Making Ammonia Visible

An Annex to *"Delivering Our Future, Valuing Our Soils: A Sustainable Agricultural Land Management Strategy for Northern Ireland"*

Produced by the Expert Working Group on Sustainable Agricultural Land Management for N. Ireland

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Chairman's Foreword

I have to admit that when the issue of Ammonia was first brought to my attention back in early to present the 2016, when I was presenting emerging conclusions of the Sustainable Land Management Strategy's Expert Working Group, to the wider N. Ireland, Agri-food Stakeholders, I had no understanding of just how immediate and complex this issue would turn out to be.

At that time, I reassured myself, in my lack of knowledge of the ammonia issue, by the fact that many of the other key players in our Sector knew no more about Agriculture Ammonia emissions, and their subsequent deposition as Nitrogen, than I did.

But there lay the first huge problem. If I and the Expert Working Group, whom I have been privileged to chair, knew little or nothing about the issue, the Sector knew even less, and that would include many within the newly formed, sponsoring Department, the Department of Agriculture, Environment and Rural Affairs, DAERA.

Sadly, in the fourteen months since the previous DAERA Minister, Michelle McIlveen MLA, asked the Expert Working Group to write an annex to the Sustainable Land Management Strategy, on Ammonia, the issue has been catapulted to the fore within the Sector. It now has the potential, if inappropriately handled, to frustrate both the good work already being carried out by the Sector to improve the environment; and the modernisation of farm businesses in a way that will help deliver the ambition laid out, in the Agri-food Strategy Board's report, "Going for Growth."

As per the methodology used in creating the original report of the Expert Working Group, the Sustainable Land Management Strategy for N. Ireland, this annex on Ammonia, titled "Making Ammonia Visible," has attempted to understand the science, the environmental and economic consequences, the regulatory imperative, and the resultant consequence on farm businesses. Many of these businesses, without being previously educated and informed around the importance of ammonia,

now find themselves on the wrong side of ammonia emissions, and their subsequent nitrogen deposition on some severely deteriorated Priority Habitats.

The Expert Working Group has tried to layout, as transparently as possible, why we have found ourselves in such a position. It has made recommendations on how we should go forward in the medium to long term, and recommends to DAERA the use of six guiding principles and approaches to alleviate the acute pressure in the short term, until our knowledge on ammonia is further improved. It has been gratifying to see how so many of the solutions for ammonia fit so well with our recommendations on sustainable land management.

There is unanimity within the Expert Working Group that the Sector can overcome the current problems with ammonia, and in the medium to long term, satisfy the joint need of bringing ammonia emissions from agriculture down to a level that lets an expanding Sector deliver the ambition laid down in the “Going for Growth” report, while allowing our Priority Habitats to recover.

As Chairman, there are a collection of people I must thank for making the output of this work possible.

Firstly, to the then DAERA Minister, Michelle McIlveen MLA, who had the foresight to see Ammonia as the next burning issue, and who had the bravery to put her confidence in our Expert Working Group.

Secondly, to all the people who gave detailed evidence to the Expert Working Group during its work to investigate and compile this annex, and who suffered a considerable interrogation at our hands.

To the Expert Working Group’s DAERA Secretariat, Mr Patrick Savage, for his unstinting support and excellent drafting.

To my own employers, Devenish Nutrition, for allowing me to have so much time out of the Devenish business, which freed me up to deliver my responsibilities as chair, to the best of my ability.

And finally, to the members of the Expert Working Group, who yet again have given of their very valuable time, without remuneration, to challenge, to understand and to seek for compromise with an issue just as complex as ammonia. To all, please can I give you a huge thank you?

Dr John Gilliland OBE
Chairman, N. Ireland Sustainable Agriculture Land Management Strategy and Ammonia Annex, Expert Working Group

December 2017

Introduction

In 2013, the Agri-Food Strategy Board's "Going for Growth" set ambitious targets for Northern Ireland's agri-food sector, including a target for a 60% growth in sales, a 15% growth in employment and a 75% growth in external sales by 2020. In October 2014, the Northern Ireland Executive's response to 'Going for Growth' explicitly stated that it was committed to doing all the Executive collectively could to make 'Going for Growth' a reality[1]. 'Going for Growth' specifically recommended development of a strategic land management policy and emphasised that agricultural productivity must be considered in parallel with the need for our agri-food industry to maintain and enhance environmental performance.

In October 2016, as the Expert Working Group on Sustainable Land Management, we published our report; "*Delivering Our Future, Valuing Our Soils: A Sustainable Agricultural Land Management Strategy for Northern Ireland."* This report set out our vision for the Northern Ireland agri-food sector, and particularly how the ambition of "Going for Growth" can be achieved in a way which simultaneously improves environmental performance. Our key recommendation is to make improved soil health and fertility a leading priority for Northern Ireland agriculture. By doing so, we can increase farm profitability through greater utilisation of better quality grass, improve environmental outcomes and positively differentiate Northern Ireland food in the marketplace.

Throughout the course of our deliberations, it became clear that nitrogen deposition, particularly on priority habitats, arising primarily from ammonia emissions, is one of the key environmental challenges facing Northern Ireland agriculture. Whilst land management is not always directly linked to ammonia emissions, or the potential solutions, it is an important consideration in our overall aim of achieving a sustainable future for the Northern Ireland agri-food sector; a future with profitable farms and good environmental outcomes which delivers against the vision set out in the "Going for Growth" report. We believe that our work on sustainable land

[1] https://www.economy-ni.gov.uk/sites/default/files/publications/deti/ni_executive_response_to_going_for_growth.pdf

management has shown the imperative of providing a strategic vision for agriculture through a partnership of the farming, supply chain, environmental and government sectors.

Recognising the importance of a comprehensive approach to ammonia emissions from agriculture, in mid-2016, the Minister for Agriculture, Environment and Rural Affairs, Michelle McIveen MLA, requested that the Expert Working Group advise on how this issue could be addressed, in an annex to the original Land Management Strategy Report. We were happy to accept this invitation and since September 2016 have examined in detail, the causes, the science, the measurement and the opportunities for mitigation relating to agricultural ammonia emissions.

Key to the development of our report on sustainable land management was the wide range of evidence we gathered directly from expert speakers. This approach continued when addressing the ammonia issue, with evidence taken from environmental regulators, agri-food and environmental consultants and leading scientific researchers from Northern Ireland, Great Britain and the Republic of Ireland. We are extremely grateful to all those who assisted us.

Ammonia: What is the issue?

Nitrogen is a critical component of our agricultural systems. Agriculture and food production depend upon the cycling of nitrogen in the rural environment. However nitrogen loss from farm livestock, their manures and from the application of fertiliser can lead to negative environmental consequences when nitrogen is lost to the air in gaseous forms such as nitrous oxide or ammonia, or enters fresh or marine waters as nitrates in drainage or runoff water. Ammonia emissions will cause the subsequent deposition on land of various nitrogen compounds. This deposition occurs in two ways;

- deposits of nitrogen compounds relatively close to the source of the ammonia (dry deposition), and

- deposits of nitrogen compounds in rainfall which can be carried much further away from the original ammonia source (wet deposition).

These deposits of nitrogen aid the growth of some plant species, but they can have extremely negative consequences for plant species that are adapted to low nitrogen concentrations, most notably in the designated sites and priority habitats which represent our most sensitive and environmentally important species and areas. In these areas, the availability of excess nitrogen results in vulnerable and sensitive species being effectively outcompeted by other, more N-tolerant species, thus causing environmental damage through biodiversity loss, soil acidification and changes in ecosystem structure and function. Extreme levels can cause localised physical damage to plant species, which has been observed in Northern Ireland. Sensitive habitats such as peat bogs effectively act as a “sponge” for ammonia, i.e. bog vegetation by its nature having a very low nitrogen content means that the impact of nitrogen deposition is greater there than if a ryegrass sward, being of high nitrogen content, existed in the same area. As well as potentially damaging the environment, the release of ammonia is a cost to the farmer through the loss of a valuable plant nutrient. Nitrogen is a key farm input (through fertilisers and feedstuffs) and our priority should be to **take steps to (i) introduce no more nitrogen into our production systems than is necessary and efficient and (ii) retain it within the production system rather than releasing it to the atmosphere**.

Ammonia emissions which are subsequently deposited as nitrogen, can also indirectly lead to emission increases in nitrous oxide from wet soils. Nitrous oxide is a potent greenhouse gas with a Global Warming Potential 298 times greater than carbon dioxide. In addition, climate change, in itself, is likely to make the task of mitigating ammonia more difficult as ammonia is highly temperature reactive and increases of 5°C will double ammonia emissions.

Moninea Bog vegetation assessment 2017

Still affected (close to former source)

Making Ammonia Visible - Impact of subsequent N Deposition on Sensitive Environmental Habitats

(Reproduced with thanks to Mark Sutton CEH)_

Recovering (away from former source)

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

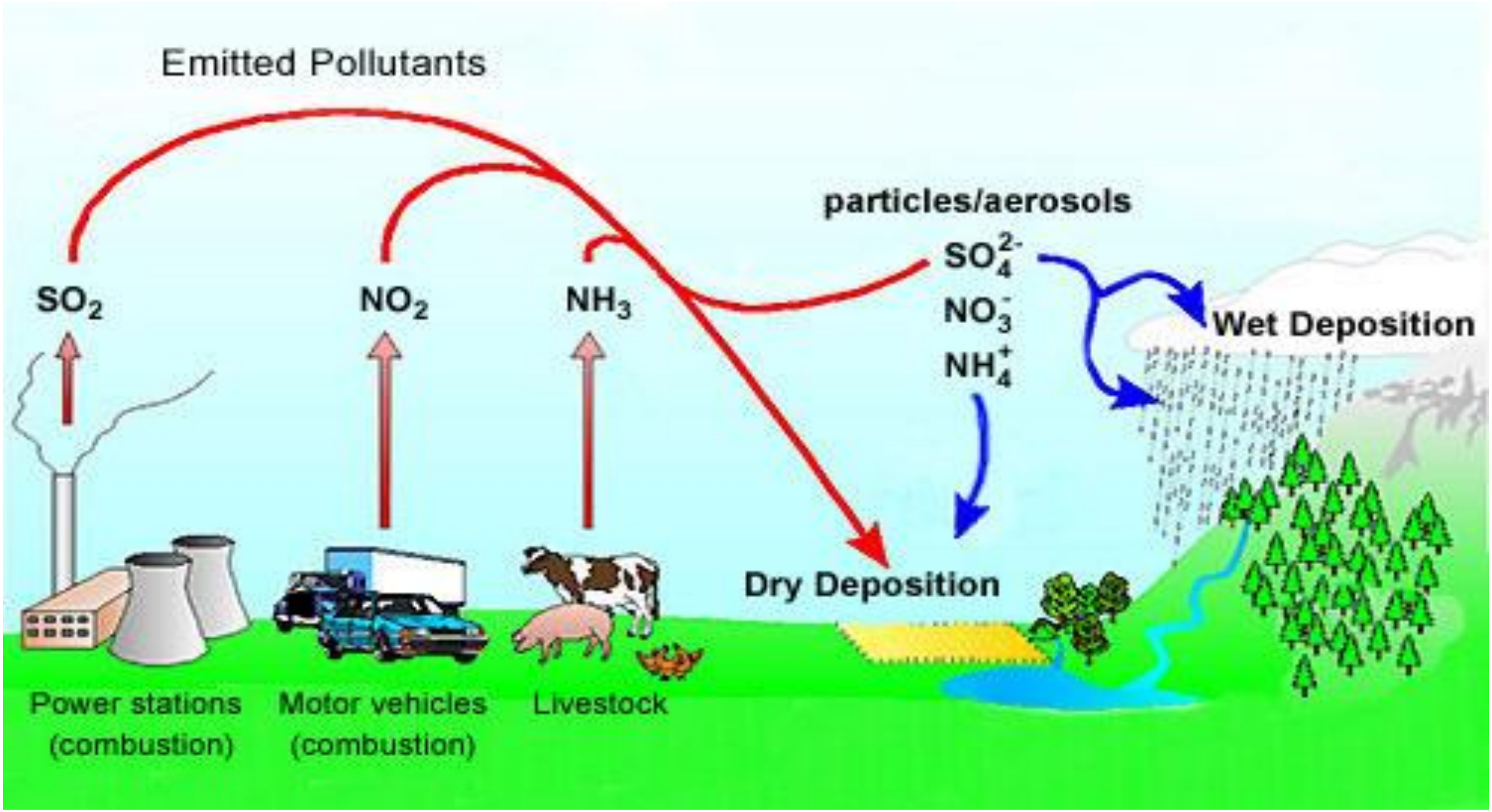
Birch Trees- Moninea Bog, County Fermanagh

Reproduced with thanks to Mark Sutton)

Left- Healthy Tree

Right – Tree impacted by nitrogen deposition

The Nitrogen Cascade

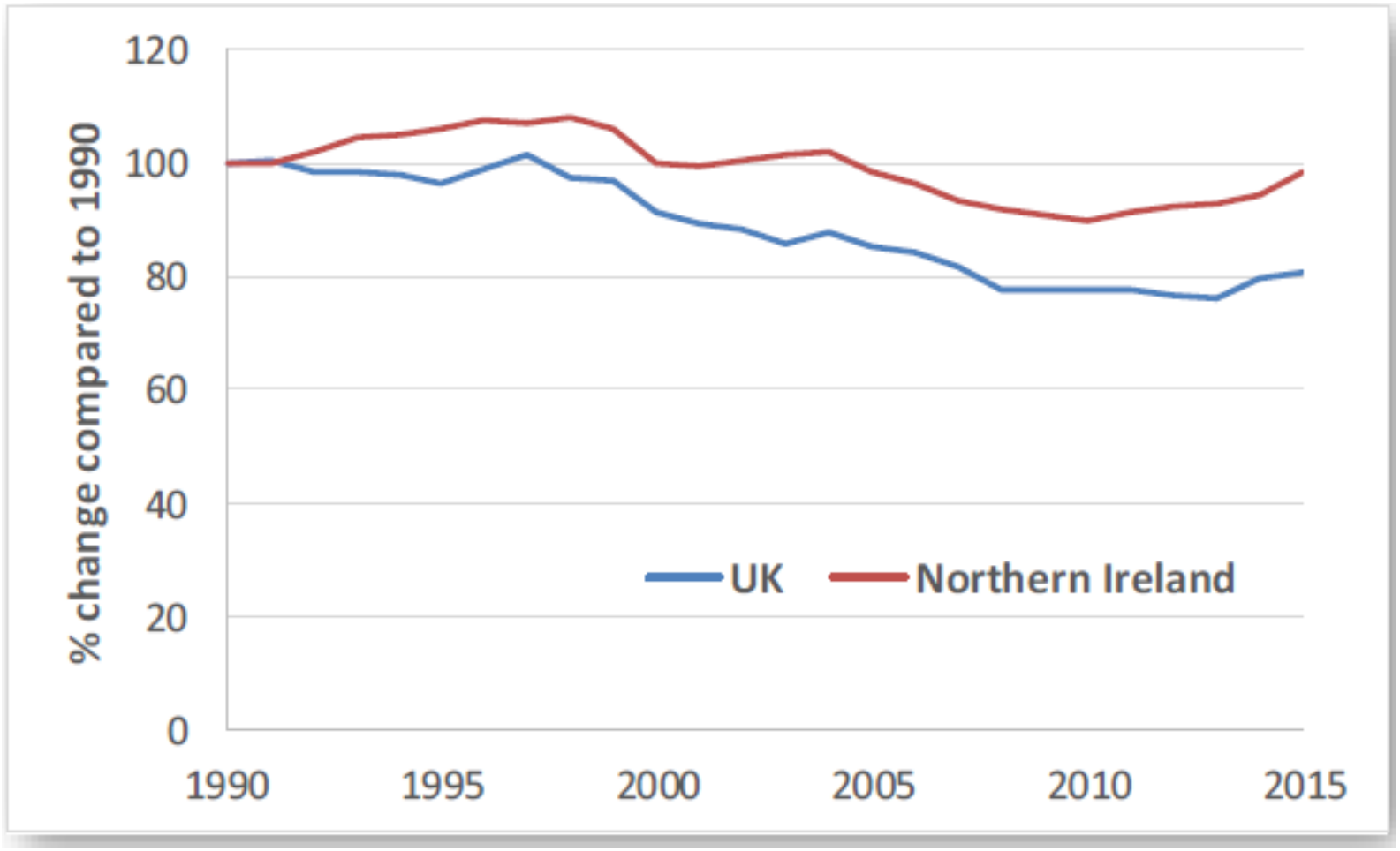


Relevance to Northern Ireland Agriculture

Agriculture is the dominant source of ammonia emissions in Northern Ireland, across the UK and throughout the world. **Current inventory figures show that 12% of total UK ammonia emissions come from Northern Ireland.** This is disproportionate when compared to Northern Ireland's population (3% of total UK) and land area (6% of total UK) as a result of the importance of agriculture to the Northern Ireland economy and our status as an exporter of high quality food produce. **91% of all ammonia emissions in Northern Ireland in 2015 came from agriculture.** This demonstrates that the solutions for addressing the environmental impact of ammonia must come from agriculture. Whilst there was a 17% decrease in agricultural ammonia emissions in Northern Ireland from their peak in 1998 to the lowest levels recorded in 2010, there is still significant work to be done to reach sustainable ammonia levels since ammonia emissions have begun to increase again in recent years, including a 4% increase in 2015, compared to 2014. In total, ammonia emissions from agriculture have risen by 9% since 2010[2].

