Chapter 12

Environment and Agriculture

Agriculture

Introduction

Value of agriculture in Ireland

Agriculture in Ireland is economically, socially and culturally important.

Farming has been an important and integral facet of Ireland's economic, social and cultural history for many thousands of years but recent decades have seen substantial changes in how farming is carried out. These changes together with comparatively abundant natural resources have led to Ireland being a major meat, dairy and food exporting country.

Agricultural practices have shaped Ireland's countryside and landscape. Along with the production of food, farmers and farming can provide valuable ecosystem services to society such as safe, clean water, regulation of nutrient cycles, control of disease, crop pollination, and enhancement of biodiversity as well as cultural, spiritual and recreational benefits.

In recent years, the potential for agriculture and its associated agri-food industry to support growth in the Irish economy has been highlighted in two strategies: Food Harvest 2020[1] and Food Wise 2025.[2] These have been developed to increase the export and employment contribution of the sector in a manner that is compatible with sustainable growth. The Irish agri-food (agriculture, forestry and fishing) sector accounted for 7.6% of national gross value added in 2014. Primary production accounted for €4,189 million with €8,562 million coming from the manufacture of food and beverage products (DAFM, 2016a).

The Context of Irish Farming

Irish farming practice is shaped by its biophysical and climate context.

The variability in weather and soils create the biophysical environment in which farmers and land owners operate but cannot control.

1 *www.agriculture.gov.ie/foodwise2025/foodharvest2020/*

2 *www.agriculture.gov.ie/foodwise2025/*

Weather, which is a major driver of agronomic and environmental responses, is variable and the predictive power of forecasting is limited over longer periods. Variations in the magnitude of meteorological parameters can have an effect on grass and crop performance and the ability to carry out field operations.

Climate change is affecting the context in which agriculture operates. The main climate change impacts expected for the agriculture sector will result from changes in air and soil temperature, changes in rainfall patterns and extreme events. The mean annual surface air temperature has increased by approximately 0.8°C over the last 110 years and the beginning of the growing season for certain species is now occurring up to 10 days earlier.[3] Average annual national rainfall has increased by approximately 60 mm or 5% in the period 1981 to 2010, compared to the 30-year period 1961 to 1990. Typically climate models project Ireland will get wetter in Winter and drier in Summer (Nolan, 2015). However, confidence in this statement is low in scenarios where climate change is successfully limited to below 2°C and the large uncertainty in modelling of climate change for Ireland at the interface between the North Atlantic and European continent. Extreme events are likely to increase in intensity and frequency. Therefore precipitation may occur in more intense downpours together with longer dry spells, impacting on runoff volumes and water availability between rainfall events. Seasonal extremes have drawn into critical focus vulnerabilities within the agriculture sector with respect to extreme rainfall events (flooding in winter 2015/2016 including Storm Desmond, Fodder Crisis Autumn/Winter 2012/2013). Therefore, there will be higher risk of disruption of agricultural activities if adaptation measures such as water management systems are not adopted. There will remain a significant risk of emergent animal and plant diseases establishing permanent foothold on the island, as winter conditions get milder and wetter. The number of annual frost days (temperatures below 0°C) has decreased which is increasing the risk of over-wintering of pathogens.

The soils of Ireland vary in their physical, chemical and biological characteristics not only at national and regional scales but also within farms and fields. While soils can be managed there are limits to what can be achieved and controlled by management practices alone. In addition, other local characteristics, such as elevation, have a profound influence on potential productivity. Generally, the drier more productive soils of the south-east combined with lower rainfall and longer growing season provide a better platform for high output systems compared with the north-west where the wetter soils, higher rainfall and a shorter growing season increase the production challenge.

One consequence of these factors is that the more intensive grass and tillage production systems are more concentrated in the south and east while the less intensive systems dominate in the north-west.

Structure of Irish Farming

140,000 farms of varying size manage 67% of all land in the country.

Land cover data in 2012 showed that 67.35% of national land cover is agricultural, making it the largest user of land in Ireland (EPA, 2015a). The land area of Ireland is 6.9 million hectares, of which approximately 4.4 million hectares is used for agriculture. Of this figure, 3.6 million hectares, or circa 81% of total agricultural area, is devoted to grassland (pasture, hay and grass silage), with a further 0.5 million hectares, or 11% of total agricultural area, being classed as rough grazing. Some 80-90% of the diet of dairy and beef animals is composed of grass or silage that is grown on-farm. Crop production in Ireland occupies an area of approximately 0.36 million hectares and accounts for about 8% of the agricultural land area in Ireland (CSO, 2016). Approximately 25,000 farmers (17%) managed over 2 million hectares. A further 1.8 million hectares was managed by 55,000 farmers with holding sizes of between 20 and 50 hectares. Nearly half of all farmers (60,000 farmers) farmed the remaining 0.6 million hectares.

In 2013, there were 139,600 farms in Ireland (CSO, 2015). Of these farms, 78,600 (excluding pig and poultry) have an output of greater than €8,000 per year. The remaining farms include 2,000 pig and poultry farms, 50,000 small farms (with output less than €8,000 per year) and 8,000 very small farms (micro farms). There is also a tendency for farms in the south and east to be larger than those in other parts of the country. In 2013, the average farm size was 32.5 hectares (ha). The farms in the Border, Midlands and Western Region were smaller on average, at 27.1 ha, compared to 38.6 ha in the Southern and Eastern Region (Figure 12.1). More than half (52.7%) of all farms were located in the Border, Midland and Western Regions.

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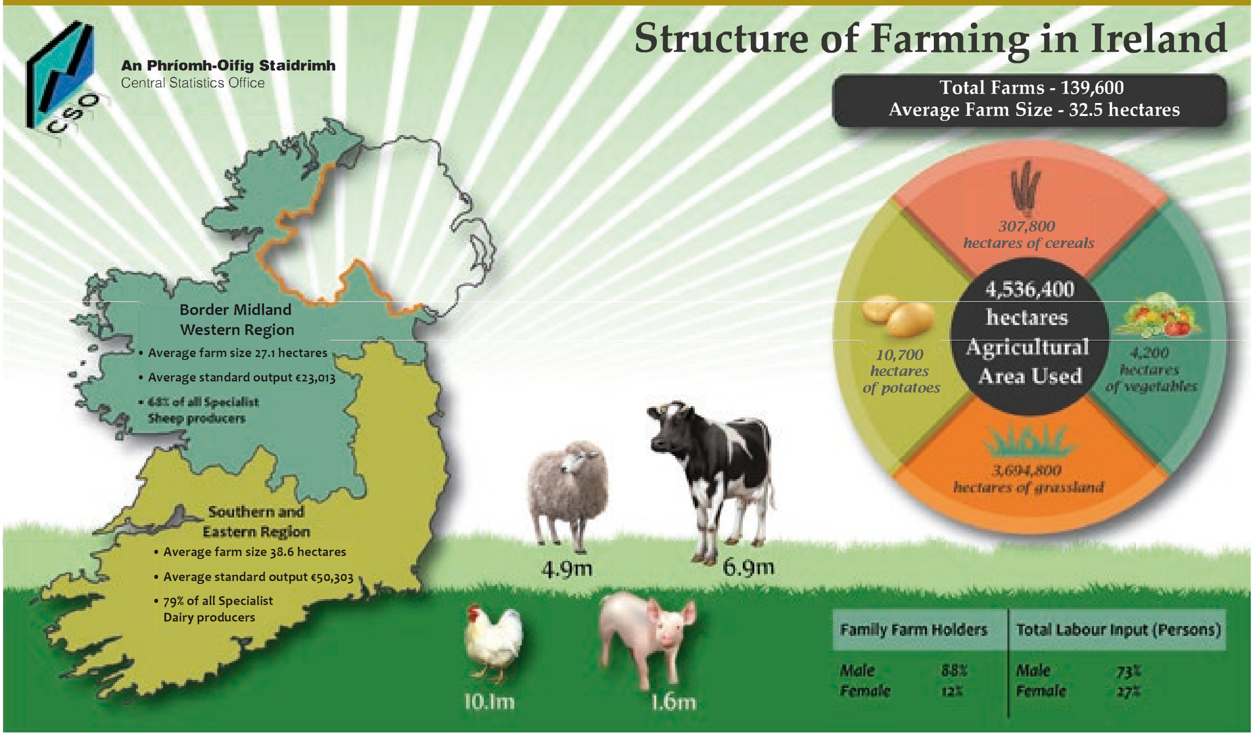
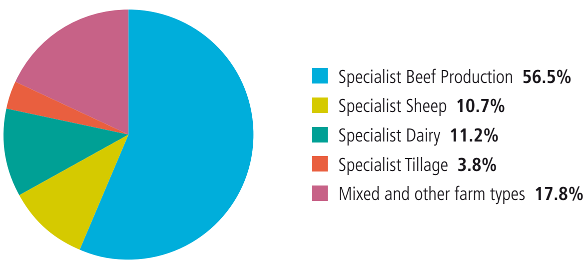
3 *www.met.ie/climate-ireland/climate-of-ireland.asp*

