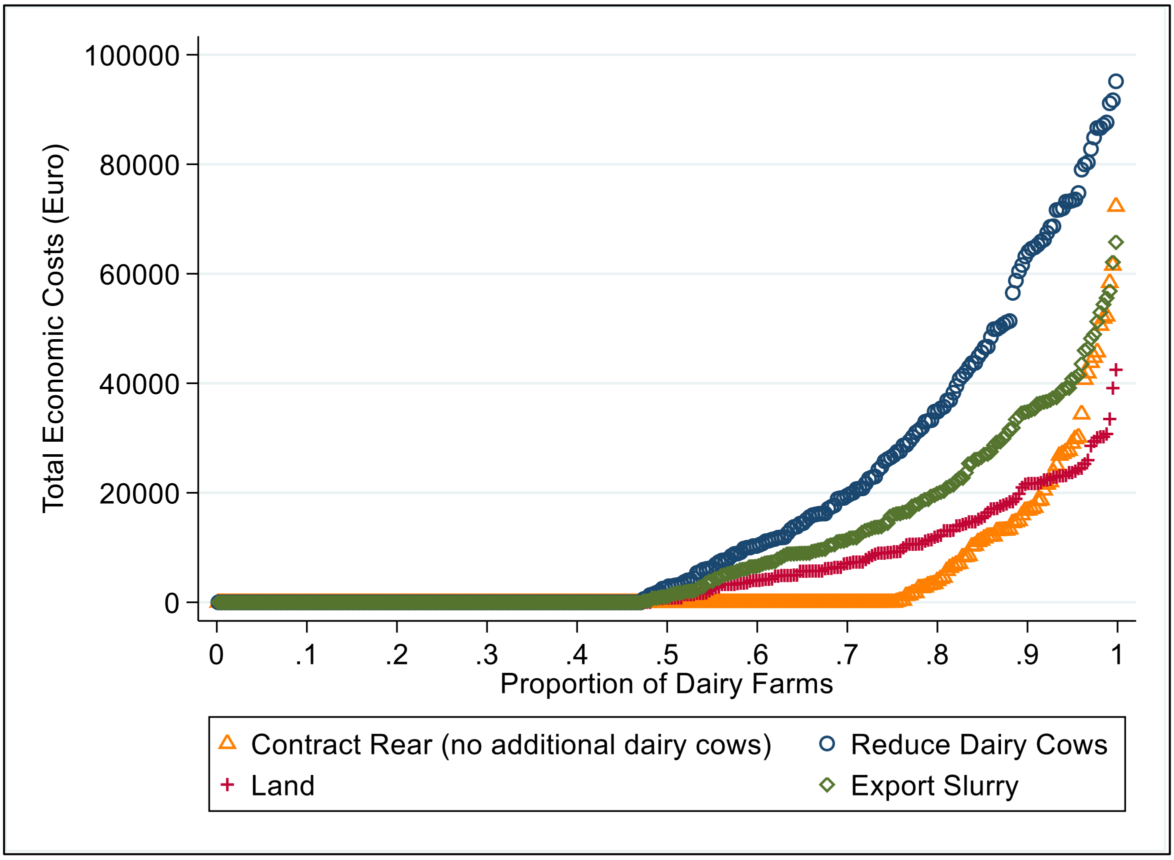
Figure 14: Comparison of Total Costs Incurred to remain ≤ 170 kg N/ha under all four Scenarios if Land Rental Prices were to increase by 50%.




Source: Derived based on data from the Teagasc National Farm Survey.

The relatively low cost of the contract rearing of dairy heifers scenario (Scenario 3), as discussed above, is largely a function of the additional income from additional cows that are assumed to be added on those farms that remove all non-dairy animals and contract rear their dairy heifer replacements. Figure 15 illustrates that if income from cows added back in under Scenario 3 is excluded that the costs of Scenario 3 converge on and in many cases exceed those associated with the rent additional land and the export slurry scenarios.

Figure 15: Comparison of Total Costs to remain ≤ 170 kg N/ha for All Four Scenarios in 2023 where no <dairy cows are added back in under Scenario Contract Rearing Heifer Replacements)



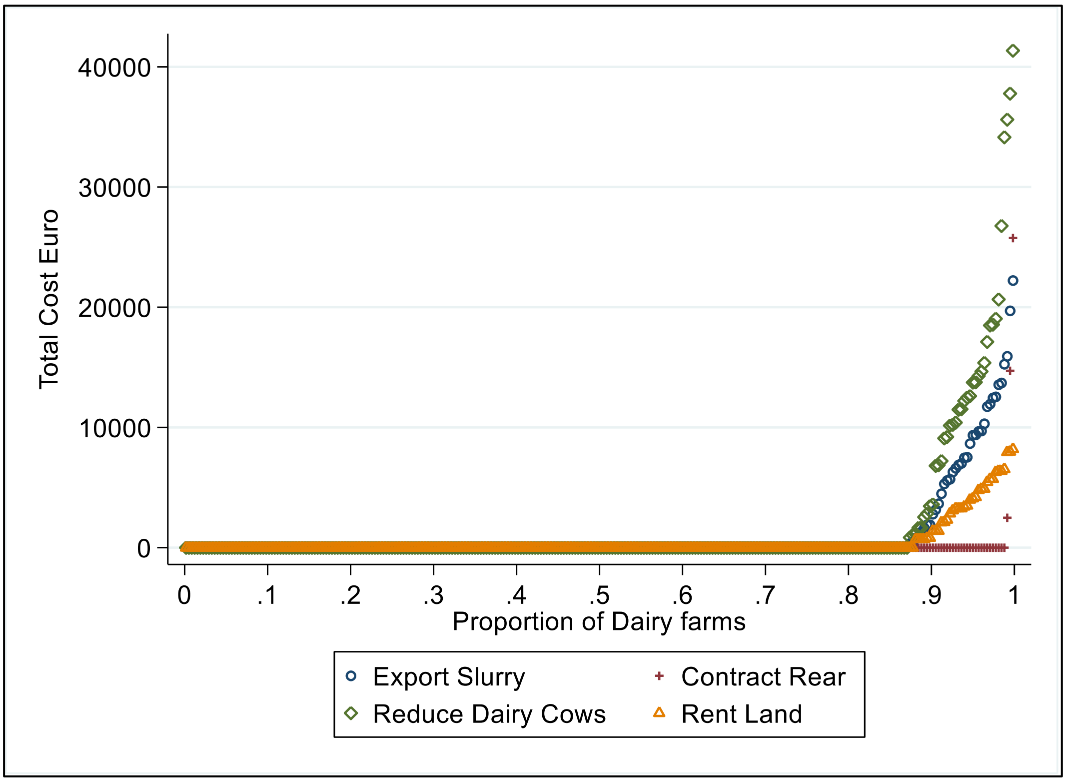

Source: Derived based on data from the Teagasc National Farm Survey.

### *7.1.2 Comparison of Total Costs to remain < 220 kg N/ha*

Total costs associated with all four scenarios to remain less than or equal to 220 kg N/ha on farms where the current organic N stocking rate including banding and midterm review (MTR) measures is greater than 220 kg N/ha are presented graphically in Figure 16. The number of farms having to make changes to their farming activities to achieve compliance with the 220 kg N/ha limit is much smaller than the number that would need to make farm activity changes if the limit were 170 kg N/ha (compare Figure 16 and Figure 14). The scale of the estimated total costs is also smaller, reflecting the smaller scale of adjustment required to achieve compliance as compared with those illustrated in Figure 14. The ranking of the measures in terms of costs of compliance where the organic stocking rate limit is 220 kg N/ha is similar to that associated with compliance with a 170 kg N/ha stocking rate limit as illustrated in Figure 14. The highest cost scenario is again that associated with reducing dairy cow numbers (Scenario 4), while the lowest cost scenario is that associated with the contract rearing of dairy heifer replacements and the removal of non-dairy animals from the farm (Scenario 3).