[2] https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1710060932_DA_Air_Quality_Pollutant_Inventories_1990-2015_v01-01.pdf

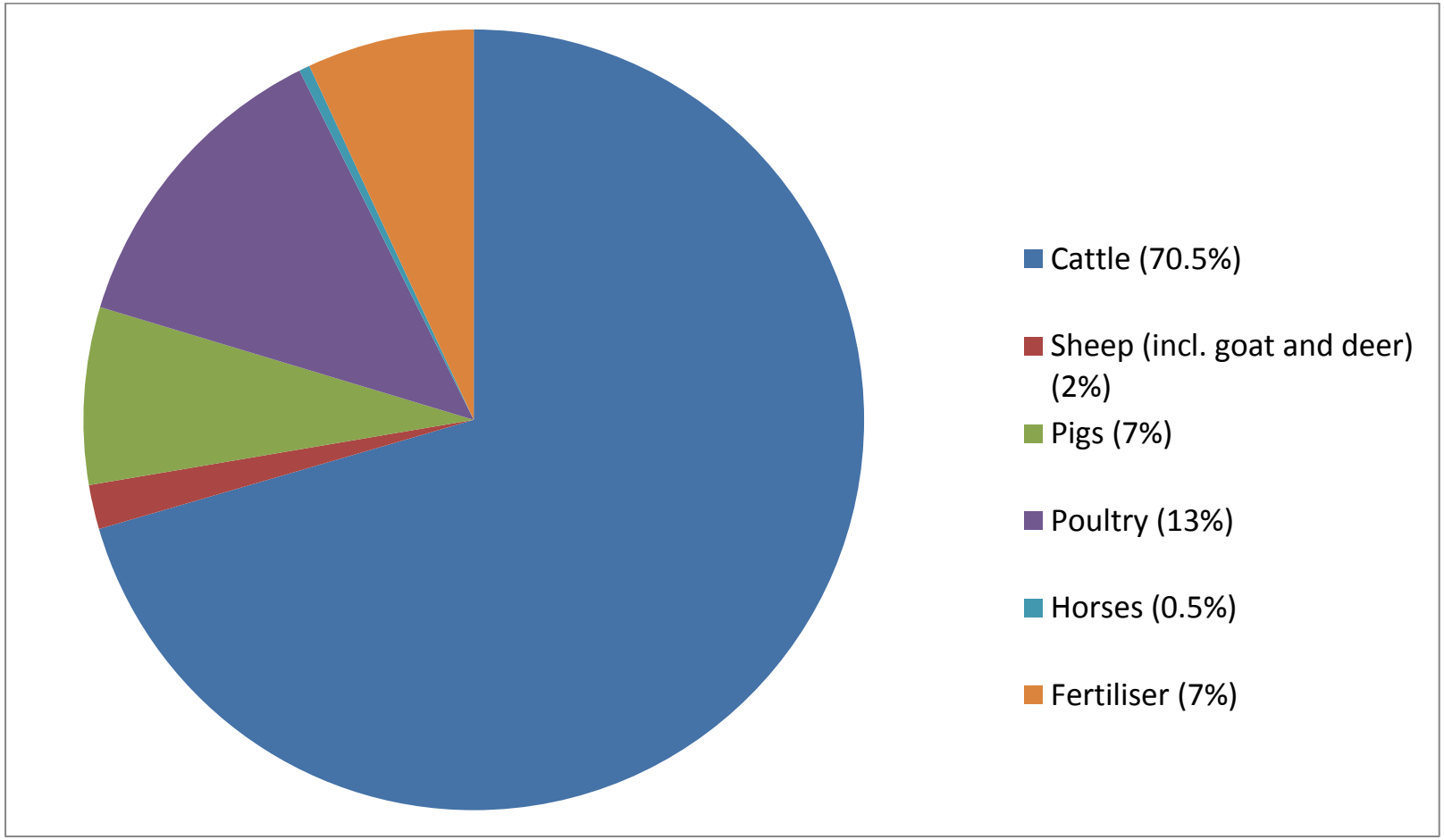
Trends in Ammonia Emissions in Northern Ireland as compared to the UK as a whole



Addressing these ammonia emissions is critical to the future sustainability of Northern Ireland agriculture. As farmers seek to achieve the ambitious targets set in *'Going for Growth'*, approvals to develop farm businesses through, for example, new farm buildings, will in many cases be dependent upon being able to show that such developments will not result in a negative impact on designated sites and priority habitats. It is therefore absolutely crucial that NI agriculture sets out a coherent approach to reducing its ammonia emissions that will also facilitate achievement of our growth targets. This will require a sustained effort from all sectors in all areas.

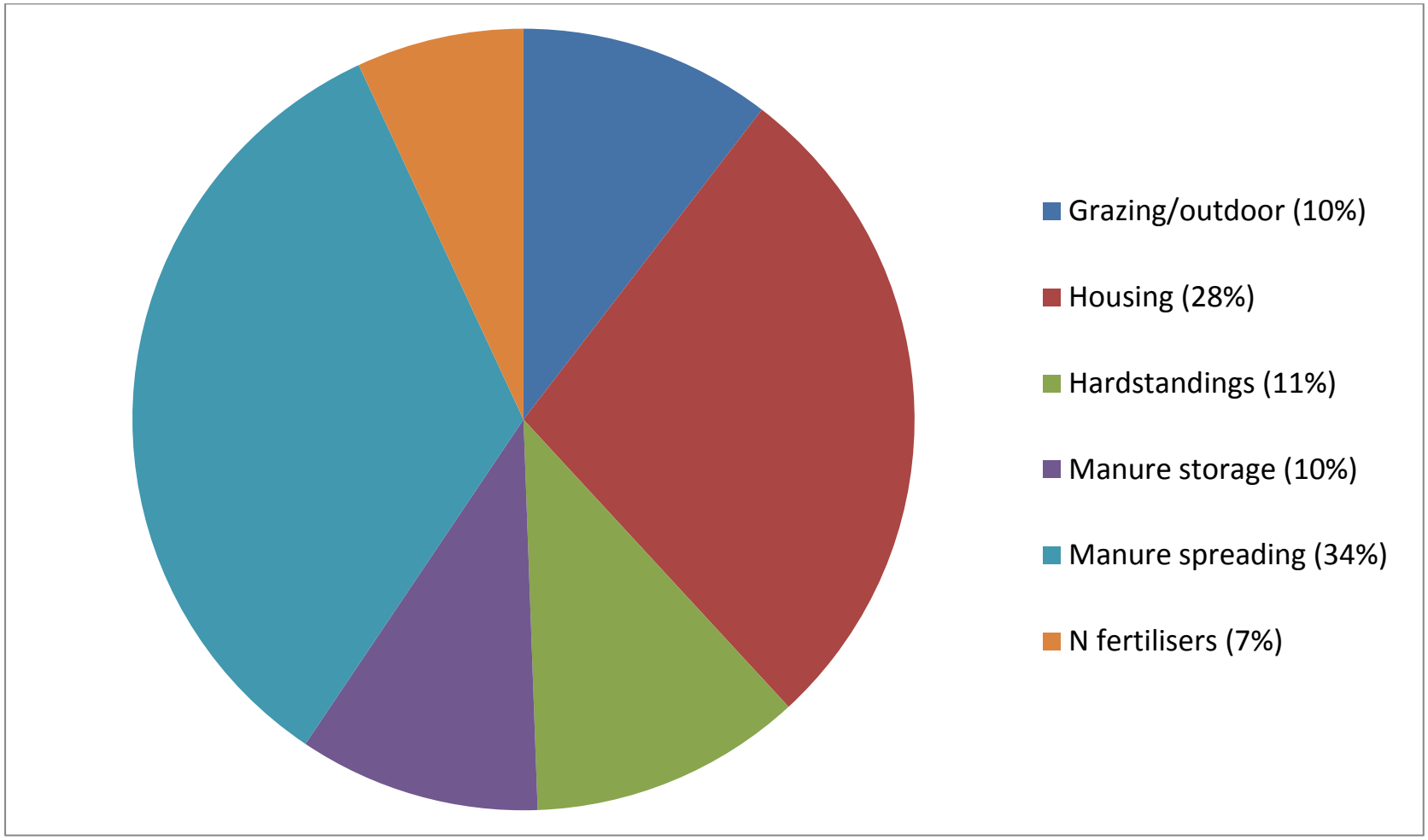
One of the most striking aspects of our evidence gathering was that there was little or no understanding of ammonia emissions within the farming community. There is a misguided perception that ammonia emissions are predominantly caused by the intensive sector since rules surrounding the permitting of large pig and poultry farms have required these businesses to address their ammonia emissions for many years. However, only 20% of ammonia emissions in Northern Ireland emanate from the pig and poultry sectors with **cattle production responsible for over 70% of agricultural ammonia.** There is a fundamental lack of awareness amongst the significant majority of farmers not affected by the permitting of large pig and poultry farms, of the impact which their farming systems can have on the environment due to ammonia emissions. This is particularly true of farmers in the ruminant livestock sector. It is clear to us that tangible reductions in ammonia emissions will require a concerted effort from across the breadth of the local agri-food industry. The first step in this effort must be an **awareness and communication campaign to educate all farmers on why ammonia is such an important issue**.

Northern Ireland Ammonia Emissions by Species (2015)[3]



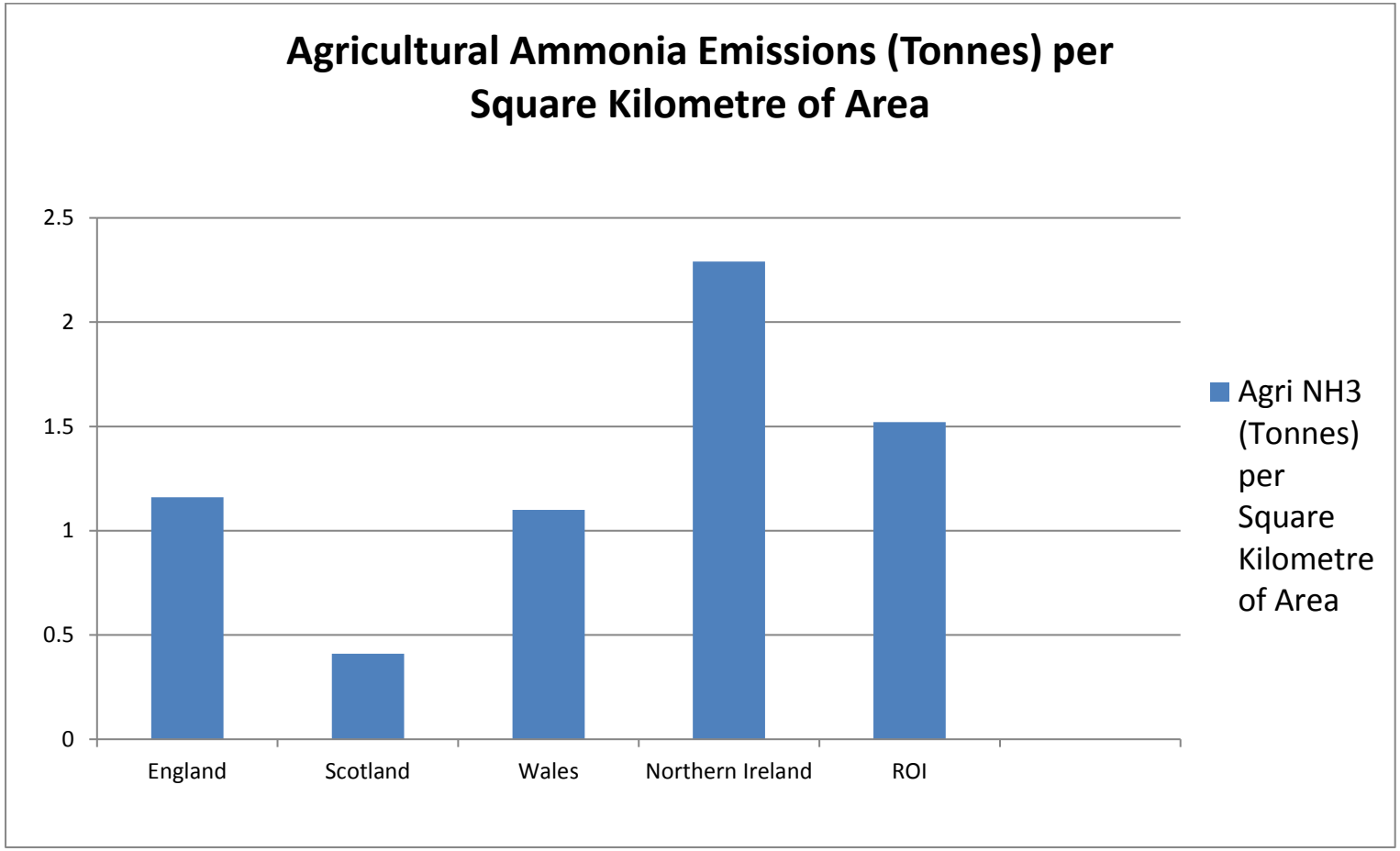
[3] Tom Misselbrook, Rothamsted Research

Northern Ireland Agricultural Ammonia Emissions by Source (2015)[4]



[4] Tom Misselbrook, Rothamsted Research

Agricultural Ammonia emissions per Square Kilometre of area: Comparing each UK Country and the ROI[5]



[5] Tom Misselbrook, Rothamsted Research

Strategic Context and Drivers for Change

We believe that it is critical for the future of Northern Ireland agriculture that action is taken to reduce ammonia emissions. In reaching this conclusion, we are extremely mindful of the N. Ireland Executive's response to the Agri-Food Strategy Board's (AFSB) 'Going for Growth' strategy and its challenging targets for the agri-food sector of a 60% increase in sales and 75% growth in external sales outside Northern Ireland. 'Going for Growth' also recognised that this growth must be achieved in a sustainable manner. This recognition was the driver for the *Sustainable Agricultural Land Management Strategy*. We are acutely aware that **our vision of a sustainable future for Northern Ireland agriculture will only be achieved if ammonia emissions are addressed and that is why this report focuses on education, making ammonia visible, investing in filling our ammonia knowledge gaps and implementation of mitigation through a range of options; and not on the contracting of the size of this sector.**

The UN's Gothenburg Protocol sets the international context for ammonia reductions and lays out strict emission reduction obligations. The UK is a signatory to this international obligation in its own right. The Gothenburg Protocol has set an 8% ammonia reduction target for the UK by 2020, compared to 2005 levels. In 2015, UK ammonia emissions were only 5% below 2005 levels. This 8% target is also contained in the National Emissions Ceiling Directive (NECD). Under the Directive, the UK will be required to have national Air Pollution Action Plans in place by April 2019, which will include plans and strategies relevant to Northern Ireland. These Plans will have to set out what the UK is doing to meet NECD targets. The UK's commitment to reduce ammonia under the Gothenburg Protocol is independent of its exit from the European Union and Northern Ireland will be expected to make its contribution.

Ammonia emissions are a particularly significant issue in Northern Ireland since per capita, emissions are approximately four times higher here, than in the rest of the United Kingdom. This reflects how Northern Ireland differs from other parts of the UK

as a food exporting region which is economically reliant on the livestock agri-food sector and has relatively little arable farming. Unlike Greenhouse Gases which impact on a global scale, the repercussions from relatively high ammonia emissions in Northern Ireland are much more localised and are generally felt within our own region and within our own townlands. The ammonia which is emitted from our farms is often deposited back on land within Northern Ireland, including designated sites and priority habitats, potentially causing environmental damage. However, atmospheric nitrogen travels freely across borders, and in southern and western NI a significant proportion of N comes from ROI while NI emissions are also likely to impact upon sensitive sites in the ROI. Transport of nitrogen compounds in air is influenced by wind patterns, the distance from the source and atmospheric chemistry. ROI has been significantly investing in addressing the ammonia knowledge gaps and has been very helpful in sharing its new knowledge with the Expert Working Group.