Figure 12.1 Structure of Farming in Ireland (Source: CSO, 2015)



In 2013, specialist beef production was the most common type of farming system, with almost 79,000 farms in this category. Dairy (15,600 farms) and specialist sheep farms (15,000 farms) were the next most common systems. There were also 5,300 specialist tillage farmers and there were approximately 2,000 farmers operating intensive pig, poultry and horticulture enterprises (CSO, 2015) (Figure 12.2).

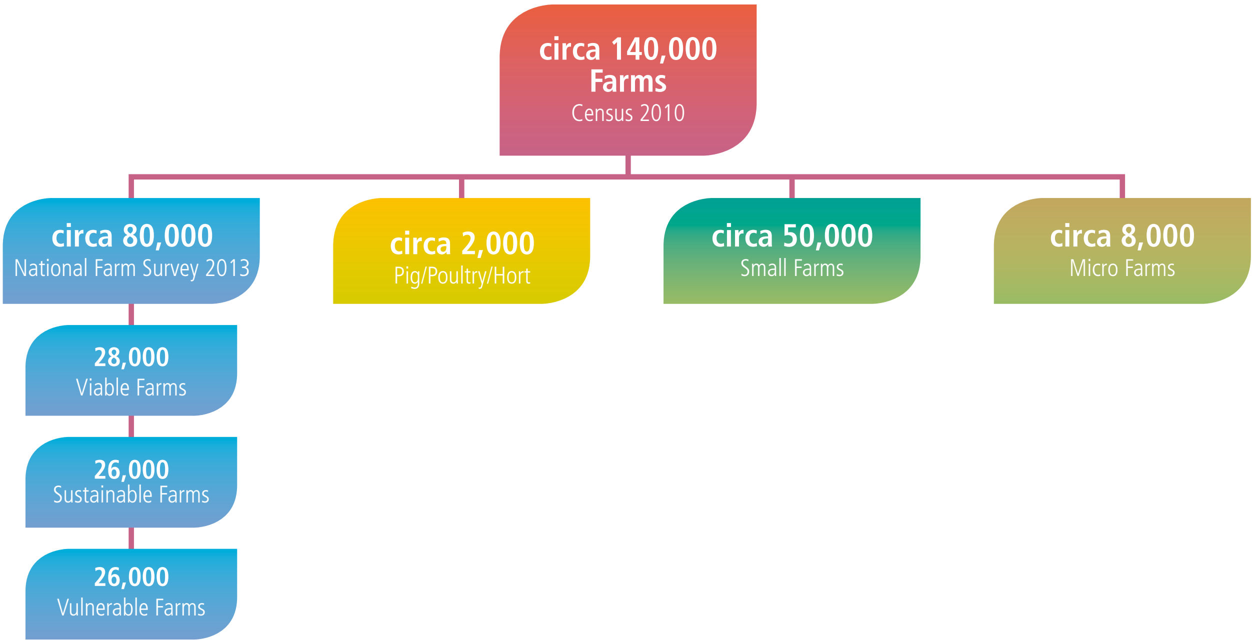
Figure 12.2 Farms by Type from the National Farm Structures Survey 2013 (Source: CSO, 2015)



Economic challenges facing the farming community

There are substantial economic challenges facing the farming community. The report of the Agri-Taxation Working Group to the Minister for Finance and the Minister for Agriculture, Food and the Marine (DAFM, 2014) estimated that, of the largest 79,000 farms in the country, just over one-third are economically viable, one-third are sustainable, but only because of off-farm income, and one-third are vulnerable in that farming is not sufficient to make the farms economically viable and off-farm employment is not locally available (Figure 12.3). In general, profitability is highest in the dairy sector with cattle rearing being the least profitable type of farming. There is, however, significant ongoing volatility in the price of agricultural commodities. When direct payments in grants and schemes are taken out of farm income, dry stock enterprises have, on average, a negative market income which indicates that a substantial percentage of direct payments go into sustaining farm enterprises in Ireland. It is within this challenging economic context that farmers are required to ensure that their operations do not have a detrimental impact on the quality of the environment.

Figure 12.3 Breakdown of Farming Enterprises and Viability Category for Teagasc National Farm Survey Farms (Source: DAFM, 2014)



Food Wise 2025

This strategy for development and sustainable intensification in primary production and value added processing is a significant challenge for the sector as it has to be achieved without damaging the environment upon which it depends.

The Food Wise 2025 strategy, published by the Department of Agriculture Food and the Marine (DAFM) in 2015[4], set out an ambitious growth projection of a 65% increase in the value of farm gate output and a 70% increase in the gross value added to be delivered by the sector by 2025. The strategy outlined significant opportunities for growth in value added of the dairy sector through innovation, value added and new premium market development, as well as an increase in volume of milk production following the abolition of EU milk quotas in 2015. Growth in the sheep and pig sectors is expected to be delivered from improved production efficiencies rather than by major increases in animal numbers. For tillage crops, growth is expected to be driven by improved production efficiencies and the extent to which new market opportunities can be realised.

Achieving growth in primary production and productivity without damaging the environment, upon which it depends, is a significant challenge. Moreover, there are current environmental challenges arising from agricultural activities that need to be addressed. Improving current performance in relation to Air Quality (Chapter 2), Climate (Chapter 3), Biodiversity (Chapter 4) and Water Quality (Chapters 5 and 8), are key environmental challenges for Ireland. Food Wise 2025 acknowledges the challenge and places great emphasis on the importance of balancing production with environmental management and protection; clearly recognising the value that a "green" environmentally sustainable agriculture sector can afford. The Food Wise strategy sets out more than 70 actions to achieve agricultural sustainability and notes that "… achieving economic competitiveness and environmental sustainability are equal pillars in the delivery of the vision". The development of a clear mechanism for tracking the implementation of these actions and assessing their effectiveness will be needed to ensure that impacts on the environment, whether positive or negative, are identified

4 *www.agriculture.gov.ie/foodwise2025/*

and managed. A Food Wise Implementation Plan has been published along with the strategy (DAFM, 2016b) and will be a key mechanism for ensuring that relevant evidence is gathered during implementation to inform decisions on achieving and maintaining a sustainable agriculture sector. In addition, a Food Wise 2025 Environmental Sustainability Committee was established in 2016 to evaluate and assess the delivery of environmental sustainability and mitigation actions in the Food Wise Implementation Plan. These developing implementation structures are welcome.

The vulnerability of the water environment and biodiversity to adverse impacts of agriculture depends on local and regional ecosystem capacity to deal with the various pressures. As such, from an environmental perspective, some areas are more suitable than others for intensification (i.e. intensification may be possible without compromising the quality of the environment) while more vulnerable areas will need more careful protection. Regional and local variations in soils, weather and biodiversity in addition to environmental commitments will place significant constraints on the achievement of the projections identified in Food Wise 2025 but which if managed correctly can create a sustainable path for Irish agriculture into the future.