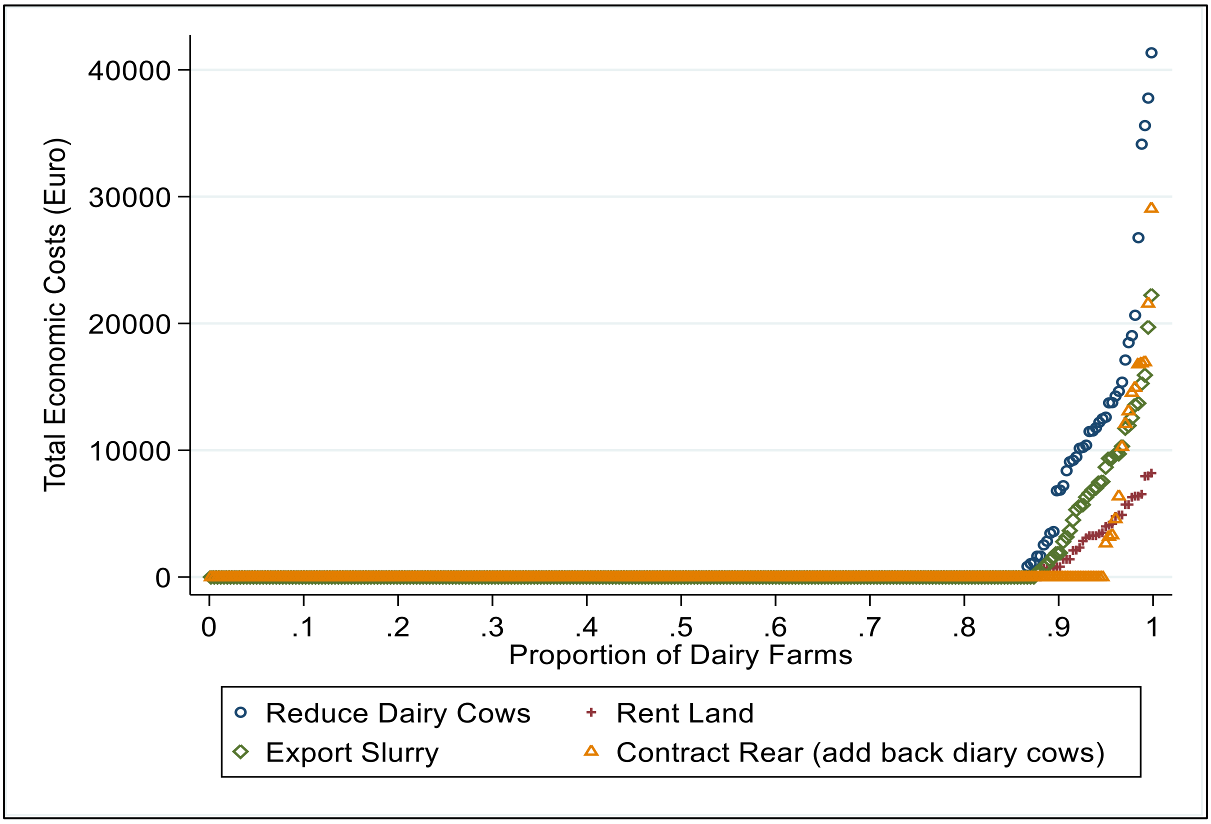
As discussed, the low relative cost of Scenario 3 is in part a function of the additional income arising from the addition of dairy cows to the farm operation after all non-dairy cattle are removed and replacement heifers are contracted reared off of the farm. As Figure 17 shows if income from cows added back in under Scenario 3 is excluded the costs of this Scenario converge and, in some cases, exceed those associated with Scenario 1 (rent in additional land).

Figure 16: Comparison of Total Costs to remain < 220 kg N/ha for All Four Scenarios in 2023.




Source: Derived based on data from the Teagasc National Farm Survey.

Figure 17: Comparison of Total Costs to remain < 220 kg N/ha for All Four Scenarios in 2023. (Contract Rearing no additional cows)




Source: Derived based on data from the Teagasc National Farm Survey.

## 7.2 Implications for Compliance and Sustainability:

In this section, we discuss the broader implications of these scenarios for compliance with the Nitrates Directive and other aspects of sustainability.

The scenarios proposed for compliance with the changed organic N stocking rate limits have significant implications for the sustainability of Irish dairy farms. These implications extend beyond immediate environmental compliance, influencing economic viability, social dynamics, and the sustainability of agricultural system. The following sections discuss these wider implications:

### *7.2.1 Compliance with the Nitrates Directive*

The analysis in section 6 evaluated the costs of actions under each scenario that might needed for all Irish dairy farms to meet the stocking rate limits that could be applicable under the Nitrates Directive regulation. However, the compliance mechanisms evaluated have further implications as follows: **Scenario 1**: Renting Additional Land. This approach could lead to land-use conflicts, as dairy farms seeking additional land to remain compliant with changed nitrates limits will competes with other agricultural sectors. Finding a balance between agricultural productivity and other land uses may prove challenging. **Scenario 2**: Exporting Slurry. Over time, exporting slurry may become costly or even impractical, and will increase the dairy sector's reliance on other farming sectors and could influence on the nitrogen loading of recipient farms. **Scenario 3**: Contract Rearing Heifers. This Scenario encourages further specialization in farming systems, but as with Scenario 2, shifts environmental burdens to contract rearers, potentially displacing rather than resolving the nitrate issue and also could displace existing agricultural enterprises on farms engaged in the provision of the contract rearing services. Scenario 4: Reducing Dairy Cow Numbers. While this scenario is clearly effective from a compliance perspective, it may push smaller or heavily stocked farms out of business, leading to a consolidation of production on larger farms, potentially reducing rural employment and economic diversity.

### *7.2.2 Environmental Sustainability*

The Nitrates Directive aims to reduce agricultural pollution, safeguarding water bodies and biodiversity. The scenarios outlined contribute differently to environmental sustainability: **Reduction of Water Pollution**: All four scenarios lower nitrogen loading on dairy farms by reducing the organic N stocking rate of the farm. However, apart from scenario 4 – reducing dairy cow numbers, all other scenarios effectively maintain the same level of organic N in the total farming system. The full effect of these scenarios on other farming systems has not been modelled and there may be unintended consequences of displacing organic N from dairy farms and regions with greater specialisation in dairy production to in other areas. **Greenhouse Gas Emissions**: Scenario 4 - Reducing cow numbers has the potential to cut emissions, aligning with broader climate targets. All other scenarios involve maintaining the national dairy herd at the same level so there are no direct benefits in terms of reducing GHG emissions from the other scenarios though emissions associated with displaced agricultural activities would arise though these could in some cases be offset by increases in emissions associated with increased land use by dairy farms (Scenario 1) or from emissions associated with the transport of slurry exports (Scenario 2). **Soil Health**: Spreading organic nitrogen over more land (Scenario 2) or reducing nitrogen load (Scenario 4) may promote balanced nutrient levels at farm level.

Improving slurry management practices can increase soil organic matter and reduce soil degradation; this could potentially enhance soil health and improve the long-term productivity of the land.

### *7.2.3 Economic Sustainability*

Balancing regulatory compliance with profitability is critical for the viability of Irish dairy farming. In this section we summarise the economic implications at both farm and sector level

- **At farm level**: Reducing the dairy herd will introduce a significant and permanent loss of income for many dairy farmers. Contract rearing may introduce a substantial increase in costs for some farmers, although removing non-dairy livestock may allow some farms to increase the dairy cow numbers to offset this additional cost while remaining below the organic N upper limits. Renting additional land introduces a significant additional overhead cost, especially as land prices rise and land availability becomes an issue. Land availability may not exist in regions where dairy production is more intensive and demand for land is already high. In areas where land is available, demand for this additional land may result in higher rental prices and a volatile business-planning horizon for farmers, unless long-term leases are available. Exporting slurry will impose recurring operational costs through slurry movement and nutrient replacement purchasing and identifying farmers who are willing to import the extra slurry can create logistic difficulties.
- **At Sector-Level**: Stricter stocking rate limits may favour larger, more efficient operations, and accelerate consolidation in the dairy sector. Smaller farms may struggle to compete, risking socio-economic impacts on rural communities.

### *7.2.4 Social and Rural Implications*

Striking a balance between environmental regulation and social acceptance also needs consideration. In this section, we summarise the social implications for rural areas.

- **Rural Livelihoods**: Herd reductions and associated income losses by reduce demand for local goods and services undermine the social and economic sustainability of rural areas.
- **Land Access and Equity**: Increasing reliance on rented land may inflate prices, disadvantaging smaller farmers and new entrants.
- **Perceptions of Farming:** Scenarios such as exporting slurry could raise public concerns about environmental externalities if poorly managed. Conversely, visible efforts to comply with regulations may enhance the public image of Irish dairy farming.

### *7.2.5 Long-Term Sustainability and Adaptation*

These scenarios underscore the possible need for systemic adaptation in Irish dairy farming and support for dairy farmers from the wider scientific community and regulators. This would involve finding solutions that suit individual farms with different regional and operational requirements. While all the scenarios analysed could contribute to compliance with the Nitrates Directive, the analysis highlights complex trade-offs between environmental goals, farm profitability, and wider social dynamics. A comprehensive approach that integrates technological, policy, and market solutions is essential for ensuring the long-term sustainability of Irish dairy farming.

- **Technology and Innovation:** Advancements in slurry management, precision farming, and low emission spreading techniques can optimise nutrient use, reducing the need for stricter measures.
- **Policy Support:** Investments in research, extension services, and infrastructure (e.g., slurry processing facilities) can improve compliance options. Financial supports can ease the transition for farmers.
- **Integrated Approaches:** Combining scenarios (e.g. modest herd reductions with slurry exports) may yield cost-effective solutions tailored to individual farms. Collaboration among farmers, policymakers, and stakeholders can promote shared land-use strategies and nitrogen management.

### *7.2.6 Challenges to Implementation*

While these scenarios have potential benefits, they also face significant barriers.

- **Economic inequalities:** Small and medium-scale farmers may struggle to meet compliance costs compared to larger operations with greater resources thereby creating economic inequalities.
- **Balancing trade-offs:** Expanding grasslands will reduce land availability for arable farming or other land uses. Balancing such trade-offs will be a challenge.
- **Enforcement and monitoring:** Effective implementation requires robust monitoring systems and consistent enforcement, which may strain administrative resources. Enforcement and monitoring will also create challenges.

