Chapter 10:
Environment and Agriculture

Environment and Agriculture

1. Overview

The agri-food sector is an integral part of Ireland's society and economy, especially in our rural and coastal communities. Farming has shaped Ireland's environment for centuries – it is a vital human activity that can deeply impact nature and the environment, but it also relies heavily on a healthy environment to thrive. There is unequivocal evidence from reports by the Environmental Protection Agency (EPA) that the agri-food sector in Ireland is a significant contributor to pollution and impacts our environment. Significant growth in parts of the sector in the last decade has brought significant environmental challenges. There is also evidence, conversely, that when agricultural practices are well managed, and are matched to the capacity of the land in a particular area, they can contribute to maintaining and enhancing environmental outcomes for biodiversity, soil health, climate, water quality and flood protection. It is clear from global assessments that tackling the climate and biodiversity emergencies will require transformative change across land and food systems, with huge implications for the products and services that will be required from farmers in the future.

The latest agri-food sector strategy, Food Vision 2030 (DAFM, 2021a), has brought into sharper focus the importance of achieving environmental sustainability alongside economic growth, and many changes in farm practices to support a healthier environment are now being made on farms across the country. But it is clear from the EPA's published assessments that a deeper level of systemic change is required in practice in the sector to ensure its environmental, social and economic sustainability in a changing world. Substantial progress can be made through the full and effective implementation of existing policies and regulations, for example through achieving full compliance with the Good Agricultural Practice for the Protection of Waters Regulations (S.I. No. 113/2022) and by implementing all the climate measures mapped out in the Teagasc marginal abatement cost curve (MACC), and these steps are urgently required. But navigating the agriculture sector towards a secure and sustainable long-term future will require more substantial fundamental changes in how we use land. Hitherto, much emphasis has been placed on continuous improvement in the product-level carbon efficiency of Irish milk and beef production, and the sector has delivered this with considerable success. Yet the latest scientific evidence increasingly focuses on absolute ecological thresholds to determine environmental sustainability at local, national and global scales. Delivering a truly sustainable and resilient agriculture sector in the long term will require a paradigm shift beyond continuous improvement and relative efficiency towards a goal-oriented approach informed by a vision of a climate-neutral and biodiverse agriculture and land sector. Strategic planning for the risks and opportunities arising from future market and policy responses to a rapidly changing world will be as important for the future economic and social viability of the sector as it will be for achieving environmental objectives. Connecting this foresight approach to current realities to identify possible 'just transitions' for farmers is a huge challenge that can be solved only through broad and constructive engagement across all stakeholders.

Key sustainability challenges

There have been increasing calls for countries to adopt a more holistic 'food systems approach' (Topic Box 10.1) in policymaking, so that all the elements of the system evolve and adapt together in a joined-up way. In practice, this means policymakers for agriculture, fisheries, land use, public health, the economy, trade and the environment working together, developing a holistic view and a shared vision of what the system should look like as a whole in the future. Food systems are complex, and the necessary trade-offs and synergies become apparent, and can be optimised in the public's best interest, only when all the elements of the system are considered together (OECD, 2021). Food systems must work for people and for the planet.

Topic Box 10.1 Food systems approach

Food systems can be described as the complex web of activities surrounding the ways in which we grow, produce, process, trade, transport, consume and waste food, or, put simply, how we get our food from farm to fork. Food systems are central to our health and wellbeing, our livelihoods and economies, and our cultural and social values. Globally, food systems are major drivers of climate change, changes in land use, depletion of freshwater resources, and pollution of aquatic and terrestrial ecosystems (OECD, 2021). At the same time, our food systems are expected to supply a growing global population with safe, secure and nutritious food – global food demand in 2050 is expected to be 56% greater than it was in 2010 (van Dijk *et al*., 2021). Consequently, global food system greenhouse gas emissions could exceed the entire global greenhouse gas budget for climate stabilisation by 2050 (Clark *et al*., 2020). However, up to one-third of food produced is wasted and never consumed, while excessive and unbalanced food intake is a major cause of disease in industrialised countries. Meanwhile, 2.4 billion people were moderately to severely food insecure in 2022 (FAO, 2023).

