Efficient Farming cuts Greenhouse Gases

Implementation Plan 2016 – 2020

Agriculture and Forestry Greenhouse Gas Implementation Partnership

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The Voice of the Family Farmer

COUNCIL FOR NATURE CONSERVATION AND THE COUNTRYSIDE
A Statutory Advisory Council to the Department of Agriculture, Environment and Rural Affairs

Dairy UK
Northern Ireland

Ministerial Foreword

I am pleased to welcome the agriculture and forestry sector's updated 'Efficient Farming Cuts Greenhouse Gases Implementation Plan 2016 – 2020'.

My vision for the agriculture industry is one of a profitable, efficient and sustainable sector. The Agri-Food Strategy Board's Going for Growth report underpins this vision and tackling emissions from agriculture is fundamental to achieving sustainable growth.

Reducing emissions from agriculture remains a complex undertaking and runs parallel to an increased global demand for food and agricultural products. This combined challenge was acknowledged in the international Paris climate agreement in 2015, which set binding commitments to limit global temperature rise and recognised that these efforts must not threaten production and food security. Production must therefore become increasingly efficient to ensure that growth is both economically and environmentally sustainable.

As Minister of Agriculture, Environment and Rural Affairs I believe we can effectively address these challenges and that environmental protection and economic competitiveness must go hand-in-hand. The Greenhouse Gas Implementation Partnership's 'Efficient Farming' plan sets out a roadmap for the agriculture sector, with support from my Department, to achieve its sustainable growth ambitions and deliver better environmental outcomes.

It provides a robust framework for action, outlining the support available to farmers to implement a range of good practice and efficiency measures. In this time of economic pressure, it is good news that these measures will not only have a beneficial impact on GHG emissions, but can also boost productivity and profits across all farm sizes and types.

My Department will continue to support the agri-food sector in its ambition to be a world-leading, efficient, and sustainable producer of safe, high quality and nutritious food products. It is vitally important that we continue to work together to ensure that we not only secure the future of the industry, but also the natural resources on which it depends.

I would like to thank the GHGIP for their proactive approach and continued commitment to driving this work forward and commend the ongoing efforts of the wider agri-food industry to reduce its carbon footprint.

Finally, I would urge all farmers to consider the opportunities they have to implement these on-farm efficiency measures and to avail of the support available from my Department.

Michelle McIlveen MLA

Minister of Agriculture, Environment and Rural Affairs

Executive Summary

Globally, climate change and a growing population are continuing to increase pressure on natural resources and the ability to produce food. We know that agriculture contributes to greenhouse gas (GHG) and ammonia emissions, but we also know that well-managed, efficient farms can contribute to many positive social, economic and environmental outcomes.

The agri-food sector is fundamental to the local economy, but as the largest source sector of emissions, we must do more to increase the efficiency of local production to maintain our world class reputation, and contribute to emission reduction targets.

Greenhouse Gas emissions arising from agriculture differ from other sectors, meaning a different approach is required. For most sectors the primary greenhouse gas is carbon dioxide, whereas methane and nitrous oxide are the emissions most associated with agriculture (along with ammonia, which causes nitrogen deposition). These gases arise from complex natural processes and are not easily controlled. Importantly however, the agriculture and forestry sectors are also unique in their ability to remove GHG emissions from the atmosphere through the process of carbon sequestration, storing carbon in soil and biomass such as plants, trees and hedges.

The agri-food and forestry sector is already taking action to minimise greenhouse gas emissions. Our **'Efficient Farming Cuts Greenhouse Gases Awareness Plan 2011-2015'**[1] marked the first steps on our journey towards a more sustainable agriculture sector. This has helped to drive progress towards greater on-farm efficiency and contributed to a reduction in greenhouse gases of 11% from peak agricultural emissions in 1998[2]. Furthermore, we will soon be able to demonstrate that the carbon intensity of milk production has reduced in the order of 25% since 1990[3], marking significant progress and confirming our dairy industry as one of the most sustainable and efficient suppliers to home and export markets. In this next phase we will extend this analysis to demonstrate efficiency gains in our beef production systems and we have prioritised the development of a robust framework to monitor and measure our progress.

We firmly believe that the most effective way for local agriculture to contribute to GHG reduction targets, without cutting or displacing production, is to continue reducing the quantity of carbon it takes to produce each unit of food (carbon intensity). We are confident that this can be achieved through the increasingly efficient use of resources and practices which improve carbon storage in our natural systems. Taking action to protect and conserve resources will not only reduce emissions and costs to the farmer, it can also result in a number of co-benefits on biodiversity, air, water and soil quality and contribute to broader sustainability objectives.

We will continue to support an efficient, resilient and competitive food sector through our 'Efficient Farming Cuts Greenhouse Gases Implementation Plan 2016-2020', which has been agreed by the Greenhouse Gas Implementation Partnership (GHGIP). The GHGIP embodies our shared commitment to a more sustainable agriculture sector, with representatives including food producers and processors, government and environmental interests.

Our combined efforts are focused on supporting the implementation of on-farm efficiency measures designed to reduce the carbon intensity of our food products, while simultaneously improving productivity and profitability.

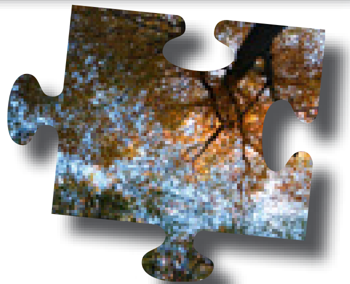
Priority on-farm actions are founded in the key themes identified in Phase One:

- Better Nutrient Management
- Better Livestock Management
- Improving Land and Carbon Management
- Increasing Energy Efficiency

Key financial, advisory, scientific and other support mechanisms to assist farmers and land managers to implement these efficiency measures are also detailed within the plan.

We recognise that sustainability is a journey of continuous improvement and this phase represents the next important step in our local roundtable approach to this global challenge. We will continue to link farm and environmental performance and our message to farmers remains that **an efficient farm is a more profitable farm, with a reduced carbon footprint.** We encourage all farmers to consider the actions they can take to boost their productivity and achieve positive environmental outcomes.

On 23 June 2016 the UK voted to leave the European Union. This implementation plan and support measures will be kept under review to reflect developments.



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1. Introduction

In summary

- Climate change will increase pressure on natural resources and the capacity to produce food on a global scale.
- The global population is growing and demand for food is expected to grow by 60% by 2050[4].
- Agriculture contributes to climate change through the emission of greenhouse gases, primarily methane and nitrous oxide, related to naturally occurring processes, which are more complex and harder to treat than in other sectors.
- Agriculture accounts for 92% of total ammonia emissions in NI, which act as a catalyst for Greenhouse Gases[5].
- The agri-food sector dominates the local economy and is the largest source sector of GHG emissions at 28%[6].
- Farming outputs are directly affected by the weather and climate, meaning production and profitability is highly exposed to climate change.
- Agriculture can also contribute to reducing greenhouse gas emissions through increased efficiency and by storing carbon in soil and biomass.

The Greenhouse Gas Implementation Partnership is a voluntary local partnership between the agri-food sector, science, government and environmental organisations, working together to tackle GHG emissions from agriculture. Our 'Efficient Farming Cuts Greenhouse Gases Strategy and Action Plan 2011-2015' set out a range of efficiency and good practice measures, designed to reduce the **carbon intensity** of our food products, while simultaneously improving productivity and profitability.

The plan has been renewed for the period 2016-2020 and outlines how we will continue to encourge and support the local agriculture sector to increase efficiency and productivity, while reducing the emissions associated with food production.

Carbon intensity explained:

Greenhouse Gas emissions are a natural consequence of farming systems and producing food will always result in some GHG emissions. Each unit of agricultural output (every litre of milk, kilogramme of beef, lamb, pork or poultry or tonne of vegetables) has a certain quantity of carbon emissions associated with its production. This is known as carbon intensity or emissions intensity. By lowering the amount of carbon it takes to produce each unit of output, a farmer can improve farm efficiency and their carbon footprint.

2. Background

2.1 The impact of climate change

Without action to tackle the GHG emissions which contribute to global temperature rise, climate change is projected to have consequences affecting all aspects of life, varying in severity according to regional and local factors. The **Climate Change Risk Assessment (CCRA) for Northern Ireland**[7] projects there will be greater climate variability and an increase in extreme weather events. The main threats for agriculture are flooding of agricultural land and new and altered patterns of pests and diseases. Building resilience is therefore an important part of a sustainable agriculture sector, alongside tackling emissions. More positively, the CCRA also identifies that there are potential opportunities for local agriculture to increase yields, grow new varieties of crops and to service the increased demand for food.

2.2 Climate Change Targets and Obligations[i]

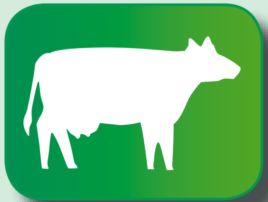
Climate obligations are currently set out in a series of international agreements and policy and legislation at European, UK and local levels. The UK Climate Change Act 2008, which extends to Northern Ireland, requires an 80% reduction in emissions across all sectors by 2050. In Europe, the Climate and Energy Package 2030 sets out an EU obligation to reduce total emissions by 40% by 2030. International commitments were renewed in the 2015 Paris Climate Agreement. While this recognises the need to protect food security, it also increases expectations on all sectors to further reduce emissions and hold global temperature rise below 2°C.

The relationship between farming and the natural resources it depends on, is also part of a broader framework of environmental policy, including the Common Agricultural Policy and the wider European Environmental Action Programme. These policy frameworks recognise the link between efficient farming practice and beneficial impacts on the wider environment and support action to conserve and protect the natural environment.

[i] Key climate policies are detailed in Annex 1.

2.3 Economic context

The agri-food sector is essential to the economic prosperity of Northern Ireland in terms of value, exports and employment.



Agriculture[8]

- Almost 70% of land in agricultural use
- 24,900 farms
- c.50,000 Total labour force
- Gross Value Added £351m

Food and Drinks Manufacturing[9]

- 21,000 FTE Employees
- Gross Turnover £4,596m
- Gross Value added £704m
- Over 70% of sales exported

The Agri Food Strategy Board (AFSB) recognises in its *'Going for Growth Strategy 2013-2020'*[10] that by making this sector more efficient and productive, there is further potential to boost economic growth, primarily through our export capacity, while also helping to address climate and food security challenges.

Increasing the sustainability of the sector will also ensure that it continues to be competitive in existing and new markets, as well as meeting the expectations of consumers, processors and retailers, who increasingly want to know that the products they select have been produced in a sustainable way.

AFSB 'Going for Growth' Targets

- **60%** growth in sales to £7bn
- **15%** growth in employment to 115,000
- **75%** growth in external sales to £4.5bn
- **60%** growth in "added value" to £1bn

Distribution of Agri-food employment in Northern Ireland

Image courtesy of NIFDA

3. Greenhouse Gases and Agriculture

3.1. GHG emissions by sector[11]

Agriculture 28%

Transport 21%

Energy Supply 19%

Residential 13%

Business 12%

Waste 3%

Other 2%

Land Use 2%

Total GHG emissions in Northern Ireland account for **4%**[12] of all UK GHG emissions

Agriculture accounts for **28%***
of GHG emissions in NI
or 5,780 tonnes of CO_2 equivalent[ii];
*Compares to EU average figure of **10%**[13] for agriculture.

92%[14] of NI's ammonia emissions relate to agriculture[iii]

[ii] Greenhouse Gas emissions are compared in terms of their Global Warming Potential (GWP) relative to CO2 and are expressed in units of CO2 equivalence (CO2e).

[iii] Although not a greenhouse gas, ammonia emissions are sometimes referred to as an indirect GHG and are closely linked to many of the farming activities which also contribute to GHG emissions. The GHGIP has therefore incorporated efforts to reduce ammonia into its approach.

3.2 Greenhouse Gas emissions from agriculture.

Greenhouse Gases are an unavoidable consequence of food production and one of the main challenges in reducing emissions is that most agricultural systems involve complex and variable natural processes. Methane and Nitrous Oxide are more powerful and difficult to control than Carbon Dioxide, meaning solutions available to other sectors are not as easily applied to agriculture.