# 8 Evolution of practice and linkage with N leaching

Irish farms are in constant evolution partly due to changes in regulations. This component of the report estimates what the impact of the evolution of the average Irish dairy farm on N leaching could be. This will be done at different levels: the average of all dairy farm based on NFS data, and the average dairy farms within specific organic N level ranges. The model used to do this analysis is the MoSt-PBHDM model (Ruelle et al., 206, Ruelle et al., 2018) in conjunction with 19 years of weather data from Met Eireann Moorepark synoptic station.

## 8.1 Description of the model (MoSt-PBHDM)

MoSt GG is a dynamic model developed in C++ that describes the grass growth and the nitrogen (N) and water fluxes of a paddock. The model is run with a daily time step simulating soil N mineralisation, immobilisation and water balance, grass growth, N uptake, N leaching and grass N content. The model is driven by a daily potential growth depending on the solar radiation and the total green biomass. To calculate the actual daily growth, this potential growth is then multiplied by parameters depending on environmental conditions (temperature, water in the soil and radiation) and a parameter depending on the availability of the mineral N in the soil compared to the N demand associated with the potential grass growth. Leaching in the model occurs when the amount of water in the soil is over the water holding capacity, which will depend on the soil type. The model only predicts total N leaching at 1 m.

PBHDM comprises of a herd dynamic milk model and integrates it with a grazing management and a paddock sub-model. Animal intake at grazing is dependent not only on animal characteristics but also on grass availability and quality. Animal intake at grazing also depends on the interactions between the animal and the grass during the defoliation process. Management of grass on farm can be regulated through different rules during the grazing season including the decision to cut some paddocks in the case of a grass surplus and to allocate supplementation in the case of a grass deficit. The model can also predict grazing season length depending on grass availability on farm and paddock trafficability.

These two models (MoSt GG and PBHDM) have already been used in conjunction in several papers and reports. For this report, N leaching is expressed as the amount of N leached in kg N/ha ($NO_3^-$-N) linked to farming activity (chemical N application, slurry application or cattle grazing). The soil background N leaching is not included in the number reported for N leaching.

## 8.2 Description of the inputs and scenarios

The data from the Teagasc NFS have been separated in two ways and used as inputs to the model.

### *8.2.1 Evolution of the average NFS farm over 10 years.*

Firstly, using data from the Teagasc NFS the evolution of the average Irish dairy farm has been simulated from the year 2013 to the year 2023. For each year a "average" dairy farm was created with the corrected area and number of cows as presented in Table 30 and this farm was run through the models (MoSt-GG and PBHDM) using 19 years of Moorepark weather data to investigate the possible long-term impact of managing the farm like a specific year. In terms of management, concentrate fed by cow was based on the value from the Table 30 and was fixed each year within the simulation, if the farm was running out of grass, silage was fed to the animals. It was assumed that silage was always available to be fed. The fertiliser application for each simulation was based on the values in Table 30, the timing of the different fertiliser applications was based on the recommendations of the Green Book (Wall and Plunkett, 2020) for a SR of 2.0 cows/ha as it was the closest in term of total fertiliser amount.

Table 30: Evolution of the NFS average dairy farm from 2013 to 2023

| Year | Area (ha) | Area simulated (ha)* | Dairy cow | Mineral N (kg N/ha) | Concentrate (kg/cow) | Milk (kg/cow) | Milk solid (kg/cow) |
|---|---|---|---|---|---|---|---|
| 2013 | 56 | 35 | 66 | 173 | 1,144 | 5,228 | 363 |
| 2014 | 57 | 35 | 67 | 168 | 959 | 5,305 | 373 |
| 2015 | 58 | 37 | 71 | 159 | 922 | 5,608 | 398 |
| 2016 | 59 | 38 | 75 | 167 | 935 | 5,469 | 392 |
| 2017 | 60 | 39 | 78 | 172 | 1,026 | 5,549 | 398 |
| 2018 | 61 | 40 | 80 | 184 | 1,380 | 5,635 | 410 |
| 2019 | 62 | 42 | 84 | 176 | 1,144 | 5,761 | 425 |
| 2020 | 65 | 44 | 88 | 179 | 1,146 | 5,852 | 435 |
| 2021 | 65 | 46 | 94 | 166 | 1,141 | 5,938 | 445 |
| 2022 | 65 | 46 | 96 | 156 | 1,226 | 5,915 | 442 |
| 2023 | 64 | 47 | 94 | 143 | 1,206 | 5,622 | 420 |

*Due to model limitation, only the milking herd has been simulated, heifer or other stock have not been taken into account as the area of the farm has been adjusted to represent the actual farm SR.

### *8.2.2 Evolution of the N leaching by organic N level*

However, the average NFS farm is not really representative of any farm in the country. This is why in a second step the NFS dairy farms sample was divided into 8 cohorts based on individual farm organic N levels (OrgN). Two years, 2019 and 2023, were analysed to see the consequences of the evolution of farm practices on possible leaching. Eight levels of farm organic N (OrgN) were simulated based on NFS data: lower than 120, 120-140, 140-160, 160-180, 180-200, 200-220, 220, 240 and higher than 240, these levels were created at an assumed cow organic N of 89 kg N/yr.

For each organic N level and each year (2019 or 2023), a farm was created with the corrected area and number of cows, as presented in Table 31. Using the MoSt-GG and PBHDM models each of these farms was analysed using 19 years of Moorepark weather data. As in the previous simulations, the concentrate fed per cow was based on the value from the Table 31 and was fixed each year within the simulation. If the farm was running out of grass, silage was fed to the animals. The fertiliser application for each simulation was based on the values shown in Table 31. The timing of the different applications was based on the recommendation of the green book for a similar level of chemical application. Due to model limitations, only the milking herd has been simulated, replacement heifers or other stock have not been taken into account.

Table 31: Evolution between 2019 and 2023 of the average Irish dairy farms by organic N level.

| Year | Organic N | Area (ha) | Corrected area (ha)* | Dairy cow | Mineral N (kg N/ha) | Concentrate (kg/cow) | Milk (kg/cow) | Milk solid (kg/cow) | % of farms |
|---|---|---|---|---|---|---|---|---|---|
| 2019 | **120<** | 61 | 41 | 45 | 90 | 957 | 5,353 | 381 | 11 |
| | **120-140** | 58 | 35 | 59 | 138 | 1,048 | 5,299 | 390 | 11 |
| | **140-160** | 58 | 40 | 67 | 150 | 1,014 | 5,634 | 416 | 14 |
| | **160-180** | 68 | 40 | 85 | 172 | 1,258 | 5,908 | 430 | 18 |
| | **180-200** | 66 | 39 | 95 | 194 | 1,180 | 5,888 | 436 | 17 |
| | **200-220** | 70 | 44 | 110 | 194 | 1,155 | 5,733 | 433 | 9 |
| | **220-240** | 56 | 45 | 100 | 240 | 1,257 | 6,081 | 448 | 12 |
| | **240+** | 55 | 44 | 117 | 247 | 1,254 | 6,135 | 467 | 8 |
| 2023 | **120<** | 52 | 45 | 39 | 73 | 1,239 | 5,211 | 380 | 9 |
| | **120-140** | 64 | 48 | 60 | 94 | 1,113 | 5,006 | 353 | 6 |
| | **140-160** | 63 | 47 | 75 | 117 | 1,212 | 5,774 | 419 | 15 |
| | **160-180** | 62 | 52 | 84 | 147 | 1,148 | 5,602 | 415 | 20 |
| | **180-200** | 67 | 39 | 103 | 160 | 1,177 | 5,612 | 427 | 17 |
| | **200-220** | 72 | 51 | 123 | 162 | 1,274 | 5,767 | 440 | 14 |
| | **220-240** | 70 | 38 | 131 | 176 | 1,266 | 5,890 | 452 | 11 |
| | **240+** | 62 | 45 | 129 | 191 | 1,239 | 5,739 | 435 | 7 |

*Due to model limitation, only the milking herd has been simulated, heifer or other stock have not been taken into account as the area of the farm has been adjusted to represent the actual farm SR.

As milk yield is an output of the model and not an input, the genetics of the animals in each of the simulations have been changed to reproduce a milk yield as close as possible to the observed NFS data.

The main output for the two sets of simulations is: N leaching due to the farming activity per ha, grass growth and forage surplus deficit.

## 8.3 Results

### *8.3.1 Yearly leaching variation*

Figure 18 shows the output of the first set of simulations by weather year simulated. The highest N leaching year was 2018 and the lowest was 2007. N leaching in some years was more sensitive to management than others. 2018 and 2023 appear as years with high sensitivity to management (larger range of leaching simulated). While N leaching in 2010 and 2011 seems to be less management dependent.

