

Improved nitrogen use efficiency (NUE) in Ireland

KEY CHARACTERISTICS

GEOGRAPHIC SCOPE



POLICIES TARGETING



Reduced use of fertiliser/ manure on land which improves water quality and reduces GHG emissions

SHORT CHARACTERISTIC OF THE POLICY ITSELF



This policy is a general term for a group of actions that aim to improve the efficiency of nitrogen use on farm. Examples are nutrient management plans and use of inhibitors

KEY RESULTS



Teagasc (Irish agriculture advisory board) produced a sustainability report of Irish agriculture. The 2020 report showed improved GHG intensity for both dairy and beef production with reductions of 8% and 12% respectively (2013 – 2018)



Ireland's 2018 National Nitrates Action Programme introduced measures to address problems with NUE



The NUE % (N outputs/N inputs) across all sectors has improved in Ireland between 2011 and 2018

SUCCESS FACTORS



Links with Ireland's sustainable food and drink programme (Origin Green) that has a high participation rate



A good combination of financial support and advice



A high level of engagement with the farming community

IMPLEMENTATION & REPLICATION PROCESS

Identify sources of nitrogen emissions



Strategic engagement between Government and the sector (e.g. local advisory boards) and research and development



Develop and identify schemes to deliver knowledge exchange and advice on-farm. Invest in technical guidance and decision support tools

Increased nitrogen use efficiency in Ireland

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This case study is part of a series of six studies which show good practice examples for reducing greenhouse gas emissions in the sectors covered under the Effort Sharing Legislation. It has been developed on behalf of DG CLIMA.

This case study explores the actions being taken in Ireland to reduce the contribution of the agricultural sector to Ireland's greenhouse gas (GHG) emissions. Reducing emissions within Ireland's agricultural sector in particular from livestock production is challenging. Ambitious plans for GHG reductions alongside continued development of the agricultural sector means that Ireland must build on its current schemes to support efficient production.

With this in mind, this case study focusses on the achievements to date in improving the GHG intensity of livestock production and the plans for increased nitrogen use efficiency (NUE) and low emission technologies in the next phase of Ireland's plan to reduce emissions. This includes an ambition to achieve net neutrality in emissions from the agriculture, land-use and forestry measures to improve the efficiency and utilisation of natural resources that have been identified as critical for Ireland's future.

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1	Description of Case Study	4
1.1	Scheme overview	4
1.2	Primary objectives of the scheme	7
1.3	Eligibility criteria and target groups	7
1.4	Key actors involved in the delivery of the scheme	7
1.5	Interaction of scheme with EU instruments	8
1.6	Does the scheme build on previous experience?	9
2	Implementation	10
2.1	Drivers and key actors for setting up the scheme	10
2.2	Lead times	11
2.3	Lessons to be learned from the scheme development and initial stages of implementation.....	12
2.4	Adjustments made during the scheme	13
3	Assessment.....	13
3.1	Successes	13
3.1.1	How successful was the scheme?	13
3.1.2	What are the key factors that make it a successful scheme?	15
3.1.3	Cohesive interactions with other schemes and instruments	15
3.2	Assessment - Limitations	16
3.2.1	Aspects for Improvement	16
3.2.2	External factors that may affect schemes success	17
3.2.3	Negative interactions with other schemes or instruments.....	17
3.3	Future Potential	17
3.3.1	How easy would it be to scale up the scheme? What are the limitations? What would be required to facilitate up-scaling?	17
3.3.2	Could the scheme be readily replicated in other territories?	18
4	References	18
	Annex 1: Overview of Policies and Measures promoting Nitrogen Use Efficiency in EU MS's.	20

1 Description of Case Study

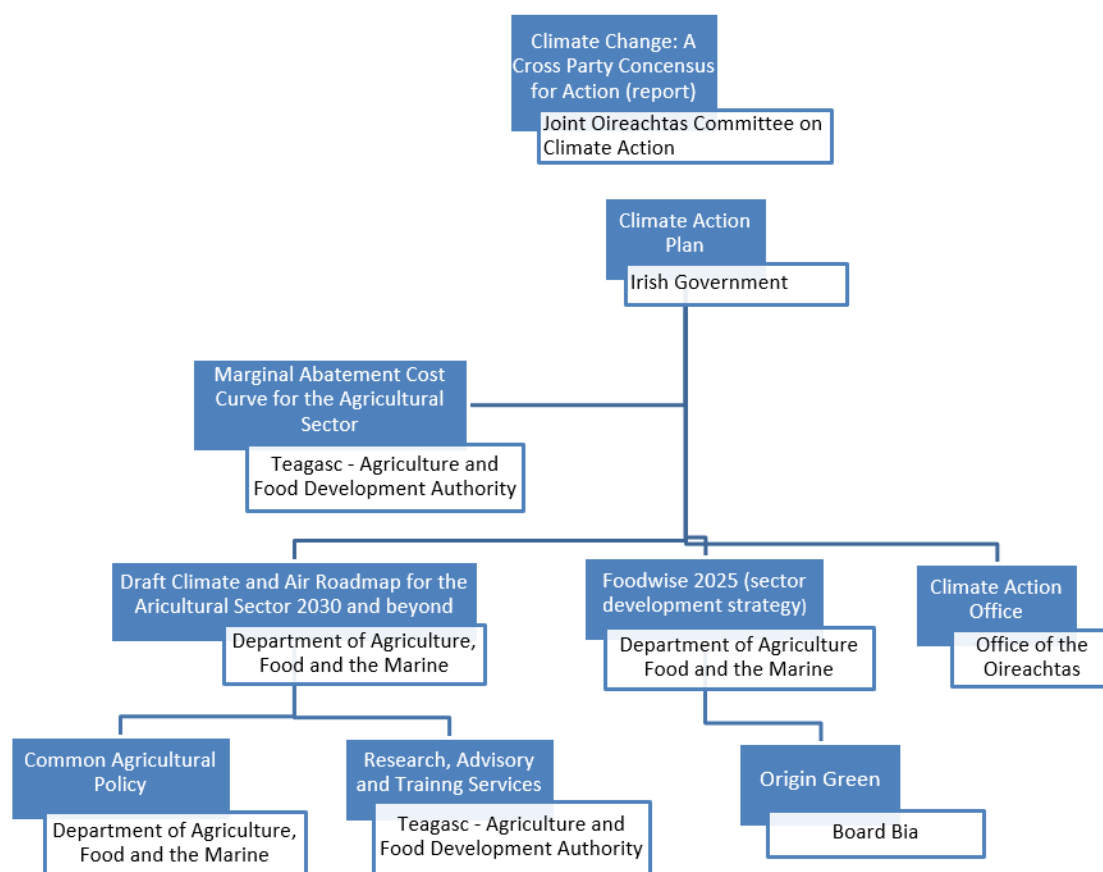
This case study explores the actions being taken in Ireland to reduce the contribution of the agricultural sector to Ireland's greenhouse gas (GHG) emissions. Agriculture contributes significantly to Ireland's economy, accounting for approximately 8% of Gross national Income (Department for Agriculture, Food and Marine, 2019b). As the largest manufacturing industry in Ireland, the agricultural sector has a higher than EU average contribution (34% in 2018) to the national GHG emissions (Environmental Protection Agency, 2018). Agriculture in Ireland is dominated by grassland based agricultural systems (81% pasture, silage, hay and 11% rough grazing). Beef and dairy dominate production, accounting for 68% of agricultural output. This characteristic of Ireland's agricultural production is in part due to the favourable maritime climate with conditions suited to growing grass. Ireland's livestock production depends upon high output of both grazed pasture and saved silage and hay with the corresponding need to utilise both organic and inorganic nitrogen to support this output. While livestock production is relatively efficient in Ireland, GHG emissions associated with livestock (in particular cattle production) are high per unit of product produced. Thus, while Irish livestock production is relatively efficient in terms of GHG emissions, the importance of livestock agriculture to Ireland's economy means agriculture remains the most significant source of GHG emissions in Ireland.