It is increasingly recognised that global food systems need urgent and profound transformation to become sustainable. While there is good progress being made in some areas, the rate of change is slow and needs to be accelerated (EEA, 2022). Global assessments clearly indicate that realising a sustainable food system will require integration of demand-side measures such as diet change, waste reduction and a reconfiguration of value chains to deliver the right types of food to where they are most needed (IPCC, 2019; Willett *et al*., 2019; Fanzo *et al*., 2021). Diet change could reduce global greenhouse gas emissions by up to 8 Gt CO_2 eq/year, while reducing food and agricultural waste could lower emissions by a further 4.5 Gt CO_2 eq/year (IPCC, 2019). Taking Irish dietary intake as an example, dairy and meat products represent around 30% of energy intake and around 70% of dietary climate impact (Williams *et al*., 2020). Globally, there is increasing recognition of the dual health and environmental benefits that could be realised by reducing the consumption of animal-derived foods across the industrialised countries that produce most of these foods. Recent Teagasc research has shown that a 25% reduction in the emissions associated with the current Irish diet could be achieved if healthy eating guidelines were observed. This would require reducing treat consumption by half, adding three extra portions of fruit and vegetables per day, and reducing the consumption of meat by one portion per day (Conway and McCarthy, 2023).

As climate, biodiversity and health crises intensify, market and policy responses will be amplified but also constrained by biophysical realities such as available land areas and climate change impacts. Profound consequences for food systems and farmers are likely, yet they cannot be extrapolated from past trends. Reactive policymaking could leave the agri-food sector heavily exposed to big risks that undermine the social licence and green marketing on which it depends and simultaneously unprepared to exploit emerging opportunities. Forecasting the future has inherent uncertainties, but strategic foresight analyses can point to the major threats and opportunities associated with specific food system trajectories. For example, the increasing future costs of healthcare for an ageing population are likely to mean that widespread diet and lifestyle changes will become an economic imperative. Diet change in Ireland may not have a significant impact on animal production nationally, which is driven by exports, but a shift towards consuming more diverse, value-added national produce could support national farm diversification – maximising the social, environmental and health benefits. Similarly, reducing food waste could be driven by economic factors if the true costs of food production were borne by consumers. Foresight analyses of future food systems require constructive and open-minded engagement across a broad range of relevant stakeholders with contrasting perspectives. There is an urgent need for critical and constructive discussions on what 'sustainability' and 'resilience' will mean for Ireland's agri-food sector in a changing global food system.

Management of land systems is also critical to sustainability. Farmers own and/or manage about 67% of land in Ireland (DAFM and DECC, 2023). Agriculture, and in particular farmers' actions, will be a key part of the solution to addressing the climate and biodiversity crises. Although there is a lot of uncertainty about precisely how an agriculture and land sector that is compatible with national objectives on climate neutrality, water quality and biodiversity will look, it is clear that the sector will need to change, and the direction of travel is sufficiently clear to inform initial action. Against this backdrop, an array of good programmes and initiatives in Ireland, e.g. Farming for Nature and BASE (Biodiversity, Agriculture, Soil, Environment) Ireland, have made some progress, and there are many positive environmental actions already being carried out on farms, but they have not yet delivered the scale and pace of change needed.

Realising dynamic, sustainable and resilient agri-food and land systems in Ireland will require the development of integrated, cross-departmental policies that recognise the interdependencies of a healthy environment, healthy people, healthy food and healthy planet. Driving the transition to a more climate-resilient and environmentally friendly agriculture sector will require vision and leadership. Urgent implementation must be a priority, and farmers and other landowners must be supported in making the changes that are needed. Some of the most important challenges affecting both the sector itself and broader society are summarised below. See Chapters 4, 5, 6, 7, 8 and 15 for further detail.