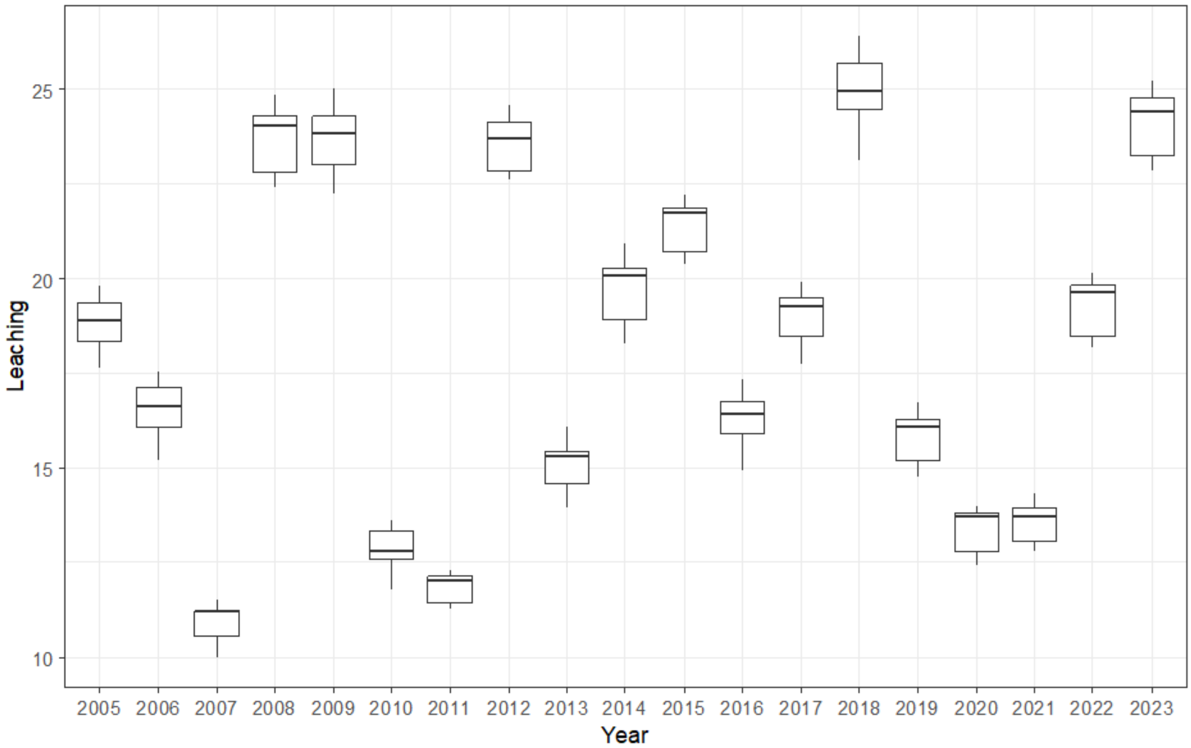



Figure 18: Variability of N leaching (kg N/ha) simulated by the model due to weather variation

### *8.3.2 Evolution of the average NFS farm over 10 years.*

The results of simulations over the period 2013 to 2023 are shown in Table 32 and Figure 19.

Table 32: Evaluation of the evolution of the average NFS farms on N leaching and farm forage self-sufficiency based on 19-year weather simulation.

| Year | SR | Chemical N | Slurry N | Grass growth | Grass intake | Concentrate | Surplus Deficit | N leaching |
|---|---|---|---|---|---|---|---|---|
| | | kg N/ha | | kg DM/ha | kg DM/ha | | kg DM/ha | kg N/ha |
| **2013** | 1.89 | 173 | 46 | 12,249 | 2,888 | 970 | 2,153 | 17.6 |
| **2014** | 1.91 | 168 | 47 | 12,137 | 2,974 | 814 | 1,830 | 17.5 |
| **2015** | 1.92 | 159 | 47 | 11,973 | 3,023 | 785 | 1,526 | 17.3 |
| **2016** | 1.97 | 167 | 48 | 12,147 | 3,056 | 796 | 1,474 | 18.0 |
| **2017** | 2.00 | 172 | 49 | 12,278 | 3,037 | 872 | 1,515 | 18.5 |
| **2018** | 2.00 | 184 | 49 | 12,552 | 2,937 | 1,164 | 1,907 | 19.1 |
| **2019** | 2.00 | 176 | 49 | 12,365 | 3,097 | 969 | 1,577 | 18.7 |
| **2020** | 2.00 | 179 | 49 | 12,420 | 3,090 | 969 | 1,559 | 18.9 |
| **2021** | 2.04 | 166 | 50 | 12,196 | 3,072 | 968 | 1,194 | 18.6 |
| **2022** | 2.09 | 156 | 51 | 12,045 | 2,999 | 1,037 | 986 | 18.4 |
| **2023** | 2.00 | 143 | 49 | 11,782 | 2,896 | 1,023 | 1,168 | 17.0 |

Overall, since 2013 the average SR on Irish dairy farms has increased from 1.89 to 2.09 cow/ha in 2022 with a small reduction in SR to 2.00 cow/ha in 2023. The variation in terms of chemical fertiliser use is not linear, nonetheless it reached a maximum in 2018 with an average of 184 kg N/ha and a minimum in 2023 of 143 kg N/ha. The quantity of chemical fertiliser applied has been decreasing every year since 2018 except for a small increase in 2020.

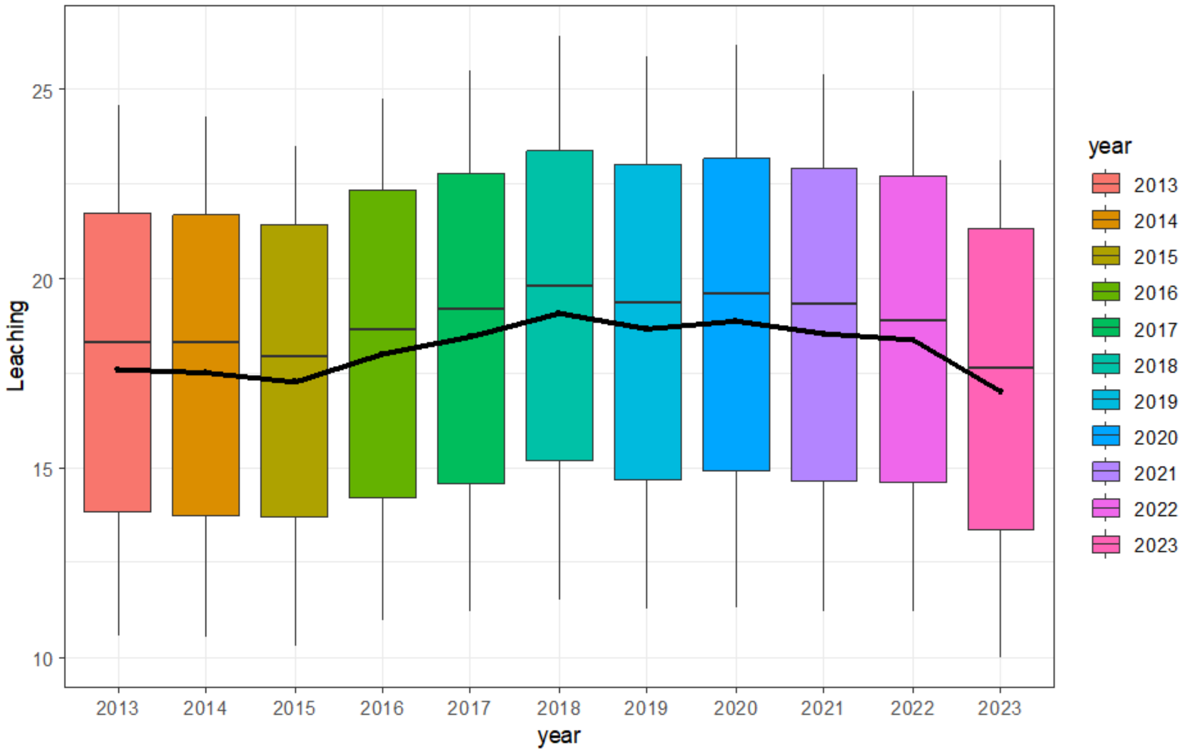



Figure 19: Evolution of the impact of the average NFS dairy farm on N leaching from 2013 to 2023

When assessing the impact of individual years' average farm management practices through a consistent 19-year weather dataset, the results are mixed. The management of 2018 is the one which should have led to a maximum grass growth (12.5 t/ha) but also maximum leaching (19.1 kg N/ha). However, the weather in 2018 with a cold spring and a severe drought in the summer make that year a very low grass growth year. Furthermore, as shown in Figure 18, 2018 was a year very sensitive to agricultural practice. This is why the year 2018-2019 has resulted in increased nutrient loss to water. In contrast, 2023 was also a year very sensitive to agricultural practice but the model is showing that the farmer reaction has been very different to 2018 with having the lowest predicted leaching since 2017 despite being a poor weather year for nutrient loss.

However, doing simulations on an average across organic N levels doesn't let us know where changes in N leaching are happening the most, the next set of simulations will give more insight on the different farm categories.

### *8.3.3 Evolution of the N leaching by organic N level*

The results are shown in Figure 20 and Table 33.