Current Trends

Agriculture places a series of pressures on the natural environment.

These environmental pressures include changes to land use, emissions of nutrients and losses of pesticides from soils to waters, changes to biodiversity impacting flora and fauna and their habitats, and emissions of greenhouse gases (GHGs) and air pollutants such as ammonia. These pressures include those which impact directly on the local environment such as the water environment and habitats and those which impact on the wider scale including transboundary air pollutants and GHGs.

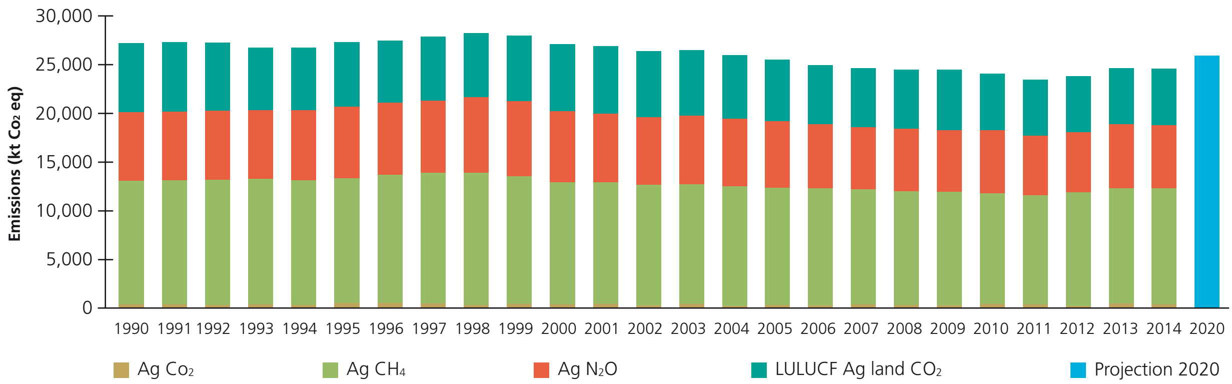
Greenhouse Gases and Agriculture

In Ireland, agriculture accounts for 32% of all greenhouse gas emissions to air.

Climate change is challenging for Irish agriculture both in the context of GHG emissions and the need for adaptation of farming practices to be more resilient to the impacts of climate change. In Ireland the Agriculture sector was directly responsible for 32.2% of national GHG emissions in 2014, mainly methane from livestock, and nitrous oxide due to the use of nitrogen fertiliser and manure management (EPA, 2016a). These direct emissions are accountable under the Effort Sharing Decision and are included in Ireland's targets for 2020 emissions reduction. In addition, agricultural land management practices can lead to both emissions and removals of GHGs associated both with biomass and soils which are reported under the Land Use and Land Use Sector (Chapter 3). Based on best available data, net impact of land management is dominated by a very significant emission of carbon dioxide due to drainage of organic soils. Although the total area involved is relatively small, at approximately 300,000 ha, the impact is large.

Agriculture accounted for over 47% of all Non-ETS emissions in 2014 (EPA, 2016b). Despite ongoing improved efficiency of production, leading to lower emissions per unit product, EPA projections estimate increasing agricultural emissions associated with Food Wise 2025 and expansion of the dairy herd. For example, projections indicate agriculture emissions will increase by 6% from 2014 to 2020 even where there is the optimum deployment of known measures and technologies to reduce emissions. The recent bulletin on Greenhouse Gas Emissions Projections to 2020 noted that the challenges associated with implementing these measures should not be underestimated. Increasing agricultural emissions at a time when Ireland is struggling to meet 2020 and 2030 emissions reduction targets may place a burden on the wider economy.

Figure 12.4 Greenhouse Gas Emissions from Agriculture and Associated Land Between 1990 and 2014 and Projection for 2020 (Source: EPA, 2016b)



Under the current EU Effort Sharing decision, Ireland has a target of 20% emissions reduction relative to 2005 compared to an EU average of 10%, from activities in the Non – Emissions Trading Sectors (Non ETS) by 2020. In July 2016, the EU announced proposals for a new Climate and Energy Framework to 2030 including a target of 30% emissions reduction for non-ETS in Ireland which is exactly the same as the proposed EU average reduction, by 2030.[5] The proposed 2030 targets remain challenging for Ireland especially in the context of limited emissions mitigation options within agriculture and projections for growth within the sector. It is important that the most effective available mitigation options are deployed, and make a meaningful contribution to meeting Ireland's non-ETS target. The sector should also engage fully with incentives to maintain and enhance sequestration within the LULUCF sector (Chapter 3), especially on those lands directly associated with agricultural production. This would enable access to the flexible mechanisms proposed under the new EU Climate and Energy Package and also support the credibility of Ireland's "Green" agri-food image.

In the Climate Action and Low-Carbon Development – National Policy Position Ireland[6] paper, the Government sets out the long term objective of "an approach to carbon neutrality in the agriculture and land – use sector, including forestry, which does not compromise capacity for sustainable food production". This is an explicit recognition of the profound challenges in decoupling food production from GHG emissions and the unique potential for carbon sequestration in biomass, soils and wood products through alternative land management and land use. At national and EU levels, there is commitment to improved reporting of the impact of land use with the development and implementation of polices and measures which demonstrate progress towards sustainable land use and enhanced carbon stock changes. In addressing these challenges Ireland must invest in structural and behavioural change to enable the transition to a carbon neutral, climate resilient environment.

Ammonia and Other Emissions to Air and Agriculture

In Ireland agriculture accounts for nearly all ammonia emissions to air.

Agriculture is a source of transboundary air pollutants including ammonia and Volatile Organic Compounds. Similar to other EU countries, the agriculture sector is the largest source of ammonia emissions to air in Ireland and accounted for 98% of total national emissions in 2014 (EPA, 2016a). The ammonia emission trend is largely determined by the cattle population and showed a steady increase to 1998. There has been some decline in the populations of cattle and sheep since 1999, as well as a decrease in fertiliser use, and this contributed to a reduction in emissions between 1999 and 2011. The ammonia emissions from the agriculture sector in 2014 were 0.9 % lower than the emission levels in 1990 and 12.4 % lower than the peak levels in 1998. Ireland has obligations under the revised National Emissions Ceiling Directive to achieve progressive reductions for ammonia by 2020 and 2030 of 1% and 5% based on a 2005 baseline (see Chapter 2). Given that ammonia emissions are largely determined by cattle numbers projected increases in the national herd present a real challenge to achieving these reductions.

Agriculture is also a source of Non-Methane Volatile Organic Compounds (NMVOCs) and particulate matter. Similar to ammonia, NMVOC emissions arise in all stages of manure management, housing, storage and land application of manures. Livestock feeding and livestock housing are sources of particulate matter. NMVOCs from agriculture account for 48 % of the national inventory total and predominantly come from manure management. Agriculture emissions of particulate matter contribute an estimated 14.5% of $PM_{2.5}$ and 44.7% of PM_{10} to national totals for these pollutants.

Biodiversity and Agriculture

Changes in agricultural practice remain one of the threats to both habitats and species and the trend in biodiversity loss in protected areas has not been halted.

Much of Ireland's rich biodiversity has evolved from agricultural land management. However, in protected areas the recent trend in biodiversity loss has not been halted and agriculture remains one of the main threats to both protected habitats and species. Insufficient data on the status of biodiversity in the other areas used for agriculture is creating a significant challenge in addressing the negative impacts and developing responses. Progress in developing our understanding of biodiversity nationally is being made via the Mapping and Assessment of Ecosystems Services project (Chapter 4). It is, however, clear that a robust baseline monitoring system and comprehensive ecosystems mapping is needed nationally to assess the overall impact of changes in agricultural practices on biodiversity in the rural environment.