Reducing emissions within Ireland's agricultural sector in particular from livestock production is challenging. Ambitious plans for GHG reductions alongside continued development of the agricultural sector means that Ireland must build on its current schemes to support efficient production. With this in mind, this case study focuses on the achievements to date in improving the GHG intensity of livestock production and the plans for increased nitrogen use efficiency (NUE) and low emission technologies in the next phase of Ireland's plan to reduce emissions. This includes an ambition to achieve net neutrality in emissions from Agriculture, Land-use and Forestry measures to improve the efficiency and utilisation of natural resources that have been identified as critical for Ireland's future.

1.1 Scheme overview

Dealing with the emissions from agriculture is a focus of recent policies within Ireland. Figure 1 provides a schematic overview of the related policies and lead organisations.

Figure 1: Agriculture and Climate policy framework



The policy framework that supports the delivery of improved Nitrogen Use Efficiency (NUE) includes:

- Report of the Joint Committee on Climate Action Climate Change: A Cross-Party Consensus for Action (Joint Committee on Climate Action, 2019).

This report builds on the findings of a National Citizens Assembly and sets out a cross party consensus for accelerated action and more ambitious targets for net zero emissions. The recommendations from this report have been adopted and form a basis for:

- The Climate Action Plan which sets the objectives and targets for climate action in agriculture to achieve an abatement of between 16.5 and 18.5 MtCO₂eq. by 2030 (Department of Communications, Climate Action and Environment, 2019)

This revised plan sets out political and legal frameworks which drive the ambitions for setting and achieving future climate goals in Ireland. The plan includes actions to create sector based roadmaps to support the implementation of actions to achieve the targets set out within the Climate Action Plan, this has been delivered through the:

- Draft National Climate and Air Roadmap for the Agricultural Sector to 2030 and beyond (Department of Agriculture, Food and Marine, 2019a).

Together the Climate Action Plan and draft National Climate and Air Roadmap for the Agricultural Sector are delivering the policy framework as promoted through the cross-party consensus and together provide the drivers for action within the Irish agricultural sector.

In addition to specific policies to reduce the GHG emissions from the sector, the Department for Agriculture, Food and the Marine has established a sectoral strategy that supports investment in the sector through more sustainable growth with specific actions at a sub sectoral level. While Foodwise 2025 (Department of Agriculture, Food and the Marine, 2015) is not specifically a direct climate policy,

it provides a consistent framework alongside the Climate Action Plan and Roadmap with the dual objectives of sectoral growth and improved sustainability of production. Improved Nitrogen Use Efficiency (NUE) plays a vital role in the achievement of more sustainable growth and in reducing climate impacts and is a crucial element in delivering the policy goals set out in the above plans and strategies.

In support of the Climate Action Plan, the national agriculture and food development agency in Ireland (known as Teagasc) produced an updated Marginal Abatement Cost Curve assessment of the abatement potential for GHG emissions in Irish agriculture up until 2030 (Teagasc, 2019). Achieving the targets set out in the Climate Action Plan will be challenging and will require the implementation of all cost-effective mitigation measures identified in the Teagasc report. These include multiple actions relating either directly to the implementation of actions to improve NUE and low emission technologies or to measures supporting their development and implementation:

- The current Common Agricultural Policy (CAP) (2014 to 2020) which requires 20% of funding to be used for agricultural practices that benefit climate and the environment. All farmers who participate in the Basic Payments Scheme (BPS) must implement 'greening' practices
- Ensuring that the future CAP (2021 – 2027) supports prioritising the protection and enhancement of carbon sinks on farms
- **The Rural Development Programme (RDP) which has provided funding of €4 billion to support rural communities in Ireland, some of which covers climate mitigation measures such as capital supports for low emission slurry equipment and multi-year commitments for agri-environment measures**
- **The majority of farm enterprises (90% beef output, and more than 90% dairy output) and food processors have engaged positively in sustainability initiatives**
- **Research (including on animal and grassland management; crops, environment and land use; and energy efficiency on farms), to inform knowledge transfer, via networks of advisory bodies**
- **Building on the online nutrient management planning to immediately progress more efficient nitrogen use through enhancement of soil fertility**
- Accelerating the assessment of feed additives (that are at an advanced stage of development) to mitigate methane emissions from enteric fermentation.

The measures in bold in the above list include elements which support the achievement of improved efficiency and associated improved NUE. The actions/measures supporting knowledge exchange and development of improved nitrogen planning were identified within the Teagasc report as requiring implementation to be delivered straight away if abatement targets within the Climate Action Plan for 2030 are to be achieved.

It is these elements of current and proposed future schemes which form the focus of this case study. There is no single scheme or entity which is solely responsible for the implementation of actions, rather a broad collaboration between multiple government departments, various initiatives, advisory, research and private sector partners.

NUE in Agriculture is a broad term covering activities that aim to minimise nitrogen emissions, whilst making efficient use of fertiliser applications.

Improvements in NUE will achieve several co-benefits, such as economic savings due to reduced fertiliser input and also a reduced requirement for clearing water pollution (European Commission, 2013).

The implementation of improved NUE includes a range of policy mechanisms and actors. Details of these are described in more detail in the main body of this case study. The focus of policy implementation has until this date, relied on research, knowledge exchange and a wide partnership on promotion from government and industry leaders. It is worth highlighting the voluntary nature of reduced

NUE in Ireland so far. While there are elements of incentives supporting the uptake of mitigation measures, it is down to farmers to choose to engage and to implement changes.

1.2 Primary objectives of the scheme

The Climate Action Plan and Foodwise 2025 set out combined objectives of carbon neutrality and sustainable intensification in agriculture, land-use and forestry sectors. Improved NUE will support both of these objectives, through improved practices and technologies, promoting carbon reduction and reduced carbon intensity. The schemes implementing actions to meet these objectives are not singular, but rather a number of mechanisms and organizations have come together to support improved practices and, within these schemes, nitrogen use efficiency is crucial to delivering both reduced GHG emissions and sustainable intensification.