- ***Environmental impact.*** The intensification of livestock farming, in particular the dairy sector, in response to ambitious growth policies has contributed to increased environmental degradation in Ireland. Over the last decade there has been an increase in greenhouse gas emissions, air pollution, water pollution from agricultural run-off and leaching, and habitat destruction. While there has been some stabilisation in recent years, and improvements in some areas, addressing these environmental impacts is crucial, not least for producing nutritious sustainable food and maintaining Ireland's green economic trading credentials. The current agri-environmental policies, and/or their rates of implementation, are not yet achieving the desired environmental outcomes.
- ***Climate change and emissions.*** The agriculture sector contributes 38% of Ireland's national greenhouse gas emissions. The key drivers are the size of the national cattle herd and the application rates of nitrogen fertilisers. While both have increased over the last decade, there has been some stabilisation in animal numbers in recent years and significant reductions in chemical fertiliser use. Full implementation of the measures outlined in the Teagasc MACC 2023, which will require additional policy measures to support implementation, will be required to reach the 25% emission reduction target by 2030. The agriculture sector is also a significant contributor to emissions attributed to the land use, land use change and forestry (LULUCF) sector, which is a net source of emissions in Ireland. Key measures include substantial afforestation of Ireland's grassland-dominated landscape, and water table management and restoration are both actions that need to be undertaken in peat soils.
- ***Climate change adaptation.*** Ireland's agriculture sector is vulnerable to the impacts of climate change, including changes in rainfall patterns, extreme weather events and rising temperatures. These factors can affect crop yields, fodder reserves, livestock and plant health, increase disease risk, and reduce overall farm productivity, which in turn could increase economic pressures and have negative impacts on farmers' health and wellbeing. Adaptation strategies are necessary to make agriculture more resilient and reduce its contribution to climate change. Such strategies could include diversification, planting drought-tolerant species, flood prevention/management, management of new pests and diseases, and nature-based catchment management solutions. Different adaptation strategies may be needed in different parts of the country depending on how they are affected by the weather.
- ***Land use and biodiversity loss.*** Agricultural practices such as land intensification and drainage have resulted in habitat loss and reduced biodiversity levels. Land abandonment can also be an issue in some areas, as can commercial afforestation with non-native species in sensitive upland areas. Native species, both flora and fauna, have suffered as a consequence. Maintaining and restoring biodiversity in agricultural landscapes is essential for ecosystem resilience and long-term sustainability.
- ***Water quality.*** Agricultural activities, particularly animal manure management and fertiliser use, contribute to water pollution in Ireland. Excess nutrient run-off, i.e. nitrogen and phosphorus, can lead to eutrophication, which negatively affects water quality and aquatic ecosystems. Pesticides and other chemicals reaching watercourses are a problem in some areas, as are activities that impact on the physical aquatic habitat conditions. Better farm management practices that work in tandem with nature and climatic conditions, in ways that build resilience into the system, are needed to minimise impacts to water quality.
- ***Farm viability and rural communities.*** Many farmers in Ireland face economic challenges, including low farm incomes, fluctuating commodity prices, and high and fluctuating production costs. Farmers are price takers, and small-scale farmers in particular struggle to remain financially viable, which in turn threatens the social structures underpinning our food system. Generational renewal is becoming increasingly challenging. Ensuring fair economic returns for farmers that reflect the true cost of food production and deliver a standard of living that is comparable with other sectors, while providing support for rural development, is important for sustaining agriculture and rural livelihoods. It is also becoming increasingly important to recognise and support the growing number of non-farming landholders to maximise the ecosystem services from their land.

- ***Dependency on farm payments.*** The agriculture sector in Ireland relies heavily on income support through farm payments and schemes under the EU Common Agricultural Policy (CAP). The potential for future reductions in CAP funding poses a significant concern for farmers and the sector's future stability and viability. Developing alternative models of support and diversifying income sources can help reduce the dependency on subsidies and create more resilient farming systems. Consumers are not currently paying the true costs of food production. Meanwhile, development of a circular bioeconomy could open up alternative revenue streams based on less impactful land uses.
- ***Technology and innovation adoption.*** The uptake of technological advances and innovation in Irish agriculture, and indeed globally, has been mixed. It is widely known that there is a diverse range of factors that influence the adoption of new technologies at farm scale, including farm and farmer characteristics and socio-psychological issues such as attitudes and social pressure (Daxini *et al.*, 2019). These factors can hinder productivity improvements, efficiency gains and the adoption of sustainable practices. Encouraging research and development, providing training opportunities and promoting knowledge exchange, such as through the Teagasc Signpost Programme, can accelerate the adoption of innovative technologies in the sector. A whole-of-government and industry approach is also needed to provide appropriate regulations and incentives.
- ***Food waste.*** Growing, processing and transporting food all use significant resources such as land, water and energy. Food loss and food waste is generated at each stage along the food chain: primary production, manufacturing and processing, distribution and retail, restaurants and food services, and households. In Ireland, households are one of the biggest sources of food waste. Prevention is the best way to address food waste – the National Food Waste Prevention Roadmap (DECC, 2022) was developed in 2022 with the aim of halving Ireland's food waste by 2030.
- ***Challenges with scale.*** There are challenges with scale in developing and implementing policy in space and time. Policies and regulations are set nationally for application at farm scale, but environmental problems are not 'one size fits all' and often need to be tackled at local community, catchment and landscape scales in different ways. Context-specific priority actions for individual farmers and other landholders should align with strategic land use priorities for the relevant habitat type or landscape setting. There are also time lags between policy design, implementation and the environmental outcome, which means that far-sighted action that extends beyond the typical policy time frame is needed.