In the context of protected habitats, agriculture was identified by the National Parks and Wildlife Service as a high-intensity pressure or threat in over 35% of protected habitats and as a pressure or threat in over 70% of these habitats (NPWS, 2013). In respect of protected species, agriculture was identified as a high-intensity pressure or threat for 10% of these species and as a pressure or

5 Factsheet on the Commission's proposal on binding GHG emission reductions for Member States (2021-2030) (July 2016) *www.europa.eu/rapid/press-release_MEMO-16-2499_en.htm*

6 *www.housing.gov.ie/environment/climate-change/policy/climate-action-and-low-carbon-development-national-policy-position*

threat for over 30% of them. The NPWS report concluded that the main pressures to habitats included ecologically unsuitable grazing levels such as under-grazing (or even abandonment) as well as some continued overgrazing. The report noted that grasslands, such as orchid-rich calcareous grasslands, are threatened by either intensification of farming or at the other extreme by insufficient grazing and abandonment.

High-Nature-Value (HNV) farming has developed from the growing recognition that the conservation of biodiversity depends on the continuation of low-intensity farming systems in both protected areas and other parts of the countryside. The dominant feature of HNV farming is low-intensity management, with a significant presence of semi-natural vegetation and diversity of land cover, including features such as ponds, hedges and woodland. Matin *et al.* (2016) produced a map of the likely distribution of HNV farmland based on established European indicators adapted for Ireland (Figure 12.5). This study identified a substantial proportion of farmland as having HNV potential and could inform targeted schemes to effectively support and reward the significant number of farmers whose farms deliver a wide range of ecosystem services particularly along the western seaboard.

Figure 12.5 High Nature Value Farming Potential (Source: Matin *et al.*, in press)

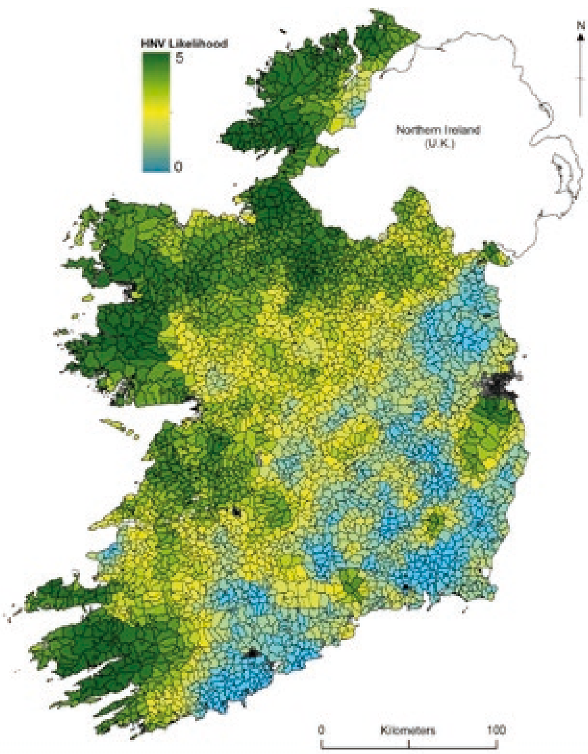
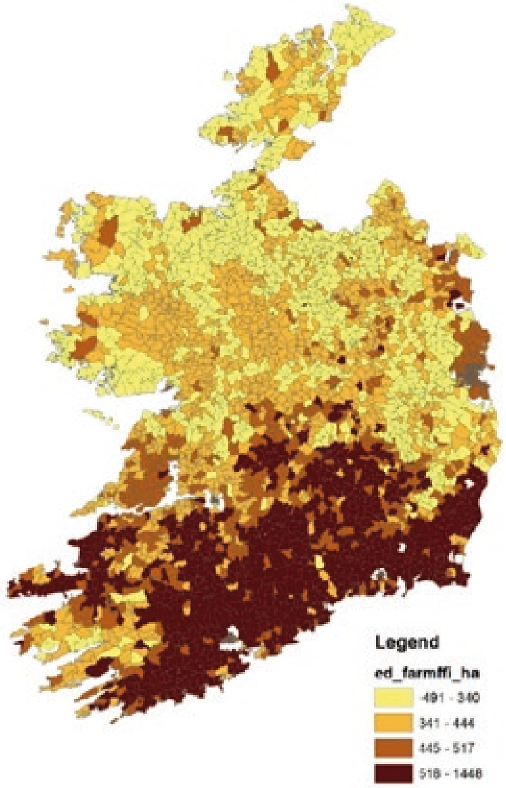


Figure 12.6 Modelled Family Farm Income per Hectare (Source: O'Donoghue *et al.*, 2014)



Modelled Family Farm Income per hectare (O'Donoghue *et al.*, 2014) found that Connaught and the border region had lower farm incomes than south of the country (Figure 12.6). When compared with farm income data it becomes apparent that the potential for maintaining HNV farming is greatest in areas with high proportions of economically vulnerable farms while also being the areas at greatest risk of losing HNV areas due to land abandonment or overgrazing. This would suggest that there is potential for incentivising the provision of other ecosystem services in these areas in addition to production-oriented ones. These benefits could be in water protection and provision of habitat for biodiversity through bankside habitat maintenance, farming for nature, and the native woodland scheme. Demonstration initiatives (such as the Burren,[7] Kerry[8] and Aran LIFE[9] projects) that target specific local sustainability issues provide evidence of how locally led community-based approaches can contribute positively to overcoming the challenge of transforming knowledge into effective actions in the agricultural sector. Moreover, the national GLAS scheme contains many initiatives that support biodiversity including protection of low-input permanent pasture, hedgerow and small orchard plantation which have important co-benefits with

7 *www.burrenprogramme.com/*

8 *www.kerrylife.ie/*

9 *www.aranlife.ie/*

regard to carbon sequestration and storage. While such a focus on protecting the current areas of high nature value is needed there is also a critical need to ensure that agricultural activities in other parts of the country are carried out in a way that will protect and enhance the environment for biodiversity.

The Burren Programme

www.burrenprogramme.com

The original BurrenLIFE project began as an innovative trial programme and tested a new model of sustainable agriculture for the Burren to conserve and renew its unique and diverse habitats. The present Burren Programme is a locally led measure under the Rural Development Programme 2014-2020 and it encompasses both results-based habitat management and complementary non-productive capital investment site works. The programme aims to deliver qualitative environmental goals on the participating holdings and payments in the scheme are based on measured deliverables. An important element of this Programme is that each farm plan is tailored to suit the needs of the individual farm, and the farmer's knowledge of his own land is paramount in this process. In previous projects in the Burren it was found that deep engagement with local farming communities has the potential for countryside and biodiversity benefits and this will continue with the new Programme.

Water Quality and Agriculture

Loss of nutrients to waters from agriculture is a significant pressure on water quality in Ireland.

Excessive nutrient losses to waters can lead to accelerated growth of algae and plants, significant ecological impacts and eutrophication in rivers, lakes and marine waters and is the most significant pollution issue for surface waters in Ireland. Agriculture was the suspected cause in 53% of river pollution in the period 2010-2012 (EPA, 2015c). While results up to the end of 2012 showed a small improvement in river water quality, preliminary results up to the end of 2015 indicate that this improvement has not been sustained and river water quality (based on Q values) has returned to the same levels found between 2007 to 2009. Importantly, the number of the highest quality river waters (Q 5 sites) has continued to decline (Chapter 5). Moreover there has been a 3% decline in the number of monitored lakes at satisfactory status since the 2007-2009 period. The preliminary analysis is also showing that no overall improvement has been found in the ecological status of transitional waters over the past 6 years. The Water Framework Directive (WFD) monitoring has noted a general decrease in levels of nitrogen with a smaller decrease in phosphorus levels in water over the last two decades nationally. Nutrient losses to waters are not uniform across the country and correlate with areas of higher human population and agricultural intensity, with the highest nutrient levels found in the south of the country (Figure 12.7). While agriculture is not the only pressure on the water environment and farmers in Ireland have made a considerable commitment to environmental measures, it is clear that supplementary action by the agriculture sector at a local and regional level will be required to improve water quality.