Previous policies have focused on reducing the carbon intensity of Irish produce. Reducing emissions from organic and inorganic nitrogen has also been identified as critical to the early action within the period 2020 – 2030 (Department of Communications, Climate Action and Environment, 2017). This built on delivery under the last CAP implementation under the RDP supporting changes to practice with knowledge transfer led by Teagsac, Origin Green¹ and the Smart Farming initiative².

Ultimately, previous policies and the recently updated Climate Action Plan set challenging targets to reduce the carbon intensity of agriculture and to achieve significant reductions in the annual emissions. This runs parallel to increasing carbon absorption to achieve net neutral carbon emissions from the Agriculture, Land use and Forestry sector. The early adoption of additional measures to improve NUE and low emission fertilisers will be necessary if Ireland is to achieve the target of 10-15% reductions in agricultural emissions by 2030 as set out in the Climate Action Plan.

1.3 Eligibility criteria and target groups

Improved NUE is widely applicable to any farmers/land managers who use nitrogen fertiliser on their land. Currently it applies to farmers and land managers who are willing voluntarily to make changes to their farming practices. However, under future proposals, some elements will become compulsory and relevant to all farming practices utilising organic and inorganic nitrogen. The techniques to improve efficiency of nitrogen vary from minor alterations to bigger changes that can involve a significant capital investment, so the activities taken on by farmers will vary depending on their situation.

There is a particular need for the dairy and beef sectors to implement abatement actions. The Climate Action Plan identifies a need for 90% of farms in these sectors to engage in implementing actions. There has been significant research and knowledge exchange activities delivered through Teagasc to support this level of uptake.

1.4 Key actors involved in the delivery of the scheme

The delivery of improved NUE is supported through extensive engagement, knowledge exchange, research and support provided through the Green, Low-Carbon Agri Environment Scheme. A broad range of actors play a key part:

- Irish Government: approve measures that fall under the policy, as well as supporting research and high level communications through national climate plans. The Department of Communication Climate Action and Environment (DCCAE), Department for Agriculture, Food

¹ The Origin Green initiative is a sustainable agriculture programme run by the Irish Food Board (Board Bia). For more information, see <https://www.origingreen.ie/what-is-origin-green/about-origin-green/>.

² The Smart Farming Initiative seeks to improve efficiency and reduce costs on farm. It is led by the Irish Farmers' Association in collaboration with 8 government agencies. For more information, see <https://smartfarming.ie/about-smart-farming/>.

and the Marine (DAFM) and the Environmental Protection Agency all have roles in the development of policies and reporting.

- Teagasc: government research and advisory body that undertakes agricultural research and delivers training and advice to the sector. They have a key role in knowledge transfer through advisory bodies to inform farmers of effective farming practices.
- Board Bia: The Irish food board³ – part state supported organisation with the role of promoting Irish food. This includes the development and running of the Origin Green assurance standards which included elements of nutrient management and the ongoing development of a Farm Sustainability Programme.
- Farm advisory bodies: on-farm direct interaction with the farmers to support the introduction of efficiency nitrogen use techniques. Ireland has retained a strong, largely publicly funded advisory service based on a model of recovering 33% of its cost from farmers. Teagasc is the national body providing advisory services through its 250 field advisors. Public funded and private funded services coexist. There is a recognition that Government no longer needs to provide the sole source of finance for all services offered by a public advisory service.
- Irish Farmers Association (Smart Farming Scheme): this scheme (supported by the membership association representing many Irish farmers) supports the objective of climate and environmentally sensitive farming practices. These seek to remove unnecessary waste to drive improvements in productivity and environmental performance. This scheme links with the actions of other schemes and stakeholders to encourage farmers to engage in practices which reduce GHG emissions including seeking efficient use of nitrogen.

1.5 Interaction of scheme with EU instruments

The efficient use of nitrogen fertiliser is very closely interlinked with several EU instruments other than those related to climate as reactive nitrogen can cause issues for water and air quality, as well as having an impact on designated sites. The following EU Instruments also set requirements on the management of nitrogen in the environment:

- **EU Nitrates Directive (directive 91/676/EEC)**⁴. The Nitrates Directive was introduced in 1991 across EU Member States (MS), with the aim of protecting water quality by preventing nitrates from agriculture from polluting water sources through promoting good farming practices. Each EU MS is required to prepare a National Nitrates Action Programme (NAP) which details the rules in place for the application of fertilisers and manure. Ireland's NAP has been in place since 2006 and included regulations on fertiliser use on farms and also set legal maximum application rates of nitrogen (N) and phosphorous (P) on land (Dillon, et al., 2015). The fourth revision of Ireland's NAP came into effect in 2018 (until 2021) and introduced measures to address problems with nutrient fertiliser efficiency. The fourth NAP also proposed measures to interrupt the pathways transporting nutrients from farmland to water sources (Department of Agriculture, Food and the Marine, 2017).
- **National Emission Ceilings Directive (Dir.2001/81/EC)**⁵ and **Ambient Air Quality Directive (Dir.2008/50/EC)**. Tackling nitrogen pollution also requires trans-national cooperation beyond European borders. To this end, the Gothenburg Protocol of the Convention on Long Range Transboundary Air Pollution (CLRTAP) has also been reviewed, coordinated by the United Nations

³ Board Bia is the Irish Government food development board. They support and promote the entire Irish food chain, supporting both national and international promotion of Irish produce as well as supporting the sectors development. For more information, see <https://www.bordbia.ie/farmers-growers/get-involved/become-quality-assured/>.

⁴ The **Nitrates Directive** (1991) aims to protect water quality across Europe by preventing **nitrates** from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. For more information, see https://ec.europa.eu/environment/water/water-nitrates/index_en.html.

⁵ The National Emission Ceilings Directive sets national emission reduction commitments for Member States and the EU. For more information, see <https://www.eea.europa.eu/themes/air/air-pollution-sources-1/national-emission-ceilings>.

Economic Commission for Europe (UNECE). The CLRTAP involves Member States of the EU and other nations, including the USA, Canada, and the Russian Federation.

Agriculture contributes to 98% (Environmental Protection Agency, 2016) of all ammonia emissions in Ireland – ammonia emissions occur as a result of nitrogen and manure management and can have significant impacts on both ecosystems and human health. Ireland is producing a national Air Quality Strategy and has already introduced a Code of Good Agricultural Practice for Ammonia in response to the requirements of the NECD. While there are some potential conflicts between air quality and GHG policies, actions to improve the management and utilisation of nitrogen fertilisers will support both policy objectives.

- **Water Framework Directive (WFD) (Dir. 2000/60/EC)**⁶. The WFD is linked to a number of other EU directives in several ways. These include Directives relating to the protection of biodiversity (Birds and Habitats Directives), directives related to specific uses of waters (drinking water, bathing waters and urban waste water directives) and directives concerned with the regulation of activities undertaken in the environment (Industrial Emissions and Environmental Impact Assessment directives). More recent directives on topics such as Floods and the Marine Strategy Framework have significant linkages with the WFD which is also supplemented by the Priority Substances Directive and the Groundwater Directive. The Nitrates Directive forms an integral part of the WFD and is one of the key instruments in the protection of waters against agricultural pressures. The Sustainable Use of Pesticides and the Sewage Sludge Directives also provide for the control of materials applied to land.