Agriculture and the economy

Over the last decade, triggered by the economic recession in the 2000s and the opportunities presented by the lifting of the dairy quotas in 2015, Ireland has pursued an ambitious strategy for growth in the agriculture sector. Three successive agriculture sector strategies have been developed and implemented: Food Harvest 2020 (DAFM, 2021b) and Food Wise 2025 (DAFM, 2015) were both focused on driving growth and economic output, while Food Vision 2030 (DAFM, 2021a) adopted a more integrated food systems approach that recognised the links between policies for food, climate, the environment and health. While these initiatives have brought significant economic benefits to the sector and the economy as a whole, the evidence shows that this growth has been associated with environmental impact. There are also significant hidden environmental, social and health costs in the agri-food system (Topic Box 10.2). There is a growing recognition in the sector, however, that this is unsustainable in the long term and needs to change.

Topic Box 10.2 The hidden costs of agri-food systems

The Food and Agriculture Organization of the United Nations (FAO), in its recent flagship report *The State of Food and Agriculture* (FAO, 2023), states that there are two sides to our agri-food systems: on the one hand they provide benefits to society through food, culture and jobs, but on the other hand they contribute to climate change and degradation of our natural resources, and they fail to provide healthy diets for all. The report attempts to uncover the hidden environmental, health and social costs that are embedded in our food systems, many of which are not reflected in market prices and are therefore unaccounted for. These hidden costs affect the wellbeing of current and future generations.

Understanding the hidden costs could bring to light the breadth of our sustainability challenges and inform policymakers about what changes are needed to transform how food travels from farm to table. FAO carried out a preliminary assessment using a true cost accounting approach and has used it to estimate these hidden environmental, social and health costs globally, and specifically for 154 countries worldwide including Ireland (FAO, 2023). The hidden environmental costs accounted for by the FAO included the impacts of nitrogen emissions to waters and ammonia emissions to air, the contribution of greenhouse gas emissions to climate change, and the costs of land use change and water use. The hidden social costs were associated with poverty and undernourishment, which can be significant in low-income countries but are usually less so in upper-middle and high-income countries such as Ireland. The hidden health costs came from unhealthy dietary patterns leading to obesity and non-communicable diseases and productivity losses, which negatively impact the economy.