Ensuring that Ireland's water resources are of good quality is vital for public health, the agri-food industry and for inward investment. There is a particular challenge ahead to deliver a sustainable agricultural production system, as envisaged by Food Wise 2025, that protects our water environment for the use and benefit of all while meeting our international commitments including those under the Water Framework Directive.

Drinking Water and Agriculture

Protecting drinking water sources from diffuse pollution by Cryptosporidium and the pesticide MCPA are key issues for drinking water quality.

Activities in catchments have an impact on the quality of the source water and can, depending on the treatment available, impact on the quality of the drinking water supplied. This does not mean that additional treatment is always required but activities in the catchment should be managed to reduce risks to drinking waters.

The number of public water supplies affected by pesticides shows an increasing trend, with levels of pesticides above the drinking water standards detected in 28 supplies in 2014, compared with 17 supplies in 2013 (EPA, 2015b). In the majority of cases the herbicide MCPA, which is used to control ragwort, rush and thistle, caused the breach of the limit. There is a seasonal pattern for MCPA, with exceedances being more common during the summer and autumn months. Information on this issue is being made available to farmers (see leaflet 'Herbicide Use in Grassland'). In all cases the development of rushes can be controlled

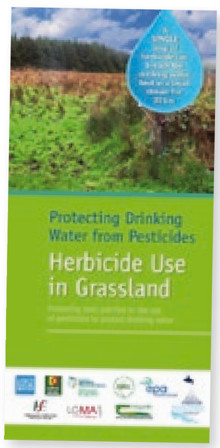
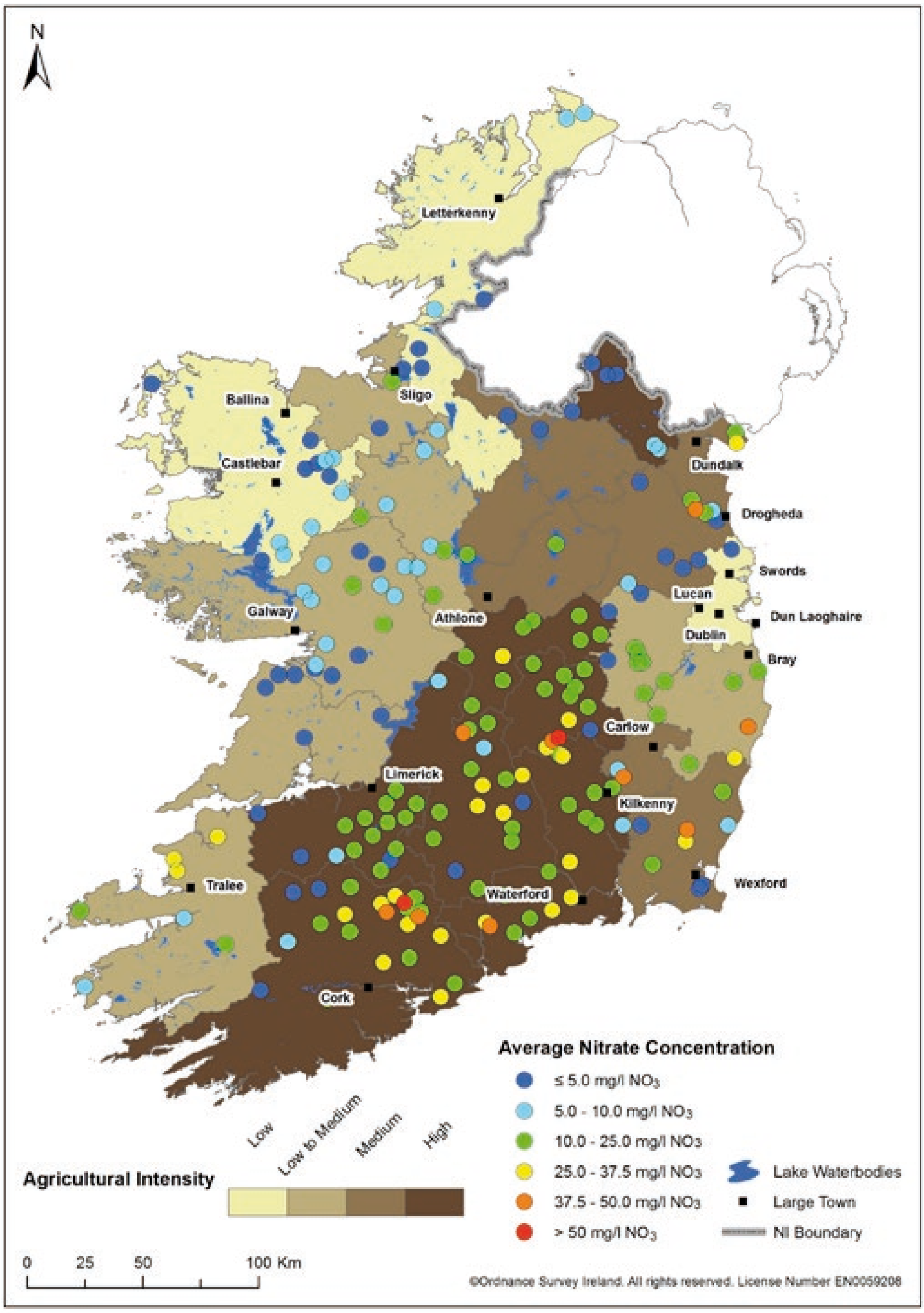


Figure 12.7 Average Nitrate Concentrations in Groundwaters (Source: EPA)



by grazing animals or by mechanical means such as mowing/ topping. Since November 2015, all plant protection products (including MCPA) must be applied by registered professional users (including farmers) and as such users must have received suitable training. MCPA containing products cannot be applied within 5 metres of surface waterbodies. This should contribute to reducing contamination of water by MCPA.

Agricultural activities pose a risk of microbial contamination of drinking water from animal excreta, especially where there are poor farm management practices that lead to microbial transport to waters or where there is inappropriate land spreading near source abstraction points. This can be exacerbated by poor construction of abstraction points. The most important health indicators of drinking water quality are its microbiological parameters and, in particular, *E. coli* and *Cryptosporidium*. In 2014, 187,804 people on 36 public water supplies were identified to be at risk from *Cryptosporidium*. Read *et al.* (2015) found that Cryptosporidium contamination of drinking water catchments in Ireland is widespread and probably mainly of animal origin. However, the majority of the species found are considered of low risk to public health. Of the species and genotypes described to date, at least eight can infect humans, with three being considered major human pathogens: *Cryptosporidium hominis*, *C. parvum* and *C. meleagridis*. While *C. hominis* is largely restricted to humans, *C. parvum* has been reported from a large range of mammals and is very prevalent in young ruminants. The third species, *C. meleagridis*, is primarily an avian parasite that occasionally infects humans. The study also found a positive relationship between rainfall events in the catchment and *Cryptosporidium* in the raw water supply, with oocyst numbers higher just after a rainfall event.

The water safety plan approach to managing drinking water supplies, which is advocated by the World Health Organization, aims to minimise the potential for entry of contaminants into water at source through catchment protection, rather than just depending on having them removed via treatment at a water treatment plant. This requires a catchment-based approach including information, education, stakeholder engagement and enforcement. Measures currently in place under the nitrates regulations and cross compliance can contribute to reducing microbial contamination of water. New targeted measures introduced under the 2014-2020 Rural Development Programme will also contribute. For example, the inclusion within GLAS[10] of actions to fence waters from cattle access protects biodiversity and reduces direct microbial inputs to waters and, therefore, the risk of microbial contamination of source drinking waters.