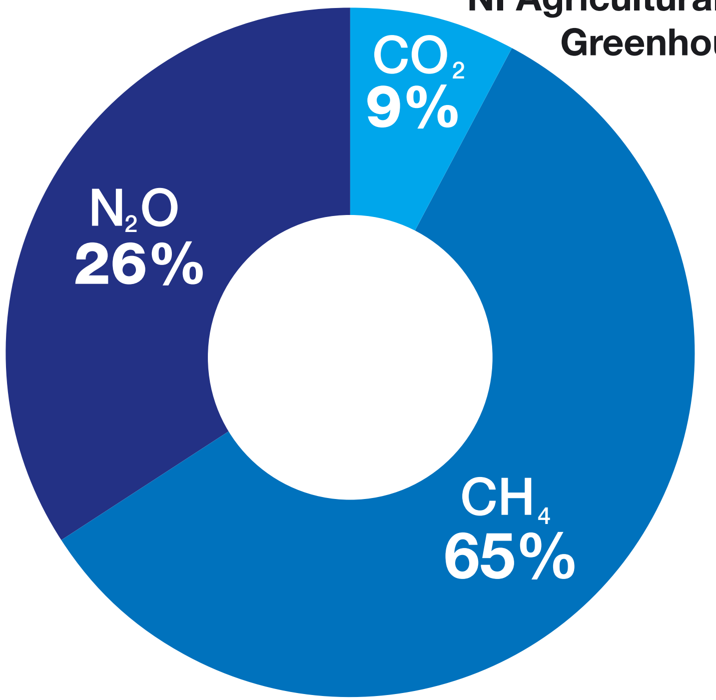
The nature of GHG emissions and the economic importance of the sector in Northern Ireland, mean that agriculture is the largest source sector of GHG emissions at 28%. This amounts to 1% of total UK emissions, however the average figure for UK and EU agriculture is much lower at around 10%. This gives a clear indication of the sector's fundamental importance locally and highlights the need for a sustained effort to make agricultural production as efficient as possible.

Carbon dioxide (CO_2)
- Relates mainly to use of fuel and energy for machinery, equipment, housing and storage.

Nitrous oxide (N_2O)
- Produced naturally by soils
- From chemical and organic (manure) fertilisers
- 298 times more powerful than CO_2

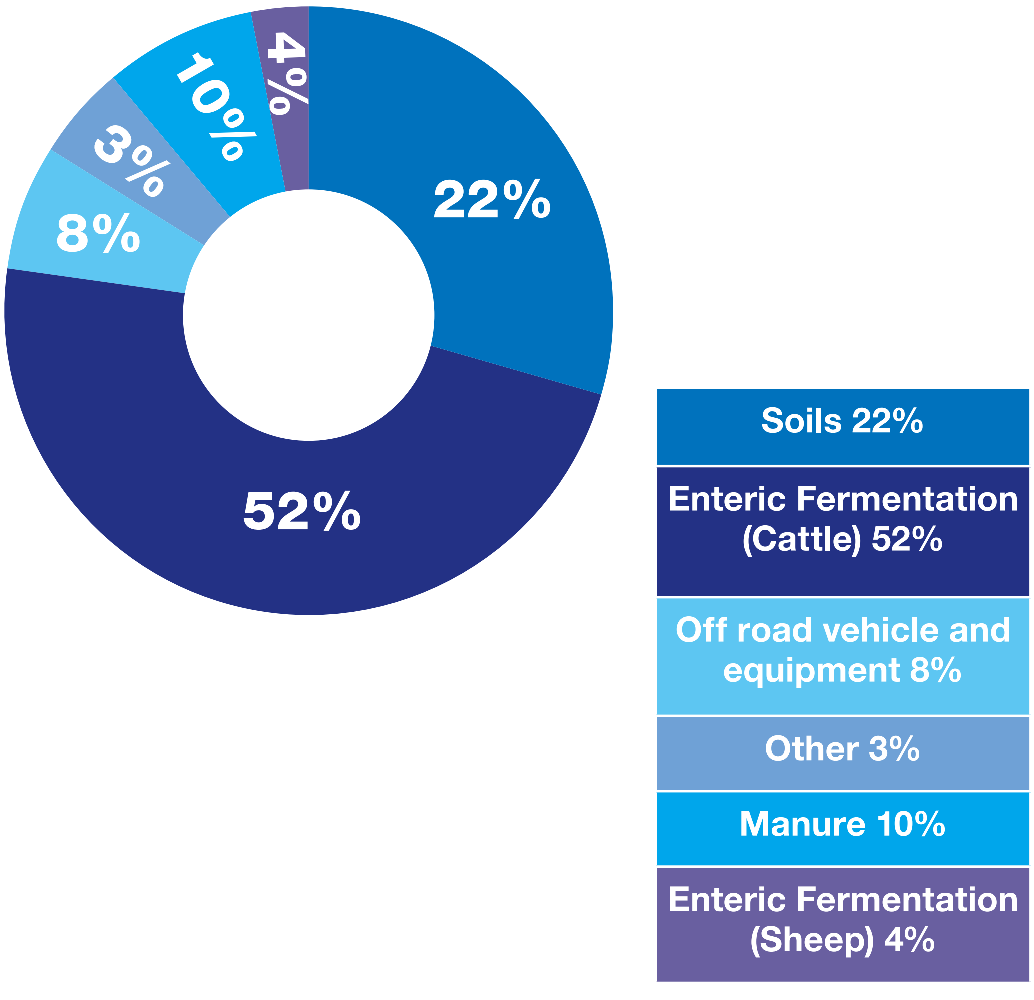
Methane (CH_4)
- Enteric Fermentation (digestion of ruminant livestock such as cattle and sheep)
- Manure management (e.g. storage)
- 25 times more powerful than CO_2

NI Agricultural emissions by Greenhouse Gas[iv]

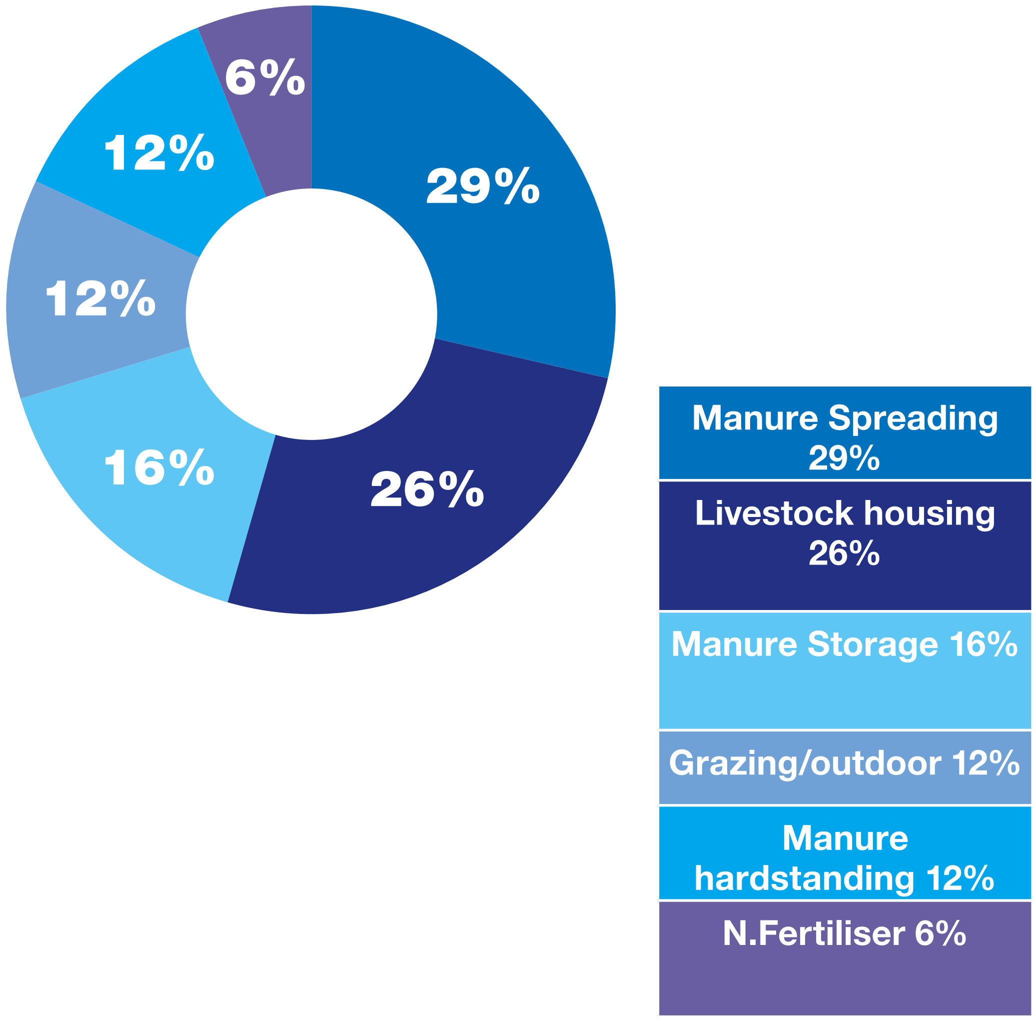


[iv] 2014 data NI GHG Inventory

Agriculture's GHG emissions by source (NI)[v]



Agriculture's Ammonia Emissions by source (NI)[vi]



[v] 2014 data NI GHG Inventory

[vi] 2013 data NI Ammonia Inventory

3.3 Carbon sequestration and storage in the agri-forestry sectors

While farming contributes to GHG emissions, it can also remove carbon from the atmosphere, storing it in soil, peatlands and biomass such as grass, trees and hedgerows. Increasing carbon sequestration can therefore provide an opportunity for the agriculture and forestry sectors to reduce net GHG emissions and provide additional benefits in soil, air and water quality, biodiversity and climate resilience.

Soils and grassland represent a substantial carbon sink (store) in Northern Ireland, although there is considerable uncertainty around the full potential. The GHGIP Sequestration Sub Group has commissioned, with support from DAERA and AFBI, local research to investigate this issue and provide the means for more accurate accounting of the carbon stored in grassland (see page 42). Since grassland also provides a natural source of feed for ruminant livestock, Northern Ireland has one of the more efficient and environmentally sustainable systems of livestock production.

Trees in woodland and hedgerows also make an important contribution to carbon sequestration. The abundant hedgerows locally could potentially have a substantial impact on Northern Ireland's GHG inventory, however they are not currently included in the accounting framework. The GHGIP will continue to pursue this inclusion to secure credit for on-farm actions which contribute to the removal and storage of carbon.

Relatively low levels of forest cover in Northern Ireland suggest that there is scope to expand, subject to the limits of land availability and suitable locations being identified. However historically there has been a low uptake of publicly-funded forestry schemes. Smaller scale planting through measures, such as agroforestry, including silvopasture, can therefore make an important contribution to the removal of carbon from the atmosphere. Support for these measures is available from DAERA (subject to necessary approvals).

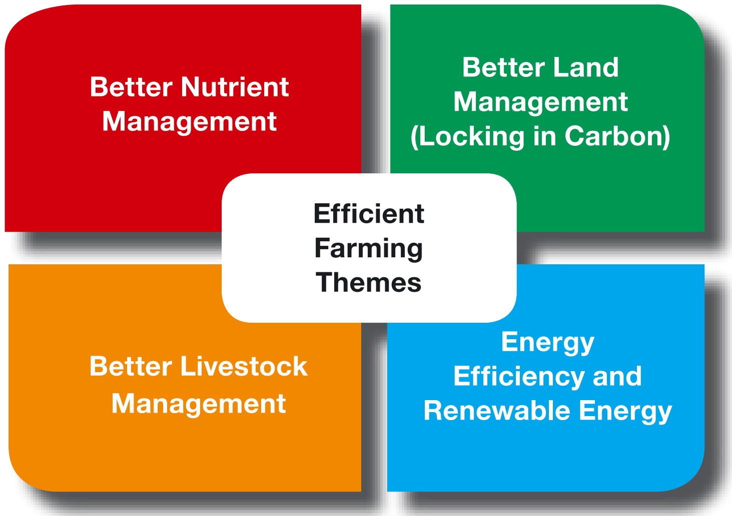
Peatlands are an important habitat and a major store of carbon, holding an estimated 200 million tonnes of carbon in Northern Ireland (about 50% of the carbon held in our soils). Damaging or destroying them can therefore release considerable quantities of carbon and reduce the quantity of carbon that could potentially be sequestered.[15]

Peatlands can also help to improve resilience to projected increases in intense rainfall and flooding as a result of climate change, through the ability to hold water and release it slowly. However climate impacts may also cause damage to peatlands for example through wildfires or cause them to dry out.