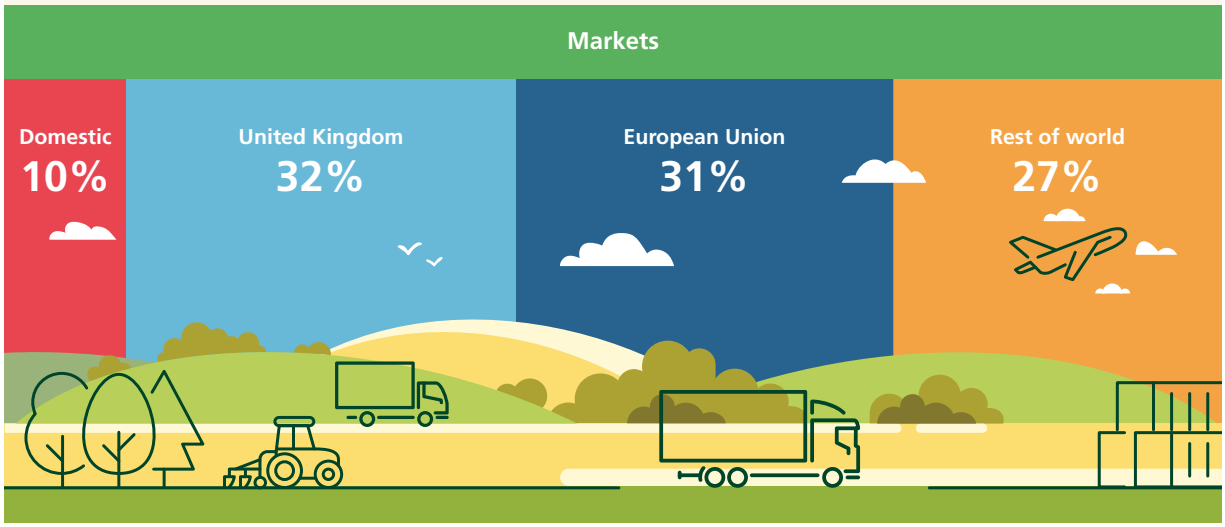
Globally, the report highlighted that hidden costs from agri-food systems reached US$12.7 trillion in 2020, which is equivalent to 10% of global gross domestic product (GDP). Even after taking uncertainty into account, the hidden costs were estimated to exceed US$10 trillion with a 95% probability. The hidden costs in Ireland's agri-food system were estimated at US$23 billion per year, or approximately 5% of GDP, just over half of which was attributed to the environmental costs, with the majority of the remainder associated with health costs. The report notes, however, that this was a phase 1 preliminary modelling exercise, using readily available data that did not include many other hidden costs and benefits and incorporated a high level of uncertainty (FAO, 2023). More detailed phase 2 analyses carried out at the national scale could take into account the specifics of each country. It was nevertheless a useful exercise to raise awareness of the magnitude of the challenges.

Addressing hidden environmental and health costs need not necessarily result in higher food prices according to FAO. For certain highly processed foods or foods with substantial environmental hidden costs, prices may indeed go up. However, prices of nutritious and whole foods without substantial processing are likely to become more competitive, and thus may be favoured by consumers. Such foods are also likely to contribute to a reduction in hidden health costs. Better policies and investment in more sustainable agri-food systems can reduce hidden costs by addressing their root causes.

Some 90% of the food produced by Ireland's farmers, fishers and agri-food companies is exported to over 180 countries worldwide, divided almost equally among the UK, EU and international markets (Figure 10.1). In 2022, agri-food exports were worth €16.7 billion (€18.8 billion including non-edible items), an increase of €3 billion (22%) on 2021 (Bord Bia, 2023). The food and drink sector accounted for 38% of all exports from Irish-owned firms in 2020. The agri-food sector sustains 170,400 jobs (7% of total employment). Beyond direct employment, the estimated output multipliers are around 2.5 for beef production and 2.0 for dairy production and food processing, demonstrating the importance of the sector in the wider rural and local economy (DAFM, 2022a).