10 *www.agriculture.gov.ie/farmerschemespayments/glas/*

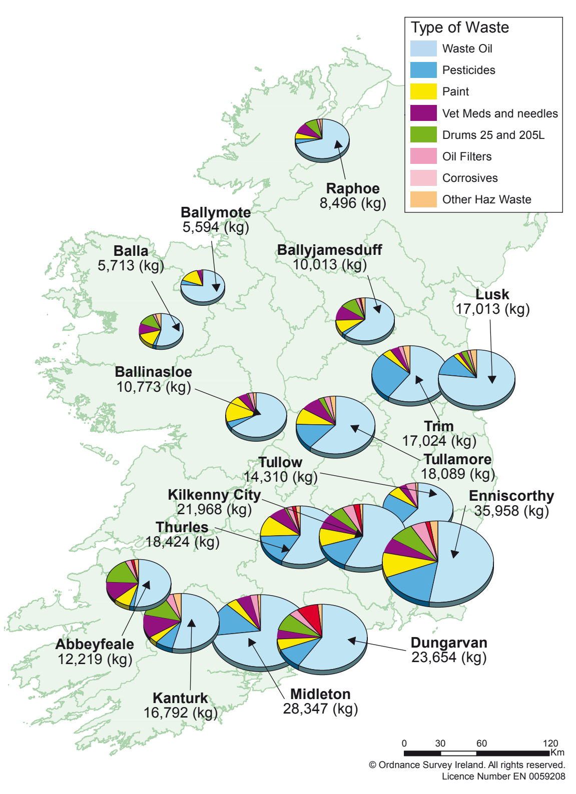
Farm Hazardous Waste Collection

A successful joint initiative to facilitate the collection, recovery and disposal of hundreds of tonnes of hazardous waste from farms.

The EPA, Teagasc, the Department of Agriculture, Food and the Marine, local authorities and waste contractors all collaborated in 2013 and 2014 in a joint initiative to facilitate the collection, recovery and disposal of farm hazardous waste. The campaign was extensively advertised and promoted by many of the project partners including Irish Farmers' Association, Irish Creamery Milk Supplier Association, Bord Bia, the Irish Farm Film Producers Group, some agricultural co-operatives and agricultural merchants.

Nearly 3000 farmers used the collection centres and a total of 264 tonnes of farm hazardous waste and 100 tonnes of waste electronic and electrical equipment and batteries were collected (figure 12.8). The main hazardous waste types presented were engine and hydraulic oil and filters, pesticides, paint, veterinary medicines, and needles and contaminated empty containers. The 32 tonnes of pesticides included insecticides, fungicides and herbicides including many that are extremely toxic to both human health and the environment. Farmers paid for the service, which confirms clearly that farmers want to manage these wastes in an appropriate manner and are willing to pay for the safe recovery and disposal of these wastes where a service exists.

Figure 12.8 Map of Farm Hazardous Waste Collections – Locations and Quantities (Source: EPA)



What's Being Done

The pressures that agriculture places on the environment are well known and a variety of actions have been implemented at EU level, national policy level and locally to address them.

These actions include Common Agriculture Policy reform; national implementation of the Nitrates Directive; sustainability initiatives including Origin Green; regulatory actions; and research and innovation in both productivity improvements and environmental management.

Common Agricultural Policy

The reform of the "Common Agricultural Policy" provides the opportunity for a move towards better targeting of action in the right places to address the environmental pressures involved.

The reforms of the Common Agricultural Policy introduced in 2015 include direct greening payments, accounting for around 30% of each farmer's single farm payment, for implementing obligatory measures such as maintenance of permanent grassland, ecological focus areas and crop diversification. These reforms reflect an awareness of the risks of unintended adverse environmental impact of previous CAP structures. There is also evidence that previous structures of the CAP encouraged intensification of agricultural production systems across Europe including Ireland, and the consolidation of land parcels and removal of hedgerows (Brouwer *et al.*, 2002). The reforms of CAP further develop Cross Compliance requirements making it necessary for lands to be eligible for direct payment to be maintained in Good Agricultural and Environmental Condition (DAFM, 2015). However, other reforms in CAP, such as removal of milk quotas, may have long term environmental impacts if the market becomes a more direct driver of farming activities. There is also a 20% allocation of Pillar II's Rural Development Programme's budget for voluntary cross cutting climate change measures under the new GLAS scheme.[11] Actions such as the Beef Data and Genomics Programme and GLAS under Pillar II are intended to focus on meaningful actions at a regional and local level. GLAS has targeted farmers in areas with high water quality for admission to the scheme indicating a welcome move towards targeting of actions to protect that element of the environment. The continuation of the Targeted Agricultural Modernisation Scheme, which provides funding for upgrade of farm facilities, may also provide benefit to the environment. It is important that incentives under Pillar I and Pillar II are consistent and complementary, for example HNV farms should not be seen to be at risk of losing eligibility status. The role of Farm Advisory Services in promotion of appropriate management is critical in this respect.

Nitrates Action Programme

Good agricultural practices for the protection of waters.

The Nitrates Directive (1991) aims to protect water quality by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. It forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures.

The Nitrates Action Programme is required under the EU Nitrates Directive (91/676/EEC). Ireland has taken a national approach defining the nutrient sensitive area for water protection under the directive as the whole national territory meaning that it applies its programme nationally thereby providing a level of water protection across the country. Importantly Ireland has also used its national implementation of the Directive to control phosphorus, which is the key driver of freshwater eutrophication, as well as nitrogen. Under the programme there is a closed period when land spreading of slurries is prohibited, minimum storage requirements are set for various geographic zones nationally, legal limits are established for nitrogen and phosphorus use and other measures to protect waters from nutrient enrichment, e.g. nutrient management planning. In addition, the Teagasc Agricultural Catchments Programme was established with funding from the Department of Agriculture, Food and the Marine with the twin aims of protecting and improving water quality and supporting the production of high-quality food including evaluating the environmental and economic effects of the Nitrates Action Programme measures. Ireland has derogation from the livestock manure application limits on land spreading in the Directive and is obliged to monitor the impact of the Nitrates Action Programme and this derogation on water quality on an ongoing basis. This monitoring information will form part of the body of evidence that will also be used to track the impacts, both positive and negative, of the implementation of the Food Wise strategy.

Origin Green

National sustainability programme for farmers and processors.

Bord Bia's Origin Green Programme[12] was launched in 2012 as the national sustainability programme for the Irish food and drink industry. It provides sustainability programmes on a national scale for Ireland's farmers and food producers with a vision for Ireland having the lowest environmental footprint in Europe. Origin Green sets out a defined structure to demonstrate sustainable performance

11 *www.agriculture.gov.ie/farmerschemespayments/glas/*

12 *www.origingreen.ie/*

and assists farmers and food processors to set plans for further improvements. In its Sustainability Report 2015, Bord Bia reported that 38,000 on farm assessments had been completed in 2014 (Bord Bia, 2016). These assessments cover GHGs, biodiversity, water conservation and energy efficiency. The Sustainability Report also sets out the next steps for Origin Green, including plans to have up to 50,000 farmers using the Teagasc Bord Bia carbon navigator,[13] and plans for every food company to have an emissions target as part of their Origin Green plan. On biodiversity it committed to supporting the implementation of the All Ireland Pollinator Plan.[14] It also commits to working with Teagasc on a pilot project to develop a sustainability tool for remote sensing of wildlife habitats on Origin Green member farms and provide guidance to farmers on how to maintain and enhance habitat areas on their farms. The potential role of Origin Green in helping to ensure progress is made in relation to water quality is also recognised. Importantly Bord Bia has highlighted that farmer and manufacturer/processor engagement and implementation are the key challenges for Origin Green into the future.

River Basin Management Plans and the Water Framework Directive

A new catchment based approach aims to connect people and communities with their local steam, river, lake, spring or coastal water.

Agriculture is the suspected cause for over 50% of river pollution (EPA, 2015c). It is against this context that a new national river basin management plan is being prepared for the period to the end of 2021. In assisting the Minister for Housing, Planning, Community & Local Government with the preparation of the new plan, the EPA is assessing and characterising the impact of pressures, including agricultural ones, on the water environment across the country at a local and sub catchment scale. To do this, the EPA is using a suite of catchment management support tools to identify areas within catchments with higher likelihood of releasing nutrients and pollutants to waters. These areas will be targeted for interventions either to protect or improve water quality. This approach is used to identify significant pressures from all sources, including agriculture, and is an important step forward in prioritising and targeting strategies, measures and resources for integrating and optimising agronomic and environmental benefits.