Livestock manures and nutrient enrichment in the form of both phosphates and nitrates have an impact upon water quality and aquatic biology. Changes to the management of land are therefore required to support the achievement of WFD requirements. River basin management plans developed by the Environmental Protection Agency include measures such as improved nutrient planning, manure management and storage improvements designed to reduce the impacts and risks of nutrients entering water. These measures align well with those that improve NUE and reduce GHG emissions.

- **Common Agricultural Policy (CAP)**. The EU (CAP) was initially established to guarantee secure supplies of food for Europe's citizens, but is now a multi-faceted policy whose primary objectives are market-oriented sustainable food production, supporting the incomes of farmers, preservation of the environment and rural development.

In Ireland, the CAP supports the development of the sector through a combination of direct payments to farmers (Pillar 1), financial assistance towards investments in rural development and environmental protection and market support measures (Pillar 2). Cross compliance and greening policies contribute to some mitigation of GHG emissions, however the Green, Low-Carbon, Agri-Environment Scheme – (GLAS)⁷ launched in 2014 – forms a primary element in Ireland's approach to reducing GHG emissions from agriculture. This is delivered through the Rural Development Programme element of Pillar 2 of the CAP.

1.6 Does the scheme build on previous experience?

Improvements to nutrient management and supporting nutrient utilisation are linked to several overarching policies and drivers, including the Nitrates Directive and clean air plans. Ireland has experience from previous implementation through the CAP, WFD River Basin Management Plans and the Nitrates Action Programme. Delivery of the enhanced ambition specified within the Climate Action

⁶ The Water Framework Directive sets a common approach to water management across the EU. Requiring the setting of standards and addressing pollution working at a river basin scale with targets to be achieved by set deadlines. For more information, see https://ec.europa.eu/environment/water/water-framework/index_en.html.

⁷ The Green, Low-Carbon, Agri-Environment Scheme (GLAS) provides payments to farmers to help tackle climate change, preserve biodiversity, protect habitats and promote environmentally-friendly farming. For more information, see <https://www.agriculture.gov.ie/farmerschemespayments/glas/>.

Plan specifically relating to improved NUE includes building on the well-established mechanisms used in support of previous programmes.

Improving NUE will build on current mechanisms such as:

- Ensuring that the future CAP (2021 – 2027) supports prioritising the protection and enhancement of carbon sinks on farms
- Through the RDP, covering climate mitigation measures such as capital supports for low emissions slurry equipment – building on the GLAS scheme launched in the last RDP round in 2014
- Increased engagement in sustainability initiatives, by Teagasc and Bord Bia, making food production more efficient and enhancing environmental outcomes, through regular auditing and data analysis
- Promoting low-emissions intensity production at both the farm and processing levels, which will help farmers earn a market premium (Origin Green)
- Through Teagasc undertaking innovative research to inform knowledge transfer, via networks of advisory bodies, on cost-effective decarbonising of farming practices
- Prioritising of agricultural advisory services (both Teagasc and private) to focus on providing tailored assistance on low-carbon farming
- Building on the online nutrient management planning to immediately progress more efficient nitrogen use through enhancement of soil fertility

The new CAP at EU level will contribute to environmental or climate action, based on verifiable results, including an opportunity to focus funding on climate mitigation and adaptation, biodiversity, and carbon sequestration and storage measures. It is expected the new CAP will be implemented in Ireland through the development of a strategic plan for the period 2021 to 2027. In developing this strategic plan, in close consultation with stakeholders through a new Consultative Committee, DAFM will mainstream climate action opportunities which optimise synergies for the delivery of environmental benefits in the areas of climate, water and biodiversity.

In addition, activities under other policy objectives such as the Nitrates Action Programme and Agricultural Catchment Programme have been supported through the initiatives delivered by Teagasc, the Environmental Protection Agency and Board Bia.

2 Implementation

2.1 Drivers and key actors for setting up the scheme

The Climate Action Plan published in 2019 in response to the Paris Agreement and growing pressure from within government and from civil society, has set challenging targets in line with Ireland's commitments under both international and European agreements. In addition, Ireland has not achieved its emission reduction target of a 20% national reduction on 2005 levels, as set out within the EU Effort Sharing regulations (European Commission, 2020). Instead, projections show that Ireland's emission reduction, at best, will be around 11% (Environmental Protection Agency, 2016). Although these targets have not previously been set at sector level for agriculture and land use, recent increases in overall emissions in Ireland mean that action must be taken to reduce sector emissions.

There is a significant programme of new legislative action behind the Climate Action Plan. This includes the establishment of oversight roles on government through a new Climate Action Council which sets out 5-year carbon budgets and decarbonation targets for each sector (Department of Communications, Climate Action and Environment, 2019).

In response to national and international commitments and to the programmes of regulatory change and sectoral budgets, there has been an acceleration in the pace and ambition of climate action in the

agricultural sector. The actions are bringing together the Departmental, government extension services and sector leadership in providing technological, educational and advisory support, in addition to the measures which will flow from the successful design and implementation of the next CAP at EU level.

The voluntary nature of the previous actions will continue, while the Irish Government and in particular the Department of Agriculture Food and Marine develop their roadmap following a consultation in 2019. In order to deliver the increased level of abatement required, the draft roadmap includes many elements of compulsory changes in activity. However, for these to be successful, they will need to be integrated with improved understanding and support to ensure that the benefits of mitigations are realised. Early implementation of low emissions technologies and increased NUE will require the continued involvement and increased investment in the mechanisms and institutions supporting current action, namely:

- Irish Government, The Department of Communication Climate Action and Environment (DCCAE), Department for Agriculture, Food and the Marine (DAFM) and the Environmental Protection Agency all have roles in the development of policies and reporting
- Teagasc: Continued research, demonstration, knowledge exchange and training with an expanded role in supporting sustainable production techniques across all sectors
- Board Bia – Origin Green, Farm Sustainability Programme.

The state supported advisory, research and training delivered through Teagasc has been recognized as unique in having a substantial component of its Agricultural Knowledge and Information System (AKIS) within a single organisation. Teagasc undertakes activities in research, extension services and education. Teagasc comprises seven research centres (with three demonstration farms), 51 local advisory offices, about 90 farmer-run demonstration farms (so-called BETTER farms and Monitor Farms), and 800 discussion groups with about 12,000 members. There has been a move from individual extension to group extension methods. Teagasc activities are complemented by private agricultural consultants and veterinarians, private research entities, universities and Institutes of Technology, government departments, various public agencies and numerous other actors. In addition, continued engagement across the food supply chain will be essential to meet the challenging levels of uptake required if the objectives of the schemes are to be achieved, together with the benefits of both public and private collaboration necessary to deliver the objective of climate mitigation.