In addition to general emission targets, Northern Ireland also has specific obligations to protect our many designated sites and priority habitats, as well as a more general legal obligation to conserve biodiversity which is shared by all statutory bodies. As part of the UK, Northern Ireland is committed to the protection of biodiversity through a number of international and European agreements. These include the Convention of Biological Diversity and its strategic plan adopted in Nagoya, Japan (the 20 Aichi Targets), the RAMSAR convention, the Bern Convention on the Conservation of European Wildlife and Natural Habitats, the EU Habitats Directive and the EU Biodiversity Strategy. A specific NI Biodiversity Strategy outlines the NI approach to improving performance on biodiversity and further highlights the need to reduce ammonia emissions.

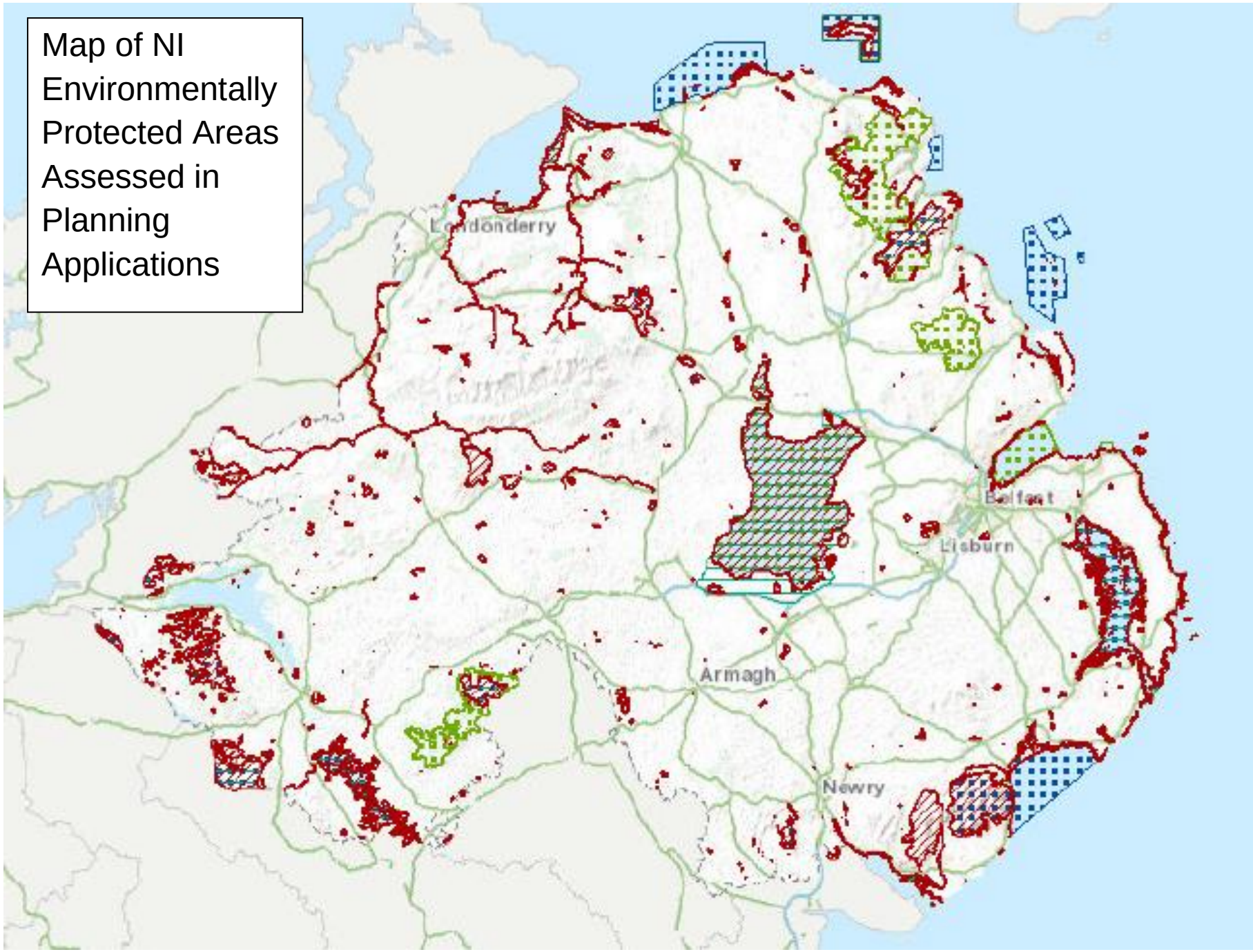
Nitrogen (N) deposition is a major threat to biodiversity, and is of particular concern as most of Northern Ireland is in exceedance of N deposition critical loads (the concentration of N at which significant ecological damage occurs). As identified in our original strategy, Northern Ireland is performing poorly in respect of European Priority Habitats with only one of our 49 habitats at favourable status. Furthermore, 36% of NI priority habitats and 31% of protected species have declined between 2002 and 2012. Although N deposition is only one of numerous causes of

biodiversity loss, for the agri-food sector to achieve good environmental performance, excessive ammonia emissions from farms must be addressed.

Air pollution from ammonia emissions has been identified as a threat in 29 out of 38 (75%) of Northern Ireland's Terrestrial Priority Habitats, and as a threat of high significance in 17 (45%) of those habitats[6]. Particularly sensitive to the effects of nitrogen deposition from ammonia are heaths, peat bogs, mires, fens, upland grasslands and woodland. In addition, two groups of Northern Ireland's designated 'Priority Species' (i.e. lichens of the genus *Cladonia* and bog mosses of the genus *Sphagnum*) are perceived to be threatened significantly by nitrogen compounds in air pollution.

[6] 3rd UK Habitats Directive Reporting 2013 http://jncc.defra.gov.uk/article17

Map of NI Environmentally Protected Areas Assessed in Planning Applications



However it is not simply legislation and environmental targets which set the impetus for better environmental performance among the farming sector. As an exporting region, deriving maximum value for Northern Ireland food in the marketplace must be a key priority for our agri-food industry. As outlined in our *Sustainable Agricultural Land Management Strategy*, we believe that a coherent approach to sustainable agriculture can form the building blocks for a world leading and credible sustainability brand which positively differentiates NI produce in international markets. We want to build on the good reputation of Northern Ireland food and provide consumers with assurance that the food they eat is being produced transparently to best in class global standards. We believe that in order to credibly assure our customers that Northern Ireland is a leader in sustainable agriculture, ammonia emissions must be controlled.

Overarching Recommendation – To achieve a sustainable future for Northern Ireland's agri-food sector, ammonia emissions must be addressed through a partnership approach which incorporates communication and education on ammonia, investing in filling our ammonia knowledge gaps and implementing a range of ammonia mitigation measures; and not on contracting the size of this sector.

We believe that there are four distinct issues to be considered as Northern Ireland's agriculture sector addresses ammonia, each with a section in this report;

1. How ammonia emissions are monitored and communicated – **Making Ammonia Emissions Visible**
2. How the evidence base is used to measure and control ammonia emissions – **Optimising the Evidence Base**
3. How ammonia emissions can be mitigated – **Mitigating the Emissions**
4. How to achieve adoption of ammonia mitigation measures by farmers – **Achieving Behavioural Change**

1. Making Ammonia Emissions Visible

1a. Making Ammonia Emissions Visible: Establishing a more robust and transparent means of measuring and monitoring ammonia

A fundamental principle expressed in our *Sustainable Agricultural Land Management Strategy* is that;

We must measure first to be able to subsequently manage optimally

We believe this principle is as relevant to ammonia emissions as it is to the water quality and soil health proposals in the *Sustainable Agricultural Land Management Strategy*. If policy is to require that farmers should take action to mitigate ammonia emissions, then they have the right to expect that the information guiding that policy is as relevant and robust as possible.

Currently, a series of models and an associated monitoring network are used to measure ammonia and determine the impact of nitrogen deposition on sensitive environmental sites (UK National Atmospheric Emissions Inventory). This is the approach taken for measuring a wide range of air pollutants. These models are as follows;

Models for estimating NH_3 emissions, atmospheric NH_3 concentrations and N deposition (national and regional level)

Model	Role	Comments
NARSES (RR)	UK emissions inventory model	Being incorporated into combined GHG/NH_3 inventory
AENEID (CEH/RR)	Spatially disaggregates emissions at 1 km grid level	Uses DA-averaged emissions per livestock type or per ha
FRAME (CEH/RR)	Uses AENEID emissions field as input to provide UK spatially mapped NH_3 concentrations	
CBED (CEH/RR)	Uses FRAME output to provide N deposition estimates and critical loads exceedance maps	

Models for estimating NH_3 emissions, atmospheric concentrations and N deposition (individual farm level)

Model	Role	Comments
SCAIL	Simple calculation of atmospheric impact limits used as a screening tool at individual farm level (local NH_3 emission impact assessments)	Uses EFs from NARSES but specific to local livestock and manure practices
ADMS/ AERMOD	Detailed air dispersion modelling tools used for individual farm level assessments	In most but not all cases uses EFs from NARSES as default values. EFs can be changed to recognise farm-specific mitigation strategies

The output of these models provides information on the level of ammonia emissions from various sources and the level of nitrogen deposition occurring on any particular area of land, including sensitive environmental sites. To assess the total level of ammonia at a local, regional and national level, emissions factors (i.e. the ammonia emissions associated with a particular farm practice) are multiplied by activity data (information derived from the farm census on the extent of each activity). The total ammonia emissions data is fed into the models. The output of these models is used to determine whether there is a risk that habitats within designated areas are being exposed to an excessive level of nitrogen deposition. This is the information which is used by the Statutory Nature Conservation Body (NIEA) in recommending to planners whether a proposal for farm development should proceed on the basis of the environmental capacity for further development, whether further detailed modelling work is necessary to explore the risk in more detail and to establish if there would be an adverse impact from the proposal.

The detailed evidence provided to us by the Department of Agriculture, Environment and Rural Affairs (DAERA), the Centre for Ecology and Hydrology (CEH), Rothamsted Research and the Agri Food and Biosciences Institute (AFBI) has reassured the Expert Working Group that the models themselves have been peer reviewed and are considered fit for the purposes for which they are used in decision-making which takes on board the uncertainty levels associated with model outputs.

However, we are very much aware that it is vital for the agri-food industry to have confidence in the output of these models, independent of the opinions of the peer review.

Bearing in mind this need for confidence, it is important to emphasise a fundamental principle of modelling;

Any model is only as good as the data inputted into it

It is therefore vital that the data provided into the modelling process is as accurate as possible. Where there are uncertainties associated with this input data, these

uncertainties will be reflected in the robustness of the outputs that the models produce for the nitrogen deposition on sensitive sites.

Our deliberations have identified some key issues with the input data used in these models to work out nitrogen deposition levels;

1. **The creation of the Baseline**: Firstly, there appears to be a lack of clarity in some areas about the conditions taken into account when the original emission factors were derived for various farm activities. For example, DAERA were not able to tell us the level of crude protein in pig diets when the emission factor for pig nutrition was calculated. Secondly, the emission factor for urinary nitrogen being used, is the GB figure and not the corrected NI figure, already agreed with the EU Commission. Lastly, we are concerned by the lack of a specific emission factor for livestock houses with slatted floors, which are the dominant design of livestock housing in Northern Ireland, and which are also known to emit considerably less ammonia than the slurry systems currently accounted for within the inventory. If we are not as clear as we can be of the point at which the baseline was created and subsequently, our current situation, then it becomes more difficult to measure and recognise future progress.

2. **Capturing Mitigation Measures already achieved by the industry:** We are also clear that some significant positive ammonia mitigation already delivered by the farming industry is not adequately captured in the assumptions embedded within the ammonia modelling. We believe that the NI farming industry has reduced its ammonia emissions in three key areas in recent times. These are;

    - The reduction of crude protein in pig diets
    - The installation of “dry heat” systems in the poultry sector using hot water heating systems
    - The move by some farmers towards spreading slurries and manures using low emission techniques, such as dribble bar, trailing shoe etc.

It is essential for farmers to have confidence in the assumptions going in to the models when these models’ outputs are then being used to inform critical decisions

relating to their future ability to develop their business. It is therefore vital that these positive behavioural changes are properly captured, with the latest information on uptake incorporated within the inventory and models. If they are not, then there is the potential for critical decisions to be made based on out-of-date information, and thereby producing an insufficiently accurate answer.

We recommend the **development of a more timely, transparent, thorough and robust** system for providing the information which inputs into these models. We want to use the most up-to-date evidence and metrics to measure ammonia emissions. We believe that **providing timely, robust and transparent information will be key for an educational communication tool, disseminated through means such as local farmer discussion groups.** This approach will raise awareness and understanding of why ammonia is an issue for farmers and why they must be encouraged to make the change required on their farms to address it. **In short, we want to simultaneously "de-myth" agricultural ammonia and make ammonia visible.**

This is not the first time a situation like this has arisen around emissions from agriculture, in the UK. In 2008, the London and Devolved Governments realised that this was the case for two greenhouse gases, methane and nitrous oxide. As a direct result, the collective Governments of the UK funded a considerable joint research programme to refine the UK's inventory, including updating the emission factors for methane and nitrous oxide, as they realised that the steady reduction of these gases would be hampered without having an accurate baseline and emission factors to use in the subsequent strategy to reduce these GHG emissions. This work has now been completed and acts as the back bone of the strategy to reduce GHG emissions from agriculture.

During the period that the Expert Working Group has been compiling its evidence on ammonia and writing this report, DAERA has been working on a parallel process to address these emerging knowledge gaps around the baseline and emission factors. In discussions, the Expert Working Group has been informed that DAERA has just completed a process of engagement and is about to procure work to enhance our knowledge in these areas through the commissioning of research on ammonia from

a UK wide partnership of science providers, led by AFBI, and supported by the Centre of Ecology and Hydrology and Rothamsted Research. A summary of the proposed research, the intended outcomes and the planned timelines can be viewed in Annex A of this report.

The Working Group welcomes this initiative to procure enhanced and up-to-date knowledge around ammonia emissions baselines and emission factors from a UK-wide science base. It is essential that this is carried out and communicated in a transparent and timely manner to the Sector's Stakeholders, with an update at least every six months. Other regions of the UK should be encouraged to join in and contribute to this process of enhancing our knowledge, as N. Ireland is not the only part of the UK with a problem with agricultural ammonia emissions and we should not have to bear all the costs of this new essential research work.

Recommendation 1a – Develop a more timely, transparent, thorough and robust method of improving our knowledge by filling the significant evidence gaps around the ammonia emission baselines and emission factors, in collaboration with a UK-wide partnership. Communicate progress on the development of this improved information to a multi-stakeholder forum, such as the revamped Agri Emissions Partnership, so that this successful cross sector stakeholder partnership can give sectoral leadership and receive six monthly updates from DAERA on how the knowledge gaps are being filled.

1b. Making Ammonia Emissions Visible: Improving the Monitoring Network

Ammonia emissions are monitored through a national UK network. This network provides vital information on the deposition of nitrogen. Three sites in Northern Ireland are used to measure "dry" ammonia deposition from the atmosphere (sites at Hillsborough, Coleraine and Lough Navar) [7] while three sites also measure "wet" nitrogen deposition through rainfall (Hillsborough, Beaghs Burn and Lough Navar)[8].

This network is of critical importance to local agriculture as the monitoring informs the models which assess nitrogen loading across Northern Ireland. These models form a key plank of the evidence base used by regulators and other competent authorities in assessing the environmental capacity for further agricultural development and are also used for a variety of other purposes such as spatial mapping of critical load exceedance. It is therefore vital that the information from the monitoring network which feeds this model is as accurate as possible. In 2004, the 'Ammonia Monitoring in Northern Ireland' project led by the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) assessed atmospheric ammonia levels at 12 sites across Northern Ireland, which found a close correlation between predicted and actual ammonia emissions. More detailed studies by CEH in Scotland have shown that ammonia emissions and deposition vary enormously over very small distances, depending on sources, vegetation, rainfall and the prevailing wind direction.