Support will therefore be offered via DAERA's Environmental Farming Scheme (subject to necessary approvals) for the management of this important natural resource.

4. Efficient Farming Cuts Greenhouse Gases Strategy and Action Plan 2011-2015

The Greenhouse Gas Implementation Partnership was formed in 2009 to tackle the issue of GHG emissions from agriculture. The Partnership published its first **"Efficient Farming Cuts Greenhouse Gases Strategy and Action Plan"** in 2011, to be delivered in a phased approach. Phase One focused on raising awareness of efficient farming practices, leading to improved business performance and reduced GHG emissions per unit of output. Four implementation themes were identifed.



Strategy aims:

- Improve the agriculture and land use GHG inventories by refining the measurement to include local circumstances;
- Research scientifically the potential for locking in more carbon in soil/grass;
- Encourage implementation, by communicating, firstly, to farmers and land owners and secondly, to customers, measures to achieve emissions reductions;
- Develop and integrate GHG reduction advice into existing services and investigate how the NIRDP 2014-2020 can be structured to support climate objectives.

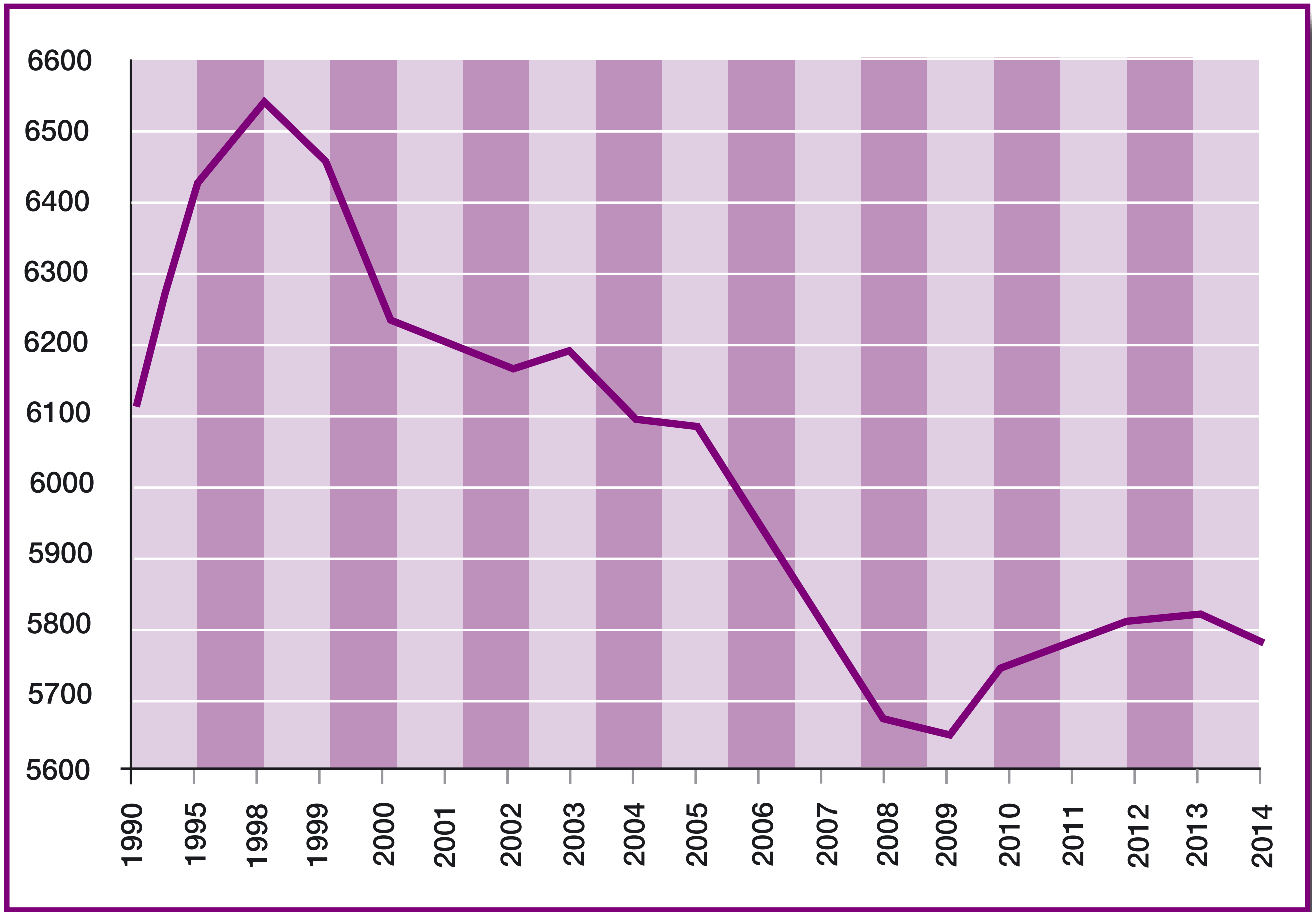
Key Principles

- Improving the resource efficiency of production and reducing emissions per unit of commodity output, whilst providing flexibility to meet future market demands.
- The agricultural GHG inventory should reflect progressive changes in local farming practices, such as improvements to livestock diets, nutrient and manure management.
- Recognition should be given to all other GHG costs and benefits associated with the industry, such as the contribution of on-farm renewable energy and the storage of carbon in grass, soils and plants.
- To capture existing good practice, and provide a potentially more cost effective way of addressing the climate change challenge than regulation.
- To proceed on the basis of voluntary actions based on good practice.

We are pleased to report substantial progress and some key achievements are highlighted in Section 5.

5. Our Progress

GHG emissions from agriculture 1990-2014 (KT CO_2e)



Local agriculture GHG emissions have reduced by:

5% since 1990

11% from peak GHG production in 1998[16]

5.1 Key achievements 2011-2015[vii]

£2m invested in state of the art demonstration facilities at the Greenmount Dairy Unit.	Publicity campaign targeting 14,000 farmers on the benefits of carbon intensity reductions.	Contribution to c.£13 million UK Agricultural GHG Inventory project.	An extensive programme of scientific research including: • Low carbon beef • Fertiliser application • Renewable Energy
£4.3 million grant assistance provided for NIRDP renewable energy projects	£7 million investment in efficient slurry spreading equipment through DARD Manure Efficiency Technology Scheme (METS).	Almost £1.5 million provided in grant support under the Biomass Processing Challenge Fund.	Over £240,000 offered by DARD for energy efficiency equipment through Tranche 3 of Farm Modernisation Programme.
Over 7,500 farm enterprises benchmarking their financial performance between 2011 and 2015.	Over 3,000 herds participating in voluntary BVD pilot scheme, leading to introduction of a compulsory BVD scheme in 2016.	Suckler Beef Programme on 8 demonstration farms highlighting a range of efficiency measures.	222 Farmers completed the Suckler Cow Fertility Challenge.
20,000 soil samples facilitated through DARD between 2011 and 2015.	Almost 2,000 farmers trained by CAFRE in land / soil management in 2011-2015	1,200 farmers trained by CAFRE in Nutrient Management, leading to the use of 4,500 Nutrient Management calculators.	Over 1,200 farmers trained in Soil and Sward Improvement since 2013.
GHG efficiency measures integrated into development of NIRDP 2014-2020.	Nearly 9,000 attending Renewable Energy training between 2011 and 2015.	c.2,500 farmers gaining Level II qualification on improving farm business performance.	c.3,500 farmers trained by CAFRE in livestock efficiencies in 2015/16.

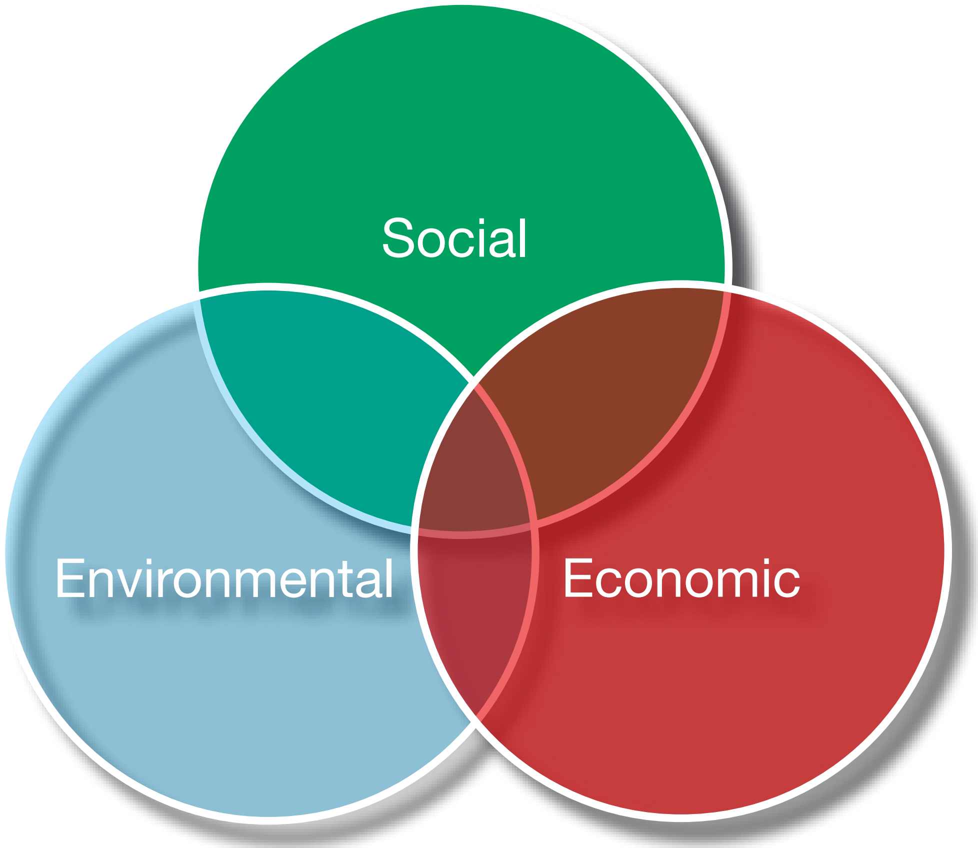
vii DAERA

6. Efficient Farming Cuts Greenhouse Gases 2016-2020

6.1 Our approach

This implementation plan is the next step forward for our 'Efficient Farming Strategy'. It retains the principles of our Phase One approach, developing and refining these for the latter half of the decade. Our aim in this second phase is to increase wider-scale implementation of efficiency measures by providing financial and advisory support.

We continue to believe that an approach based on increased resource efficiency and reduced carbon intensity offers the best route for the agriculture sector to fulfil its multiple objectives of food security, economic and social prosperity, alongside stewardship of the natural environment and a reduction in emissions. This is the foundation of the Efficient Farming Cuts Greenhouse Gases Implementation Plan.



Sustainable Agriculture

***Sustainable agriculture** is the efficient production of safe, high quality agricultural products, in a way that protects and improves the natural **environment**, the **social** and **economic** conditions of farmers, their employees and local communities, and safeguards the health and welfare of all farmed species.*[17]

A sustainable approach to agriculture is founded upon all three pillars and our efforts must equally consider each to ensure that positive outcomes are achieved in each area.

7. On-farm actions: Advice to farmers and landowners

This section summarises some of the key actions farmers, growers and land managers can take to increase efficiency and productivity, while simultaneously reducing GHG emissions (carbon intensity).

7.1 Better Nutrient Management Efficiency Measures

- Nutrient Management Planning
- Efficient Slurry Spreading Techniques
- Timing and Rate of Fertiliser Application
- Nitrogen Fixation by Clover/Sward
- Fertiliser type: urea based fertiliser with urease inhibitor

Nutrient Management Planning (NMP)

Good nutrient management planning involves applying nutrients based on crop need. This approach ensures that nutrients are utilised efficiently on farm and expensive chemical fertiliser is only purchased and used when necessary. In addition to making good economic sense, efficient nutrient planning will also reduce greenhouse gas emissions and improve soil fertility, which in turn can maximise crop production.