All the respective farm categories had a decrease in predicted leaching when using the management of 2023 compared to 2019. The most important reduction was for the higher organic N farms (-3.6 and –5.5 kg N/ha) due to a reduction of the chemical N applied (-64 and -56 kg/ha respectively). It is important to note that for both farm Organic N categories (220-240 and 240+) this decrease in chemical N has not been compensated by an increase in concentrate feed use, and that the SR has stayed stable for both categories. In the simulation, this translated into a reduction of grass growth which led to a increase in the scale of the farm forage deficit for the >240 farm and brought the 220-240 farm from a forage surplus in 2019 to a forage deficit in 2023. In reality, it is possible that different management has been taken up by the farmer to compensate for this reduction of fertiliser, a better use of slurry, better timing of N application or the inclusion of clover could lead to a reduction of chemical application with reduced consequences for annual grass yield and forage availability.

Overall, when weighing back the N leaching to the proportion of farms in each organic N category this show an overall leaching level in 2019 of 18.7 against 20.5 in 2023.

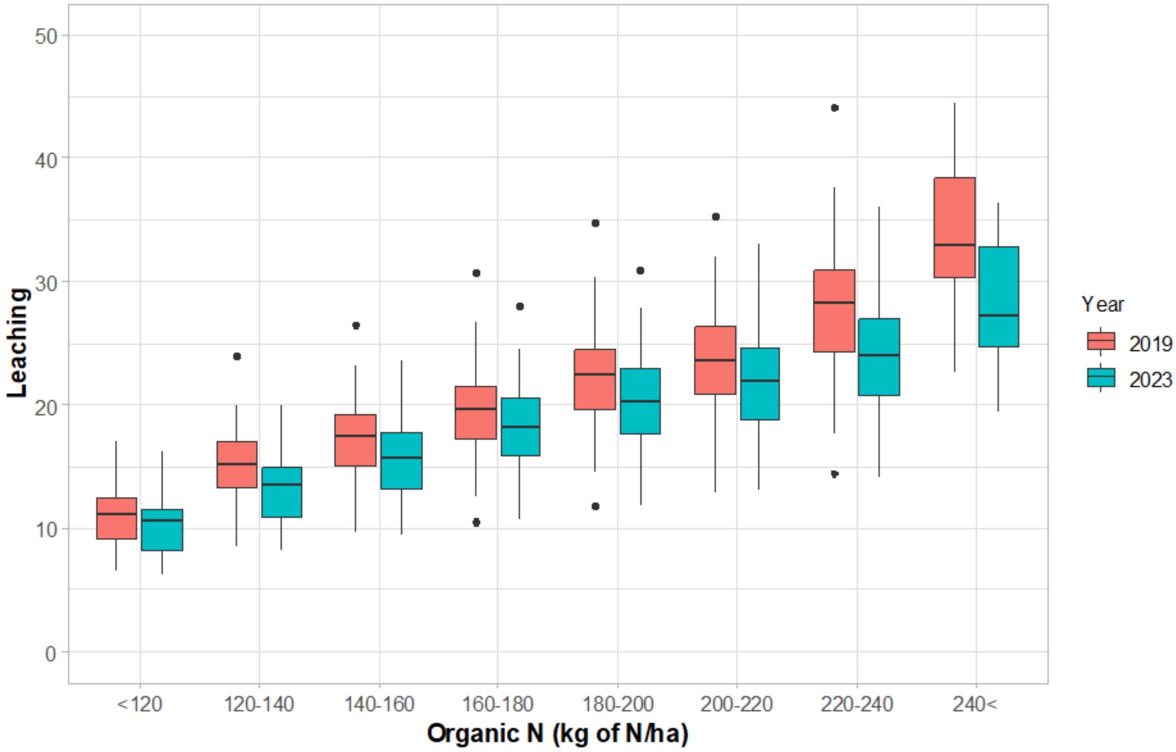



Figure 20: Evolution of the impact of the average NFS dairy farm on N leaching between 2019 to 2023 by Organic N level.

Table 33: Evaluation of the evolution of the average NFS farms on N leaching and farm forage self-sufficiency by organic N level (based on 89 kg N/cow)

| | Organic N | SR | Chemical N | Slurry N | Grass Growth | Grass intake | Concentrates | Surplus Deficit | N leaching | % of farmers |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | kg N/ha | kg N/ha | kg DM/ha | kg DM/cow | kg DM/cow | kg DM/ha | kg N/ha | % |
| **2019** | **120<** | 1.10 | 90 | 27 | 9,955 | 2,960 | 808 | 2,980 | 10.7 | 11 |
| | **120-140** | 1.48 | 138 | 36 | 11,210 | 2,870 | 888 | 2,537 | 15.0 | 11 |
| | **140-160** | 1.72 | 150 | 42 | 11,594 | 2,880 | 859 | 1,835 | 17.1 | 14 |
| | **160-180** | 1.89 | 172 | 46 | 12,117 | 2,848 | 1,062 | 1,667 | 19.3 | 18 |
| | **180-200** | 2.11 | 194 | 51 | 12,604 | 2,930 | 999 | 1,290 | 21.9 | 17 |
| | **200-220** | 2.34 | 194 | 57 | 12,736 | 2,864 | 980 | 602 | 23.3 | 9 |
| | **220-240** | 2.56 | 240 | 63 | 13,660 | 2,858 | 1,063 | 443 | 27.5 | 12 |
| | **240+** | 3.08 | 247 | 75 | 14,036 | 3,028 | 1,062 | -1,114 | 34.0 | 8 |
| **2023** | **120<** | 1.11 | 73 | 28 | 9,580 | 2,838 | 1,038 | 2,801 | 10.1 | 9 |
| | **120-140** | 1.50 | 94 | 36 | 10,350 | 2,783 | 944 | 2,021 | 13.0 | 6 |
| | **140-160** | 1.70 | 117 | 42 | 10,969 | 2,877 | 1,024 | 1,601 | 15.4 | 15 |
| | **160-180** | 1.91 | 147 | 47 | 11,684 | 2,801 | 973 | 1,308 | 18.2 | 20 |
| | **180-200** | 2.15 | 160 | 52 | 12,054 | 2,790 | 996 | 799 | 20.2 | 17 |
| | **200-220** | 2.37 | 162 | 58 | 12,248 | 2,782 | 1,078 | 156 | 21.8 | 14 |
| | **220-240** | 2.57 | 176 | 63 | 12,618 | 2,873 | 1,072 | -340 | 23.9 | 11 |
| | **240+** | 2.87 | 191 | 70 | 13,032 | 3,000 | 1,049 | -936 | 28.4 | 7 |

# 9 Wider Implications of Scenarios to Achieve Compliance

In this chapter we briefly consider the wider economic implications of the various scenarios that could be adopted to address the need for compliance with the nitrate's limits. The focus in this chapter is on aspects beyond the dairy farm gate since the economic implications of the scenarios for dairy farm income have already been analysed in Chapter 5.

## 9.1 Scenario 1 Wider Consequences of Dairy Farmers Acquiring Additional Land

**Irish Milk Output and Dairy Production:** By maintaining the aggregate dairy cow herd size and milk production volumes, this scenario, wherein additional land is rented in by dairy farmers to maintain compliance with changed maximum organic stocking rate levels, could help sustain the level of Ireland's milk and dairy product production and dairy exports volumes and earnings.

**Irish Beef (and other agricultural) Output:** This scenario would mitigate the need for a reduction in dairy cow numbers and would limit the reduction in calves born from the dairy herd that a cow reduction would imply. However, there could still be adverse consequences for aggregate beef output, if the additional land rented in by dairy farmers was previously used to raise animals for beef. A reduction in the volume of land farmed by beef farmers would be reflected in reduced demand by these farmers for cattle and, other things equal, lower young cattle prices. With dairy cows now producing more than two thirds of all calves born in Ireland, it is likely that the reduced demand for cattle for beef production would be mostly reflected in an additional contraction in the beef cow (suckler) herd and a concomitant reduction in the total aggregate production of beef in Ireland. If land rented in by dairy farms under this scenario was land currently used by tillage farmers, tillage production would also be negatively impacted.

**Land Market:** Increased demand for rented-in land by dairy farmers could drive up agricultural land rental prices, particularly in regions where dairy farms are the dominant farming activity. This could price some non-dairy farmers out of the land rental market. Marginal land is not ordinarily in demand by dairy farmers, but as better land becomes harder to acquire, dairy farmers could be motivated to compete with drystock farmers for such marginal land. Farmers in other sectors (e.g., beef, sheep, or tillage) may lose access to rented land, as land demand and land rental prices increase, potentially forcing some to scale back their drystock or tillage farming activities. Rising land rental prices could lead to speculative behaviour in the land market, creating increased volatility and uncertainty for farmers which, other things equal, would be reflected in reduced levels of non-dairying economic activities.

**Income Diversification:** Landowners outside of the dairy sector who are renting out farmland could see increased rental income, benefiting those land owning farm households.

**Monitoring and Enforcement:** Effective monitoring and enforcement mechanisms would be required to ensure land rented in by dairy farmers is used in compliance with the changed nitrates limits and broader environmental objectives.