As the NI agri-food sector begins a concerted effort to reduce ammonia emissions, we believe that there is a need for another large scale effort at measuring and monitoring ammonia as a key component of a comprehensive and transparent approach to assessing ammonia emissions and nitrogen deposition. This monitoring will also "ground-truth" the modelling by providing actual information on nitrogen deposition within sensitive environmental sites. We want to see monitoring stations located at some of our designated sites and priority habitats to improve our knowledge on the extent of nitrogen deposition at these sensitive sites.

[7] https://uk-air.defra.gov.uk/interactive-map?network=namn
[8] https://uk-air.defra.gov.uk/interactive-map?network=precipnet

The monitoring of ammonia must be accompanied by sustained efforts to communicate the information gathered to farmers. We believe that this ammonia monitoring should be at a "real-time" frequency, at least once a day, in conjunction with the equivalent in local weather recording, with the aim of informing local farmers within discussion groups about how their practices impact upon ammonia emissions. We believe there is a clear need for a monitoring regime of sufficient frequency to identify when and why "spikes" in ammonia emissions occur and then advise farmers on how these can be mitigated. The key objective would be to increase understanding at farm level of how farming activities impact upon ammonia emissions and empower farmers to take up one or more of the mitigation options.

Establishing this enhanced monitoring regime will have three major benefits;

- Transparently validating the accuracy of the models which estimate nitrogen deposition
- Providing a means to measure the success of mitigating ammonia emissions and the subsequent reduction of nitrogen deposition on sensitive sites
- Providing localised information to farmers on ammonia emissions and subsequent nitrogen deposition in a manner which will increase their awareness and encourage them to further mitigate ammonia emissions

The Expert Working Group welcomes the previously mentioned research initiative by DAERA, which we are led to believe will include a considerable increase in the number of monitoring sites, in excess of the number used in the 2004 SNIFFER Report. But the Expert Working Group still recommends that the frequency of measurement and its vital link to weather recording is done on a more regular basis, enough to show farmers, "cause and effect," i.e. enough to make ammonia visible to farmers, so they can understand better why they need to reduce ammonia emissions and how they can effectively do so.

Recommendation 1b – Establish an enhanced regime for the monitoring of atmospheric ammonia and nitrogen deposition across Northern Ireland on a

daily basis, with the simultaneous recording of the weather, so that the results are sufficiently detailed to define the causes. This information must be communicated to farmers in order to positively influence farmer behaviour through means such as farmer discussion groups. As nitrogen deposition from ammonia emissions is such a localised problem, recording sites need to be sufficiently numerous, including at some of our designated sites and priority habitats, to assess and promote local understanding by showing farmers the "cause and effect" of farming practices on ammonia emissions and subsequent nitrogen deposition.

1c. Making Ammonia Emissions Visible: Setting the Thresholds

Because of our real problems with nitrogen deposition from ammonia emissions, all planning applications for livestock enterprises which emit ammonia are now being screened for their potential impact on designated sites and priority habitats under an evolving regime of ever more restrictive thresholds. In 2010, NIEA introduced a new threshold for screening of 1% of the critical load of nitrogen deposition for each designated site. In 2012/13, NIEA reduced the screening distance to 7.5km and the highest permissible threshold to 10% of the critical load. In 2015, the NIEA unit which regulates IPPC farms also moved to the 1% screening threshold. To our knowledge, these decisions to introduce more restrictive thresholds were made without consultation with the sector and were never communicated to the majority of livestock farmers who had previously fallen outside the IPPC regulations that large pig and poultry producers have been under for many years. In light of the previous helpful Government consultations on Nitrates and Phosphates, the Expert Working Group understand the sector's anger that these new requirements were introduced without any consultation with the sector and without an appropriate educational and communication programme.

Currently, when an application is received, an assessment is made of the requested development and its proximity to designated environmental sites and priority habitats. If projected ammonia emissions are above set thresholds then the farmers must undertake a detailed air impact assessment. This assessment can be a lengthy and expensive process for farmers, a cost which most farmers within the industry have never had to bear before. We agree that where there is a material risk of damage to protected or vulnerable sites, it is vital to assess any potential impact as accurately as possible. However the Expert Working Group struggled with the lack of transparency as to how these thresholds evolved and the failure to consult, educate and communicate with the sector before these tighter thresholds were put in place. The Expert Working Group recommend that these tighter thresholds be reviewed with the justification for any deviation in Northern Ireland from the rest of the UK and the Republic of Ireland to be clearly articulated publicly.

Recommendation 1c – To give transparency to the Sector, review the thresholds at which detailed ammonia modelling is required for the assessment of applications for new livestock units as compared to other parts of the UK and the Republic of Ireland and publically articulate the justification for the existing evolved Northern Ireland thresholds.

Comparison of Thresholds at which detailed monitoring is Required[9]

	Environment Agency Website			NIEA Accepted		
Nature conservation site designation	**Distance from site (km)**	**Lower threshold (%)**	**Upper threshold (%)**	**Distance from site (km)**	**Lower threshold (%)**	**Upper threshold (%)**
Special protection areas (SPAs), special areas of conservation (SACs), Ramsar sites	10	4	20	7.5	1	10
Sites of special scientific interest (SSSIs)	5	20	50	7.5	1	10
National nature reserves (NNRs), local nature reserves (LNRs), local wildlife sites (LWS), ancient woodland (AW)	2	100	100	2	1	50

% levels are a percentage of the limit value

[9] Table kindly provided by Shane Carr of Irwin Carr Consulting in a presentation to the Expert Working Group

1d. Making Ammonia Emissions Visible: Assessing Developments & managing perverse outcomes

Farm developments such as new housing for livestock require planning permission when they are sized above set statutory limits, or meet certain other conditions. As outlined above, through the planning process NIEA is required, as the statutory nature conservation body, to advise the planning authority on potential impacts from any such developments on designated environmental sites and priority habitats. NIEA then advises the planning authority on its findings. Where there will be an adverse impact, approval for development cannot be granted unless the proposer of the planning application agrees to take on enough mitigation options to reduce the ammonia emissions and subsequent nitrogen deposition to avoid an adverse impact.

With significant areas of Northern Ireland at or above critical levels of ammonia, achieving planning approvals is becoming more difficult, and almost impossible in some areas, for farmers in all sectors. This situation is aggravated by the absence of communication on what the ammonia emission mitigations are, their effectiveness and our lack of knowledge on how one mitigation option interacts with another. The importance of this issue has been highlighted by the legitimate desire of farmers to avail of vital Rural Development Programme funding for farm developments and therefore contribute to achievement of ‘Going for Growth’ targets by the Northern Ireland agri-food industry.

As mentioned earlier, we believe that the extreme difficulties currently being experienced by some farmers seeking to achieve planning permission to develop their business have been exacerbated by a failure to communicate this issue to farmers outside the regulated sector or to consult properly with the industry around how best to address the ammonia issue. This has led to the situation where farmers are being introduced to the ammonia issue for the first time and in some cases find that due to historic farming activities in their area, but outside their control, the critical loads for nitrogen deposition on nearby sensitive sites have been exceeded and therefore their plans for development of their farm business are being rejected. We absolutely sympathise with farmers who, having previously never been aware of the impact of ammonia emissions, now find that they cannot develop their business

because the combined levels of ammonia in their area are adjudged to cause an adverse impact.

We believe that the plan set out in this report will address Northern Ireland's ammonia issue in the medium to long term using the twin approach of improving measurement and implementing adequate mitigation measures which deliver a reduction in total ammonia emissions, while allowing the industry to expand and deliver the 'Going for Growth' ambitions. However, achieving those goals will take time, particularly since scientific research is required to update emission factors and improve the accuracy of the data being fed into the models used for regulation. We also realise that many farm businesses are keen to progress their development plans over the next one to two years. We do not believe that it is acceptable for the agri-food industry to be effectively "fossilised" over this period.

As we await the evidence to fill the knowledge gaps already highlighted previously in this report, the current output of the models should be used as an indicative tool, rather than a definitive tool when assessing an application for farm development. In the interim period, we believe that there are six guiding principles and approaches which DAERA must apply in considering applications for development in the immediate future;

- **Communicate** and explain the current planning process and requirements and the ammonia mitigation options available.

- **Prioritise** mitigating and reducing ammonia emissions at the Northern Ireland scale first, and at a local level secondly. Implementing ammonia mitigation measures on farm is a priority right across Northern Ireland, regardless of location, because without reducing background ammonia levels across NI, there will be little room to manoeuvre in specific problem areas near priority habitats, if adjacent individual livestock producers are asked to carry the total burden of ammonia reduction on their own.

- **Recognise** total ammonia emission reduction measures being proposed by farmers and consider this when making a decision on their planning application

- **Minimise** the risk of perverse incentivisation of farmers to choose smaller, less efficient ways of modernising in an effort to circumnavigate ammonia mitigation obligations

- **Accept** that farmers who agree to reduce their total ammonia emissions from their current emission levels are not creating a new "adverse impact." It is illogical and perverse if a planning refusal directly leads to the failure to implement mitigation measures which would achieve a reduction in total ammonia were the planning application to go ahead.

- **Facilitate** access for applicants who are encountering difficulties in achieving approval for farm development due to the impact of ammonia emissions to the appropriate experts on ammonia mitigation options. This dialogue should be used to inform applicants on the most appropriate and cost-effective ammonia mitigation strategy needed for that farm to deliver a successful planning consent, prior to further engagement with the planning process. The type of experts used in this process should include environmental scientists, agricultural scientists and qualified farm advisors. The emphasis must be on rewarding positive behavioural change through the uptake of appropriate mitigation rather than whether the mitigation is considered to be "enforceable" based on how easy or difficult it is to inspect or monitor. The planning process should also take into account that many mitigation measures can be monitored through farm records.

We want to see these principles implemented in decision-making on approvals for farm developments. We believe that these principles should be applied in assessing farm developments to complement the results of the existing models until these models are improved through the addition of more accurate emission factors on key local farming activities and supported by the results of the improved monitoring regime. When this new knowledge becomes available, we believe DAERA should establish a training programme for private sector consultants on the cumulative impact of ammonia mitigations options so that they can fulfil the role of advising

applicants on how to implement sufficient ammonia mitigation options to achieve a successful planning consent.

We believe that by following these six principles and approaches, DAERA can avoid perverse outcomes, engender much greater trust and transparency within the sector on this issue and therefore encourage the positive behavioural change required on farms to reduce ammonia emissions.

Recommendation 1d - DAERA should immediately adopt the following six guiding principles and approaches in assessing planning applications;

- ***Communicate and explain the current planning process and requirements and the ammonia mitigation options available***

- ***Prioritise mitigating and reducing ammonia emissions at the Northern Ireland scale first, and at a local level secondly***

- ***Recognise total ammonia emission reduction measures being proposed by farmers and consider this when making a decision on their planning application***

- ***Minimise the risk of perverse incentivisation of farmers to choose smaller, less efficient ways of modernising in an effort to circumnavigate ammonia mitigation obligations***

- ***Accept that farmers who agree to reduce their total ammonia emissions from their current emission levels are not creating a new "adverse impact"***

- ***Facilitate access for applicants who are encountering difficulties in achieving approval for farm development due to the impact of ammonia emissions to the appropriate experts on ammonia mitigation options.***

1e: Making Ammonia Emissions Visible: Guidance for Planning Applicants

We particularly want to emphasise that farmers need more guidance to help them navigate the unfamiliar and sometimes complicated process of assessing ammonia emissions for planning purposes. The application process should be structured in such a way so that all the information required to make an informed decision on the environmental impact of the development is sought from farmers at the outset in a clear and concise manner. In particular, information on whether developments such as farm buildings are replacing existing housing or intended to facilitate farm expansion should be sought and provided at the earliest opportunity. It is vital that regulators are aware of this information when assessing the environmental impact of a development as total animal numbers on-farm are crucial in determining whether and to what extent, ammonia emissions will vary post-development.

Recommendation 1e - Review the planning application process to ensure that all appropriate guidance on ammonia is provided and that all relevant information is sought at the earliest possible opportunity to minimise delays.

1f. Making Ammonia Emissions Visible: Use of “In Combination” Records

There are concerns around how NIEA are compiling their ‘in combination’ records. As we have outlined above, the models take data reflective of all farming activity in Northern Ireland and use this to produce estimates of nitrogen deposition at each particular site. We are aware that NIEA separately hold a spreadsheet to record applications for farm development and the “process contribution” of ammonia from each such applications.

NIEA have advised us that this spreadsheet is used for simple addition of process contributions of ammonia to establish when the cumulative threshold of 10% has been reached and ensures that there is no double counting. However, we are unclear as to whether this spreadsheet includes information on the ammonia emissions from previously existing farms which have successfully applied for planning permission since NIEA have begun to compile this spreadsheet. Although such farms have received planning permission, they may not have increased their ammonia emissions or may have increased emissions by only a small proportion. We are therefore concerned that this spreadsheet may consider emissions from such farms to be completely “additional,” over and above the emissions estimated by the background models. If this is the case, then we feel there is potential for double counting of emissions as NIEA tally emissions from this spreadsheet to identify when the 10% threshold has been reached. Therefore we believe that the role of this spreadsheet in informing NIEA decision making needs to be clarified. A full explanation of the operation of this NIEA spreadsheet should be communicated to industry in order to build transparency and confidence between the industry and the regulator.

Recommendation 1f - To provide assurance that the regulatory process is not “double counting” some emissions from approved farm developments, DAERA should communicate directly to stakeholders outlining how their “in combination” spreadsheet is compiled, how it operates, and why it is needed over and above the models

2. Optimising the Evidence Base

As highlighted in the previous chapter, since some of Northern Ireland is in exceedance of critical loads of N deposition, regulators and planning authorities are required to take into account ammonia emissions before approving new livestock developments. Failing to do so would risk harm to our most sensitive environmental habitats. However it is absolutely vital that such decisions, which can have huge ramifications for the future of a farm business, are **guided by the best available science and up to date data on mitigating ammonia emissions**. Improving scientific information based on research conducted in Northern Ireland and beyond will make it possible to farm competitively while simultaneously reducing ammonia emissions through modifying livestock diets, housing, manure management and various other techniques.

2a: Optimising the Evidence Base: Slatted Floors in Livestock houses

The predominant system of livestock housing in Northern Ireland is a slatted floor system with a below ground tank. The most recent Farm Structure survey states that 71% of all farms in Northern Ireland have below ground slurry tanks, including 87% of medium and large farms[10] while survey data states that 72% of cattle were housed on slatted floors in 2010[11]. However the emission factor within the ammonia inventory for slurry systems does not include measurements for slatted-floor systems. The current UK ammonia inventory report states that;

*"It is recognised that slatted-floor slurry systems also exist for dairy and beef systems, particularly in Northern Ireland and Scotland, and that **the current slurry housing system EF (emission factor) is not representative of these systems**. Emission measurement being undertaken on such systems in the Republic of Ireland may provide useful data from which the UK can derive a system-specific EF."*

[10] 2016 EU Farm Structure Survey https://www.daera-ni.gov.uk/sites/default/files/publications/daera/17.18.088%20EU%20Farm%20Structure%20Survey%202016%20V2.pdf

[11] 2010 EU Farm Structure Survey https://www.daera-ni.gov.uk/sites/default/files/publications/dard/european-structure-survey-2010.pdf

Preliminary results from trials in the Republic of Ireland have suggested that the current emission factor used in the inventory may significantly overestimate the actual ammonia emissions from slatted floor systems. Whilst we understand that scientific results must be comprehensive and to a peer-reviewed standard before they can be used to amend an emission factor, we believe that it is vital that work is urgently undertaken to ascertain to the required standard the emission factor for slatted-floor systems. This is a key evidence gap which must be addressed through the newly commissioned research project on ammonia.

Recommendation 2a - Undertake the scientific work necessary to define an emission factor for slatted-floor slurry systems for use in the national ammonia inventory. Ensure that this new emission factor is fully accounted for in considering planning approvals.

2b. Optimising the Evidence Base: Crude Protein in Pig Diets

The treatment of crude protein in pig diets has been identified to the Expert Working Group as an issue where available scientific knowledge could contribute to better regulation. An AFBI scientific review has concluded with a high degree of confidence that ammonia emissions will reduce by 8%, and probably by 10%, for every 1% reduction in the crude protein of growing and finishing pig diets. This review further states that;

This reduction is applicable to a broad range of dietary crude protein levels i.e. from 20% down to 12% dietary and therefore the impact is additive (e.g. 8% shift in CP level would reduce ammonia emissions by at least 64% and possibly by 80%)[12]

However, while a full 8 percentage point reduction in crude protein levels in feed will prove difficult to achieve for technical and practical reasons, our concern is that the principles of these scientific findings have not been fully recognised within the regulatory framework. We believe that where farmers can show that they are implementing crude protein savings in pig diets, the scientific evidence for the associated ammonia emissions should be taken into account without the application of any cap for which there is no scientific justification. We also believe that the administrative process whereby farmers are required to demonstrate their proposed crude protein reductions should be made as straightforward as possible with information from quality assurance schemes and feed records used where available.