- **Soil analysis** should be carried out to check the nutrient status of fields before slurry or fertiliser is applied. Soil analysis will provide key information on the fertility of the soil and identify the type and amount of fertiliser needed to meet the crop requirement.
- **pH Levels** - Soil pH is vital to yield, but can decline over time. It is estimated that over 64% of soils in NI are below the optimum values of 6.5 (arable crops) and 6.0 (grassland)[18]. Grass yields can increase by up to 30 percent when the pH is raised to 6.0 from 5.0 – 5.5. This can also improve water quality through reduced diffuse pollution when soil indices are reduced from excessively high levels[19].
- **Slurry Nutrients** - Slurry contains valuable nutrients in the form of nitrogen, phosphate and potash which can significantly reduce the need for chemical inputs, saving money and emissions. **Slurry analysis** can establish the nutrient content and the amount of chemical fertiliser needed to meet crop requirement.
- **Nutrient management calculator tools** can be used to work out how much chemical fertiliser Nitrogen (N), Phosphate (P_2O_5), Potash (K_2O), Sulphur (S) and lime is required in addition to the organic manures applied. CAFRE's **Crop Nutrient Management Calculator** is available on the DAERA website.

Efficient Slurry Spreading Techniques

Efficient slurry systems such as the Trailing Shoe, Shallow Injection or Trailing Hose can[20]:

- Reduce GHG emissions and ammonia loss
- Reduce phosphorus run-off
- Provide a wider window of opportunity to apply slurry
- Allow higher slurry application rates
- Provide opportunities to use slurry on grazing fields

- Allow spreading to within 3 metres of a waterway
- Reduce odour from slurry spreading
- Increase grass growth by 25% compared with splash plate application, reducing fertiliser costs and use while improving yield.

Timing and Rate of Fertiliser Application

Application of chemical fertiliser above recommended rates, at inappropriate times or in unsuitable weather conditions can be costly to farmers and lead to unnecessary GHG and Ammonia emissions and water pollution from run-off. To prevent this:

- Nitrogen from manufactured fertilisers and organic manures should be applied at times and rates that match the crop uptake of nitrogen.
- Chemical and organic fertilisers should not be applied in unsuitable conditions e.g. on waterlogged, flooded or snow-covered land or if the ground has been frozen for more than 12 of the preceding 24 hours.
- Apply slurry four or five days before Nitrogen (N) fertiliser to reduce Nitrous Oxide (N_2O) emissions by up to 80%, compared to applying both slurry and Nitrogen (N) fertiliser on the same day[21].
- Variable rate fertiliser applicators can improve fertiliser use, by applying it only to areas where there is a need.

Nitrogen Fixation by Clover/Sward

Clover provides an important source of nutrients on-farm and can reduce the need for chemical fertiliser, potentially saving £33 per cow per year[22]. Nitrogen is vital to crop growth but some of this will be emitted as nitrous oxide and lost to the farming system.

- **White and red clover** are legumes that are capable of 'fixing' atmospheric nitrogen for take up by crops/grass, increasing carbon storage and reducing the amount of costly chemical fertiliser and associated emissions. Indirect GHG emissions in grassland systems can be reduced by 25% or more when relying on clover rather than N fertiliser[23].
- Clover can also increase the protein available for feed, improve stock performance resulting in increased milk yields, and improve lamb and beef performance.
- Recent science suggests that clover also has significant benefits for soil percolation, with water infiltration rates up to 14 times greater than perennial ryegrass, which can improve resilience to extreme rainfall events[24].
- Break crops can significantly reduce chemical fertiliser costs as part of a well planned rotation.

Fertiliser type: Urea based fertiliser with urease inhibitor

Recent research undertaken by AFBI in partnership with Teagasc, has shown NBPT (urease inhibitor) treated urea is a suitable year round fertiliser to replace CAN as the dominant N fertiliser for grass production under Irish soil and climatic conditions, reducing N_2O emissions *(see page 40 for more details of this research).*

7.2 Better Livestock Management

- Health and welfare
- Feed and nutrition
- Genetics and fertility
- Manure management

Livestock efficiency can improve the technical performance of livestock systems, lower the cost of production and reduce carbon emissions per kilogramme of meat or litre of milk. Close monitoring of livestock can pinpoint where improved practices and efficiency gains can be made. The key areas for farmers to focus on include fertility, genetic selection, health and welfare, feed efficiency and monitoring and analysis of the current production system[25].

Health and welfare

- Working with your vet to produce an **animal health plan** and focusing on disease prevention and eradication, can help to maximise performance and reduce wastage including emissions.
- Focusing on welfare of housed livestock, with particular attention to cow comfort and feed space allowances, will also contribute to improved health and performance.
- Lameness can have a significant impact on cattle health and productivity. Routine paring and foot bathing can help to prevent this, improving health and reducing costs.
- The eradication of production diseases will reduce the number of expensive herd replacements that are needed and reduce additional methane (CH_4) emissions from replacement heifers. Lowering replacement rates is a key way to reduce GHG emissions.
- Reducing disease levels will also increase stock performance and longevity, further reducing the carbon footprint per kg of carcase weight/milk.

Genetics and Fertility

- **Genetic Selection** for feed conversion efficiency produces higher live weight gains per kg of feed. The use of breeding tools for genetic selection is crucial when selecting sires.
- Improving **fertility** will reduce replacement rate and maximise output per breeding female, boosting productivity and reducing costs.
- Using tools and technical advances such as the **Profitable Lifetime Index**[26], **sexed semen**[27] and **Estimated Breeding Values**[28] can increase productivity levels and reduce carbon emissions through the selection of animals for particular genetic traits.
- Efficient practices such as **24 month calving**[29] and **early finishing** will also reduce costs and carbon emissions.

Feed and Nutrition

Efficient and precision feeding practices can help to reduce feed costs and increase productivity.

- **Feed analysis and additives** can identify nutritional content and meet precise requirements, thereby reducing waste and contributing to improved carbon efficiency.
- **Reducing concentrate feed** is a key way to save money, reduce GHG emissions as well as the phosphorus balance.

- **Maximising home grown feed, improving yield and forage quality.** On beef and sheep farms there is a direct relationship between forage utilisation and gross margin. Each 100kg of beef gained from forage is worth an extra £100 of gross margin per suckler cow. For every 10kg of lamb produced from forage, this generates an extra £15 gross margin per ewe[30].

Manure Management

Efficient manure management practices can reduce GHG and ammonia emissions, as well as water pollution caused by run-off.

- Measures such as adequate slurry and dirty water storage capacity, slurry separation, scrapers and covered stores can all help address losses to the atmosphere of GHG and ammonia emissions[31].
- Anaerobic digestion, where appropriate, can help to make better use of on-farm resources to generate an energy supply and reduce energy costs and emissions. There are high initial capital costs and it is important that the feasibility of an AD development is considered in detail. Further advice is available from CAFRE.

7.3 Energy and Fuel Efficiency Measures

- **Increasing energy and fuel efficiency on farm**
- **Installation of renewable energy technologies**
- **Energy crops**

While Carbon Dioxide (CO_2) emissions from on-farm energy use make up a small proportion of total emissions, energy use represents a significant cost to the farmer. Field operations, heating, cooling, lighting, air circulation and ventilation are all significant uses of energy and finding ways to make these more efficient can represent a significant saving in financial and energy terms[32].

Energy and Fuel efficiency

- Check energy tariffs and monitor energy and fuel bills to identify potential savings;
- Use well maintained and appropriately calibrated vehicles and machinery to reduce fuel costs and use;
- Switch to efficient lighting such as fluorescent tubes, compact fluorescent lamps (CFLs) or light-emitting diodes (LEDs);
- Use and adjust timers, switches and controls for equipment and lighting;
- Check building ventilation and insulation;
- Use GPS and monitoring tools.

Renewable Energy can provide an opportunity for farm businesses to make better use of their own resources, diversify and reduce costs over the longer term. DAERA supports the adoption of Renewable Energy technology by providing training, advice, research and demonstration facilities.

Growing energy crops such as Short Rotation Coppice Willow can also provide a renewable source of fuel, displacing fossil fuels, minimising soil disturbance, thereby protecting carbon stores and improving biodiversity.

In arable and horticulture systems opportunities to reduce costs and emissions include[33]:

- Fuel efficient tractors and machinery - modern equipment and technology, such as GPS, alongside regular cleaning and maintenance, can optimise fuel use and field operations.
- More efficient electric motors in potato and grain stores; energy efficient light bulbs; effective insulation; and effective management of potato stores will reduce electricity use, energy costs and carbon emissions. Moist grain storage can result in large energy savings when compared to drying grain prior to storage.
- Reducing cultivations – minimum tillage and direct drilling can reduce the energy required for the establishment of crops and help to conserve carbon in soils.
- Efficient glass houses which effectively distribute heat can lead to significant energy savings.
- Removing unnecessary louvres and larger air inlets will promote more efficient air movement and installation and management of an integrated environmental control system can help to increase efficiency and reduce costs.

In livestock systems opportunities to reduce costs and emissions include:

- **Dairy farms** - fuel efficient tractors will reduce diesel use; more efficient vacuum and milk pumps in milking parlours; high efficiency plate cooling systems or heat recovery systems and energy efficient light bulbs will help to reduce energy use and costs as well as carbon emissions[34]. CAFRE's state of the art demonstration facilities at the Greenmount Dairy Unit showcase a range of these efficient technologies[35].
- **Pigs and Poultry** - efficient heating and ventilation systems; accurate controls; efficient lighting; and regular maintenance of equipment will save energy and associated costs[36]. Biomass boilers in poultry houses can also result in efficiency gains from energy use and of improved bird health[37].

7.4 Improving Carbon and Land Management Efficiency Measures

Locking in carbon:

- **in grass and soil, through improved land management;**
- **through restoration and management of peatlands;**
- **through creation of new, and management of existing, woodlands and hedgerows.**

The way in which land is managed can have a significant effect on the amount of carbon stored in soils, grasslands and peatlands.

Sub-soiling can **improve drainage** on agricultural land by reducing compaction and aerating plant roots which can reduce water logging and carbon losses. This can also improve nutrient uptake by the crop leading to a reduced fertiliser requirement.

Managing farm land **soil pH** can help to increase productivity while also reducing emissions. Soil sampling and applying lime in recommended quantities can result in improved nutrient uptake, yield and drainage capacity.

Other ways to boost sequestration and storage capacity are **planting winter cover crops** to add **organic matter** and locking in more carbon; **planting crop margins; planting hay or pasture** in rotations with annual crops; and changing **grazing practices** on environmentally sensitive lands. Beneficial grazing practices may include keeping live stock from stream banks, properly resting pastures to restore degraded land, and determining the proper duration and season for grazing pastures.

Reducing tillage intensity may also help to reduce emissions, although there is some scientific uncertainty around the impact of this practice on *carbon storage*. However reduced tillage farming and other forms of conservation agriculture can mean fewer tractor passes are needed, reducing *carbon emissions*. Reduced tillage may also have additional benefits such as increased soil water storage and water use efficiency; reduced establishment costs and increased soil structure and organic matter.

Action to **restore degraded peatlands** can have a beneficial impact on **GHG** emissions and removals, as well as restoring important habitats, improving biodiversity and improving climate resilience.

Planting new, and managing existing, woodland can offer significant potential to sequester and store carbon in biomass and soil. Significant sequestration benefits stem from the establishment of woodland within traditional agricultural systems. Research has found that agroforestry systems can store up to 3.8 times more carbon than ryegrass pasture[38]. In silvopasture, grazing stock and trees are combined on the same land base. AFBI trials at Loughgall found that grazing sheep within planted trees had no appreciable reduction in livestock grazing capacity for 12 years[39].

Hedge planting and management, including growing hedges taller and wider, can provide further opportunities to increase the capture of carbon on-farm.

Many of these measures are supported within DAERA's Environmental Farming and Forestry Schemes (subject to necessary approvals).