## 9.2 Scenario 2: Wider Consequences of Dairy Farms Exporting Slurry

**Irish Milk Output and Dairy Product Production:** Exporting slurry to remain compliant with reduced nitrates limits in theory could maintain dairy cow herd size, helping to sustain the level of Ireland's milk production volume and associated dairy exports earnings. However, the results in Chapter 5 indicate that for some dairy farms slurry exporting, as a sole measure, would not achieve full compliance with the nitrates limits.

On some dairy farms, because of the relatively low number of days that cattle are housed, there are farms where there is insufficient slurry to allow for the use of slurry exports as a means of ensuring compliance with reduced nitrates limits. Therefore, even with slurry exporting, a decrease in dairy cow numbers and national milk and dairy product production might still need to occur to assure compliance, unless the dairy farmers affected also adopted other solutions to ensure compliance, such as outsourcing the rearing of replacements and/or acquiring additional land.

**Irish Beef Output:** This scenario where slurry is exported could at least partially mitigate the need for reductions in dairy cow numbers, which would limit the reduction in calves born from the dairy herd. Additionally, there could be positive consequences for beef and tillage producers accepting slurry from dairy farmers. It could generate additional income for them if they are paid to take the slurry and it could either increase their grass output or reduce their chemical fertiliser expenditure. Thus, the profitability of beef farming could increase, with potential positive implications for beef output if in response to improved profitability beef farmers increase the numbers of cattle being farmed for beef production.

**Land Market:** Slurry export as a means of achieving compliance would not generate demand for additional land. Slurry export could therefore limit the amount of additional land being sought by dairy farmers and would dampen the impact of additional demand for land by dairy farmers on land rental prices. This would be to the benefit to other (non-dairy) farmers renting in land.

**Income Diversification:** Additional jobs would also be created in slurry contracting services to transport slurry between farms. The principal economic saving for farms receiving slurry exports from dairy farms would be due to savings from reduced expenditure on chemical fertilisers.

**Monitoring and Enforcement:** The State would need to monitor slurry export practices to ensure compliance with spreading regulations and to avoid unintended environmental consequences on importing farms. There would be a need to ensure that environmental risks associated with the spreading of slurries are addressed rather than simply moved from one location to another. Mechanisms might also need to be in place to ensure slurry quantity and quality can be validated/monitored. This is important, not just for environmental, but also for agronomic reasons.

**Increased interdependence between farm systems:** Managing the logistics of slurry movements, will be a challenge for both the exporting and importing farms. While some slurry movement between farms already take place, the scale of this activity would need to increase considerably if this strategy were to be employed as to a means to achieve compliance with changed nitrate limits. Slurry movements between farms and between different farming systems would support circular economy practices. It would result in the recycling of nutrients between various farming systems. It would also potentially reduce the dependency on imported chemical fertilisers and improve the overall resource efficiency of Irish agriculture. In the event that Ireland in the future develops an AD industry slurry exports as feedstocks for AD biogas or biomethane production could be an additional outlet for slurry exports from Irish farms.

**Production Costs:** The transport of additional volumes of slurry will result in additional capital costs and direct costs associated with the distance the slurry is transported. Drystock and tillage farms importing slurry could benefit from lower chemical fertiliser expenditure. This may increase the challenge faced by regulators. Drystock or tillage farms importing slurry may need to invest in slurry storage infrastructure and/or slurry spreading equipment to handle larger slurry volumes being used on their farms. Dairy farms exporting slurry will need to consider the implications of exporting the P and K contained within their slurry for their own farm's nutrient balances.

## 9.3 Scenario 3: Wider Consequences of the Raising of Dairy Replacements on Non-Dairy Farms and Dairy Farmers Selling Calves at a Younger Age.

**Irish Milk Output and Dairy Product Production:** Outsourcing the raising of dairy replacements and selling dairy calves to non-dairy farmers at a younger age, could help sustain the level of Ireland's milk production and dairy product exports by allowing dairy farmers to retain current dairy cow numbers and comply with nitrates limits.

**Irish Beef Output:** This scenario would mitigate the need for a dairy cow reduction, which would limit the reduction in calves born from the dairy herd. However, it also creates a farm enterprise which competes with conventional drystock production systems. This could lead to a movement of farmers and/or farmland out of suckler production or cattle finishing, which could have a negative impact on aggregate beef production volumes.

**Land Market:** Relative to the alternative of dairy farmers renting additional land, outsourcing the rearing of replacements would avoid additional dairy farmer driven pressure on the agricultural land market. However, the scenario could have an impact on future land use decisions by drystock farmers if they move into this dairy replacement production system. Land use options such as forestry or the supply of grass for anaerobic digestion might appear less attractive to drystock farmers when the opportunity to raise dairy replacements grows.

**Income Diversification:** Non-dairy farmers could benefit financially from rearing replacement heifers or purchasing and rearing dairy calves for beef production. This could be viewed as a form of farm diversification, potentially reducing income inequality between the dairy and non-dairy farming systems.

**Monitoring and Enforcement:** Compliance with the nitrate limits would be essential on farms raising dairy heifer replacements. Separately, there might be a need to introduce standards and norms in terms of the contractual arrangements associated with such heifer replacement rearing activities. Issues such as the implications for farm biosecurity and associated animal disease risks would also need to be considered.

I**ncreased interdependence between farm systems:** Dairy farmers would become more reliant on non-dairy farmers if they choose to outsource the rearing of dairy heifer replacements, creating logistical, financial, and contractual challenges. The development of contractual templates and advisory programmes in support of such new business models would support these activities and reduce barriers to their adoption.

**Shifting Farm Management Practices:** Farmers rearing dairy heifers would need additional skills which could create advisory and training requirements. However, that would also yield benefits, as it would create a stronger incentive to improve the technical knowledge of farmers rearing dairy replacements. These farmers might also need additional or improved farm facilities for the rearing of dairy replacements.

### 9.4 Scenario 4: Wider Consequences of a Dairy Herd Reduction

**Irish Milk Output and Dairy Production:** Fewer dairy cows on farms would reduce the national milk pool, and the volume of milk delivered by Irish dairy farmers in aggregate to the Irish milk processing industry. A reduction in the volume of milk delivered to Irish milk processing plants would likely lead to the underutilisation of milk industry processing capacity and higher unit processing costs for milk, as the fixed costs of milk processing are allocated over a smaller volume of milk processed. Such higher processing costs per litre of milk are likely to have a negative impact on the farm milk price paid by processors to farmers. However, the scale of these additional processing costs and their incidence is difficult to quantify. The magnitude of the additional costs would depend on the extent of the milk volume reduction, which would be likely to vary by processor, as would the extent of the difference between processors' milk processing capacities relative to volume of milk processed.

Reduced milk supply would also impact on Ireland's dairy product export capacity (i.e. the volume of butter, cheese, milk powder available for export). Bord Bia (2025) estimate that dairy products worth €6.4 bn were exported from Ireland in 2024. These exports were based on a domestic milk intake of approximately 8.4 bn litres (CSO, 2025). Each 1% reduction in milk volume can be expected to be reflected in a reduction, other things equal, in the value of dairy product exports. The exact magnitude of the loss of export earnings would depend on the volume reduction for each dairy product, as the production of some dairy products is more lucrative pro-rate reduction in the volumes of all dairy product exports in response to a contraction in the national volume of milk processed should not be expected. For simplicity, a 1% reduction in the value of aggregate dairy product exports based on the 2024 value, would be equivalent to a loss in export revenue of €64m.

In response to a reduced volume of milk intake, dairy processors and associated food manufacturers might defer or even cancel future expansion plans or mothball underutilised facilities. This would have an adverse impact on employment and investment in the dairy processing sector and on future export earnings associated with dairy and associated food product exports. Job losses could occur in dairy processing plants, milk and dairy product transport and ancillary services. The scale of losses would depend on the scale of the reduction in aggregate milk production and associated milk processing industry activity levels.

**Irish Beef Output:** With the growth in the dairy sector and contraction in the suckler herd in Ireland over the last decade, an increasing proportion of beef in Ireland comes from dairy-origin calves. In 2023 67% of all calves born in Ireland were born to dairy dams (DAFM 2024).

The growth in the number of dairy cows since the abolition of milk quotas in 2015 has offset the impact of the contraction in the Irish suckler herd. While aggregate cow numbers have declined from its peak of 2.47 million in 2021 to 2.35 million in 2024, the volume of cattle delivered for slaughter and the total volume of beef produced have both increased as dairy cow numbers increased. The numbers of cattle slaughtered in 2024 was over 14% higher than in 2015, while the volume of beef produced in carcass weight equivalent was almost 7% higher. This growth reflects the higher ratio of calves produced per dairy cow as compared to suckler cows. The increased proportion of dairy cow progeny in total calves born has been reflected in a reduction of 7% in the average carcass weight of cattle slaughtered since 2015.