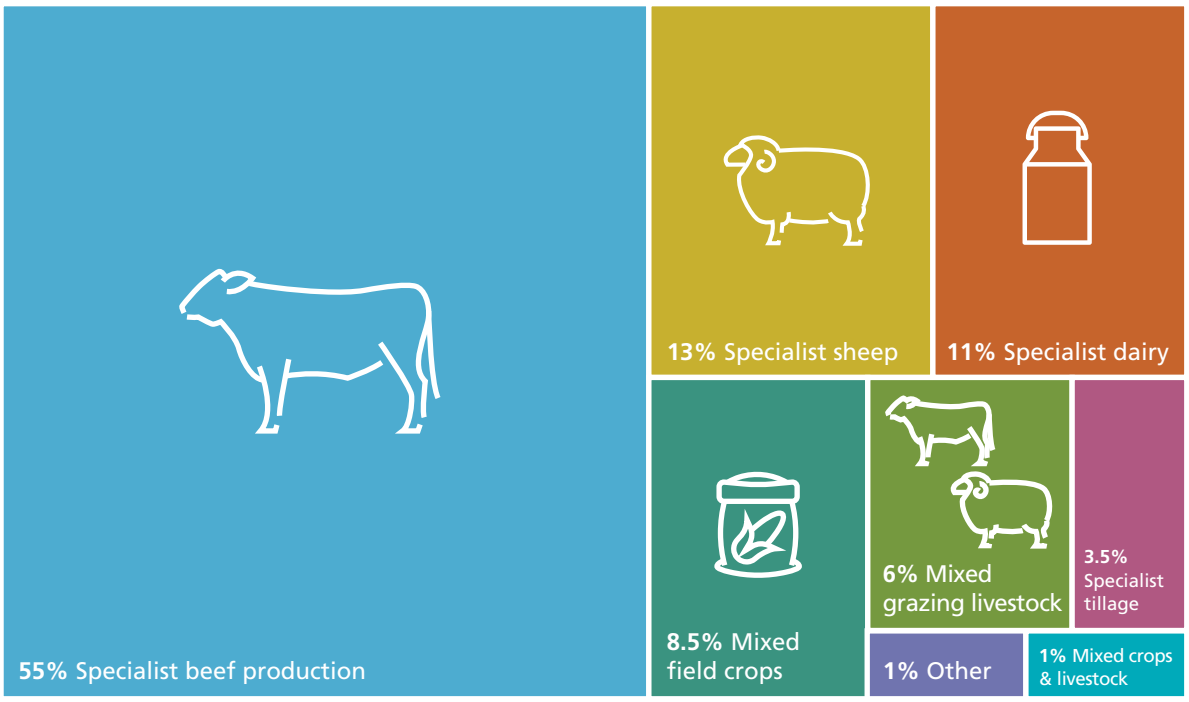
The latest agricultural census data for 2020 (CSO, 2021) show that there are 135,000 farms in Ireland, encompassing 4.5 million hectares (ha) of agricultural area, the vast majority of which is grassland (4.15 million ha). Just over half the farms are classified as specialist beef (55%), while specialist dairy accounts for 11% of farms, specialist sheep 13% and specialist tillage a little under 4% (Figure 10.2), with the remainder being mixed farming. The average farm size nationally is 33 ha (about 80 acres), although farms in the south-east of the country are larger (44 ha). Dairy farms are the largest of all farm types (with an average size of 65 ha).

Figure 10.1 Proportion of Irish food produced for the domestic and export markets, 2022