2.2 Lead times

Detailed implementation plans for the continued development and deployment of measures to encourage and support improved NUE and reduced fertiliser emissions have not yet been published. However, DAFM has undertaken a consultation on the measures and mechanisms for implementation of actions to achieve the objective set out in the Climate Action Plan (Irish Government, 2019). The early adoption of measures to deliver improved NUE and low emission technologies relating to manures and fertilisers has been highlighted with a blend of improved support to the sector through agri-environment schemes, increased knowledge exchange and education support and additional requirements in terms of manure and fertiliser practice.

The actions proposed within the Climate and Air Roadmap include (Department of Agriculture, Food and Marine, 2019a):

- Adopt online nutrient management planning – lime use & fertiliser use efficiency
- Achieve a target of 60% of all slurry spread by low emissions spreading techniques by 2022; 75% by 2025; and a longer-term ambition of 90%
- Require slurry/farm yard manure applied to arable land to be incorporated into the soil within 12 hours of application to land by 2022

- Require all newly constructed external slurry stores to be covered by 2022 and all recently constructed external slurry stores (i.e. within the last 5 years) by 2025
- Promote the use of an approved software package as a decision support tool for the majority of dairy farmers by 2022. Furthermore, promote beef and sheep farmers to use Grass10 as a model for improving grass utilisation. Grass10 is a 4-year campaign launched by Teagasc (2017-2020) to improve grass utilisation on Irish farms⁸
- Require incorporation of clover (and mixed species) in all grass reseeds by 2022
- Develop a blueprint for zero/near zero nitrogen use and carbon neutral production suitable to all productivity levels and support its implementation
- Develop an electronic fertiliser and manure data base to support best practice and evidence of optimum nutrient management and soil fertility
- Promote the use of protected nitrogen products switching 50% of calcium ammonium nitrate (CAN) sales to protected urea by 2022
- Prohibit the use of urea (replacing with protected urea), in particular on grassland by 2025
- Create an information portal on protected N products that will:
 - Ensure the widespread dissemination of information on the different types of nitrogen protection inhibitors, including specifications for their use
 - Increase awareness around the use and benefits of protected nitrogen products.

2.3 Lessons to be learned from the scheme development and initial stages of implementation

Improvements in the GHG intensity and NUE of Irish agriculture have developed over time. Schemes such as the GLAS, Origin Green and Sustainable Farming Initiative combined with the support provided by Teagasc have been successful in delivering efficiencies across Irish farming.

Due to the structure and drivers that have supported the implementation, there are only a few lessons learned that can be drawn out. However, success to date has been based on the high levels of **collaboration across government** and the promotion and engagement of schemes such as Origin Green which provide a focus and mechanism to achieve additional recognition for the improvements in farm performance. **Regular reviews and continued communication** with the sector through these initiatives such as GLAS and Origin Green, have supported ongoing improvements and implementation of changes in practice. **Support from agri-environment schemes** has helped remove some barriers, such as high capital investment costs of some technologies. Also **support through the well-regarded and funded government research, advisory and educational means**, have ensured farmers are supported by coherent and supportive schemes working together.

While there has been good engagement in current schemes a **lack of clear targets for reduced emissions and increases in output** means that overall emissions from the agricultural sector have remained relatively flat. However, it should be noted that the **joint objectives of increased output and sustainable agricultural development** promoted through schemes such as Origin Green and the Foodwise strategy have seen increased output from the sector and have helped keep emissions relatively stable through improvements in the intensity of emissions.

In order to meet the future targets for significant reductions in emissions from agriculture, additional action will need to be taken.

⁸ Teagasc initiative promoting better utilisation of grass in livestock (Cattle, Dairy, Sheep). For more information, see <https://www.teagasc.ie/crops/grassland/grass10/>.

The frameworks and institutions already embedded within Ireland provide a coherent and well-respected structure on which to build. High engagement with future schemes to accelerate and drive more refinement in the implementation of carbon reducing technologies will be required to achieve the policy outcomes being sought. A key element of this will be clear communication on the target reductions being sought, and the actions required to achieve them. NUE has been identified as crucial to the achievement of these policy goals. The combination of schemes planned for the future will encourage this transition, building on the current good practice and leveraging additional impetus from the Climate Change Plan and associated roadmaps.

2.4 Adjustments made during the scheme

Detailed analysis of the changes to the scheme is difficult as it is not a single defined entity, but rather a coordinated implementation of shared cross-organizational plans supported through overarching strategies for a green, productive sector.

The various schemes including Agri-Environment, Origin Green and the Smart Farming Initiative, alongside the research, knowledge exchange, technology and education from Teagasc have developed over time. However, the introduction of more challenging targets, the latest iterations of the Climate Action Plan, Marginal Abatement Cost Curves and supporting draft Climate and Air Roadmap for Agriculture (DAFM, 2019) all provide a significant update to previous schemes, setting out actions and timelines for delivery. A significant change to the measures will be required in the future. Delivery of the enhanced ambitions within the new policies will require significant adjustment to all previous plans and schemes. This will include updating them with new measures, communications and in the light of potential continued updates to regulations and tools/technology requirements to deliver the abatement required up to 2030 and beyond.

3 Assessment

3.1 Successes

Actions supporting improved NUE in Ireland have until now focused on reducing the intensity of GHG emissions. Schemes such as Origin Green, the Smart Farming Initiative and the research and knowledge exchange delivered through Teagasc have been considered successful in delivering improvements to the performance of individual farms and have delivered improvements in both the intensity of production and also in NUE.

3.1.1 How successful was the scheme?

Previous actions under improved NUE have been relatively successful in reducing the GHG intensity of outputs and improving NUE. Teagasc produce a sustainability report of Irish agriculture each year. The 2020 report (Teagasc, 2020) provides details of performance for each sector and shows continued reductions in GHG intensity for both dairy and beef production with reductions of 8% and 12.3% (2013-2018) respectively. These figures build on previous reductions of 14% from 2005 – 2013 across all sectors (Department of Communications, Climate Action and Environment, 2017).

The trend for improved NUE is shown in Table 1 below. It illustrates that across all farm systems, NUE (N outputs / N inputs) has generally increased over the years when examined on a rolling 3-year moving average basis. Dairy and cattle farms tend to have the lowest NUE over the study period, although NUE was seen to improve slightly between the start and end of the period presented. Tillage NUE was generally significantly higher than all other systems due to the mainly non-livestock nature of this system. The relatively low NUE for Ireland is indicative of livestock systems and supports the dominance

of livestock production in Irish agriculture. Future focus on NUE should support significant improvements in this area.

Table 1: NUE (%): 3-year average, 2011-2018 (Source (Teagasc, 2020)).

	2011-2013	2012-2014	2013-2015	2014-2016	2015-2017	2016-2018 (weather impacted*)
Dairy	21.9%	21.4%	22.3%	23.7%	24.5%	23.3%
Cattle	21.6%	21.3%	21.5%	23.7%	24.5%	22.7%
Sheep	28.0%	26.8%	28.1%	29.7%	31.0%	28.5%
Tillage	61.6%	61.1%	64.5%	66.3%	68.2%	64.7%
All Farms	25.7%	25.2%	25.8%	26.9%	27.6%	26.5%

* Adverse weather during 2018 impacted upon agricultural output and the efficiency of N utilisation impacting upon the 2016-2018 rolling average NUE.