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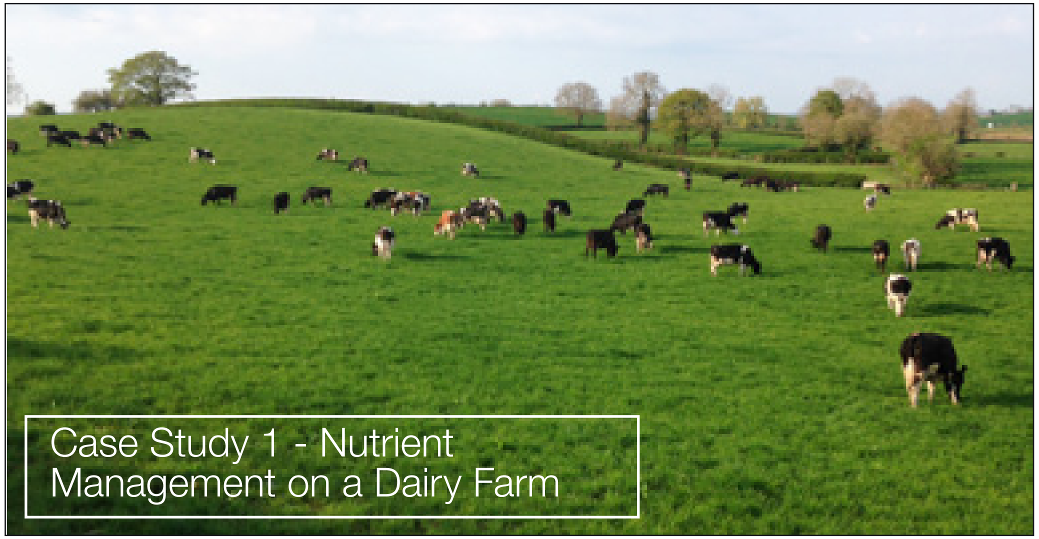
8. Case Studies



Background

Philip Clarke and his son David farm near Ballygawley in Co. Tyrone. The farm extends to 46 hectares. Half of the land area is available as a grazing platform for the dairy cows. The remaining 23 hectares are used for youngstock grazing and silage making.

The main enterprise is a herd of 75 to 77 spring calving dairy cows plus 20 to 25 replacement heifers. David also manages a broiler breeder unit, while Philip has off farm employment in addition to managing the dairy herd. Their objectives are to grow and utilise as much grass as possible to produce a high level of milk solids to be sold off the farm. They want to do this from on farm resources in a way that is sustainable for the longer term.

Cow genetics

The Clarkes have bred a dairy cow suited to grazing grass and producing high solids milk over the past 10 year period. Higher milk solids lead to a higher milk price and significantly reduce the amount of water transported to a processing plant to be evaporated off. Crossbreeding with Montbeliarde, Swedish Red and Friesian sires has now progressed to the use of mainly New Zealand Friesian and Jersey genetics. Target body weight for mature cows in the herd is 525 kg.

Milk solids yield per cow in the year to 31 March 2016 was approximately 420 kg with a milk volume of 5,400 litres at 4.20% butterfat and 3.60% milk protein. Concentrate feeding level was between 300 and 350 kg per cow. Milk from forage is almost three times the Northern Ireland average at over 4,600 litres per cow. Breeding a lower body weight cow, optimising the utilisation of high energy content grass and minimising concentrate feeding in a technically efficient management system all contribute to reducing the greenhouse gas emissions per litre of milk sold from the farm.

Grassland management and grass budgeting

Grazed grass management is critical to herd performance according to Philip, with seasonal grassland management starting from October. Grazing swards out cleanly in the autumn, while avoiding poaching, are critical to having grass available for grazing the following February.

David walks the farm on a weekly basis to measure grass cover on the farm. Measurement is carried by grass quadrant clipping and weighing. Grass cover is then calculated using local grass dry matter data published online. Weekly grass budgeting decisions are made with the help of the online Agrinet software. This software also allows the Clarkes to assess grazed grass yield which was 12 tonnes of dry matter per hectare in 2015.

Reseeding

Reseeding decisions are based on grass growth information with soil fertility status getting a greater focus recently. Between 2 and 6 hectares are reseeded annually with highly productive grass varieties. Reseeding is carried out in mid season (May/June), while grass on the remainder of the farm is still growing vigorously, to ensure that the new swards are productive by the time grass growth rates have fallen off in autumn.

Nutrient management

Most of the slurry on the farm is spread by contractor in spring and early summer to optimise nutrient utilisation. Soil analysis is carried out every two years. Lime is applied based on soil analysis results to achieve a soil pH of 6.5 across the farm to optimise grass growth and fertiliser nutrient utilisation.

Replacement heifers

Replacement heifers are reared to calve at 24 months of age. This helps to reduce rearing costs and greenhouse gas emissions from having less non-milking stock on the farm. The replacement heifers are bred from sires selected from the Republic of Ireland EBI list. Key sub-indices on which sires are selected include milk solids yield and fertility.

Herd health

All new-born calves are fed 3 to 4 litres of colostrum within 2 to 6 hours of birth to optimise calf immunity and growth rates to achieve the necessary heifer service weights for calving at 24 months. All calves are BVD tissue tagged at birth.

Energy and labour efficiency

The farm milking parlour has been extended on 3 occasions to currently accommodate 11 milking units in a swing-over herringbone arrangement. The simple upgrades have reduced the time taken to milk the herd and hence the electrical power required to drive the plant. Photo voltaic (PV) panels, with output potential of 6.5 kWh, were installed in 2014. Half of the electricity produced is used on farm and half is exported. Milk is pre-cooled prior to storage in a direct expansion tank. Electricity costs are minimised through the use of a night rate electricity tariff.

Once-daily milking in the month of December has been adopted as a management practice for several years, before the complete herd is dried off prior to Christmas. Given the declining milk price in 2015, once daily milking was also practiced through October and November. Only marginal impacts were observed on milk output volume, which was largely cancelled out by improved milk compositional quality, compared to 2014. The marginal impact observed on milk output was not deemed to justify the extra labour input required to milk the herd twice daily at this late stage of lactation. Philip did not experience any adverse impact on milk somatic cell count.

Summary of farm management factors reducing greenhouse gas emissions:

- High yields of high quality grazed grass increase the energy density of the diet
- Soil fertility is important to ensure the best return from purchased fertiliser
- Cows bred for a low concentrate input grazed grass system with reduced mature body weight
- Replacement heifers reared to calve into the milking herd at 24 months
- Investment in energy and labour efficient equipment to improve labour efficiency and GHG emissions.

Allan Chambers farms 106 hectares at Seaforde, near Downpatrick, in share-farming partnership with his nephew Neill Patterson. This is a relatively new concept which has been pioneered by the Chambers family in Northern Ireland. The partnership is based on Allan & Neill combining their assets, skills and experience in terms of land, machinery, agronomy and labour.

The cereal yield figures for the farm are impressive, with 2014 harvest yielding 8.86t/ha for Winter Barley and 9.60t/ha for Winter Wheat, placing the farm in the top 25% of farms benchmarked in NI. An additional 25.3ha of Forage Maize is also grown for supply to a local anaerobic digester. These yield figures are achieved through 3 key areas, all of which help reduce the emissions per ton of cereal produced.

1. Efficient use of nutrients

Allan & Neill continue to apply all crop nutrient requirements on the basis of soil analysis and according to the DEFRA RB209 fertiliser manual to maintain yields and avoid waste. They achieve further efficiency and carbon reductions through the use of organic manures, broiler litter of which the farm uses 400 tonnes per annum, replacing approximately 50 tons of chemical N fertiliser. Soil indexes for both P & K have been improved and maintained at optimum levels with the added benefit of increased earthworm populations thus improving soil condition and easing cultivations.

2. Good crop rotations

Allan continues to focus on the overall farm efficiency and recognises the benefits of break crops both in improving soil structure and in spreading workload. Spring break crops are the key focus as these fit best with the efficient use of organic manures by ensuring the maximum availability of the nitrogen. Forage Maize grown as a break crop is supplied on contract to a local Anaerobic Digester. The current rotation is a three year cycle: Forage Maize followed by Winter Wheat & Winter Barley. A cover crop of stubble turnips is established immediately post Winter Barley harvest and grazed off by sheep thorough the following autumn, prior to spring planting. This further maximises land utilisation, improves soil structure; reduces potential erosion and nutrient leaching as well as increasing carbon storage.

3. Effective land use

With the assistance of the premium woodland and farm woodland grant schemes, 12.6 Ha of established native woodland grown on less productive cropping areas are managed to produce wood. This contributes to a more efficient arable crops enterprise, improved biodiversity, and also created a carbon sink on the farm.

4. Renewable energy production

Four wood pellet burners have been installed on the farm each with an output of 99 kWhr. Three of the burners are providing heat for the 2 poultry houses with the fourth heating the workshop and grain storage area. Future plans would be to utilise the heat from the wood burners within the grain drying operation, thus replacing the need for the current oil fuelled drying system.

Poultry Production on farm

For many years poultry litter was imported on to the farm. In 2016 two poultry house were commissioned, both with capacity for 56,000 birds. With potential for 7 crops per year poultry organic manure output is expected to be 455 ton/year. The majority of this organic manure will be utilised on the farm; negating the need to import organic manure, reducing transport costs and increasing the farms self sufficiency.

Benefits seen

- Costs have decreased
- Chemical fertiliser usage has decreased
- Improved soil condition
- Easier cultivation
- Spread of workload
- Better field efficiency
- Improving efficiency has reduced carbon emissions
- Increased yield
- Improved biodiversity
- Reduced reliance on imported manures.

Challenges faced

- Increased management required
- More co-ordination of field operations required
- Ensuring timing of operations fits with rotations
- Making sure nutrition levels are optimised for each crop
- Ensuring compliance with regulations

Background

The Steele family of Thomas, his brother Samuel and father William farm near Kircubbin in the Ards Peninsula. The farm extends to 280 Ha of which 50% is rented on a conacre basis. The main enterprise is a herd of 500 dairy cows with herd numbers maintained through rearing 180 replacement heifers. Annual milk sales per cow are almost 10,000 litres produced from high quality forage and supplemented with less than 3,000 kg of concentrates per cow. Milk from forage is considerably above the local average at over 3,300 litres per cow.

Forage utilisation

Conserved forage quality is critical to maintaining herd performance according to Thomas. Four cuts of grass silage are taken annually starting in late April or early May each year. Thomas: says “we aim for a dry matter of 25 to 30% and an ME level as high as we can and a protein level of 16 to 17%. Silage analysis is carried every six weeks to take account of any variations in forage quality.

In addition to grass silage, 40 Ha of forage maize are grown to provide about 40% of the milking cows forage intake. Target quality is 30% DM and 30% starch. To balance the lower protein content of the maize silage, 8 Ha of Lucerne are grown annually without the need for any fertiliser input given the plants ability to fix its own nitrogen supply. The fibre content of the Lucerne removes the need for straw in the diet in Thomas’s experience.

Nutrient management

All the slurry on the farm is spread where conditions allow using a trailing shoe tanker. Thomas says that as well as the savings in fertiliser from using the trailing shoe system, he has had favourable comments on the reduction in smell from slurry spreading from residents in Kircubbin village. Slurry is applied 4 to 5 days before nitrogen fertiliser to reduce nitrous oxide emissions. Thomas also believes this helps the grass yields of second and third cuts.

Having been involved in farm research projects with AFBI and Cafre, Thomas has seen the practical benefits of soil analysis and nutrient management planning. Forage maize is grown with slurry only and most of the grass silage is grown from slurry plus straight nitrogen fertiliser. Straight nitrogen supplemented with sulphur is applied to the grassland twice a year to meet the grass crop sulphur requirement on the relatively light soils in the area.

Replacement heifers

Replacement heifers are reared to calve at 22 to 23 months of age. This helps to reduce rearing costs and greenhouse gas emissions from having less non-milking stock on the farm. Thomas also finds that it helps to improve cow longevity as the younger calving heifers are much easier to get back in calf. The replacement heifers are all bred from high PLI sires with positive sub-indices for fertility and longevity with the aim of reducing herd replacement rates in future.

Herd health

All new-born calves are fed 4 litres of colostrum within 2 hours of birth to optimise calf immunity and achieve the necessary heifer service weights to calve down before 2 years of age. All calves are BVD tissue tagged at birth. Disease status of cows in the herd is closely monitored through bulk milk sample screening and twice yearly individual animal testing for Johne's disease. A comprehensive vaccination schedule for infectious diseases is closely followed, supervised by the farm vet.

Energy efficiency

When a new rotary milk parlour was installed, the Steele family included a variable speed vacuum pump and a heat recovery system in the specification to reduce electrical power consumption and running costs.

Summary of farm management factors to reduce GHG emissions:

- High dairy cow milk yields diluting maintenance feed requirements
- High yields of high quality forage increase the energy density of the diets
- Investment in energy efficient equipment
- Efficient nutrient management planning and excellent utilisation of slurry nutrients
- Replacement heifers of high genetic merit reared to calve into the milking herd at an young age
- Good disease management protocols to ensure high levels of animal performance

Case Study 4 - Cow fertility at Greenmount

One of the biggest drivers of profitability, efficiency and greenhouse gas emission reductions is cow fertility. It has long been known that crossbred cows with more hybrid vigour are more robust and fertile but often there is no specific strategy in place to capitalise on the benefits. A three-breed rotational crossbreeding policy (Shorthorn, Aberdeen Angus and Limousin) is implemented at Greenmount's hill farm to optimise hybrid vigour alongside a series of management practices and new technologies which aim to increase output and efficiency.