However, if a contraction in dairy cow numbers is required to achieve compliance with lower nitrates limits, this would result in fewer calves of dairy origin being produced for rearing and finishing in the beef sector. This in turn would lead to a reduction in the aggregate volume of cattle presented for slaughter at meat plants and a reduction in the volume of beef carcass produced in and exported from Ireland. The magnitude of the reduction in Irish beef production would depend on the degree to which growth in supplies of calves from the suckler herd might offset the contraction in cattle supplies from a reduced dairy cow herd. The Irish suckler cow herd has been declining in recent years due to continued low levels of profitability in specialised beef production. Finished cattle prices in Ireland are largely determined on Irish beef export markets. It is unlikely that any increase in prices would be large enough to lead to an increase in suckler cow numbers that fully offsets the impact of reduced dairy cow numbers on aggregate beef production.

The negative impact of reduced milk intake on average processing costs per litre in the milk industry would be replicated in the meat processing industry if cattle throughput declines. Lower numbers of animals presented for slaughter would be expected to increase the fixed costs per animal processed and, other things being equal, would be expected to reduce the price for finished cattle that factories would be able to pay farmers.

At the farm level, beef farmers specialised in rearing dairy-origin calves for beef production would be likely to experience greater income pressures if the supply of dairy origin calves is reduced.

**Land Market:** This scenario would have a neutral impact on the land market. Dairy farmers would reduce their dairy herd size, but it is assumed that they would not change their farms' land area.

**Monitoring and Enforcement:** There would be no additional nitrates monitoring or enforcement requirements associated with this scenario.

# 10 Conclusions and Summary

In this study, we examined the implications of possible farm level changes that might be required for farmers to remain compliant with recent changes to the Good Agricultural Practice for Protection of Waters legislation often referred to as the Nitrates Action Plan. The legislation introduced new banded calculations for dairy cows where the nitrogen co-efficient is linked to milk production per cow, higher yielding cows having a higher N co-efficient and lower milk yielding cows a lower N co-efficient. Our findings suggest that the majority of Irish dairy farms (76%), are in Band 2 where organic N per cow increased from 89 kg N/cow to 92 kg N/cow in 2023. Of the remaining dairy farms, 14% operate in Band 1 with low milk yielding cows and 10 % operate in Band 3 with high milk yielding cows. We also find that because milk yields were lower in 2023 compared to 2022 that the number of farms in Band 3 fell from 19% to 10% between 202 and 2023. It is too early to say if this reduction is policy related or driven by other market and climatic conditions.

We examined four different nitrate limit compliance scenarios: i) rent additional land, ii) export slurry, iii) contract rearing of replacement heifers and removal of non-dairy animals from dairy farms and iv) reduce dairy cow numbers and we also examined the contribution of reducing the crude protein content of concentrate feed used by dairy farms. In each scenario we investigated the scale of change at the farm level that is required to leave the farm compliant with the nitrates regulatory regime that is assumed to prevail. Under each scenario we investigated costs associated with the changes modelled. The costs of implementing a scenario for individual farms would be specific to the circumstances of those farms, however, we find that in general

- Decreasing dairy cow numbers is the most expensive option.
- Renting additional land or exporting slurry have similar costs, slurry export being slightly more expensive, but the logistics and management of these two scenarios are considerable.
- Contract rearing dairy heifer replacement and removing non-dairy animals from the farm may prove the most cost-effective scenario, depending on a) the availability and willingness of other farmers to carry out this task and b) the capacity of farms that remove non-dairy animals and contract rear heifer replacements to carry additional dairy cows.

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# 12 Appendix

Table A 1: Annual nutrient excretion rates for livestock

| Livestock Type | Total Nitrogen | Total Phosphorus |
|---|---|---|
| | kg/year | kg/year |
| Dairy Cow (2022 only) | 89 | 13 |
| Dairy cow band 1 (from 2023) | 80 | 12 |
| Dairy cow band 2 (from 2023) | 92 | 13.6 |
| Dairy cow band 3 (from 2023) | 106 | 15.8 |
| suckler cow | 65 | 12 |
| Cattle (0-1 year old) | 24 | 13.6 |
| Cattle (1 -2 year old) | 57 | 15.8 |
| Cattle > 2 year | 65 | 10 |
| Mountain ewe & lambs | 7 | 1 |
| Lowland ewe & lambs | 13 | 2 |
| Mountain hogget | 4 | 0.6 |
| Lowland hogget | 6 | 1 |
| Goat | 9 | 1 |
| Horse (> 3 years old) | 50 | 9 |
| Horse (2 - 3 years old) | 44 | 8 |
| Horse (1-2 years old) | 36 | 6 |
| Horse foal (< 1 year old) | 25 | 3 |
| Donkey/small pony | 30 | 5 |
| Deer (red) 6 months - 2 years | 13 | 2 |
| Deer (red) > 2 years | 25 | 4 |
| Deer (fallow) 6 months — 2 years 7 1 Deer (fallow) | 7 | 1 |
| Deer (sika) 6 months — 2 years | 13 | 2 |
| Deer (sika) > 2 years | 6 | 1 |
| Breeding unit (per sow place) | 10 | 2 |
| Integrated unit (per sow place) | 35 | 8 |
| Finishing unit (per pig place) | 87 | 17 |
| Laying hen per bird place | 9.2 | 1.7 |
| Broiler per bird place | 0.56 | 0.12 |
| Turkey per bird place | 0.24 | 0.09 |
| | 1 | 0.4 |

Source: Table 6, S.I. 113 of 2022

Table A 2: Slurry storage capacity required for cattle, sheep, and poultry.

| Livestock Type | $m^3$/week |
|---|---|
| **Dairy cow** | 0.33 |
| **Suckler cow** | 0.29 |
| **Cattle > 2 years** | 0.26 |
| **Cattle (18 - 24 months old)** | 0.15 |
| **Cattle (6 - 12 months old)** | 0.15 |
| **Cattle (0 - 6 months old)** | 0.08 |
| **Lowland ewe** | 0.03 |
| **Mountain ewe** | 0.02 |
| **Lamb – finishing** | 0.01 |
| **Poultry** | 0.81 |

Source: S.I. 113 of 2022

Table A 3: Summary Farm statistics - Mean and Median - by farm category (three-year average for 2021, 2022, and 2023)

| | Farms ≤ 170 (Category 1) | Farms >170 & ≤ 220 (Category 2) | Farms > 220 (Category 3) |
|---|---|---|---|
| Number of Farms | 7,656 | 5,351 | 2,255 |
| % dairy farm population | 49% | 36% | 15% |
| % of National Milk Produced | 35 | 39 | 27 |
| | | | |
| Average dairy cows per farm | 69 | 106 | 138 |
| Median dairy cows per farm | 61 | 88 | 125 |
| | | | |
| Average UAA per farm (ha) | 62 | 67 | 69 |
| Median UAA per farm (ha) | 55 | 55 | 60 |
| | | | |
| Average total cattle per farm | 143 | 206 | 250 |
| Median total cattle per farm | 125 | 172 | 227 |
| | | | |
| Average Chemical N kg/ha | 118 | 178 | 215 |
| Median Chemical N kg/ha | 117 | 176 | 204 |
| | | | |
| Average Organic N kg/ha | 137 | 194 | 245 |
| Median Organic N kg/ha | 147 | 192 | 238 |
| | | | |
| Average Milk Yield kg/cow | 5,333 | 5,805 | 6,053 |
| Median Milk Yield kg/cow | 5,475 | 5,886 | 6,197 |
| | | | |
| Average concentrates kg/cow | 1,120 | 1,246 | 1,377 |
| Median Concentrates kg/cow | 1,076 | 1,161 | 1,263 |
| | | | |
| Average Family Farm Income €/ha | 1,261 | 1,654 | 2,259 |
| Median family Farm Income €/ha | 1,180 | 1,554 | 2,237 |

Source: Derived based on data from the Teagasc National Farm Survey.

Table A 4: Summary Statistics (Mean and Median) for Dairy Farms in excess 170 kg N/ha at the MTR Stocking Rate 2021-2023

| Year | 2021 | 2022 | 2023 | 2021-2023 Average |
|---|---|---|---|---|
| Mean UAA per farm (ha) | 67 | 66 | 68 | 67 |
| Median UAA per farm (ha) | 59 | 55 | 60 | 57 |
| | | | | |
| Mean Dairy Cows per farm | 115 | 113 | 118 | 115 |
| Median Dairy Cows per farm | 102 | 101 | 103 | 102 |
| | | | | |
| Mean Total Cattle | 224 | 218 | 216 | 219 |
| Median Total Cattle | 190 | 187 | 189 | 189 |
| | | | | |
| Mean kg Milk per Cow | 6,013 | 5,971 | 5,665 | 5,879 |
| Median kg Milk per Cow | 6,090 | 6,101 | 5,771 | 5,962 |
| | | | | |
| Mean kg Concentrate per Cow | 1,232 | 1,344 | 1,277 | 1,285 |
| Median kg Concentrate per Cow | 1,128 | 1,274 | 1,184 | 1,189 |
| | | | | |
| Mean Chemical N per ha | 203 | 196 | 170 | 189 |
| Median Chemical N per ha | 199 | 189 | 171 | 184 |
| | | | | |
| Mean Organic N per ha | 211 | 212 | 204 | 209 |
| Median Organic N per ha | 206 | 206 | 200 | 205 |
| | | | | |
| Mean Family Farm Income €/ha | 1,823 | 2,781 | 928 | 1,834 |
| Median Family Farm Income €/ha | 1,803 | 2,223 | 896 | 1,746 |

Source: Derived based on data from the Teagasc National Farm Survey.