A new approach to implementation called "integrated catchment management" is being used to support the development and implementation of this plan. The catchment based approach aims to connect people and communities with their local stream, river, lake, spring or coastal water. It integrates all water types and relevant disciplines, including social science, and establishes linkages with biodiversity, flood mitigation and water quality. Recognising the same implementation challenge as Origin Green, it requires close collaboration between relevant public bodies and a combination of bottom-up and top-down approaches to implementation. The development of the Catchments.ie website collaboratively by the EPA; Department of Housing, Planning, Community and Local Government; and the Local Authorities' Waters and Communities Office is providing open access to information on the water environment to all stakeholders and is a first step to improving awareness and supporting future dialogue and collaboration. It is expected that further action to develop connections between communities and public bodies involved in water management will be included in the draft River Basin Management Plan that will go for public consultation at the end of 2016.

Climate Action and Low Carbon Development Act 2015

The vision is of climate resilience and carbon neutrality for the agriculture and land use sector.

The Climate Action and Low Carbon Development Act 2015, in combination with the National Policy Position that was published in 2014 (DHPCLG, 2014), provide the framework for national actions to address climate change. It establishes a vision of climate resilience and carbon neutrality for the agriculture and land-use sector, including forestry by 2050 which does not compromise safe and sustainable food production. Under the Act, the National Mitigation Plan and the National Adaptation Framework will outline the short and longer term policies and actions at a sectoral and local level needed to achieve the shorter term targets and long term objective. Sector plans for Agriculture will need to address mitigation of agriculture, land use and forest GHG emissions and provide a framework for adaptation measures required in the agriculture sector.

13 *www.teagasc.ie/media/website/about/our-organisation/Bord-Bia-Beef-Carbon-Navigator-LR4.pdf*

14 *www.biodiversityireland.ie/wordpress/wp-content/uploads/All-Ireland%20Pollinator%20Plan%202015-2020.pdf*

Industrial Emission Licences for Pig and Poultry Enterprises/Installations

Significant improvements in production efficiency in the sector.

Substantial productivity improvements are being achieved in the Irish pig sector, with Irish pig producers now producing almost 1,500 kg of pig meat per sow compared with 1,221 kg in 1990 (DAFM, 2016a). Pig meat production has increased by 76% between 1990 and 2015 against the background of the falling size of the female breeding herd. This reflects a significant improvement in production efficiency in the sector. Moreover, the annual amount of phosphorus excreted by pigs has been reduced from 26 kg to 17 kg per sow and progeny over the last 25 years. This has been achieved through better ration formulation and the use of enzymes to improve digestibility of phosphorus. It has reduced the land area required for the spreading of pig manure. The land spreading of pig manure is regulated under the Nitrates Regulations and Nitrates Action Programme which permit manure applications above the prescribed crop's phosphorus requirements. This transitional arrangement will cease in 2017, increasing the area of land required to utilise pig manure and will create an additional challenge for the sector.

By the end of June 2016, the EPA had issued licences (Industrial Emission Licences) for 117 pig and 93 poultry enterprises/installations with a further 7 pig and 15 poultry applications on hand. Applications are still being received from farms that are and have been operating above the licensing threshold without a licence. Continued failure by these operators to become regularised places them at increasing risk of enforcement actions and risks reputational damage to Ireland's food image.

Smart Farming

www.smartfarming.ie

Reducing costs and protecting the environment inside the farm gate through better resource management.

Improving farm incomes and protecting the environment are the drive behind the voluntary Smart Farming green business programme. This initiative focuses on ways to reduce costs inside the farm gate and protect the environment through better resource management in eight key areas: feed, grassland, water, inputs, time management, soil fertility, machinery management and energy use. The programme is led by the Irish Farmers Association (IFA) in partnership with the EPA and brings together the knowledge of Teagasc, the Fertilizer Association of Ireland, the EPA, University College Dublin and others. Smartfarming is communicating this knowledge in a targeted way to improve farm incomes whilst also protecting the environment (Figure 12.9).

These bodies collaborated to produce a Smart Farming guide, which is a summary of top-tips to save money and reduce waste while safeguarding the environment. This guide is available through the farm directory (*www.ifarm.ie* and *www.smartfarming.ie)* . During 2014, over 600 farmers across the country participated and saw members of their discussion groups identify average cost savings of €6,600 per farm.

The Carbon Navigator tool developed by Teagasc in partnership with Bord Bia was piloted on a number of farms in 2015. The tool is designed to assist farmers in assessing their GHG status, with a focus on mitigation actions that can be taken to achieve improvements. It is being rolled out across participating Smart Farming farms during 2016. Measures adopted by participating farmers have resulted in less risk of runoff to watercourses, extended grazing of grass, better targeting of fertiliser application, reduced energy, improved water efficiency and inputs use and reduced GHG emissions and improved farm profitability.

Figure 12.9 Stakeholders Involved In and the Items Dealt With in Smartfarming Programme (Source: Smartfarming.ie)

Research Responses

Significant investment in agriculture and agri-environmental research is improving the knowledge base to underpin environmental protection and sustainable environmental development of agriculture.

In recent years both EPA and DAFM have invested heavily in agricultural and agri-environmental research aimed at improving the knowledge base to underpin policy development and application at farm level. There are two separate but linked strands of research: DAFM's Stimulus Programme and the EPA's Research Programme. Together these programmes aim to provide the knowledge to improve production efficiencies whilst also developing our understanding of the complex physical, chemical, biological, climatic, hydrological and geomorphological factors that determine emissions to air, soil and water, their potential impact on the receiving environment and effective measures to control them. Bringing these two strands together to inform policy and transferring this knowledge to the "on the ground" activities has been highlighted as a challenge and will require an integrated approach and dedicated effort. The EPA funded AgImpact project identified the importance of translating the research knowledge and outcomes into formats that can be understood by policy maker, adviser, educator, farmer and consumer stakeholder and emphasised the importance of the farm advisor in the system (Carton *et al.*, 2016).

Substantial work has been undertaken by the Department of Agriculture funded Teagasc Agricultural Catchment Programme (ACP) to assess the impact of the Nitrates Action Programme measures. An important outcome is that phosphorus loss from wet soils has been identified as the most important freshwater quality pressure emphasising the need to target efforts for reducing phosphorus loss on wetter soils. This would be consistent with the approach being taken by the EPA's risk assessment approach to characterising the impact of agriculture and other pressures on the water environment. The ACP has also identified lag times between changing management and achieving good water quality in certain geographic settings resulting in a delay between improved farming practices and water quality response. While this needs to be considered it is not a basis for delaying actions to improve water quality or not implementing effective additional measures in areas with identified water quality problems caused by agriculture.

The Agricultural Greenhouse Gas Research Initiative for Ireland (AGRI-I)[15] is a consortium of researchers, students and professionals working collaboratively to improve estimation of GHG emissions and develop verified strategies to decrease GHG emissions from Irish agriculture. AGRI-I was launched in January 2012 and is one of a number of agri-environment research projects funded by the Department of Agriculture, Food and the Marine. In addition, the EPA research programme (that is coordinated with AGRI-I) has funded a number of projects primarily aimed at improving understanding of how to accurately represent country specific characteristics of agriculture and land use in Ireland in national reporting of emissions and removals.

With respect to Climate Change Adaptation, the EPA Research programme funds regional climate modelling to provide state of the art projections of climate change and support dissemination of this knowledge to stakeholders through the development of the Climate Information Platform.

Recent research has produced country specific emission factors for nitrous oxide emissions and identified the potential for significant emissions reductions using alternative fertiliser formulations which have the added advantages of being cost neutral while achieving similar or improved yields (Harty *et al.*, 2016).