Although the intensity of production has seen good improvements, this is countered by recent increases in emissions. In the period 2005 – 2011 Ireland's emissions from agriculture declined by 9.5%. This trend was driven in part by reductions in the carbon intensity of production, but greater reductions were driven through reductions in livestock numbers during this period. Economic recovery and policies to promote Irish agricultural products, alongside the competitive advantage of production in Ireland, has supported growth in herd sizes and in milk production. These increases in livestock numbers have driven a sharp increase in emissions in the period 2011-2017 (12.8%) leading to a slight increase in annual emissions from the sector since 2005.

While the schemes supporting improved NUE have undoubtedly contributed to reduced GHG intensity of Irish production, the challenge of now meeting the targets set out in the Climate Action Plan will require additional effort. Continued improvement in NUE has been identified as crucial in the early phases of delivery. However alongside improved efficiency in production, maintaining or even increasing food production will be very difficult, while at the same time reducing aggregate emissions. Complementary policies will certainly be required to ensure that the emissions reductions identified by Teagasc (2019) are achieved, these could limit the output of Irish agriculture. In the Analysis of Abatement Potential of Greenhouse Gas Emissions in Irish Agriculture 2021-2030 (Teagasc 2019) the emission mitigation potential of improved NUE has the potential to save emissions corresponding to 112 kt CO₂ equivalents per year. This abatement potential is dependent upon uptake of mitigation practices and forms a significant portion of the wider production efficiency measures assessed in the report.

The positive contribution of planned NUE improvements can be set against potential increases in production with associated GHG increases. In their report Teagasc (2019) have undertaken some market development analysis up to 2030. Under the future scenarios for sectoral growth (excluding any additional mitigation) emissions are projected to range from 19.45 to 21.75 Mt CO₂ equivalents per year, which represent a 4 – 15% increase in overall agricultural GHG emissions from 2005. On its own the implementation of NUE measures would mitigate 0.5-0.6% of total emissions. However, as part of a suite of mitigation measures, which include improved utilisation of forage and changes to nitrogen fertiliser formulations, they become a foundation for many other mitigation actions planned. The introduction of measures to support improved NUE are identified as cost neutral having no detrimental impact on the financial performance of the sector. This feature of NUE measures is important to recognise in the context of timing and wider impact of their implementations. NUE measures can act

as an important facilitating influence on the uptake of more extensive and impactful actions such as alternative fertiliser products, nutrient limits and improved application technologies (low emission spreading, precision agriculture etc). In addition NUE measures support the dual ambition of improved productivity and reduced GHG intensity/emissions. While on their own the continued implementation of measures to improve NUE have a relatively small impact on net GHG emissions, as part of a wider policy package they become fundamental in the early engagement with the sector and will form the foundation for building confidence and action to reduce overall emissions related to both organic and inorganic fertilisers.

The Climate Action Plan has recognised this challenge which is for Ireland both an economic and political concern which is yet to be resolved. Within the Climate Action Plan there are ambitions for Ireland to work with other Member States and the European Commission to develop an alternative regulatory regime (similar to the EU Emissions Trading System) to help address the challenge of meeting both international climate reductions and increasing demand for food. In effect this approach is seeking to deal with the offshoring impacts of moving production to less efficient systems in order to achieve domestic climate targets. Furthermore, the plan states “However, such an initiative could only be successful if Ireland is seen to be credible on its climate obligations, which it is not at present. Therefore, the achievement of such an ambition depends – in the first instance – on implementation of this Plan”. Ireland is aware of the need therefore for the actions within the Climate Action Plans and supporting policies to deliver real climate reductions. The promotion of improved NUE is part of a wider and complementary suite of measures but there is a significant challenge for Ireland to deliver these ambitious targets and balance any impacts on the wider sector and economy.

3.1.2 What are the key factors that make it a successful scheme?

Engagement in sustainability schemes has been high across Ireland, with participation in the Origin Green assurance scheme reaching over 52,000 participants and representing over 90% of exported produce. Over 50% of expenditure from the CAP Pillar 2 elements of the agri-environment schemes in 2017 was on climate-related measures, such as the provision of support for the use of low emission slurry equipment and farm nutrient storage.

This combined with the integration between the sectoral development strategies - Food Wise 2025, Board Bia and Origin Green Assurance schemes - and the environmental and climate based policies along with a well-developed advisory, research and educational organisation in Teagasc have ensured high levels of leadership within the sector. Combined coherent schemes, financial and advisory support, coordinated with market advantages through sustainability assurance schemes have ensured good engagement within the farming community.

Action to improve NUE aligns well with improving farming practices. Improved NUE is synonymous with improved productivity, i.e. it is a measure of the efficient use of resources in delivering the farming outputs. Improved NUE therefore should encourage better returns to inputs of nitrogen. In general, improving NUE is the result of implementing cost effective measures such as nutrient management planning, precision application and careful assessment of nitrogen inputs from all sources. It can save costs as well as reducing emissions to the environment. While actions to improve NUE are generally cost effective and align well with current farming practices there can be a need for capital investment in equipment in order to implement the practices. Many require additional management input which can add complexity to the current farming system. There is therefore a need for training, advice and support in order to implement these actions effectively and to gain the financial and environmental benefits.

3.1.3 Cohesive interactions with other schemes and instruments

Past policies for improving water management, nutrient use, biodiversity and productivity have been integrated well into coherent schemes such as the agri-environment GLAS scheme and the

sustainability assurance through Origin Green. Future implementation as suggested in the draft Climate and Air Roadmap, is proposed with continued high levels of interactions with other instruments. Ireland has been successful in supporting clear communications to the sector focused on drivers, language and messaging that are relevant to farmers. Instruments such as Nitrate Action Programmes, River Basin Management Plans and requirements under clean air regulations are all complementary and have supported much of the gains seen already.

3.2 Assessment - Limitations

3.2.1 Aspects for Improvement

Objectives set out within the Climate Action Plan are challenging and will require more drastic changes across the sector. The success of these new actions, as well as the continuation of current schemes, will not be known until closer to 2025. While there has been success in improving the efficiency of Irish agriculture, achieving GHG reductions has been low, with indications that emissions are likely to continue rising.

The challenges of achieving future targets have been recognized and the following recommendations have been proposed in support of accelerating delivery, particularly in terms of NUE and Low Emission technologies.

- Establish an industry group to promote new “environmentally friendly” branding and standards on low emissions fertilisers to improve awareness
- Develop a blueprint for low N use, suitable to all productivity levels and develop implementation options
- Reduce nitrogen fertiliser use through the inclusion of clover in grassland swards
- Improve adoption of low emission slurry spreading equipment
- Complete research in respect of potential food residues arising from certain fertiliser formulations (e.g. protected urea) which will allow industry to have confidence in the widespread use of these products which lower N₂O emissions.