Cows only run with the bull for 3 oestrous cycles which results in a compact calving, increasing average calf weight at weaning and also ensures breeding from the most fertile stock. All replacement heifers are born on the farm and are selected from cows which conceived to their first or second heat, which improves fertility in the long term. Indeed, cow fertility at the hill farm is excellent with calving interval for 100 cows averaging 374 days compared with the national average of 410 days. A synchronisation and AI protocol is implemented with replacement heifers, which allows the use of bulls with superior genetics for ease of calving traits. Stock bulls for the mature cows are also selected for maternal and terminal traits based on their estimated Breeding Values (EBVs). In addition, the hill farm is a member of the AFBI herd health scheme and is routinely screening for BVD and Johne's disease and also has a vaccination programme for a range of other diseases in place. The result is a crop of calves each year with high genetic merit and health status to be transferred to Greenmount's 90 ha Abbey farm for growing and finishing into the food chain using high quality silage and grazing grass/clover swards.

Shorthorn cattle are marketed through Hannan Meats of Moira and are eligible for a valuable premium over conventional beef price. Likewise, a bonus scheme is available for Aberdeen Angus cattle marketed through Aberdeen Angus Quality Beef Ltd, slaughtered in Foyle Food Group and retailed through Tesco. Limousin cattle are marketed through ABP Lurgan and are destined for ASDA.

CAFRE Greenmount is focused on improving cow fertility and efficiency to ensure that more stock with good growth rates are produced, which enhances profitability and reduce GHG emissions.

Case Study 5 - Livestock Management on a Beef Enterprise

John & Jonathan Carson manage an organic 100 cow suckler to beef farm extending to 166ha near Downpatrick Co Down. No chemical sprays or chemicals are used and all feed is home grown. To achieve high performance in their finishing cattle during winter, 14ha of cereals are grown. Obtaining organic protein is a real challenge so high protein red clover silage is grown to accommodate this requirement. The farm is situated in a low rainfall area and is free draining so an early turnout and extended grazing seasons are possible. Grass budgeting and block grazing techniques with up to nine grazing divisions per stock group and forward creep grazing are used to further extend the grazing opportunities. White clover is also used in grazing swards as this fixes atmospheric nitrogen, has a higher protein content and improves animal performance over a grass only sward. Reseeding is carried out regularly using the under-sowing technique and recommended list grass varieties are used to get maximum production from newly established swards.

Stock bull selection is based on their Estimated Breeding Values (EBVs) for terminal and maternal traits. Some home-bred heifers are retained each year but a proportion of the annual replacement heifer requirement can be sourced from non-organic herds. John & Jonathan have a relationship with a neighbouring dairy farmer who supplies beef cross dairy heifers which maximises hybrid vigour and milk production. Heifers are screened for a range of diseases before they are brought onto the farm. All finished stock are marketed to ABP for the organic range in Sainsbury's and obtain a significant premium over conventional beef price. Typically, steers are sold from 23 to 26 months of age at an average carcase weight of 390 kg with heifers reaching 320kg carcase weight at 20-22 months.

John & Jonathan Carson work closely with their Cafre adviser and are keen to implement new technologies to maximise output from their organic farm to improve efficiency, profitability and reduce GHG emissions.

Case Study 6 - Livestock Management on a Sheep Farm

Isaac Crilly runs a flock of 450 ewes on 28 ha (16 ewes/ha, 6.5 ewes/ac) of lowland near Castlederg Co Tyrone making it one of the most densely stocked sheep farms in the province. Isaac's focus is on having an efficient and profitable flock that maximises output from grass, meets market specification and reduces Greenhouse Gas emissions.

How is it done?

Ewes

A three-breed rotational crossbreeding policy is implemented with all ewe lambs retained from within the flock from the most prolific ewes using the Hillsborough Management Recording Scheme. Currently Isaac's flock is achieving a weaning efficiency of 87%, i.e. for each kg of ewe weight maintained 0.87kg of weaned lamb is produced.

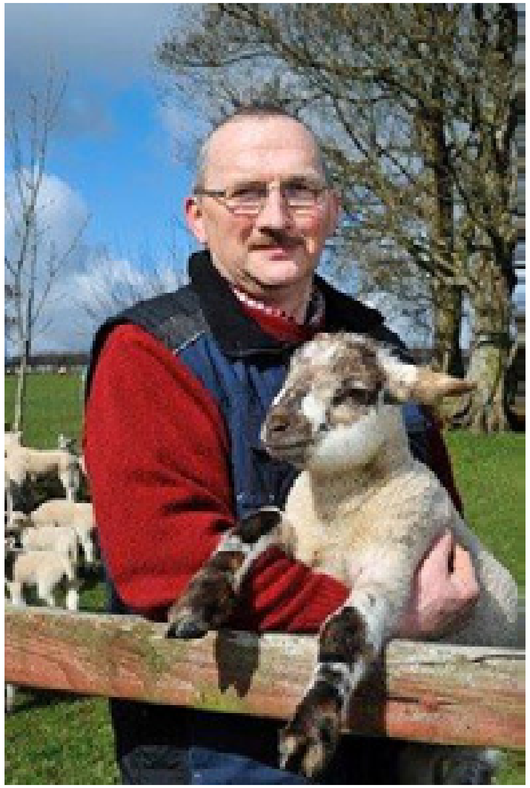
Rams

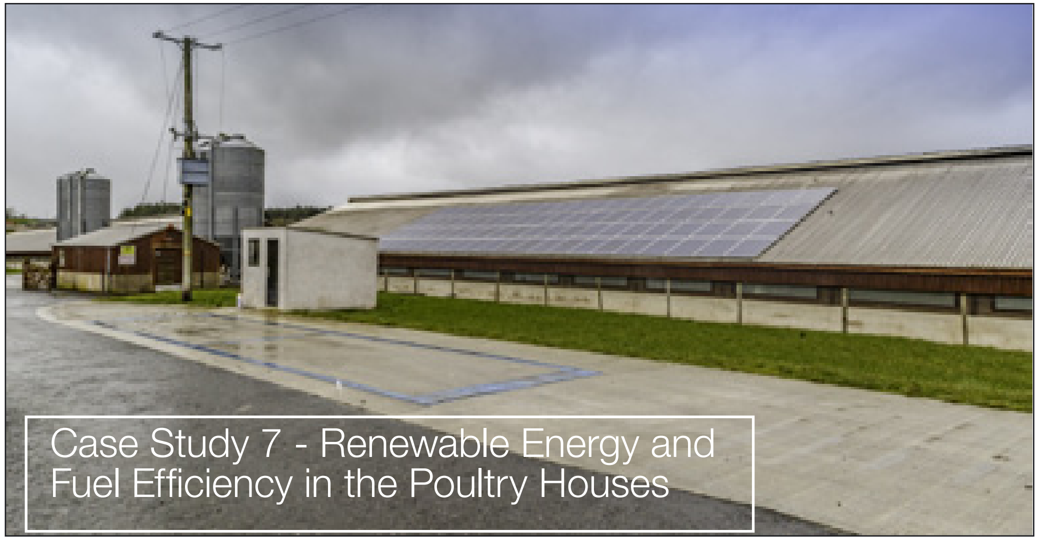
The only animals brought onto the farm are stock rams. Some of these are pure breeds while others are composite breeds which capture additional hybrid vigour. Rams are selected based on performance figures for their maternal capabilities (when breeding replacements), carcase quality (when used as a terminal sire) and worm resistance to reduce anthelmintic usage which in turn reduces the likelihood of developing wormer resistance.

Isaac implements an all concentrate precise nutritional feeding programme for pregnant ewes based on body condition score and predicted litter size. No silage is made on the farm due to the extremely high stocking rate. However, weight of carcase produced per ha is more than double the benchmarking average.

All finished lambs are marketed to Dunbia via Tyrone Quality Livestock which provides important carcase feedback which informs breeding goals and ram selection.

Isaac works closely with AFBI and his Cafre adviser and is continually striving to improve biological efficiencies on the farm which in turn drives profitability and GHG reductions.





Background

Fred Maxwell owner of Maxwell Farms based in the Clogher Valley, Tyrone has ten poultry houses, holding 270,000 birds. Each house measures 250ft x 57ft. The farm was using over 200,000 litres of gas costing £80,000 per year for heating alone, causing significant financial pressure on the business.

Carbon Reduction Measures

An opportunity was sought for the farm to reduce energy costs and improve the overall sustainability of the business by implementing carbon reduction measures.

Whilst Fred considered his options, he attended CAFRE's Practical On -farm Renewable Energy event at Enniskillen and Heat from Biomass workshops at Enniskillen and Colebrooke Park, Brookeborough. Following discussions with CAFRE technologists and renewable energy companies, a program of carbon reduction measures was put into place.

The program involved installing a 99kW woodchip boiler for each of the poultry houses on the farm. On considering options for fuel delivery to the farm, the remaining two houses had 99kW pellet boilers installed. The biomass systems provide heating through indirect water to air heat exchangers. It has been noted that this generates a more beneficial heat for the birds with improved air quality, humidity control and litter management throughout the crop cycle improving overall bird performance.

A 20kW Photo Voltaic (PV) system was also installed on the farm, to reduce dependence on mains electricity and provide further reduction in carbon output. An additional 6.5kW system has been installed on the farmhouse.

Future Plans

Fred would like to utilise the farm's own fuel supply and is considering the installation of a woodchip drying floor using biomass to provide the heating required. It is also the intention that the existing gas boiler back up heating system will be replaced with biomass boilers.

Benefits of carbon reduction program to date

- **Fuel cost reduced by over 50%**
- **CO_2 output reduced by over 80%**
- **Ammonia emissions reduced**
- **Costs further curtailed by the Renewable Heat Incentive**
- **Payback from Capital spend in under 4 years**
- **Improved bird health and performance**

9. Support to Implement On-Farm Actions

The 'Efficient Farming Cuts Greenhouse Gases Implementation Plan 2016-2020' provides the framework through which we will continue to provide support to farmers and land managers to reduce the carbon intensity of production over the period. Priority activities are planned under five key areas:

Activity Area 1 - Supporting and facilitating implementation of efficiency measures

Our primary aim is to increase the implementation of on-farm efficiency measures which reduce the carbon intensity of agriculture and boost the profitability of farm enterprises. The Northern Ireland Rural Development Programme 2014 – 2020[40] (subject to necessary approvals and future policy changes) has been designed to help achieve this and will act as a key delivery mechanism. Details of the support measures to help farmers and land managers to address climate and environmental objectives are available at the DAERA website.

Action Area 2 - Improving monitoring and measurement of Progress

Carbon Intensity Indicators

The GHGIP is supporting work to develop a scientifically and statistically robust method of calculating an average figure for the carbon intensity of Northern Irish milk each year from 1990. This will help to address the challenge of measuring the impact of efficiency measures and vastly improve our ability to monitor performance. The calculator will clearly demonstrate the efficiency gains made as well as identifying key emission factors. This in turn will help us to target future advice and actions and direct our ongoing reduction ambitions.

Preliminary results show that the carbon intensity of local dairy farms has reduced the order of 25% from 1990[41], significantly below the global average and among the top performers[viii]. A statistical bulletin will be published with full details when the work is complete. Development of a similar methodology for the beef sector will commence thereafter.

Tracking our progress

The Greenhouse Gas Implementation Partnership will continue to support implementation of this plan and oversee its progress. We will produce a framework of key indicators in the first year of the plan to track our progress over the period 2016-2020. A huge amount of information is already collected and this will be supplemented with indicators associated with the current NIRDP and developed into a suite of output indicators for this plan. While this cannot track a direct relationship between an on-farm action and carbon intensity, it will provide a meaningful gauge of progress on key areas and complement both the GHG inventory and carbon intensity indicators.

GHG Inventories

We will continue to support the c.£13m **UK Agriculture GHG Inventory Project**[42] as it seeks to improve the accuracy of accounting for methane and nitrous oxide emissions from agriculture. An improved inventory will be implemented in 2016 and a fully revised model is planned for 2017. This should enable greater precision in reporting GHG emissions from the sector and take account of specified on-farm efficiency measures and will also assist government, working with industry, to identify and target further measures to reduce emissions.