Source: Adapted from DAFM, 2022a

Figure 10.2 Farms classified by farm system type, 2020

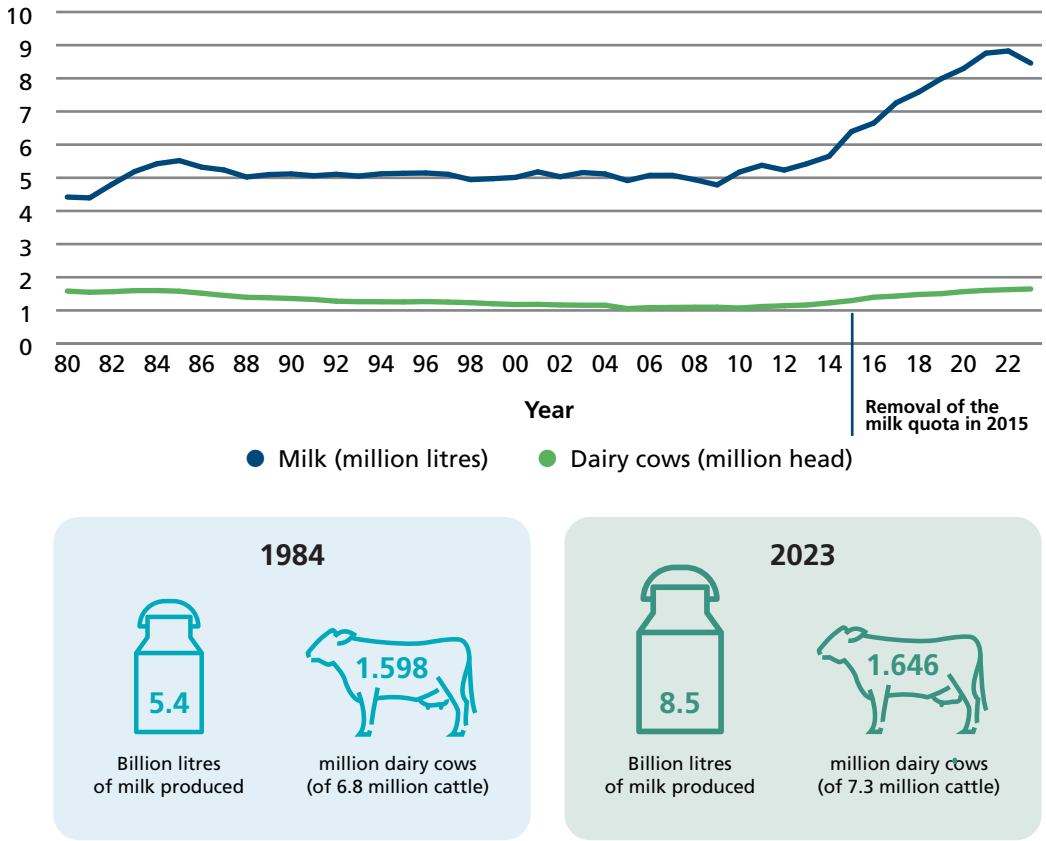


Source: Adapted from CSO, 2021

There were 7.3 million cattle in Ireland in 2023, of which 1.6 million were dairy cows. In the 10 years from 2013 to 2023, dairy cow numbers increased by 41% with a corresponding increase in milk production of 56%. This reflects the removal of the milk quota in 2015 and the national ambition to expand milk production under Food Harvest 2020 and Food Wise 2025, following 30 years of the industry being constrained at 1984 production levels.

While the number of dairy cows in 1998 (1.598 million) was similar to that in 2014, the output per cow in 2014 was 48% more than it was in 1984 (CSO, 2021). Figure 10.3 compares dairy cow numbers and milk production in 1984 and 2023. Between 1984 and 2014, the output per hectare increased by 54% to 10,500 litres (Donnellan *et al.*, 2015).

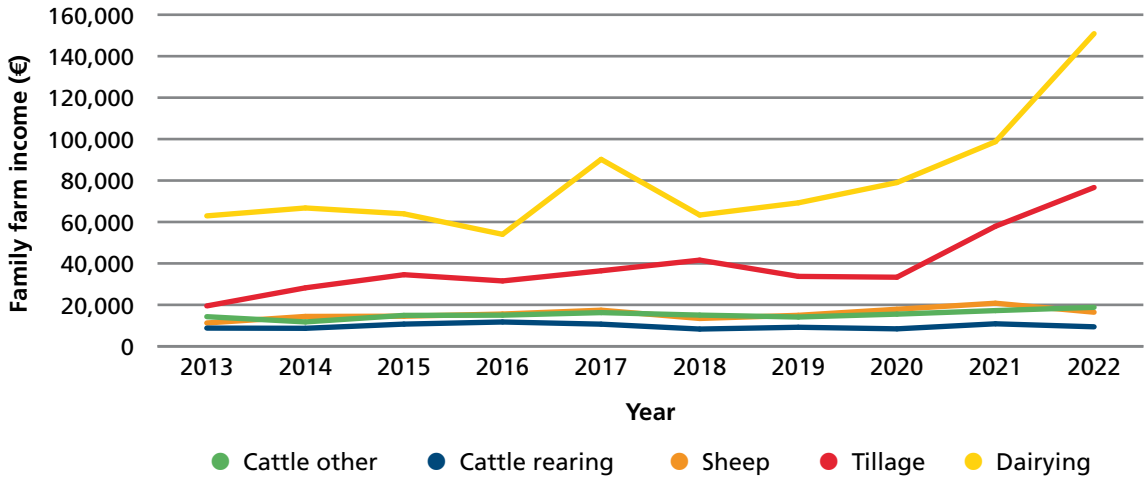
Figure 10.3 Dairy cow numbers and milk production, 1984-2023



Source: Adapted from CSO, 2021

The National Farm Survey, which is carried out annually by Teagasc, provides an overview of the economics of farming at the farm scale. Family farm incomes vary considerably by farm system. Dairy and tillage systems are the most profitable and are financially viable, with increasing trends in income in recent years (Figure 10.4); however, they represent only 11% and 4%, respectively, of Irish farms. In stark contrast, however, incomes on beef cattle and sheep farms, which are the dominant farming systems in Ireland, remain low and relatively unchanged. Small increases in output value are being offset by rising input costs. Direct payments and other payment supports from agri-environmental and other schemes continue to play a critically important role in supporting family farm incomes, in particular on cattle rearing and sheep farms (Teagasc, 2023b).