This case study is focused on the implementation of measures to improve the NUE of Irish agriculture. Continued improvements to the efficiency of production will deliver multiple benefits of reduced emissions and improve economic performance. However, in order to achieve the GHG emission reductions required by the Climate Action Plan, these measures are not enough on their own. Complementary actions to limit the overall emissions are also planned and may include constraints on the total output of Irish agriculture. Past schemes have led to reduced intensity of emissions but corresponding increases in production (in particular livestock numbers) have outweighed any efficiency improvements.

In order to ensure actions are contributing to the relevant targets, the Climate Action Plan includes new Governance and oversight roles including:

- A Climate Action Delivery Board within the An Taoiseach (Prime minister’s office) tasked with holding each relevant government department to account and reviewing performance against sectoral targets
- A Climate Action Council – which will supersede The Climate Change Advisory Council with additional powers – an independent advisory body tasked with assessing and advising on how Ireland is making the transition to a low carbon, climate resilient and environmentally sustainable economy as well as setting carbon budgets, monitoring progress and providing policy evaluation.
- Standing Committee of both Houses of the Oireachtas (Parliament) on Climate Action; Will hold Ministers and public bodies accountable for their actions to deliver the climate targets

- Climate Action Office, within the Oireachtas, to provide robust advice and evidence to the Standing Committee regarding the impact of particular policy decisions on the decarbonisation and climate action objectives.

These additional governance and oversight roles will ensure all government departments are delivering to the agreed targets, making effective plans and regularly reviewing the new regulatory targets set out in the Climate Action Plan. The additional support of Parliamentary oversight bodies will ensure that the Government is also held to account in delivering and continuously reviewing progress against the Climate Action Plan.

3.2.2 External factors that may affect schemes success

The high importance of agriculture to the Irish economy has been reasserted in recent years with increasing support for milk processing, corresponding with increases in the outputs of dairy and meat products. Global demand for protein and dairy products is projected to increase in coming years and looks likely to continue to support growth in demand for Irish exports.

In order to achieve a sustainable balance to deliver the degree of uptake required in additional climate mitigations, Ireland will have to ensure that they can find measures which can deliver the joint goals of supporting growth in this vital sector, while at the same time achieving net reductions in GHG emissions.

3.2.3 Negative interactions with other schemes or instruments

This is likely to be a significant challenge. Farmers will be unlikely to engage in schemes where their financial performance and potentially their competitiveness are impacted. To date most of the implementation of activities to improve NUE and reduce GHG emissions has involved either improvements in farming practice or support through CAP where there are potential negative economic impacts (e.g. low emission spreading equipment grants). The coordinated communications and link between the Origin Green assurance schemes and the sustainable farming practices supporting improved NUE have provided additional confidence, awareness and financial drivers for farmers to engage in improved practices. (Origin green assurance membership requires the implementation of audited actions and provides additional market access).

There is no indication that past schemes have interacted negatively with other schemes or drivers. Current implementation of measures to improve NUE and low emission technologies have benefitted other drivers such as WFD, Air Quality and productivity. However future expanded schemes have the potential to conflict with other instruments. For example, switching to urea based fertilisers has the potential to increase ammonia emissions and the inclusion of abated fertilisers still retains some uncertainty in terms of wider environmental and human health risks (Byrne, et al., 2020), or reduced productivity impacting upon the competitiveness of Irish production. The risk of these negative interactions has been recognized within the relevant strategies and the draft Climate and Air Roadmap.

3.3 Future Potential

3.3.1 How easy would it be to scale up the scheme? What are the limitations? What would be required to facilitate up-scaling?

Engagement in the current schemes which together contribute to improve NUE and Low Emission technology adoption has been widespread across Ireland. Scaling up the schemes requires an expansion of the ambition and level of mitigation rather than significant expansion in the number of farmers engaged. As such, the mechanisms to reach the sector are already well established and advancements in technology and knowledge can be scaled relatively easily. Additional elements within the Climate Action Plan have been assessed as cost effective. However, there will be requirements for additional investment through national budgets and within the CAP in order to ensure effective

additional impacts. The inclusion of GHG abatement and adaptation actions has been supported within the proposals for developing the CAP Strategic plans. Ireland has plans to use this mechanism to support additional roll out.

With the introduction of specific targets there is a need for greater mitigation. This will require a suite of additional policies and mechanisms to ensure they are delivered. An example of this is the regulation of fertiliser type that has been proposed in Ireland. Going beyond voluntary engagement with the current schemes may be required and while the actions may be relatively similar in the short term, regulation supported by training and advice as well as financial support is likely to be required.

3.3.2 Could the scheme be readily replicated in other territories?

The measures and schemes in Ireland build on the current mechanisms within the Rural Development Programme and state supported knowledge exchange, research and advisory services lead by Teagasc. In addition, Bord Bia, the state supported food board works through the Origin Green assurance standards to support the uptake of sustainable farming practices.

The implementation of practices to improve NUE and methods and infrastructure supporting moves to low emission technologies are all applicable to farming practice where manures and inorganic nitrogen are used. Technologies are readily available but often require support both in terms of financial assistance and advice in order to effectively support uptake and improved practice.

The plans proposed for future action in Ireland are broadly applicable across Member States. Action to improve NUE will benefit all sectors whether using inorganic or organic forms of nitrogen. The delivery of improved NUE requires a coherent and integrated approach utilising sectoral communication campaigns, with supporting technical advice based on sound research and technology R&D. Investment in equipment and planning tools are also critical in ensuring the technological and practical aspects of changing practice are effectively supported and farmers are positively engaged in the implementation.

The example of Ireland with a well-established collaboration between multiple government departments and organisations and the farming community provides a sound model which could be replicated elsewhere across Europe. The strong delivery framework present has successfully delivered improvements in the intensity of Irish agricultural production and will form a strong basis for future delivery with more ambitious targets to reduce emissions from the sector.

4 References

Byrne, M. p. et al., 2020. Urease and Nitrification Inhibitors—As Mitigation Tools for Greenhouse Gas Emissions in Sustainable Dairy Systems: A Review. *Sustainability*, 12(6018).

Department for Agriculture, Food and Marine, 2019b. *Fact sheet on Irish Agriculture July 2019*, s.l.: Department of Agriculture and Marine.

Department of Agriculture, Food and Marine, 2019a. *A Draft National Climate & Air Roadmap for the Agriculture Sector to 2030 and beyond.*, s.l.: Department of Agriculture, Food and Marine.

Department of Agriculture, Food and the Marine, 2015. *Food Wise 2025*.

Department of Agriculture, Food and the Marine, 2017. *Nitrates Explanatory Handbook for Good Agricultural Practice for the Protection of Water Regulations 2018*.

Department of Communications, Climate Action and Environment, 2017. *National Mitigation Plan*, s.l.: Irish Government.

Department of Communications, Climate Action and Environment, 2019. *Climate Action Plan 2019 to tackle climate breakdown*, s.l.: Government of Ireland.