[viii] Methodologies for calculating carbon intensity differ in different regions and use different emissions factors

Efforts are also ongoing to ensure that the revised Agriculture GHG inventory is better aligned with the "**Land Use, Land Use Change and Forestry**"[43] (LULUCF) inventory. The LULUCF inventory is concerned with both GHG emissions and removals, although removals are primarily related to Forestry. The European Commission is currently considering how to integrate the LULUCF sector into the Climate and Energy Package 2030, as reflected in the recent Paris Climate Agreement (COP21). Locally we are pursuing research on the sequestration potential of grassland, with the aim of establishing sufficiently robust scientific data to allow for the incorporation of this data into the inventory accounting framework. We will also continue to pursue the inclusion of hedgerows within the accounting mechanism.

Action Area 3 - Providing research and evidence

We will continue to ensure that robust science and evidence underpins the measures we recommend. Farmers and policy makers alike must be confident that action to reduce emissions will be both effective and achievable, without risking production levels or farm performance. We will also consider future research needs to help the industry to achieve its growth ambitions, in tandem with reducing its carbon footprint.

Action Area 4 - Communicating efficient farm practices

Raising awareness remains a vital component of our approach. We will increasingly focus our efforts on delivering the efficient farming message in an integrated way, through initiatives such as the Business Development Groups.

Action Area 5 - Effective partnership working

We believe that a robust partnership approach is key to our success. By continuing to work together we can support the industry to make further progress towards environmental and economic sustainability.

We will also seek to work collaboratively across government and with other stakeholders on areas of mutual interest. In particular we will continue to engage with the Agri Food Strategy Board to achieve our shared vision of a sustainable and profitable agriculture sector, principally in the following areas:

- **Sustainability** – The AFSB is examining opportunities and approaches to reduce the environmental footprint of the agri-food sector, across a number of themes including soil and land management, air and water quality, carbon and biodiversity and subsequently market sustainable food products.
- **Livestock genetic improvement** is a permanent, cumulative method of improving efficiency and profitability which offers significant potential to reduce the carbon intensity of livestock production. The AFSB is currently examining the options to accelerate genetic gains locally.
- **Sustainable Land Management Strategy** - The Expert Working Group on Sustainable Land Management is progressing an AFSB recommendation to develop a strategy which improves land management and ensures the targets of 'Going for Growth' can be achieved in a sustainable way. This strategy will focus on how improved agricultural competitiveness can be achieved in tandem with better environmental performance.

The Northern Ireland Rural Development Programme 2014 – 2020: Support Measures

The Rural Development Programme (subject to necessary approvals and future policy changes), will provide financial and other support to farmers and landowners for adopting farming practices that enhance our countryside and build resilience to climate change.

Six priorities have been identified in the NIRDP.

- Fostering knowledge transfer and innovation in agriculture, forestry and rural areas;
- Enhancing the viability and competitiveness of all types of agriculture, and promoting innovative farm technologies and sustainable forest management;
- Promoting food chain organisation, animal welfare and risk management in agriculture;
- Restoring, preserving and enhancing ecosystems related to agriculture and forestry;
- Promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors;
- Promoting social inclusion, poverty reduction and economic development in rural areas.

Key measures are listed overleaf. Further detail is available at **www.daera-ni.gov.uk**

Farm Business Improvement Scheme

Business Development Groups

This aims to improve business and technical efficiency through advice, collaboration and knowledge exchange. Knowledge transfer and extension services are recognised as a vital step in supporting farmers to change behaviour and adopt new techniques and technologies. Groups will take a sectoral approach and address the key challenges in each. They will address important environment and climate priorities such as nutrient management planning, energy efficiency, GHG emissions, and animal and plant health.

Farm Business Improvement Scheme - Capital

- **Tier 1** – Will support investments up to £30k to improve the efficiency and profitability of farm businesses. Capital support will be prioritised on the basis of resource efficiency, animal health and climate mitigation and adaption and environmental priorities, including water quality.
- **Tier 2** - Will support investments over £30k (with grant up to a maximum of £250k) aimed at transformational change, increasing productivity driven growth, efficiency and sustainability of market orientated farm businesses.

Farm Family Key Skills

This targeted training programme will cover key areas including animal health and new technologies, which are directly linked to the reduction of carbon intensity of agricultural enterprises.

Innovation and Technology Evaluation Demonstration Scheme

This on-farm evaluation and demonstration scheme aims to raise awareness of innovative technologies and techniques and encourage uptake at a commercial level. It is expected that technologies supported under this measure will lead to greater on-farm efficiency, productivity gains and carbon reductions.

European Innovation Partnerships

These collaborative innovation partnerships will support projects which advance innovation in the agricultural and horticultural sectors, including support for climate and environment objectives, for up to 15 groups.

Farm Innovation Visit Scheme

Farm Innovation visits across EU with focus on Innovation; Sustainable Farming and Forestry; Farm Diversification, Short Supply Chains; and the development of new business opportunities and new technologies.

Environmental Farming Scheme (EFS)

The Environmental Farming Scheme (EFS) will aim to support some 6,200 farmers to carry out environmentally beneficial farming practices on their land (subject to the necessary approvals).

The EFS will offer participants a 5-year agreement to deliver a range of environmental measures and will have three levels:

- A higher level, primarily for environmentally designated sites and other priority habitats;
- A wider level to deliver benefits across the countryside, outside of environmentally designated areas; and
- A group level to support co-operative action by farmers in specific areas such as a river catchment.

The EFS aims to:

- Restore, preserve and enhance biodiversity;
- Improve water quality;
- Foster carbon conservation and sequestration in agriculture; and
- Reduce greenhouse gas and ammonia emissions from agriculture.

EFS Higher Level

EFS Higher Level will aim to improve the condition status of environmentally designated areas, and protect and enhance priority habitats and species, through the implementation of site-specific management plans.

EFS Wider Level

EFS Wider Level aims to create green infrastructure and new habitat in the wider countryside. Key options include:

Establishment of Native woodland Less Than 5 ha	Cultivated uncropped margins
Planting new hedgerows	Annual wildflower margins
Establishment of agro-forestry	Pollen and nectar margins
Creation of riparian buffer zones	Rough grass margins
Natural regeneration of native woodland	Creation of Arable Margins
Planting native tree corridors	Retention of winter stubble
Creation of Traditional Orchard	Organic conversion and management

EFS Group Level

Group level support will facilitate co-operative action by farmers in specific areas, such as river catchments or commonages.

Advisory Training and Support

Associated advisory training and support will be an integral part of the scheme.

Support for afforestation/creation of woodland

DAERA Forestry Schemes aim to support 1,800 hectares of new woodland and sustain approximately 4,000 hectares of woodland created under previous programmes.

Forest Expansion Scheme

This scheme will support the establishment of new woodland over 5 hectares, on suitable agricultural and non-agricultural land. This will increase carbon sequestration with secondary benefits including the production of timber and wood for processing and marketing including material for renewable energy systems; improved biodiversity; improved water quality and public amenity value. Support will be provided for the costs of establishment and payments for income foregone to cover loss of income compared to agricultural production.

Woodland Investment Grant

This will support sustainable forest management to improve the environmental value of woodlands, build resilience to climate change and enhance the public amenity value of forests. Improved environmental and climate outcomes will include increased resilience of forest ecosystems, protecting priority habitats, removing non-native invasive species and improving ecological status of rivers and water catchments. Support will be provided for direct costs associated with the implementation of the investments.

Forest Protection Scheme

This scheme provides support for the prevention of pest and disease outbreaks and for restoration of forests following pest and disease outbreaks, thereby increasing resilience to projected climate change risks.

Establishment of Native Woodland less than 5 hectares (via the EFS)

This aims to increase the area of native woodland, provide wildlife corridors and areas free from disturbance for wildlife and contribute to the landscape character. The main benefits of native woodland creation will be improved biodiversity, carbon sequestration, water quality and public amenity value. Support will be provided for non-productive investments and income foregone to cover loss of income from agricultural production.

Focus on Research: Strategies to reduce N_2O emissions from nitrogen fertiliser application[44]

The GHGIP is supporting a research project, via DAERA's Evidence and Innovation Programme, to develop strategies to reduce nitrous oxide emissions.

Nitrogen fertiliser applied to grassland can have an impact on the magnitude of N_2O emissions, particularly from soils with high organic matter in Northern Ireland's temperate climate. Calcium Ammonium Nitrate (CAN) is currently the most widely used fertiliser N source in Ireland, but can be vulnerable to losses, with N_2O emissions typically much higher from CAN than from an ammonium-based fertiliser such as urea.

A potential mitigation strategy to lower agricultural N_2O emissions is to substitute CAN for urea. However, urea can result in significant losses of N as ammonia-N (NH_3) from surface applied granules, potentially leading to reduced yields and N off take.

The research considers a potential solution, which allows N to remain in the soil in a form readily available for plant uptake, by treating urea granules with:

i) **A urease inhibitor (e.g. N-(n-butyl) thiophosphoric triamide; NBPT) and/or;**

ii) **A nitrification inhibitor (e.g. dicyandiamide; DCD),**

Project Aims:

This project investigated the effect of fertiliser form (CAN; Urea; Urea + NBPT; Urea + DCD; Urea + NBPT + DCD) on grass dry matter (DM) yields, N offtake, and NH_3 and N_2O emissions over a 2 year period at 3 grassland sites. The joint AFBI/ Teagasc project had three field sites located at AFBI Hillsborough, Co. Down, Johnstown Castle, Co. Wexford and Moorepark, Co. Cork, yielding six site-years of valuable information on GHG emissions and yield data from different soil types and climatic conditions.

Key Results:

- **NBPT is a highly effective compound for reducing ammonia volatilisation from urea fertiliser**
- **Field trials at Hillsborough and Johnstown Castle showed that NH_3 emissions from Urea + NBPT were 78.5% lower than those from straight Urea in 2014.**
- **Switching from CAN to NBPT treated Urea resulted in similar annual dry-matter production and N offtake.**

Overall there was no significant difference in annual grass yield between urea, CAN and Urea + NBPT. However, urea resulted in lower N offtake than CAN, but this inefficiency was resolved when urea was treated with NBPT. There was some evidence that Urea + DCD had an adverse effect on yields and N offtake.

> **Averaged over all sites, switching from CAN to NBPT treated urea reduced direct cumulative N_2O emissions by approximately 73%.**

The research investigated the nitrous oxide emission factor of each fertiliser form. IPCC default emission factor (EF) for N_2O from soils used in GHG inventories is 1% of the N applied, irrespective of its form. However, N_2O emissions tend to be higher from nitrate-containing fertilisers e.g. calcium ammonium nitrate (CAN) compared to urea, particularly in regions, which have mild, wet climates and high organic matter soils.

The research found the average direct N_2O EF from CAN was 1.49% (above IPCC default value of 1%) and was highest at the Hillsborough site which had impeded drainage. Direct EFs from urea and urea + NBPT were 0.25 and 0.40%, respectively (lower than IPCC default value). DCD lowered these EFs even further.

Table 1. Direct Emission Factor Summary (modified from Harty et al., 2016 (in press)).

Table 1

Fertiliser Form	Average direct EF %	Drainage impeded EF %	Moderately/ Well drained EF %
CAN	1.49	2.74	0.87
Urea	0.25	0.40	0.18
Urea + NBPT	0.40	0.37	0.41
Urea+ NBPT + DCD	0.11.	0.12	0.11
Urea +DCD	0.11	0.07	0.13

Conclusion:

NBPT treated urea is a suitable all year round fertiliser to replace CAN as the dominant N fertiliser for grass production under Irish soil and climatic conditions, reducing N_2O emissions.

Focus on Research: Grassland Carbon Sequestration in Northern Ireland[45]

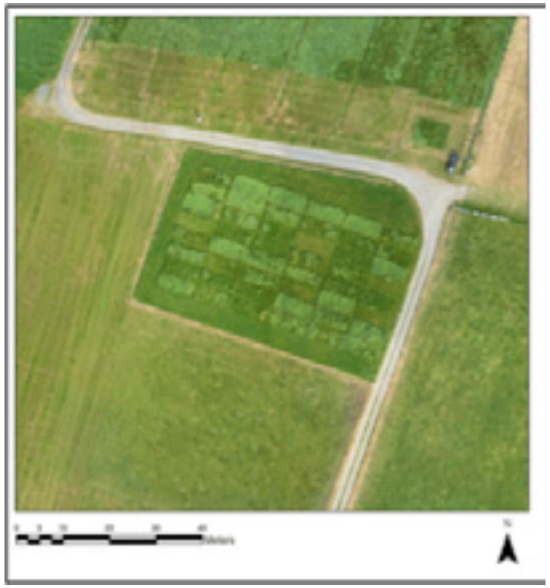
The GHGIP Sequestration Sub Group has commissioned research, via DAERA's Evidence and Innovation Programme, to establish a more accurate estimate of the Carbon (C) sequestration potential of Northern Ireland's grassland soils.