Table A 5: Summary Statistics (Mean and Median) for Dairy Farms in excess 220 kg N/ha at the MTR Stocking Rate 2021-2023

| Year | 2021 | 2022 | 2023 | 2021-2023 Average |
|---|---|---|---|---|
| Mean UAA per farm (ha) | 69 | 68 | 70 | 69 |
| Median UAA per farm (ha) | 64 | 57 | 64 | 60 |
| | | | | |
| Mean Dairy Cows per farm | 139 | 135 | 141 | 138 |
| Median Dairy Cows per farm | 129 | 120 | 128 | 125 |
| | | | | |
| Mean Total Cattle | 252 | 250 | 247 | 250 |
| Median Total Cattle | 236 | 207 | 227 | 227 |
| | | | | |
| Mean kg Milk per Cow | 6,239 | 6,048 | 5,859 | 6,053 |
| Median kg Milk per Cow | 6,402 | 6,205 | 5,991 | 6,197 |
| | | | | |
| Mean kg Concentrate per Cow | 1,347 | 1,447 | 1,316 | 1,377 |
| Median kg Concentrate per Cow | 1,244 | 1,369 | 1,238 | 1,263 |
| | | | | |
| Mean Chemical N per ha | 235 | 214 | 194 | 213 |
| Median Chemical N per ha | 230 | 215 | 185 | 204 |
| | | | | |
| Mean Organic N per ha | 249 | 249 | 236 | 245 |
| Median Organic N per ha | 238 | 240 | 232 | 238 |
| | | | | |
| Mean Family Farm Income €/ha | 2,149 | 3,223 | 1,094 | 2,259 |
| Median Family Farm Income €/ha | 2,275 | 3,301 | 1,021 | 2,237 |

Source: Derived based on data from the Teagasc National Farm Survey.

Table A 6: Additional ha required to remain below stocking rate limits, Median and Average (Arithmetic Mean) Levels (2021, 2022 &2023) NFS dairy farms.

| Year | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|
| | To remain ≤170 kg N/ha; across all farms > 170 kg N/ha | | | |
| No of Farms affected | 7,312 | 7,627 | 7,889 | 7,609 |
| Average additional ha per farm | 15 | 16 | 14 | 15 |
| Median additional ha per farm | 11 | 10 | 10 | 11 |
| | | | | |
| Average cost extra rented land (€) | 11,851 | 10,559 | 10,428 | 10,928 |
| Median cost extra rented land (€) | 9,118 | 7,641 | 7,330 | 8,206 |
| | | | | |
| Total additional ha required | 112,505 | 118,094 | 108,348 | 112,983 |
| | | | | |
| | To remain ≤ 220 kg N/ha; across all farms > 220 kg N/ha | | | |
| Number of Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| Average additional ha per farm | 7 | 7 | 5 | 6 |
| Median additional ha per farm | 5 | 6 | 4 | 5 |
| | | | | |
| Average cost extra rented land (€) | 5,229 | 4,804 | 3,613 | 4,590 |
| Median cost extra rented land (€) | 3,709 | 4,007 | 3,267 | 3,499 |
| | | | | |
| Total additional ha required | 20,724 | 20,940 | 12,841 | 18,168 |

Source: Derived based on data from the Teagasc National Farm Survey.

Table A 7: The median number of tankers of slurry to be exported to remain below Stocking Rate limits on NFS dairy farms.

| Year | | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|---|
| | To remain ≤ 170; Across all farms > 170 | | | | |
| No. of Farms affected | Farms | 7,312 | 7,627 | 7,889 | 7,609 |
| Average No. Tankers Exported to be Compliant | Tankers | 97 | 99 | 87 | 94 |
| Tankers equivalent produced (Average Farm) | Tankers | 83 | 85 | 98 | 89 |
| | | | | | |
| Median No. Tankers Exported to be Compliant | Tankers | 71 | 65 | 62 | 63 |
| Tankers equivalent produced (Median Farm) | Tankers | 75 | 73 | 85 | 77 |
| | | | | | |
| Cost of Exporting for Average Farm Exporting | € | 19,443 | 19,778 | 17,378 | 18,841 |
| Cost of Exporting for Median Farm Exporting | € | 14,219 | 13,083 | 12,337 | 13,313 |
| | To remain ≤ 220; Across all farms > 220 | | | | |
| No. of Farms affected | Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| Average No. Tankers Exported to be Compliant | Tankers | 56 | 59 | 39 | 52 |
| Tankers equivalent produced (Average Farm) | Tankers | 96 | 98 | 112 | 101 |
| | | | | | |
| Median No. Tankers Exported to be Compliant | Tankers | 483 | 48 | 33 | 38 |
| Tankers equivalent produced (Median Farm) | Tankers | 87 | 85 | 92 | 88 |
| | | | | | |
| Cost of Exporting for Average Farm Exporting | € | 11,173 | 11,701 | 7,802 | 10,392 |
| Cost of Exporting for Median Farm Exporting | € | 8,485 | 9,586 | 6,603 | 7,526 |

Source: Derived based on data from the Teagasc National Farm Survey.

Table A 8: Total Costs of contract rearing including additional dairy cows to remain below SR limits, Average (2021 2022 & 2023)

| Year | | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|---|
| | | To remain ≤ 170; Across all farms > 170 | | | |
| No of Farms | Farms | 7,312 | 7,627 | 7,889 | 7,609 |
| Economic Cost (average) | € | 1,229 | 530 | 1,556 | 1,109 |
| Economic Cost as % of FFI | % | 1% | 0.5% | 3% | 2% |
| | | | | | |
| Economic Cost (Median) | | 0 | 0 | 0 | 0 |
| Economic Cost as % of FFI | | 0 | 0 | 0 | 0 |
| | | To remain ≤ 220; Across all farms > 220 | | | |
| Number of Farms | Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| Economic Cost (Average) | € | 1,987 | 486 | 1,556 | 947 |
| Economic Cost as % FFI | % | 1% | 0.5% | 3% | 2% |
| | | | | | |
| Economic Cost (Median) | | 0 | 0 | 0 | 0 |
| Economic Cost as % of FFI | | 0 | 0 | 0 | 0 |

Source: Derived based on data from the Teagasc National Farm Survey.

Table A 9: Total Costs of contract rearing excluding additional dairy cows to remain below SR limits, Average (2021 2022 & 2023)

| Year | | 2021 | 2022 | 2023 | Average |
|---|---|---|---|---|---|
| | | To remain ≤ 170; Across all farms > 170 | | | |
| No of Farms | Farms | 7,312 | 7,627 | 7,889 | 7,609 |
| Average Economic Cost | € | 16,818 | 8,945 | 8,009 | 11,257 |
| Economic Cost as % of FFI | % | 14% | 5% | 13% | 9% |
| | | | | | |
| Economic Cost (Median) | | 10,673 | 924 | 0 | 3305 |
| Economic Cost as % of FFI | | 10% | 1% | 0% | 4% |
| | | To remain ≤220; Across all farms > 220 | | | |
| Number of Farms | Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| | | | | | |
| Economic Cost | € | 14,695 | 7,629 | 6,173 | 9,499 |
| Economic Cost as % FFI | % | 11% | 4% | 9% | 7% |
| | | | | | |
| Economic Cost (Median) | | 9890 | 0 | 0 | 2571 |
| Economic Cost as % of FFI | | 8% | 0% | 0% | 3% |

Source: Derived based on data from the Teagasc National Farm Survey.

Table A 10: Reduction in cow numbers to remain under 170 and 220 SR limits, Average and Median adjustments (2021, 2022 and 2023)

| Dairy Cow Reduction | | | | | |
|---|---|---|---|---|---|
| | All farms ≤ 170 kg across all farms > 170 kg N/ha | | | | |
| Year | | 2021 | 2022 | 2023 | Average |
| Number of farms affected | Farms | 7,312 | 7,627 | 7,889 | 7,609 |
| | | | | | |
| Average Number of Dairy Cows on farm | Cows | 115 | 114 | 118 | 116 |
| Average Reduction in cows per farm | Cows | 28 | 28 | 25 | 27 |
| | | | | | |
| Median Number of Dairy Cows on farm | Cows | 102 | 101 | 103 | 102 |
| Median Reduction in cows per farm | Cows | 21 | 19 | 18 | 20 |
| | | | | | |
| | All farms ≤ 220 kg across all farms > 220 kg N/ha | | | | |
| Number of farms affected | Farms | 2,153 | 2,614 | 1,982 | 2,258 |
| | | | | | |
| Average Number of Dairy Cows on farm | Cows | 139 | 135 | 141 | 138 |
| Average Reduction in cows per farm | Cows | 16 | 16 | 11 | 15 |
| | | | | | |
| Median Number of Dairy Cows on farm | Cows | 129 | 120 | 128 | 125 |
| Median Reduction in cows per farm | Cows | 12 | 14 | 10 | 11 |

Source: Derived based on data from the Teagasc National Farm Survey