Recommendation 2b – Take proper account of scientific findings relating to the impact on ammonia emissions of reductions in crude protein in pig diets when assessing applications for pig farm developments.

[12] Ammonia and Odour Abatement Methods for the NI Pig Industry. DARD E&I Project report No.13/04/03 Dr Elizabeth Magowan (2015)

2c. Optimising the Evidence Base: Crude Protein in other Livestock Diets

While local verified research supports the proposition that there is an 8 to 10% reduction in ammonia for every 1% reduction in the crude protein content of pig diets, there is also good evidence that similar relationships exist for other livestock diets. In ruminants, ammonia is mostly derived from the urine component of manures, rather than the faeces. Decreasing the crude protein content in the diets of livestock such as cattle and sheep leads to less nitrogen being excreted, reducing concentrations of total available nitrogen and potentially leading to lower ammonia emissions. There is also evidence that poultry on a reduced crude protein diet supplemented with essential amino acids could produce up to 35% lower ammonia emissions.[13] Since the majority of ammonia emissions in Northern Ireland are derived from ruminant livestock, it is important that the potential for ammonia abatement by reducing crude protein in ruminant diets is properly quantified. It has been suggested that reducing the crude protein in dairy cow diets by 3-4 percentage points will significantly reduce the N excretion in urine by around 45%[14]. We want to see the evidence around the impact of crude protein reductions on ammonia emissions rigorously assessed in a Northern Ireland context (to include impact on yield) and appropriate account taken of the abatement which can be achieved. There is also scope for research on the level of ammonia emissions arising from grass silage based diets.

Recommendation 2c – Quantify the correct emission factors for dietary crude protein reduction for livestock other than pigs. Take these corrected emission factors into account in decision-making.

[13] AFBI Literature Review

[14] 'The Importance of Research and Innovation in the Dairy Sector' Dr Keith Agnew, AFBI Stakeholder Day, 1st June 2017

2d. Optimising the Evidence Base: Dry Air Heating in Poultry Houses

Initial Trials in England have found that poultry installations substantially reduce their ammonia emissions when switching their heating source to a hot water system which produces “dry air heat” from products such as biomass, as opposed to a LPG “wet air” system. Since nearly all of the Northern Ireland poultry industry has recently switched to utilising these “dry air” systems, it is vital that any associated reduction in ammonia emissions, already achieved, is properly quantified, verified and recognised in regulation here.

Recommendation 2d – Quantify the correct emission factor for poultry units following the recent substantial switch to “dry air” heating systems. Take this corrected emission factor into account in decision making.

2e. Optimising the Evidence Base: NI evidence on Nitrogen Excretion

A very significant body of scientific research was undertaken in 2005 within AFBI as part of the preparation for government's negotiation with the European Commission on the Nitrates Action Programme which is reviewed every three years. This scientific research has ensured that the Nitrates Action Programme can be properly tailored to meet local needs and take local conditions into account. One area where specific NI data has been critical in convincing the Commission to approve a more relevant and locally focussed programme is in relation to the nitrogen excreted by cattle and sheep.

This involved a comprehensive review of a series of previously published AFBI studies, undertaken with animals managed under local soil and weather conditions and offered diets representative of those used in Northern Ireland. The model developed from this review demonstrated that the manure N output of ruminants in Northern Ireland is significantly less than in GB, largely due to differences in diet and management systems. The European Commission noted that the research undertaken by AFBI was highly informative, robust and appropriately reflected Northern Ireland's production systems. Similarly, in advance of the 2010 review, AFBI undertook a comprehensive review of manure N excretion from pigs and demonstrated lower N excretion rates from Northern Ireland pigs compared to those in GB, due mainly to difference in diet composition. Whilst this information has been accepted by both the European Commission and the environmental regulator in respect of the Nitrates Directive, it is not obvious to us that this distinct Northern Ireland evidence has been properly taken into account in assessing ammonia emissions from NI agriculture.

While we understand that the NARSES model does not use a fixed nitrogen excretion value, we believe that it is vital that all available NI-specific information is fed into the ammonia inventory as part of the forthcoming ammonia research project. We believe that this must be addressed as a matter of priority to ensure that decisions are being made using the best available evidence.

Recommendation 2e – Ensure and communicate to stakeholders that all available evidence from Northern Ireland on N excretion from livestock is properly taken into account in the measurement of ammonia emissions and nitrogen deposition.

2f. Optimising the Evidence Base: Local Weather Data

A significant variable in the deposition of nitrogen from ammonia emissions is the impact of the weather. In particular, wind speed and direction are critical in determining where ammonia emissions from a farm will be deposited. Rainfall levels will also determine the extent of “wet deposition” of nitrogen in a particular area. A concern raised within the Expert Working Group is that the models used to estimate nitrogen do not properly take into account the significant disparity in weather patterns across Northern Ireland. We believe that the weather data utilised within the models should be reviewed to assess whether improvements in accuracy can be made. We also want to see the proposed additional ammonia and nitrogen deposition monitoring stations measuring weather data.

Recommendation 2f – Ensure and communicate to stakeholders that the weather data used within the nitrogen deposition assessment process is as accurate as possible. Weather data should be recorded at each current and future ammonia and nitrogen deposition monitoring site

2g. Optimising the Evidence Base: Managing Slurry and Manure Storage

A critical element of any livestock housing system is the management of the slurry and manure produced, particularly since the mixing of urine and faeces is a significant cause of ammonia emissions. Good practice in this area can not only reduce emissions but will also ensure that maximum benefit is derived from what is a key farm resource. However, extreme care is needed when designing policy in this area as our local farming industry is only too aware of the potential for tragedy when dealing with slurries and manures. Slurry bubbler systems occupy a unique but potentially perverse position in this debate as they are recommended for installation within slurry stores for safety reasons whereas the prevailing research opinion is that these systems can significantly increase ammonia emissions. We believe that further research is required in this area to ascertain whether it is possible to reach a position on the benefits or otherwise of bubbler systems which is consistent across our various priorities. However we absolutely understand that safety must be the primary consideration on every farm.

Treatment of slurry with additives has also been proposed as a means of reducing ammonia emissions, as well as reducing the requirement to mix slurry which would lessen health and safety risks. We believe that this is an area of farming practice which requires additional research so that farmers can benefit from clear advice on the appropriateness and cost-effectiveness of such treatment.

Recommendation 2g - Research should be commissioned into the costs and benefits of a range of slurry additives to mitigate ammonia emissions. There should also be research commissioned examining the trade-offs between using slurry bubbler systems to improve human safety and perversely, increasing ammonia emissions.

2h. Optimising the Evidence Base: An Agile Approach to Science

Establishing and maintaining an evidence base which allows farmers and policy makers to identify the most effective means of addressing ammonia abatement requires access to high quality scientific knowledge in a timely fashion. We are concerned that the current process for commissioning science on the environmental footprint of the agri-food sector does not respond to emerging urgent needs with sufficient speed. We believe that there is a need for a more agile process whereby scientific advice can be sought on an urgent basis where there is a clear policy requirement.

One of the key ways to identify and optimise mitigation actions is by encouraging the innovation which produces new and improved mitigation techniques. The private sector will have an important role in developing novel ways to reduce emissions while continuing to support farm profitability. Whilst environmental regulators must evaluate and verify all proposed means of mitigation in a transparent and robust manner, government should also support the agri-food sector to establish a culture of good environmental and economic performance through innovation. We are strongly of the view that where the agri-food sector is willing to work in partnership with government and fund new scientific research to address an important knowledge gap, government should make every effort to facilitate and encourage private sector involvement. Where new techniques to mitigate emissions emerge, government must be proactive in assessing and recognising these within the appropriate inventories, as a priority.

Recommendation 2h(i) – Government should ensure that the process for commissioning scientific research is sufficiently agile to meet emerging urgent policy needs

Recommendation 2h(ii) – Government and the agri-food sector should work together to create a culture of innovation which encourages private sector involvement in the development of new scientific knowledge, particularly where such knowledge can contribute to improved farm efficiency and better

environmental performance. Government should do all it can to facilitate the private sector in providing this investment.

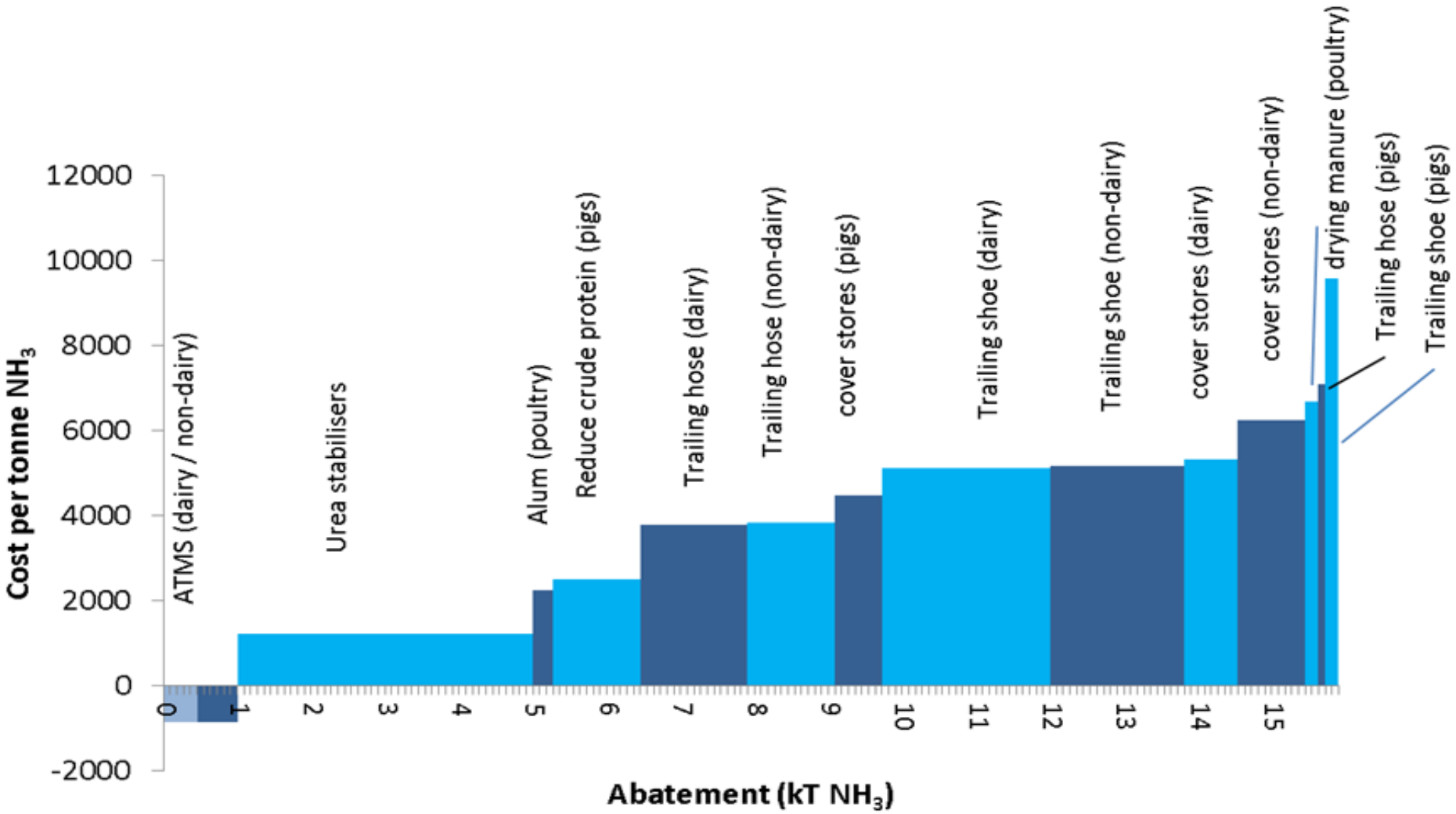
2i. Optimising the Evidence Base: Prioritising Cost-Effectiveness

Action to reduce emissions is not a new concept for our farmers who have already made tangible strides in implementing mitigation measures to reduce the carbon footprint of local food through the "Efficient Farming Cuts Greenhouse Gases" strategy[15]. The guiding principle for both that strategy and our original report on sustainable land management is that the best way to improve environmental outcomes on farms is by identifying mitigation measures which also improve farm profitability. We want to turn the environment from a cost centre into a profit centre. In particular, the agri-food sector needs to prioritise the mitigation measures which can be implemented at least cost to the farmer, using evidence from economic tools such as Marginal Abatement Cost Curves (MACCs). We want to see a MACC developed for Northern Ireland's ammonia emissions so that informed decisions can be made on how best to address ammonia emissions in ways that also facilitate the economic development of the agri-food sector. An Ammonia MACC for Northern Ireland should include analysis of each of the mitigation measures highlighted in section 3 of this report.

Recommendation 2i – Develop a MACC for agricultural ammonia in Northern Ireland to prioritise ammonia abatement measures based on cost-effectiveness, using local evidence as far as possible.

[15] https://www.daera-ni.gov.uk/publications/efficient-farming-cuts-greenhouse-gases-implementation-plan-2016-2020

Teagasc Example of an Ammonia MACC for the Republic of Ireland



2j. Optimising the Evidence Base: Assessing the cumulative impact of mitigation techniques

At present, the information available on ammonia emissions is not robust enough to allow farmers to accurately assess the impact on ammonia emission reductions of combining mitigation measures at farm level. This is a significant knowledge gap as without robust data on the cumulative impact of ammonia mitigation measures, farmers, regulators and policymakers cannot be confident in assessing the impact of the uptake of the suite of ammonia mitigation measures we have highlighted and therefore the extent of uptake required is unknown. It is also unclear if there are any synergistic or contradictory impacts among various abatement measures. This is particularly important in relation to ammonia emissions as the expert evidence we received strongly emphasised the point that where mitigation measures achieve ammonia savings at an early stage in the manure handling process, those savings will be largely undone if there is poor practice at a later stage, for example when spreading the manures.

It is therefore vital that the evidence base around ammonia is improved so that it is possible to properly analyse the cumulative impact of mitigation techniques. We hope that the scientific programme around ammonia to be commissioned will address these concerns and provide sufficient new information to allow the relationship between mitigation measures to be properly assessed.

Recommendation 2j - Improve and communicate the scientific evidence base so that robust assessment can be made at farm and NI level of the cumulative impact of uptake of multiple mitigation measures

2k. Optimising the Evidence Base: Impact of agricultural ammonia on human health

Ammonia emissions cause health problems in humans through reactions in the atmosphere with other molecules to form compounds such as ammonium sulphate and ammonium nitrate which are precursors to particulate matter which **damage air quality and can lead to adverse effects on human health.** While it is widely accepted that ammonia from agriculture plays a role in producing this harmful particulate matter, the extent of its contribution is not clear. The Expert Working Group has been guided by the Chief Environmental Health Officer for Northern Ireland who has drawn our attention to the most recent report on the health effects of air pollution[16] which states that;

Particulate air pollution is a complex mixture of many chemical components. Although it might be expected that some components are more harmful to health than others, ***the evidence available from population-based studies does not give a consistent view of their relative toxicity****. Both particles emitted directly from a range of pollution sources, such as traffic and solid fuel combustion, and those formed by chemical reactions in the atmosphere are associated with adverse effects on health and the current consensus is that these associations are, at least in part, causal.* ***Hence, reductions in concentrations of both types of particles are likely to benefit public health.***

It is therefore not possible to state with accuracy the precise impact of agricultural ammonia on human health, though an impact is recognised. We see this as a knowledge gap which should be addressed so that comment relating to the agriculture sector is properly informed and the reputation of our agri-food sector is not unfairly denigrated. We urge caution in the communication around the link between ammonia and human health beyond information that has been shown to be scientifically robust. However, regardless of the precise impact of agricultural ammonia on human health, it is clear that improved human health represents

[16] https://www.gov.uk/government/publications/particulate-air-pollution-health-effects-of-exposure

another key justification for a significant reduction in ammonia emission from farming.