Grasslands, which represent 79% of the agricultural land area in Northern Ireland, are of fundamental agronomic importance for the efficient production of livestock and forage[1]. The high proportion of long-term swards locally also have a significant capacity to sequester large quantities of carbon. Global estimates suggest that grassland soils contain at least 20% of all terrestrial soil carbon (C) and also have the potential to store higher amounts of C than arable soils[2], which are disturbed more frequently in the arable rotation.

Data[3] from multiple grassland sites across Europe show that soil C sequestration rates may vary considerably and provides evidence that grassland soils can actively sequester C. The variability associated with current estimates of soil C sequestration rates results from the complex interactions between common agricultural practices and other environmental factors. Agricultural practices such as reseeding, liming and nutrient fertilisation (e.g. animal slurry or NPK fertilisation) can significantly influence soil C stocks in grasslands, but their combined effects are not fully understood at present.

Despite its potential, the full C sequestration capacity of grasslands is not currently recognised within GHG accounting frameworks, due to a lack of long-term soil data from agricultural grasslands. Instead grassland C sequestration is based on standard emission factors and currently it is assumed not to sequester C beyond 20 years in Northern Ireland. This means grasslands are still considered a net carbon source and not a C sink (store). Data from a long-term AFBI trial, however, suggests that C continues to accumulate under grassland for at least 40 years, which if accounted for, would change the NI LULUCF inventory from a net source of carbon to a sink.

The Long-Term Slurry (LTS) experiment at Hillsborough shows that grassland soils not only act as significant C sinks but have not yet reached C saturation after 43 years. Unfertilized-control soils show C sequestration between 1970 and 2013. High application rates of cattle slurries further increase soil C sequestration and a key cause of this C accrual is greater C inputs from cattle slurry. It is not clear, however, whether and how soil disturbance due to reseeding practice will affect soil C stocks in the long-term.



[1] (Smith et al., 2008; Power, 2010)
[2] (Conant et al., 2001; Acharya et al., 2012; Gützloe et al., 2014).
[3] (Soussana et al., 2010; Schulze et al., 2009; Chang et al., 2015)

The Agri Food and Biosciences Institute (AFBI) will therefore undertake research to investigate how grassland management might influence long-term soils' ability to sequester C. The study will include (1) a review of existing literature and critical information on GHG emissions to update the NI LULUCF inventory, (2) a series of field studies established across multiple farms and grassland fields in NI to estimate the impact of management history, especially in relation to the frequency of grassland reseeding, on CO_2 fluxes from soils and on soil C stocks.

Findings from this research study will provide more accurate data to estimate of NI's contribution to the UK GHG inventory and increase the reliability of estimates in our progress towards meeting national GHG reduction targets.

Research aims:

- Analyse and evaluate activity data and emission factors applied in the NI LULUCF inventory to derive more accurate estimates;
- Analyse LULUCF assumptions and methods and expose potential categories of land use relevant to NI not currently considered, and revision of activity data and emission factors appropriate to NI conditions;
- Measure Carbon (C) stocks to 60 cm soil depth to quantify soil C sequestration for the whole soil profile;
- Determine whether the C saturation of grassland soils should be extended beyond 20 years by quantifying the relationship between total C stocks and

  (i) grassland age (conditioned by soil type and management) and;
  (ii) key agricultural practices (e.g. animal slurry applications).
- Quantify the impact of grassland cultivation on CO_2 exchange to provide more relevant emission factors associated with changes in land use from grassland, or renewing grassland;
- Quantify the economic implications of changing management to increase C sequestration to underpin evidence based policy interventions.

Emerging conclusions

Some initial conclusions emerging in the first year of research are:

1. **Soil C stocks are not affected by one-off reseeding event (20-yeartime span)**
2. **The effects of grassland management on soil bulk density (i.e. soil compaction) are more important than infrequent reseeding events in affecting soil carbon sequestration.**
3. **Grassland soil carbon sequestration has not yet reached saturation after 43 years and;**

   a) increases under cow slurry applications;

   b) does not change under NPK applications;

   c) can offset 11-22% of GHG when cow slurry is applied.

Next steps:

The project is due to conclude in 2018. The Sequestration Sub Group will monitor progress and consider the emerging and final conclusions to guide their work. Better knowledge of current carbon stocks and the effects of agricultural practices will point to future mitigation measures which can minimise carbon losses and/or encourage carbon accumulation. This research will support our ambition to see the agriculture sector given credit for the carbon benefits accrued as a result of agricultural activities, and not solely for the greenhouse gases it emits. We will seek to have this more accurate data recognised in the UK GHG Inventory to replace the broad emission factors currently used. We will also continue to pursue other omissions from GHG accounting which could also significantly benefit the NI inventory such as woodland strips, hedgerows, controlled development of scrub and agroforestry.

10. Efficient Farming Cuts Greenhouse Gases Implementation Plan 2016-2020

Activity Area 1: Supporting and facilitating implementation of efficiency measures

Action Number:	Action	Lead responsibility	Timescale
1. Incorporate and promote uptake of GHG reduction measures via the Northern Ireland Rural Development Programme 2014-2020 (subject to necessary approvals and future policy change):			
a.	Encourage uptake of farm efficiency measures via Business Development Groups.	CAFRE	2016-2020
b.	Provide financial support for efficient, precision and emission reducing technologies via the Farm Business Improvement Scheme - Capital.	DAERA	2016-2020
c.	Provide financial support to target carbon sequestration and climate objectives via the Environmental Farming Scheme (subject to approvals).	DAERA	2017-2020
d.	Provide financial support to encourage afforestation, improved management and resilience via NIRDP Forestry Schemes.	FOREST SERVICE	2016-2020
e.	Provide training on farm efficiency measures via Farm Family Key Skills.	DAERA	2016-2020
f.	Offer support for novel projects via the Evidence and Innovation Partnership Operational Groups.	DAERA	2016-2020
g.	Offer support to test the viability of technologies to increase efficiency via the Innovation Technology Evaluation Demonstration scheme (ITEDS).	DAERA	2016-2020
h.	Offer specific and targeted advice on environmental land management options via the Environmental Advisory Service.	DAERA	2017-2020

Action Number:	Action	Lead responsibility	Timescale
2. Deliver a targeted and prioritised programme of activities to increase implementation of efficiency measures:			
a	Increase uptake of efficient nutrient practices via the Feed Adviser Register.	NIGTA	2016-2017
b.	Promote uptake of nutrient management planning and use of crop nutrient calculators.	CAFRE	2016-2020
c.	Promote resource efficient and profitable practices via Benchmarking.	CAFRE	2016-2020
3. Develop and deliver a focused advice and knowledge transfer programme to target and support:			
a.	Use of the Profitable Lifetime Index.	GHGIP/ CAFRE	2016-2020
b.	Efficient calving of heifers at 24 months of age.	GHGIP/ CAFRE	2016-2020
c.	Use of Estimated Breeding Values.	GHGIP/ CAFRE	2016-2020
d.	Optimise age at slaughter.	GHGIP/ CAFRE	2016-2020
e.	Reducing Replacement Rates.	GHGIP/ CAFRE	2016-2020
f.	Efficient use of feed and concentrates.	GHGIP/ CAFRE	2016-2020
g.	Efficient Nutrient Management Practices.	GHGIP/ CAFRE	2016-2020

Activity Area 2: Improving monitoring and measurement of progress

Action Number:	Action	Lead responsibility	Timescale
4.	**Track the carbon intensity of milk production:**		
a.	Finalise methodology for calculating Northern Ireland average figure for emissions intensity of milk.	AFBI/DAERA	31 December 2016
b.	Produce GHG emissions intensity indicator for Northern Ireland Dairy Farms.	AFBI/DAERA	Annually from 31 March 2017
c.	Consider an ambition for a reduction in emissions intensity for Northern Ireland Dairy Farms.	AFBI/DAERA/ GHGIP DAIRY SUB GROUP	31 June 2017
5.	**Track the carbon intensity of beef production:**		
a.	Develop methodology for calculating Northern Ireland average figure for emissions intensity of beef.	AFBI/DAERA	31 March 2018
b.	Produce GHG emissions intensity indicator for Northern Ireland Beef Farms.	AFBI/ DAERA	Annually from 31 March 2018
c.	Consider an ambition for a reduction in emissions intensity for Northern Ireland Beef farms.	AFBI/ DAERA/ GHGIP RED MEAT SUB GROUP	31 June 2018
6.	Support the Agri GHG Inventory projects and consider the findings at Northern Ireland level.	DAERA/ GHGIP	31 March 2018
7.	Develop a performance monitoring framework for the Efficient Farming Cuts Greenhouse Gases Implementation Plan.	DAERA/ CAFRE	31 March 2017

Activity Area 3: Providing research and evidence

Action Number:	Action	Lead responsibility	Timescale
8.	Pursue a programme of research which supports partnership aims.	GHGIP and sub groups	2016 - 2020
9.	Consider actions based on findings of research projects, commencing with strategies to reduce emissions from nitrogen fertiliser application.	AFBI/ GHGIP	31 March 2017

Activity Area 4: Communicating efficient farm practices

Action Number:	Action	Lead responsibility	Timescale
10.	Deliver a targeted communication programme focused on key messages.	GHGIP	Annual plan
11.	Explore potential for developing Technology Demonstration Farms focused on priority issues.	CAFRE/ DAERA	2016 - 2020
12.	Develop CAFRE Sustainability Strategy as an exemplar of efficient farming.	CAFRE	31 March 2017
13.	Explore potential to use social media to promote on-farm efficiency.	CAFRE	31 March 2017

Activity Area 5: Effective partnership working

Action Number:	Action	Lead responsibility	Timescale
14.	Maintain overview of related policy, research and activities to inform the work of the Partnership.	GHGIP Secretariat	Ongoing
15.	Work with processors to promote efficient farming messages through existing communication channels.	GHGIP	2016-2020
16.	Engage with AFSB on Sustainability and Genomics.	GHGIP	31 March 2017
17.	Support the development and implementation of Sustainable Land Management Strategy (subject to necessary approvals).	DAERA/ GHGIP	31 March 2017
18.	Monitor progression of the National Emissions Ceiling Directive and develop and implement appropriate mitigation options.	GHGIP	2016 - 2020
19.	Review and report on Implementation Plan 2016-2020 progress.	GHGIP	Annually from 2017

11. Appendices

	Annex 1 – Current Policy Context

United Nations Framework Convention on Climate Change	• Series of international agreements, most recently Paris 2015.
	• Sets binding commitments via Internationally Determined Contributions (INDCs) to:
	  • limit global temperature rises to under 2°C, with efforts to hold temperature rise to 1.5
	  • improve adaptive capacity
	  • protect food security
	• Kyoto Protocol (2008) set requirement to monitor emissions via GHG inventory methodology.

EU Climate and Energy Package 2030	• EU wide target of 40% reduction by 2030 in GHGs, which will form the basis of the INDC agreement above.
UK Climate Change Act 2008	• Extends to Northern Ireland. • 80% reduction in GHG emissions by 2050, and at least 34% in the period 2018-2022. • Requires publication of a Climate Change Risk Assessment every 5 years and; • An adaptation programme to address risks identified.
Northern Ireland Programme for Government (Draft)	• Outcome: We live and work sustainably, protecting the environment. • Indicator: Increase environmental sustainability. • Lead Measure: Greenhouse Gas Emissions.
European 7th Environment Action Programme (EAP) 2013-2020.	Identifies three key objectives: • To protect, conserve and enhance the Union's natural capital. • to turn the Union into a resource-efficient, green, and competitive low-carbon economy. • to safeguard the Union's citizens from environment-related pressures and risks to health and wellbeing.

Common Agricultural Policy	The reformed CAP aims to achieve three sustainable development objectives of the European Union: • To make agriculture more competitive; • To make it more environmentally sustainable; • To keep vital agricultural activities and rural areas across EU territory.
National Emissions Ceilings Directive (NECD)	National Emission Ceilings Directive (NECD) aims to improve air quality, setting new emission ceilings for a range of harmful gases including Ammonia (NH3) and will propose new reduction targets which are currently under negotiation.

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