- Dillion, E. et al., 2015. Teagasc National Farm Survey. Fertiliser use survey 2005-2015.
- Environmental Protection Agency, 2016. *Ireland's Environment An Assessment*, s.l.: Government of Ireland.
- Environmental Protection Agency, 2016. Ireland'd Environment - An Assessment 2016 - Chapter 12: Environment and Agriculture.
- Environmental Protection Agency, 2018. *Ireland's greenhouse Emissions - Sources and Solutions*, s.l.: Government of Ireland.
- European Commision , 2020. *Annual emission allocations 2013-2020 and flexibilities*. [Online] Available at: https://ec.europa.eu/clima/policies/effort/framework_en [Accessed 3 September 2020].
- European Commission, 2013. *Science for Environmental Policy. In-Depth Report: Nitrogen pollution and the European environment. Implications for Air Quality Policy*, s.l.: s.n.
- Government of Ireland, 2019. *Climate Action Plan 2019*, s.l.: s.n.
- IPCC, 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, s.l.: s.n.
- Joint Committee on Climate Action, 2019. *Report of the Joint Committee on Climate Action Climate Chane: A Cross Party Consensus for Action*, s.l.: Houses of the Oireachtas.
- Teagasc , 2019. *Teagasc Green House Gas Working Group: An Analysis of Abatement Potential of Greenhouse Gas Emissions in Irish Agriculture 2021-2030*, Carlow: Teagasc.
- Teagasc, 2020. *Teagasc National Farm Survey 2018 Sustainability Report*, Athenry: Teagasc.

Annex 1: Overview of Policies and Measures promoting Nitrogen Use Efficiency in EU MS's.

Table 2 Examples of Policies and Measures from EU Member States – (Source: European Environment Agency (<https://www.eionet.europa.eu/>))

Country	Name	Type of Measure	Entities responsible for implementing the policy	Related Union Policy	Policy and Measure summary source EIONET (European Environment information and Observation Network)
Belgium	Reduction of greenhouse gas (GHG) emissions from fertilizers and manure usage	Economic; Information; Regulatory	Regional: administrations of agriculture; Regional: Flanders: also environment administration	CAP Reform 2013 regulations; CAP Reform 2014-2020	EIONET Measure 54
Belgium	Increase nitrogen efficiency	Planning; Regulatory	Regional: Flemish Government; Regional: DGO3 Agriculture	CAP Reform 2013 regulations; CAP Reform 2014-2020; Nitrate Directive	EIONET Measure 147
Croatia	MAG-4: Improvement of mineral fertilizer application methods	Economic; Information; Research	Government: Ministry of Agriculture; Government: Advisory services	Nitrate Directive; CAP Reform 2014-2020.	EIONET Measure 48
Czech Republic	Strategy for Growth in Agriculture	Economic	Government: Ministry of agriculture	CAP Reform 2013 regulations	EIONET Measure 51

Country	Name	Type of Measure	Entities responsible for implementing the policy	Related Union Policy	Policy and Measure summary source EIONET (European Environment information and Observation Network)
Czech Republic	Ministry of Agriculture Strategy with view until 2030 (since 2016)	Economic	Government: Ministry of Agriculture	CAP Reform 2013 regulations	EIONET Measure 57
Denmark	Environmental Approval Act for Livestock Holdings	Regulatory	Government: State; Local: Municipalities	Effort Sharing Decision; CAP Reform 2014-2020	EIONET Measure 46
Estonia	Site-specific fertilization	Education; Information	Government: Ministry of Rural Affairs and Ministry of the Environment	Effort Sharing Decision; Effort Sharing Regulation EU	EIONET Measure 79
Finland	Climate Programme for Finnish Agriculture - Steps Towards Climate Friendly Food	Economic; Information; Regulatory; Research	Government: Ministry of Agriculture and Forestry	CAP Reform 2014-2020	EIONET Measure 41
France	Agro Ecological Project	Education; Information; Research	Ministry of Agriculture and Food	No information	EIONET Measure 1
Greece	Common Agricultural Policy (CAP) Green Direct Payments: Reduction in fertilizers use	Economic; Planning; Regulatory	Government: Ministry of Rural Development and Food	CAP Reform 2013 regulations, Nitrate Directive	EIONET Measure 16
Hungary	Limiting nitrogen surplus during fertilizer and manure application	Regulatory	Government: Ministry of Agriculture	Nitrate Directive	EIONET Measure 24
Hungary	Further measures to reduce GHG emissions in the field of agriculture	Planning	No information	No information	EIONET Measure 68
Iceland	Reduced use of non-organic fertilizers	Regulatory	Government: Ministry of Industries and Innovation; Government: Ministry for the	No information	EIONET Measure 2

Country	Name	Type of Measure	Entities responsible for implementing the policy	Related Union Policy	Policy and Measure summary source EIONET (European Environment information and Observation Network)
			Environment and Natural Resources		
Italy	Emissions of nitrous oxide from agricultural soil - Nitrogen fertilizer	Regulatory	Government: Ministry of Agriculture	CAP Reform 2013	EIONET Measure 12
Latvia	Future support to precision farming practices and practices promoting to reduce synthetic N use, including biogas production.	Economic	Government: Ministry of Agriculture	Policy framework for climate and energy from 2020 to 2030	EIONET Measure 80
Lithuania	Modification of compulsory requirements for manure and slurry application.	Regulatory	Government: Ministry of Environment; Government: Ministry of Environment	CAP Reform 2013 regulations	EIONET Measure 46
Lithuania	Amendment of mandatory requirements for the use of mineral nitrogen fertilizers	Education; Regulatory	Government: Ministry of Agriculture	Nitrate Directive; CAP Reform 2013 regulations	EIONET Measure 48
Netherlands	Covenant on Clean & Efficient Agricultural sectors	Voluntary	Government: Ministry of Agriculture, Nature and Food Quality (LNV); Companies: various; Other: Intermediaries	No information	EIONET Measure 19
Poland	Agri-environment-climate measures (AECM)	Economic; Education; Information; Regulatory; Research; Voluntary	Government: Minister for Agriculture; Government: Minister for Environment; Government: Agency for Restructuring and Modernisation of Agriculture (ARiMR); Regional: Agricultural Advisory Centre (ODR) in BrwinÅ³w; Other: National Support Centre for Agriculture; Research: National Rural Network national research institutes, universities; Other: farmers	CAP Reform 2013 regulations; European Agricultural Fund for Rural Development (EAFRD); Birds Directive, Habitats Directive	EIONET Measure 19

Country	Name	Type of Measure	Entities responsible for implementing the policy	Related Union Policy	Policy and Measure summary source EIONET (European Environment information and Observation Network)
Portugal	Incentive to reduce the use of nitrogen fertilizers	Regulatory	Government: Financing Institute for Agriculture and Fisheries	CAP Reform 2014-2020	EIONET Measure 28
Spain	Promotion of emission reduction in the agricultural sector (Crops)	Economic; Planning; Regulatory	Government: Ministry of Agriculture Fisheries and Food Regional: Communities	CAP reform post 2020	EIONET Measure 90
Switzerland	Resource programme (subsidies for a more efficient use of natural resources)	Economic	Government: Federal Office for Agriculture FOAG	No information	EIONET Measure 23
Switzerland	Climate strategy for agriculture	Research	Government: Federal Office for Agriculture FOAG	No information	EIONET Measure 25