Recommendation 2k – Address the knowledge gap and manage the communication carefully around the impact of agricultural ammonia emissions, the subsequent formation of atmospheric particulate matter and its effect on human health

3. Mitigating the Emissions

As outlined above, much effort is required to improve both the measurement of ammonia emissions and the way in which these emissions are taken into account in the regulatory regime. While it is vital that these matters are addressed, that should not detract from the inescapable conclusion that **Northern Ireland agriculture must take practical and sustained action urgently to reduce its ammonia emissions**.

We believe that the reduction of ammonia emissions is a challenge for the entire agri-food industry, and not simply those farmers who happen to be located close to sensitive habitats. In order to properly address our ammonia issue and put the NI farming industry on a sustainable pathway, it is crucial that the background levels of ammonia right across the industry are reduced. This will require action on all farms and mirrors the approach taken in the Republic of Ireland where their focus has been on reducing total ammonia emissions across the country. In tandem with addressing background levels of ammonia across NI, localised exceedances of nitrogen deposition on sensitive sites will also require local solutions in the form of specific ammonia mitigation measures.

We believe that there are two priorities in relation to mitigating ammonia;

1. To reduce ammonia emissions across Northern Ireland first, which will provide better headroom at a local level to allow businesses to modernise and develop
2. To reduce ammonia emissions at a local level, second

The evidence we considered highlighted the importance of **taking a comprehensive and coherent approach to agricultural ammonia**. As outlined in previous sections, ammonia emissions are a component of the nitrogen cascade. Where nitrogen is lost within the food and farming system, it can be emitted as ammonia. It therefore follows that where nitrogen losses are avoided in one part of the system, that effort can be undone if poor practice in another part of the system leads to that “saved” nitrogen eventually being emitted as ammonia or nitrous oxide, or lost through

leaching. **Ammonia mitigations must therefore be considered throughout the agricultural system.**

A key driver of ammonia emissions is the reaction between urine and faeces when these substances are mixed together. Since that reaction occurs on a much greater scale when livestock are confined within housing systems, a starting point for achieving ammonia abatement in the ruminant sector must be the management of livestock through increasing outdoor grazing. During outdoor grazing, the urine produced by animals will soak through the soil's surface so that volatilisation is limited. A first step in ammonia abatement is therefore to maximise the length of the grazing season. This can also reduce the level of nitrogen introduced into the production system through imported feedstuffs. Once this has been achieved, the next step is to address how livestock are housed and also what they are fed within that housing system. Further mitigation can be achieved through measures around the storage and subsequent spreading of manures, and also use of artificial fertilisers. Finally it is also possible to reduce emissions through animal genetics and by capturing some ammonia on site. Adopting mitigation measures at all stages is the most effective method of reducing emissions as saving ammonia at one stage could simply leave more to be lost later if good practices are not followed throughout.

This section outlines ten ammonia mitigation measures for implementation on farms in Northern Ireland. We believe that every farm will be able to implement at least some of these measures and it is vital to ensure that there is widespread uptake of them across Northern Ireland. Therefore, we have ordered the mitigation measures in this section based on our best estimate of cost-effectiveness. Combining ammonia mitigation with good economic performance must be a key priority for the NI agri-food sector.

3a. Mitigating the Emissions: Extending the Grazing Season

Livestock housing and hardstandings are the greatest contributors to ammonia emissions from NI agriculture, being responsible for 36% of all agricultural ammonia. It therefore follows that the simplest means of decreasing these emissions is by minimising the amount of time which livestock spend housed, thus reducing the scope for emissions through the mixture of urine and faeces. Since grazed grass is also the most cost-effective means of feeding livestock, an approach focused on increasing the length of the grazing season will have significant financial benefits.

Our original report on sustainable agricultural land management highlighted the benefits of extending the grazing season in order to maximise utilisation of grass and therefore increase farm profitability and reduce phosphorus balances on-farm. We would emphasise that the methods we recommended for extending the grazing season in our main strategy will also make a significant contribution to ammonia abatement. Ways of extending the grazing season include;

- Using a rotational grazing system to allow progressive build-up of grass yield[17]

- Using the wettest fields first for autumn grazing in case they get too wet later in the autumn

- Keeping lighter animals on grazing fields during wet periods to avoid damage to the sward

- Improving soil structure with soil aeration when subsoil conditions are dry enough. This will allow water to percolate through the soil better, keeping the soil drier for longer, reducing further compaction and the risk of flooding. Compaction can also be decreased by reducing the total axle weight of farm machinery, maximising tyre width and diameter, reducing tyre pressure and adopting a controlled traffic system, whilst keeping machinery out of wet fields where possible.

[17] https://www.cotswoldseeds.com/seed-info/extending-grazing-season-dairy-farms

- Incorporating legumes and other deep-rooted herbs such as chicory within grazing swards to increase the percolation of water through soil, thus providing drier swards and longer grazing seasons. Grass clover swards are also well suited for autumn grazing

- Establishing agro-forestry within grazing fields to produce drier swards which allow livestock to be turned out earlier and kept out later. Recent measurements in Northern Ireland have shown that agro-forestry swards have a much greater livestock carrying capacity at the beginning and end of the grazing season, as compared to conventional swards[18]

- Incorporating additional woodland within farming systems through taller hedges and shelter belts to increase soil porosity, thus producing drier and more sheltered swards which allow livestock to be turned out earlier and kept out later

- Research into the viability of using technologies such as soil thermometers and soil potentiometers to match the application of nutrient to soil conditions, potentially allowing better grass growth in early Spring and late Autumn

Recommendation 3a - Farmers should implement land management techniques to extend their grazing season where possible, thereby reducing the level of ammonia emissions from ruminant livestock

[18] Jim McAdam, AFBI

3b. Mitigating the Emissions: Fertiliser Application

The application of chemical fertiliser to land also produces ammonia emissions with 7% of agricultural ammonia coming from this source. Between 7% and 53% of the nitrogen in urea can be lost as ammonia[19] while Calcium Ammonium Nitrate (CAN), the predominant form of N fertiliser used in Northern Ireland is also vulnerable to denitrification. However recent research conducted on a cross-border basis by AFBI and Teagasc has shown that use of a urea fertiliser with a urease inhibitor (i.e. 'stabilised' or 'treated' urea) can significantly reduce ammonia emissions (by up to 78.5%) compared to straight urea fertiliser. This study also found that use of treated or stabilised urea fertiliser significantly reduced the risk of ammonia losses compared to straight urea during relatively dry summer conditions at the sites measured – the most challenging conditions in terms of ammonia loss for urea. Research has shown that stabilised urea will maintain agronomic yields and will have substantially lower nitrous oxide emissions relative to CAN[20], thus reducing the carbon footprint. In terms of cost per kilogram of nitrogen, urea has historically been more than 20% less expensive than CAN on average[21]. There is potentially significant scope for farmers to reduce their ammonia emissions by switching from straight urea fertiliser to using stabilised urea. Given the huge potential for ammonia reduction by displacing straight urea with stabilised urea, we believe the use of straight urea fertiliser should be phased out.

Recommendation 3b – Farmers should consider applying treated or stabilised urea fertilisers where these can maintain agronomic output, and particularly where stabilised urea can displace straight urea fertiliser. By 2020, the use of straight urea fertiliser should no longer be permitted.

[19] Forrestal et al., 2015
[20] Forrestal et al., 2015
[21] Forrestal P.J, Teagasc Stakeholder Meeting 31st May 2017

3c. Mitigating the Emissions: Timing of Slurry and Manure Spreading

There is significant scope to reduce ammonia emissions by adjusting the timing of slurry and manure application. Scientific research has found that moving the timing of slurry application from mid-year to early spring when conditions are less favourable for ammonia volatilisation can reduce emissions of ammonia and nitrous oxide. In a ROI context, Bourdin et al. (2014) demonstrated that overall gaseous N emission reductions of up to 43% were possible with an April compared to July slurry application. Adjusting timing of application has also been shown to have a positive impact on farm profitability. Technology such as soil potentiometers and thermometers have the potential to assist farmers in identifying when soil conditions in Spring are appropriate for nutrient application.

Daily weather variations can also have an important impact on ammonia emissions. Nitrogen loss can be minimised by avoiding application on particularly warm and windy days. Applying slurry and manure in the early morning or evening (as opposed to the middle of the day) will generally help to minimise ammonia volatilisation and improve nitrogen availability.

Recommendation 3c - Farmers should apply slurry and manure earlier in the season, where land and weather conditions allow. If the farmer has a choice and where possible, slurry and manures should be spread in the early morning or evening, but not on warm, windy days. This will not only reduce ammonia loss, but also improve the efficiency of nitrogen use within the production system.

3d. Mitigating the Emissions: Better Methods of Slurry and Manure Spreading

Land spreading of slurries and manures is responsible for 28% of ammonia emissions. Yet again, there is a key element of our original report on sustainable agricultural land management which can deliver on ammonia emission reductions, as well as improving soil health and increasing farm profitability through better nutrient management. Scientific research has shown that applying slurry using low emission techniques will achieve significant ammonia reductions compared to splashplates (reductions of 26%, 57% and 75% for band spreaders, trailing shoe and injection respectively). This emphasises the importance of these technologies which increase nutrient uptake in swards while reducing the risk of slurry transferring to watercourses and also decreasing GHG emissions and odour. Achieving best practice in slurry and manure application also ensures that where ammonia emissions are avoided in the storage of slurry and manures (for example by covering stores), the potential benefit of those mitigation measures is not lost, but rather is maximised.

Promotion of these methods of slurry application must be a key priority for both government and the farming sector and progress has been made through both previous and current capital grant schemes with funding for low emission spreading equipment. However given that currently only 33% of slurry in Northern Ireland is spread using low emission techniques[22], there is a need to accelerate uptake of this "win-win" farming technique. We therefore repeat the recommendation in our original report that uptake of these technologies must be increased with the use of splashplates gradually phased out.

In our original report, we recommended that that the sale of new splashplates should not be permissible after 2020. Given the further evidence we have considered around the impact of low emission techniques on ammonia emissions, we believe that the logical conclusion of that recommendation is to set a date by which the use of splashplates is not acceptable. We believe that 2025 is a reasonable date by which slurry spreading by splashplate should be banned. By proposing a date 8

[22] AFBI Survey of Slurry Spreading Practices in Northern Ireland, February 2013

years into the future, this gives the industry ample time to prepare for a mandatory change in practice and to further develop the appropriate technologies. Given the significant danger to the sustainability of the industry posed by excess ammonia, we believe that it is vital for the industry to change and to use technologies that improve nutrient efficiencies, reduce risk of run off, reduce emissions and odour, thus resulting in better environmental outcomes.

Recommendation 3d – Accelerate the significant increase of the proportion of slurry and manures which is applied on land by dribble-bar, trailing shoe/hose, band spreader or shallow injection. Take steps to prohibit the sale of new slurry spreading equipment without low emission technologies by 2020 in preparation for a total ban on spreading slurry and manures by splashplate by 2025.

3e. Mitigating the Emissions: Farm Cleanliness

A simple but effective way in which to reduce ammonia emissions on a large number of farms is by maintaining cleanliness within the farmyard and housing area. By regular cleaning of hard standing and collecting areas and ensuring regular waste removal, ammonia emissions can be reduced by up to 49%[23].

Recommendation 3e – Farmers should recognise and embrace the benefits of brushing, scraping and washing livestock housing and handling areas and prioritise these tasks. As well as reducing ammonia emissions, this can produce significant reductions in animal lameness and associated production losses.

[23] Ammonia Emissions from Livestock Production in Northern Ireland, Dr Rachael Carolan, AFBI

3f. Mitigating the Emissions: Livestock Diets

Reducing the amount of N in excreta has significant potential to reduce ammonia emissions and is a vital component of the manure management system. As outlined in previous sections, scientific evidence shows that significant reductions can be achieved in ammonia emissions when pig diets are amended to reduce the content of crude protein within the diet. Ammonia emissions are reduced by 8 to 10% for every 1% fall in crude protein intake in pig diets. There is evidence that significant reductions of up to 35% are possible in poultry diets. Although it is more difficult to control crude protein intake in the forage-based diets of cattle, there is still potential for tangible ammonia abatement through crude protein reductions in ruminant diets, as highlighted in our earlier recommendations. Once local scientific evidence has verified the potential for ammonia abatement through livestock diets (other than pigs where it is already verified), we believe that the optimal strategies to reduce crude protein in livestock diets must be communicated to farmers and adopted in feeding practices. However care must be taken to ensure that crude protein is not reduced below a level where animal performance will be affected. It is also vital that these strategies to reduce crude protein are communicated within government and taken account of by regulators.

Recommendation 3f – Identify the optimal strategies to reduce crude protein intake in livestock diets while maintaining and enhancing livestock performance and communicate these to farmers for adoption. Regulators must also ensure that adoption of these practices is properly recognised in planning decisions.

3g: Mitigating the Emissions: Genetic Improvement

The efficiency of feed conversion in cattle also has a significant influence on ammonia emissions. The greater the feed conversion efficiency of beef cattle, the less nitrogen is excreted per kilogram of meat produced. Evidence provided to the Expert Working Group suggests that the most efficient cattle breeds such as Stabiliser are 30% more feed efficient than the average bovine and therefore excrete less nitrogen per kilogram of meat produced. Some of this additional efficiency will be transmitted to a bull's offspring in the first cross. This improved feed efficiency will have a particularly significant impact on ammonia emissions during the winter feeding season. Our estimates suggest that significant ammonia savings of up to 7.5% could be achieved through the use of the highest feed efficient cattle sires.

Recommendation 3g - Livestock farmers should utilise the most feed efficient genetics to increase efficiency and reduce ammonia emissions.

3h: Mitigating the Emissions: Capturing Ammonia

However successful efforts to minimise ammonia emissions may be, a certain level of ammonia will continue to be emitted by the farming sector since such emissions are a natural consequence of farming livestock. It is therefore vital that there are also strategies in place to reduce the negative impact of the ammonia after it has been emitted. As highlighted in our original strategy, woodland can be an effective aid in mitigating the impact of nitrogen deposition from ammonia emissions. Shelterbelts of trees around livestock farms can capture ammonia emissions while the turbulence created by their canopies can reduce nitrogen deposition to the immediate surroundings. As highlighted in the Sustainable Agricultural Land Management Strategy, such woodland also provides multiple other benefits, including shelter for livestock and buildings, carbon sequestration, farm fuel, improvement to soil permeability, and habitat for a range of plants and animals.

Scientific evidence suggests that well designed tree plantings located downwind of livestock housing can "capture" up to 27% of ammonia emissions. Trees which can grow rapidly and have a high leaf area index (LAI) are ideal for shelterbelts established to recapture nitrogen[24]. Evidence shows that shelterbelts are one of the most cost effective ways of reducing nitrogen deposition from intensive livestock units. Therefore, there is a clear rationale for tree plantations to be placed strategically around livestock units to capture and disperse ammonia away from nearby sensitive sites. However biosecurity should be a key consideration in establishing such plantations which may not be suitable for farms with free range hens. Research should be commissioned to identify the optimal means of ensuring biosecurity, including recommending the appropriate species, and spacing, of trees.

Recommendation 3h – Farmers should establish woody species around livestock units where these can decrease the deposition of nitrogen on environmentally sensitive sites. Government should produce and communicate guidance on best practice for planting and maintaining tree-belts to maximise ammonia capture and catching and treating farm dirty water.

[24] Agroforestry and Ammonia Mitigation, Bill Bealey, Christine Braban & Mark Sutton, CEH Edinburgh

Government should also financially support establishment of these tree-belts. Research should identify how biosecurity can be ensured around such plantations.

3i. Mitigating the Emissions: Manure Storage

16% of all agricultural ammonia emissions in NI come from manure storage, a proportion greater than in the rest of the UK, reflecting the greater predominance of slurry systems over farm yard manure systems in Northern Ireland. In particular, above ground uncovered slurry stores have significant potential to emit ammonia. While the predominate form of slurry storage in Northern Ireland is in underground tanks, one third of our medium sized and large farms store slurry in above ground tanks and less than 10% of these above ground slurry tanks have covers[25]. Given that the provision of covers on such slurry stores may provide up to an 80% reduction in ammonia emissions[26], there is significant potential for abatement. In the parts of the pig and poultry sectors covered by IPPC, all new above ground slurry stores and lagoons must be covered and existing structures are required to be covered by 2021.

There are also ancillary benefits for farmers as covering slurry stores reduces the dilution of the slurry by rainfall, therefore decreasing the total slurry volume to be spread and potentially allowing savings to be made on slurry spreading costs. While it is often neither practical nor cost-effective for farmers in the ruminant sector to retro-fit covers to existing above ground slurry tanks, we recommend that where government grant aid is provided for new farm buildings, any associated new above ground slurry stores should be fitted with a cover in order to qualify for capital support from the public sector.