Clearly there will need to be a more tailored approach to addressing agricultural pressures so that intensification takes place in appropriate parts of the country. However, rather than consider agriculture as a pressure, an alternative perspective is to consider the services it provides. Schulte *et al*. (2015) has developed a framework for considering soil functions called the Functional Land Management approach. This approach categorises the varied ecosystem services provided by soils into five functions: primary production; water purification and regulation; carbon storage and regulation; provision of a habitat for biodiversity; and cycling of nutrients. All soils can perform all of these five functions, but some soils are better at supplying selective functions. Recognising these differences in soils, Functional Land Management is a possible framework for policy-making aimed at meeting these demands by incentivizing land use and soil management practices that selectively augment specific soil functions, where required.

15 *www.agri-i.ie/*

Measuring progress in agricultural sustainability is difficult. Dillon *et al*. (2016) developed a series of farm level sustainability indicators using information from the National Farm Survey data and looking at three dimensions: environmental sustainability (relating to GHGs and nitrogen use), economic sustainability and social sustainability. While this approach and the creation of the Food Wise 2025 Environmental Sustainability Committee have promise in assisting to ensure the environmental sustainability of agriculture, the regional and local variation in the physical setting as highlighted by the ACP and EPA characterisation work indicate the complexity in achieving sustainable intensification. When considering this in the context of the knowledge and practice transfer issues highlighted by the AgImpact project and Origin Green, it is clear that the interplay between the two strands of research will require attention in the immediate future. In addressing this issue, Dillon *et al*. (2016) noted that 'There is a growing recognition of the need for interconnected policy in the area of sustainability'. It is clear that addressing these interplays will be a key challenge for farmers, public bodies, and agricultural and environmental policy-makers in the coming years.

Innovation

There have been a number of positive innovations to support the sustainable development of the agricultural sector.

Recent years have seen a number of positive innovations to support the sustainable development of the agricultural sector. PastureBase Ireland[16] is a citizen science enabled system into which farmers provide data on grass growth from their farms, which facilitates the quantification of grass growth in a range of biophysical environments. PastureBase then provides feedback that can be used by farmers to support day-to-day management decisions to improve production efficiency (getting more from less) or to evaluate longer-term performance from the farm. The Teagasc-Bord Bia Carbon Navigator tool referred to previously represents a pro-active approach to addressing resource efficiency. The newly developed Nutrient Management Planning (NMP) Online system has the potential to assist with the management of soil fertility and may allow for the tracking of spatial and temporal changes in it. Coupling NMP online with other productivity efficiency tools may help farmers to improve productivity while protecting water quality.

The *Teagasc Technology Foresight 2035* report (Teagasc, 2016) identified the potential contribution of the converging ICT technologies that can provide new, more cost-effective, integrated and streamlined systems at all levels in the agricultural value chain. New and larger datasets are now and will increasingly be collected using affordable sensor technologies that will be employed at farm level. The risks inherent in addressing and managing all the production and environmental resources can be significantly reduced when data are used to inform the decision making at all stakeholder levels. Substantial datasets are being collated via EPA work on catchment characterisation and via PastureBase, NMP online, ACP and other initiatives. Clearly future data sharing and management will be a key support to environmental protection in the context of agriculture.

Conclusion and Future Challenges

The quality of Ireland's environment plays a vital role in the quality of Ireland's agricultural produce and its marketing. It is essential to ensure the implementation of the Food Wise strategy does not result in damage to the environment and supports progressive improvement where it is already impacted. Food Wise recognises this and its vision of economic competitiveness and environmental sustainability being equal pillars is a significant step towards dealing with the tensions that can exist between environmental goals and socio-economic ones. Addressing these tensions will require a strong, reliable and independent evidence base upon which all stakeholders involved in environmental protection and agriculture development and management can depend and upon which actions can be developed and implemented. Better information and more evidence are being delivered on the interactions between agriculture, its productivity and its consequences on the environment via research and other channels. There is however a challenge in improving the sharing of this information and more importantly developing a common understanding of the interactions between agricultural management choices and their effects on the environment and the measures on how to address them.

16 *https://www.teagasc.ie/crops/grassland/pasturebase-ireland/*

The structure of Irish farming enterprises is partially but substantially predicated by the biophysical and climatic context in which these enterprises are situated. Consequently increases in primary production systems will not be uniform across the country as regional and local biophysical factors together with socio-economic considerations will determine where intensification may take place. The consideration of how farmland can provide multiple benefits within a Functional Land Management framework provides an opportunity to achieve a more holistic and positive outcome for the Irish environment and for farming communities. This would, however, require continuing the drive towards a more targeted approach than is currently employed to address the pressure agriculture places on local environments. There are substantial challenges in seeking to apply such an approach at a local scale. Incentivising location – appropriate farming that can provide a reasonable economic return such as the Burren programme may provide an exemplar of how this could be achieved. That being said there are substantial constraints on farmers, both economic and time wise to engage with environmentally positive activities given the issues of farming viability. Nevertheless there are double dividends to be achieved where certain practices such as improved nutrient management planning can save farmers money whilst also reducing the risk of nutrient loss to the environment.

The main climate change impacts expected for the agriculture sector will result from changes in air and soil temperature, changes in rainfall patterns and more extreme events. For farming, climate change will require adaptation to a new reality and this will impact on farmers more directly than most other sectors of society. Adaptation to these changes is a key consideration for Irish agriculture to be addressed in the sectoral Climate Adaptation Framework mandated under the Climate Act. The challenge of achieving GHG neutrality within the combined agriculture and land use sectors is substantial and agriculture has a pivotal role to play in combatting climate change by improving the GHG efficiency of production. The challenges associated with implementing planned policies and measures that are aimed at reducing emission should not be underestimated and will need a combination of education, incentives, resources and substantial commitment by all stakeholders to enable implementation.

There are clearly substantial current challenges in relation to improving the environment from a water quality and biodiversity standpoint. Eutrophication caused by nutrient loss from agricultural activities is the most significant pressure on the water environment and the current lack of progress with attaining improvement in water quality is a major concern. The rise of the detection of pesticides in source drinking water is a particularly worrying development. Both the World Health Organisation drinking water safety planning approach and integrated catchment management approach being developed under WFD highlight the need to address these issues in the catchment.

The AgImpact Project (Carton *et al*., 2016) highlighted the significant challenge in developing processes to promote the application of knowledge that will deliver increased efficiency and profitability while protecting natural capital including water. This challenge is characterised within the variability of the biophysical setting and more importantly within the context of the socio-economic challenges facing farming communities including the viability of their enterprises. The study identified the need for improved communications that will build mutual trust between and within generators of knowledge, policy development stakeholders and active "on the ground" parties including farmers and advisors. Achieving improved environmental performance within this context is a major challenge and will require the building of trust and partnerships to help overcome the sectoral, natural, economic, social and demographic variability that characterises and shapes the sector and its interactions with its environment. This will require fostering collaboration across a wide number of stakeholders including the farming community.

Key High-level Messages

Ireland's environment plays a vital role in the quality of Ireland's agricultural produce and productivity. Recognising local and regional contraints and valuing the range of ecosystems service that agicultural land provides will be key to ensuring a balanced approach to the future development of Irish agriculture and rural communities.

Environmentally sustainable intensification of the agriculture sector will depend on a strong, reliable evidence base upon which all stakeholders involved in environmental protection and agriculture development and management can depend.

Adapting to and mitigating the impacts of climate change will be a key challenge for the Irish agricultural sector and the challenge of achieving GHG neutrality within the agriculture and land use sectors is profound.

Water pollution caused by the loss of nutrients and the loss of pesticides to waters from agricultural land are major concerns that need to addressed collectively by all environmental and agricultural stakeholders.

Building trust between environmental and agricultural stakeholders is a major challenge that will need to be addressed to achieve meaningful engagement on achieving economic competitiveness and environmental sustainability.

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