Recommendation 3i – All new installations of above ground slurry stores and renovations associated with existing stores which are in receipt of capital grant support should be fitted with a cover.

[25] https://www.daera-ni.gov.uk/sites/default/files/publications/daera/17.18.088%20EU%20Farm%20Structure%20Survey%202016%20V2.pdf

[26] Ammonia Emissions from Livestock Production in Northern Ireland, Dr Rachael Carolan, AFBI

3j. Mitigating the Emissions: Livestock Housing Systems

Livestock housing and hard standings are the greatest source of ammonia from NI agriculture, accounting for 36% of all emissions. There are a number of actions that can be taken within a housing system to reduce the volume of ammonia emissions. For example, slatted floors are estimated to reduce ammonia emissions by 36% compared to solid floors while grooved floor systems with tooth scrapers can provide 46% ammonia abatement compared to conventional slatted floors[27]. Key to minimising ammonia emissions from livestock housing is the separation of urine and faeces through the flooring and storage system.

The obvious difficulty with addressing ammonia through interventions on housing is the prohibitive cost of retrofitting existing structures. However where new developments for livestock housing are planned, these should incorporate the most appropriate ammonia abatement technologies. In the intensive sector, larger pig and poultry facilities must be licensed under the Industrial Pollution Prevention and Control (IPPC) regime which requires use of best available technologies (BAT). Where capital grant support is being provided by government, prioritisation in any competitive process should be given to proposals which incorporate ammonia abatement technology and management practices with scoring criteria weighted in favour of developments that will provide the greatest amount of ammonia reduction per unit of output. This should be clearly communicated to applicants. New developments which incorporate these technologies should also be recognised and rewarded within the Planning Approval Process.

Recommendation 3j – New developments of livestock housing should include appropriate ammonia abatement technologies with priority for capital grant support given to those developments which maximise ammonia abatement. The inclusion of these abatement technologies should be recognised and rewarded in planning decisions.

[27] Swiersta et al. (2001) http://edepot.wur.nl/198524

4. Achieving Behavioural Change

As we have highlighted, the mitigation of ammonia emissions is a challenge which is shared right across the NI farming industry and is not, as is widely perceived, an issue solely for producers in the intensive sector. With cattle production being responsible for 73% of agricultural ammonia, the support and co-operation of these farmers is crucial if we are to achieve tangible reductions in ammonia emissions. However this key audience has a very different structure to those in the intensive sector. As a general rule, the ruminant sector consists of multiple small units, is structurally small and extremely diverse in nature. Crucially the same level of vertical integration does not exist as in the intensive sector and ruminant farmers do not have the same level of experience of environmental regulation.

4a. Achieving Behavioural Change: Communicating the Message

From the outset of our deliberations, it has been very clear to us that most significant barriers to engagement will be the simple lack of awareness amongst all farmers, but particularly in the ruminant sector, of what ammonia is, why it is important, how it is produced on their farms and how they can address it.

The work of the Greenhouse Gas Implementation Partnership through its "Efficient Farming Cuts Greenhouse Gases" strategy has significantly increased awareness of how farming systems will naturally produce methane and nitrous oxide and also highlights efficiency measures which farmers can take to reduce their carbon intensity per unit of output while increasing farm profitability. Since 1990, the carbon intensity of milk production in Northern Ireland has reduced by 30.7%, even when the impact of carbon sequestration is excluded[28].

We believe that a similar campaign in respect of ammonia is necessary if we wish to inspire a concerted effort to reduce ammonia emissions across the agri-food industry. Given the linkages between greenhouse gases and ammonia and the fact that many of mitigation measures which will reduce GHGs will also lower ammonia emissions, we believe that the existing GHGIP should be reorganised and its remit extended to include ammonia. This will provide an opportunity for a partnership between government, industry and the environment sector to provide oversight as Northern Ireland continues to reduce its carbon footprint and renews in earnest its efforts to address ammonia emissions.

The key objectives for a revamped Agri Emissions Partnership should be to;

- Build a partnership and foster trust between industry, government and the environment sector

[28] https://www.daera-ni.gov.uk/sites/default/files/publications/daera/Greenhouse%20Gas%20Emissions%20on%20Northern%20Ireland%20Dairy%20Farms_2.pdf

- Establish an awareness and communication campaign for all farmers on the issues associated with agricultural ammonia
- Provide stakeholder input to the DAERA-led ammonia research programme on a six monthly basis
- Capture the positive behavioural change in ammonia mitigation achieved by farmers for communication to scientific modellers, policy and regulatory decision-makers and also consumers
- Work with the entire supply chain to ensure that positive behavioural change by farmers around agri emissions is used to positively differentiate Northern Ireland produce in the marketplace.

Recommendation 4a - Revamp the Greenhouse Gas Implementation Partnership to incorporate ammonia within its remit. The new Agri Emissions Partnership should establish an awareness and communication campaign for all farmers on the issues associated with agricultural ammonia to deliver positive behavioural change leading to reduction of ammonia and greenhouse gas emissions. It should also provide stakeholder input on research and capture and communicate positive behavioural change on ammonia and greenhouse gases to policy and regulatory decision-makers and the marketplace.

4b. Engaging the Ruminant Sector

The scale of behavioural change needed to deliver significant ammonia reductions in the ruminant sector will only be delivered by winning hearts and minds through partnership and not through threat of regulation. Our focus is on putting a template in place to win those hearts and minds and establish a partnership based on trust and mutual respect which empowers farmers to put their business on the road to sustainability. We are mindful however that because of the lack of vertical integration in the ruminant sector, the supply chain does not have the same influence to force changes in behaviour as in the intensive sector. Therefore, it is incumbent upon government and the revamped Agri Emissions Partnership to provide the leadership required to ensure a successful partnership between farmers, regulators and the supply chain.

Recommendation 4b – The ruminant sector must engage on the topic of ammonia emissions and play its part in implementing mitigation measures, including through participation in the new Agri Emissions Partnership. This partnership must recognise the diverse nature of the ruminant sector and devise a means of encouraging positive behavioural change based on trust and mutual respect.

4c. Achieving Behavioural Change: Government Communication

Throughout our deliberations, it has been clear to us that the communication from government on the impact of ammonia emissions on the local farming sector has not been sufficiently coherent and consistent. For example, some farmers feel aggrieved that their efforts to participate in DAERA capital grant schemes have incurred significant and unexpected expense to their business and ultimately led to another part of DAERA recommending refusal of permission for their proposed development. Furthermore, we are aware of other farmers who, due to the perceived difficulties in securing planning permission, have chosen not to proceed with their proposed expansion.

Although we recognise DAERA's statutory responsibility to protect the environment and want to achieve better environmental performance on farms, we are concerned that elements of DAERA are not fully supportive of the Northern Ireland Executive's commitment to do all it collectively can to support the agri-food sector in realising its ambitions, maximising agri-food's contribution to our local economy and making Going for Growth a reality[29].

We do appreciate however that over the course of our deliberations, DAERA has made efforts to improve communication and knowledge on ammonia across the DAERA family, including NIEA, AFBI, CAFRE and its Environment and Farming policy groups. We believe that these efforts must lead to a coherent DAERA position on ammonia being developed and effectively communicated. This communication should be framed in the context of the Executive's endorsement of the Going for Growth strategy and the delivery of the *Sustainable Agricultural Land Management Strategy.*

It is vital that the task of communicating a consistent position on ammonia is shared across the DAERA family. Building on the research and support of AFBI and others, CAFRE plays a crucial role in the provision of information to farmers and it is

29 https://www.economyni.gov.uk/sites/default/files/publications/deti/ni_executive_response_to_going_for_growth.pdf

therefore important that they assist NIEA and the revamped Agri Emissions Partnership in informing farmers on the issues surrounding ammonia. Opportunities to begin this dialogue with farmers have already been missed so it is vital that a clear communication plan is agreed within DAERA as soon as possible. DAERA, supported by AFBI, should use its presence at all outreach events and agricultural shows in 2018, including the Balmoral Show, to communicate with farmers on the issue of ammonia.

In order for government to play its role in encouraging positive behavioural change, there is a need to build confidence within the farming industry around the decisions made by government relating to ammonia and to develop the trust needed for a successful partnership. Currently, the lack of consultation prior to regulating farmers based on models whose assumptions do not fully account for the ammonia mitigation already achieved, has created an atmosphere of mistrust between the industry and DAERA. If large scale ammonia emission reductions are to be achieved, the deterioration of this relationship must be addressed and a positive partnership created, based on sound and up to date science and where decisions do not create perverse outcomes. DARD played a leading role in the successes of the Greenhouse Gas partnership and we believe that this is an excellent model to allow government, industry and the environment sector to work together and rebuild relationships and trust.

4c – DAERA should develop an agreed position on its approach to ammonia emissions. This approach should be consistent both with achieving the targets outlined in 'Going for Growth' and meeting our environmental obligations. All branches of the DAERA family should play their part in communicating this message. DAERA must also take a leading role as part of the revamped Agri Emissions Partnership.

4d. Achieving Behavioural Change: Advising the Farmers

Many of the ammonia mitigation practices outlined above can be relatively easily adopted by farmers. It is therefore vital that these practices are incorporated into the advice given to farmers. In our original Sustainable Agricultural Land Management report, we highlighted the need to develop a comprehensive advisory campaign by training public, private and voluntary sector advisors so that these advisors could roll out the programme to farmers. The fundamental premise should be that all those who contact farmers in an advisory capacity are familiar with the principles of sustainable agriculture and be willing to guide farmers towards the greater profitability associated with this behavioural change. All those providing advice to farmers need to be comprehensively trained to an accredited standard so that farmers are receiving consistent messages on how best to implement sustainable land management and ammonia mitigation techniques. We believe it is imperative that the ammonia abatement measures recommended in this annex form an integral part of this advisory campaign.

Recommendation 4d - Incorporate ammonia mitigation measures within the comprehensive advisory programme on Sustainable Land Management. The programme should focus on the training of public, private and voluntary sector advisors through an accredited course and qualification. These advisors will then roll out the programme to farmers.

4e. Achieving Behavioural Change: Integrating Implementation

Having deliberated on ammonia abatement following the publication of our original report on sustainable land management in the agri-food sector, it has been very apparent to us as an Expert Working Group that the actions required to reduce ammonia emissions on farms will have multiple benefits for the environment and link extremely well to our overall strategy for sustainable land management on Northern Ireland farms. While the recommendations in this annex are aimed at reducing ammonia emissions, a significant number of other environment benefits will accrue. These include;

- Reduced phosphorus balances on-farm due to extended grazing seasons contributing to greater utilisation of grass by livestock
- Better soil health due to improved soil structure
- Improved levels of carbon sequestration and water quality while reducing reliance on chemical fertiliser due to greater incorporation of legumes within grazing swards
- More carbon sequestration from increasing the proportion of fields in agro-forestry
- Lower greenhouse gas emissions and a reduced risk of nutrient transfer to watercourses by increasing the proportion of slurry applied by low emission techniques
- Significant reductions in greenhouse gas emissions due to the use of stabilised urea fertiliser
- Reduced greenhouse gas emissions from installations of new livestock housing with emission abatement technologies
- Reductions in Greenhouse Gas emissions due to increased use of “dry air” heating systems fuelled by biomass rather than fossil fuels
- Greater biodiversity, better water quality and increased carbon sequestration from the establishment of woodland around livestock units

Given the significant synergy and overlap between this ammonia annex and our wider strategy, it is clear that these documents must not be treated separately and

that implementation of this ammonia annex should be considered part of a wider commitment to sustainable agriculture by both government and farmers. The two sets of recommendations link together under a common framework of achieving a sustainable future for Northern Ireland agriculture, based on sound scientific evidence, best farming practice and robust transparent validation. Achieving a sustainable agri-food sector must become the key priority for farmers, food processors and policy makers alike.

Recommendation 4e - For the purposes of implementation, the proposals in this ammonia annex should be considered as an integral part of the Northern Ireland agri-food sector's plan for sustainability

Conclusion

We believe that this document makes a significant contribution to the task of setting a pathway to sustainable agriculture and offers a means of bringing ammonia under control whilst supporting a sustainable and expanding Northern Ireland agri-food industry in the medium to long term. We are convinced that the same principles should apply to agriculture's approach to ammonia emissions as we outlined in our strategy on sustainable land management. These key aspects of our proposal are;

- Establishing a sound baseline so that the scale of the challenge can be accurately described
- Ensuring that the baseline is as accurate as possible and that policy and regulatory decisions are based on sound and up to date science
- Establishing an awareness and communication campaign for all farmers, but particularly ruminant farmers, on the issues associated with agricultural ammonia
- Prioritising the on-farm measures which will benefit both the farmer and the environment
- Placing farmers at the centre of a partnership approach which delivers positive behavioural change on farms

We firmly believe that this approach will not only deliver for the environment but will also benefit our farmers and positively differentiate Northern Ireland food in the international marketplace. We are adamant that this document provides a coherent roadmap with mutually beneficially solutions to one of the greatest challenges faced by our agri-food sector and can be linked to our coherent plan for sustainable land management. By taking positive steps to transparently address ammonia, Northern Ireland agriculture can turn a potential problem into a competitive advantage.

Annex A: Filling and Updating our knowledge on Ammonia Emissions- Modelling ammonia emissions, atmospheric ammonia concentrations and nitrogen deposition.

This Annex is a summary and timeline of the soon to be procured research project on Ammonia, sponsored by DAERA and led by AFBI in partnership with CEH and Rothamsted research. This Annex was kindly provided to the Expert Working Group by DAERA. We are very grateful to all DAERA staff who assisted in the production of this Annex.

Introduction

In the UK a number of inter-linked sophisticated models are used for estimating ammonia emissions from agriculture and other sources, atmospheric ammonia concentrations and nitrogen (N) deposition. These models (outlined in Table 1) are used for (1) production of the UK ammonia emissions inventory, UK atmospheric concentration (ammonia and other pollutants) and N deposition datasets (2) regulation and (3) knowledge transfer and advice. The models are interlinked and work at a range of levels from national scale down to individual farm level.

Ammonia emissions, atmospheric concentrations and nitrogen deposition are all highly variable – both spatially and temporally. Consequently the models, some of which incorporate monitoring data, are complex, and continually develop as new information becomes available. For example, relevant new studies on emission estimates for different sources (such as specific livestock housing systems, slurry application methods etc.) are incorporated into the model input data as they become available to the inventory team. The models have been peer reviewed and are considered fit for the purposes for which they are used in decision-making which takes on-board the uncertainty levels associated with model outputs. However, it is recognised that the inclusion of additional Northern Ireland-specific data will further enhance the robustness of the various models.

In view of this background, DAERA is currently in the final stages of commissioning 2 new ammonia-related research projects from AFBI in partnership with the Centre for Ecology & Hydrology (CEH) and Rothamsted Research under the DAERA-directed

Evidence and Innovation AFBI Work Programme. The milestones for work within these projects are summarised below.

Research area 1 – additional NI data for UK models.

Feeding in additional new NI-specific data into the models underpinning:-

- **Inventory** of **Ammonia** Emissions from UK Agriculture (NARSES).
- UK spatially mapped ammonia concentrations (AENEID).
- Nitrogen deposition estimates and critical loads exceedance maps (FRAME, CBED, critical limits assessment).
- Farm level assessments (SCAIL).

Research and development activities

- Collate activity data on farm management practices in Northern Ireland.
- Collate historical nitrogen utilisation data from livestock studies undertaken at AFBI Hillsborough and from elsewhere.
- More detailed derivation of nitrogen intake and excretion for livestock based on diet and production characteristics for Northern Irish practice

Timescales

- Production and transfer of new NI-specific data input into UK ammonia emissions inventory model (NARSES): Dec 2017 to March 2018.
- Production of annual Inventory of Ammonia Emissions from UK Agriculture (Rothamsted Research) late 2018; i.e. incorporation of new data into 1990-2017 inventory which will be published late 2018.
- Updates to be inputted into this annual cycle thereafter for the UK National Atmospheric Emission Inventory (NAEI).
- NARSES model updates will follow through to other models - AENEID, FRAME, SCAIL.

Link to EWG Ammonia Annex

- Fulfils recommendation 1a by developing improved knowledge around emission factors in a more timely, transparent, thorough and robust manner
- Provides a framework to address the issues on which the EWG Ammonia Annex suggests that science on local NI emissions is not properly accounted for in emission factors e.g. the reduction in crude protein in pig diets, the move to dry air heating in poultry houses and nitrogen excretion levels in ruminant livestock.
- EWG report that the increased use of NI-specific data in the UK-wide models will increase farmer confidence in decision making around ammonia and therefore improve the likelihood of effective communication leading to increased uptake of mitigation measures

Research area 2 – assessment of impact of recommended EWG mitigation strategies.

- Assessment of the impact of the SALMS Expert Working Group's (EWG) 9 mitigation strategies on ammonia emissions and environmental impact.
- Assessment of costs and environmental impact of agricultural mitigation measures.

Research and development activities

- The effects of the 9 ammonia mitigation measures recommended by the SALMS EWG on ammonia emissions, atmospheric ammonia concentrations, nitrogen deposition and critical loads/critical levels exceedance on sensitive vegetation and designated sites will be assessed using the appropriate UK models (NARSES, FRAME/CBED).

- AFBI, Rothamsted Research and CEH will work in partnership to evaluate the impact of the range of mitigation options proposed by the EWG, based on current NI ammonia emissions in the first instance. A similar effects assessment will be repeated with improved model input data, following work undertaken in Research areas 3 and 4, towards the end of the project.

Timescales

- December 2017 to June 2018. Completed by June 2018

Link to EWG Ammonia Annex

- The 10 mitigation strategies highlighted by the EWG in section 3 of this report are;

    - Extending the grazing season
    - Include abatement technologies in livestock housing systems such as slatted floors or grooved floors with tooth scrapers
    - Maintaining clean farmyards
    - Reducing the crude protein intake in livestock diets
    - Covered manure stores
    - Applying slurry and manure earlier in the season
    - Using low emission techniques to spread slurry and manures
    - Using stabilised urea fertilisers, particularly where these displace straight urea
    - Establishing woody areas around livestock units
    - Genetic improvement of livestock

Research area 3. Increased ammonia monitoring.

- Increased monitoring of atmospheric ammonia concentrations in NI.
- Validation of modelled concentration and deposition estimates in NI using the FRAME model.
- Develop relationships between slurry and fertiliser applications and 'dry' and 'wet' ammonia deposition monitored at AFBI Hillsborough over the last 20-years.

Research and development activities

- Validate the predictive accuracy of the FRAME model for NI, by comparing predicted model output with additional ammonia concentration data from a 1-year study with 20-30 monitoring stations supplementing the 3 current sites in

NI which are currently present in the UK National Ammonia Monitoring Network (UK NAMN) and following the same protocol/standards.

Timescales

- Identify suitable monitoring sites, installation of equipment and recording systems (to the same standards as the UK NAMN). By March 2018.
- Measure ammonia deposition at the additional ammonia monitoring station sites for an annual period, supplemented with data from the 3 NAMN monitoring stations already in situ in NI. April 2018-March 2019.
- CEH will then compare the predicted concentrations from the FRAME model (using the current three NAMN sites in NI) with the new high-density monitoring data collected under this WP. April –September 2019.

Link to EWG Ammonia Annex

- This research area will address recommendation 2j and provide the evidence for robust assessments at farm and NI level on the impact of uptake of multiple mitigation measures
- As this information emerges, the communication campaign around ammonia will be able to include a robust reference to the scale of ammonia reductions possible through on-farm mitigation techniques

Research area 4. Filling evidence gaps in relation to potential abatement techniques

- Collate historical nitrogen utilisation data from previous livestock studies undertaken in AFBI Hillsborough and elsewhere and use these data to inform development of the NARSES model and identify effective dietary factors influencing nitrogen excretion, including partition between faeces and urine.
- Quantify range of new mitigation strategies on cattle, sheep, poultry and pig production.

Research and development activities

- Collation and manipulation of data on nitrogen utilisation and where necessary input into model development activities.
- Investigation of dietary factors to reduce ammonia emissions for dairy cattle, beef cattle, sheep and pig sectors
- Investigation of housing factors on ammonia emissions from the cattle and poultry sectors in NI.

Timescales

- New data as it becomes available will be inputted into the annual cycle for updating the National Atmospheric Emission Inventory (NAEI); commencing March 2018 for the incorporation of new data into 1990-2017 inventory which will be published late 2018.
- Updates to be inputted into this annual cycle thereafter for the UK National Atmospheric Emission Inventory (NAEI).
- NARSES model updates will follow through to other models - AENEID, FRAME, SCAIL.
- Work to be undertaken from Nov 2017 to March 2022.

Link to EWG Ammonia Annex

- This research area addresses recommendations 2b and 2c by examining how livestock diets and poultry housing factor can influence ammonia emissions
- The outputs of this research area should lead to additional mitigation measures for the NI livestock sector being developed, to complement the mitigation measures highlighted in section 3 of this Ammonia Annex
- Developing mitigation measures in this way is an example of using a more agile approach to science as recommended in this Annex at 2g
- The outputs of this research will inform the communication campaign and highlight to farmers how they can maximise cost-effective ammonia reductions on their farms

Summary

A GANNT chart summarising key milestones in the DAERA-directed AFBI research and development projects currently being commissioned to address the science-related issues within the EWG Ammonia Annex is presented in Table 2.

Table 1. Outline of the models used for estimated ammonia emissions, atmospheric concentrations and nitrogen deposition

Model	Role	Comments
NARSES	UK ammonia emissions	Has been combined with the agricultural GHG inventory, data reported to UK National Atmospheric Emission Inventory (NAEI), annual data & reports publicly accessible via http://naei.beis.gov.uk/
AENEID	Spatially disaggregates emissions at 1 km grid level	Spatially distributes DA emissions using high-resolution livestock and land cover statistics; maps submitted to the UK NAEI for public use
FRAME	Uses mapped UK NAEI data (ammonia, NOx, SO_2) data from all emission sources (including AENEID agricultural NH_3 emissions field) as input to provide UK ammonia concentration and deposition maps	FRAME output is validated against the UK monitoring network data and calibrated to CBED for calculating future deposition scenarios and the exceedance of critical loads. The 1 km resolution model is used to derive UK NH_3 critical level exceedance statistics and for future predictions and scenario modelling. FRAME is also used for preparing source attribution datasets and as part of the UK Integrated Assessment Model

CBED	CBED (Concentration-Based Estimated Deposition; 5 km grid resolution) combines measurements and interpolation with modelling to produce spatially distributed data for concentrations of nitrogen and sulphur concentrations in precipitation and gas and particulate concentrations in air. This is combined with annual precipitation data and deposition velocities calculated with a big leaf canopy resistance model to calculate dry and wet vegetation specific deposition of ammonium, nitrate and sulphate.	CBED output is used for estimating UK critical loads exceedance
Model	**Role**	**Comments**
SCAIL	Simple calculation of atmospheric impact limits used as a screening tool at individual farm level (local) for NH_3 emission impact assessments for planning purposes	Uses background concentration and deposition data from the national models; for planning of additional livestock houses, EFs from NARSES are used, but specific to proposed livestock and manure management practices
ADMS/ AERMOD	Detailed air dispersion models used for individual farm level assessments for planning purposes	In most (but not all) cases uses EFs from NARSES as default values. EFs can be adapted to recognise farm-specific mitigation strategies

Table 2. GANNT chart summarising key milestones in the DAERA-directed AFBI research and development projects currently being commissioned to address the science-related issues within the EWG Ammonia Annex

	Dec 17	Mar 18	Jun 18	Sep 18	Dec 18	Mar 19	Jun 19	Sep 19	Dec 19	Mar 20	Jun 20	Sep 20	Dec 20	Mar 21	Jun 21	Sep 21	Dec 21	Mar 22
Production and transfer of new NI-specific data input into UK ammonia emissions inventory model (NARSES)																		
Production and Publication of Inventory incorporating new NI-specific Data (annual process)																		
Ongoing Transfer of NI-specific data into UK inventory																		
Assessment of cumulative impact of 9 mitigation measures in EWG ammonia annex																		
Identify suitable ammonia monitoring sites, installation of equipment and recording systems																		

Measure ammonia deposition at the additional ammonia monitoring station sites for an annual period																		
Compare predicted concentrations from FRAME model with new high-density monitoring data collected																		
Review evidence on EFs relating to housing systems (cattle slatted floors and poultry hot water heating systems) and fill any outstanding gaps.																		
Investigate effects of range of new mitigation strategies on cattle, sheep, poultry and pig production.																		

Annex B: List of Recommendations

Overarching Recommendation – To achieve a sustainable future for Northern Ireland's agri-food sector, ammonia emissions must be addressed through a partnership approach which incorporates communication and education on ammonia, investing in filling our ammonia knowledge gaps and implementing a range of ammonia mitigation measures; and not on contracting the size of this sector.

1. Making Ammonia Emissions Visible

a. Develop a more timely, transparent, thorough and robust method of improving our knowledge by filling the significant evidence gaps around the ammonia emission baselines and emission factors, in collaboration with a UK-wide partnership. Communicate progress on the development of this improved information to a multi-stakeholder forum, such as the revamped Agri Emissions Partnership, so that this successful cross sector stakeholder partnership can give sectoral leadership and receive six monthly updates from DAERA on how the knowledge gaps are being filled.

b. Establish an enhanced regime for the monitoring of atmospheric ammonia and nitrogen deposition across Northern Ireland on a daily basis, with the simultaneous recording of the weather, so that the results are sufficiently detailed to define the causes. This information must be communicated to farmers in order to positively influence farmer behaviour through means such as farmer discussion groups. As nitrogen deposition from ammonia emissions is such a localised problem, recording sites need to be sufficiently numerous, including at some of our designated sites and priority habitats, to assess and promote local understanding by showing farmers the "cause and effect" of farming practices on ammonia emissions and subsequent nitrogen deposition.

c. To give transparency to the Sector, review the thresholds at which detailed ammonia modelling is required for the assessment of applications for new

livestock units as compared to other parts of the UK and the Republic of Ireland and publically articulate the justification for the existing evolved Northern Ireland thresholds.

d. DAERA should immediately adopt the following six guiding principles and approaches in assessing planning applications;

- Communicate and explain the current planning process and requirements and the ammonia mitigation options available

- Prioritise mitigating and reducing ammonia emissions at the Northern Ireland scale first, and at a local level secondly

- Recognise total ammonia emission reduction measures being proposed by farmers and consider this when making a decision on their planning application

- Minimise the risk of perverse incentivisation of farmers to choose smaller, less efficient ways of modernising in an effort to circumnavigate ammonia mitigation obligations

- Accept that farmers who agree to reduce their total ammonia emissions from their current emission levels are not creating a new “adverse impact”

- Facilitate access for applicants who are encountering difficulties in achieving approval for farm development due to the impact of ammonia emissions to the appropriate experts on ammonia mitigation options.

e. Review the planning application process to ensure that all appropriate guidance on ammonia is provided and that all relevant information is sought at the earliest possible opportunity to minimise delays.

f. To provide assurance that the regulatory process is not “double counting” some emissions from approved farm developments, DAERA should communicate

directly to stakeholders outlining how their “in combination” spreadsheet is compiled, how it operates, and why it is needed over and above the models

2. Optimising the Evidence Base

a. Undertake the scientific work necessary to define an emission factor for slatted-floor slurry systems for use in the national ammonia inventory. Ensure that this new emission factor is fully accounted for in considering planning approvals.

b. Take proper account of scientific findings relating to the impact on ammonia emissions of reductions in crude protein in pig diets when assessing applications for pig farm developments.

c. Quantify the correct emission factors for dietary crude protein reduction for livestock other than pigs. Take these corrected emission factors into account in decision-making.

d. Quantify the correct emission factor for poultry units following the recent substantial switch to “dry air” heating systems. Take this corrected emission factor into account in decision making.

e. Ensure and communicate to stakeholders that all available evidence from Northern Ireland on N excretion from livestock is properly taken into account in the measurement of ammonia emissions and nitrogen deposition.

f. Ensure and communicate to stakeholders that the weather data used within the nitrogen deposition assessment process is as accurate as possible. Weather data should be recorded at each current and future ammonia and nitrogen deposition monitoring site.

g. Research should be commissioned into the costs and benefits of a range of slurry additives to mitigate ammonia emissions. There should also be research commissioned examining the trade-offs between using slurry bubbler systems to improve human safety and perversely, increasing ammonia emissions.

h. (i) Government should ensure that the process for commissioning scientific research is sufficiently agile to meet emerging urgent policy needs

(ii) Government and the agri-food sector should work together to create a culture of innovation which encourages private sector involvement in the development of new scientific knowledge, particularly where such knowledge can contribute to improved farm efficiency and better environmental performance. Government should do all it can to facilitate the private sector in providing this investment.

i. Develop a MACC for agricultural ammonia in Northern Ireland to prioritise ammonia abatement measures based on cost-effectiveness, using local evidence as far as possible.

j. Improve and communicate the scientific evidence base so that robust assessment can be made at farm and NI level of the cumulative impact of uptake of multiple mitigation measures.

k. Address the knowledge gap and manage the communication carefully around the impact of agricultural ammonia emissions, the subsequent formation of atmospheric particulate matter and its effect on human health.

3. Mitigating the Emissions

a. Farmers should implement land management techniques to extend their grazing season where possible, thereby reducing the level of ammonia emissions from ruminant livestock.

b. Farmers should consider applying treated or stabilised urea fertilisers where these can maintain agronomic output, and particularly where stabilised urea can displace straight urea fertiliser. By 2020, the use of straight urea fertiliser should no longer be permitted.

c. Farmers should apply slurry and manure earlier in the season, where land and weather conditions allow. If the farmer has a choice and where possible, slurry and manures should be spread in the early morning or evening, but not on warm, windy days. This will not only reduce ammonia loss, but also improve the efficiency of nitrogen use within the production system.

d. Accelerate the significant increase of the proportion of slurry and manures which is applied on land by dribble-bar, trailing shoe/hose, band spreader or shallow injection. Take steps to prohibit the sale of new slurry spreading equipment without low emission technologies by 2020 in preparation for a total ban on spreading slurry and manures by splashplate by 2025.

e. Farmers should recognise and embrace the benefits of brushing, scraping and washing livestock housing and handling areas and prioritise these tasks. As well as reducing ammonia emissions, this can produce significant reductions in animal lameness and associated production losses.

f. Identify the optimal strategies to reduce crude protein intake in livestock diets while maintaining and enhancing livestock performance and communicate these to farmers for adoption. Regulators must also ensure that adoption of these practices is properly recognised in planning decisions.

g. Livestock farmers should utilise the most feed efficient genetics to increase efficiency and reduce ammonia emissions.

h. Farmers should establish woody species around livestock units where these can decrease the deposition of nitrogen on environmentally sensitive sites. Government should produce and communicate guidance on best practice for planting and maintaining tree-belts to maximise ammonia capture and catching and treating farm dirty water. Government should also financially support establishment of these tree-belts. Research should identify how biosecurity can be ensured around such plantations.

i. All new installations of above ground slurry stores and renovations associated with existing stores which are in receipt of capital grant support should be fitted with a cover.

j. New developments of livestock housing should include appropriate ammonia abatement technologies with priority for capital grant support given to those developments which maximise ammonia abatement. The inclusion of these abatement technologies should be recognised and rewarded in planning decisions.

4. Achieving Behavioural Change

a. Revamp the Greenhouse Gas Implementation Partnership to incorporate ammonia within its remit. The new Agri Emissions Partnership should establish an awareness and communication campaign for all farmers on the issues associated with agricultural ammonia to deliver positive behavioural change leading to reduction of ammonia and greenhouse gas emissions. It should also provide stakeholder input on research and capture and communicate positive behavioural change on ammonia and greenhouse gases to policy and regulatory decision-makers and the marketplace.

b. The ruminant sector must engage on the topic of ammonia emissions and play its part in implementing mitigation measures, including through participation in the new Agri Emissions Partnership. This partnership must recognise the diverse nature of the ruminant sector and devise a means of encouraging positive behavioural change based on trust and mutual respect.

c. DAERA should develop an agreed position on its approach to ammonia emissions. This approach should be consistent both with achieving the targets outlined in ‘Going for Growth’ and meeting our environmental obligations. All branches of the DAERA family should play their part in communicating this message. DAERA must also take a leading role as part of the revamped Agri Emissions Partnership.

d. Incorporate ammonia mitigation measures within the comprehensive advisory programme on Sustainable Land Management. The programme should focus on the training of public, private and voluntary sector advisors through an accredited course and qualification. These advisors will then roll out the programme to farmers.

e. For the purposes of implementation, the proposals in this ammonia annex should be considered as an integral part of the Northern Ireland agri-food sector’s plan for sustainability