Figure 10.4 Trends in annual family farm income by farm system, 2012–2022



Note: Preliminary estimates indicate significant reductions in family farm incomes in 2023 on dairy and tillage farms, back to an annual average of €59,000 and €30,000, respectively (Buckley *et al*., 2023).

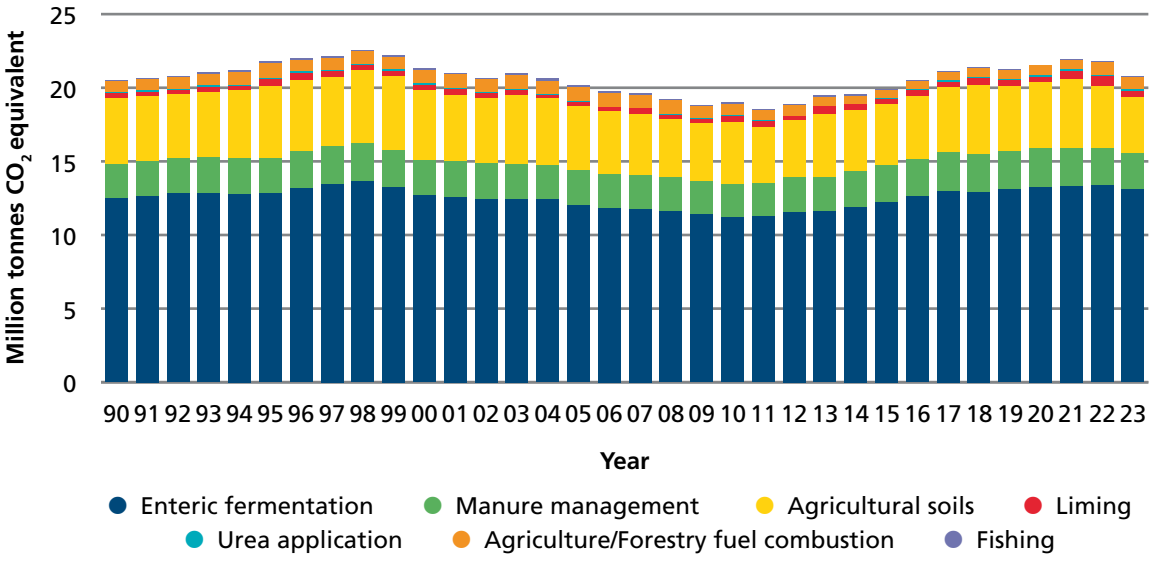
Source: Teagasc, 2023a

2. The impacts of agriculture on the environment

Greenhouse gas emissions

The agriculture sector accounted for 38% of Ireland's national greenhouse gas emissions in 2023 (EPA, 2024a). Trends are largely determined by the size of the national cattle herd and the application rates of nitrogen fertilisers and have been increasing over the last decade as the sector has grown (Figure 10.5). While dairy cattle numbers increased by 2.2% annually on average over the period 2018–2023, the increases have been partially offset by the numbers in other cattle categories that have decreased by 0.6% annually on average over the same period. From 2018 to 2023, an annual average decrease of 3.9% in fertiliser sales was achieved which is positive, however, these lower levels of fertiliser nitrogen use must be maintained.

Figure 10.5 Greenhouse gas emissions from agriculture, 1990–2023



Source: EPA, 2024a

Over the last three decades, emissions were at their lowest in 2011 at 18.5 Mt CO_2 eq (megatonnes of carbon dioxide equivalent), associated with a decrease in the national cattle herd to 6.43 million animals and a decrease in nitrogen fertiliser application to just under 300,000 tonnes. Over the following decade to 2021, emissions increased with the removal of milk quotas and the growth in the sector under Food Harvest 2020 and Food Wise 2025, but since then total emissions have started to decrease. In 2023, the national cattle herd comprised 7.25 million animals, and under 281,000 tonnes of nitrogen fertiliser were applied; in 2023 the national greenhouse gas emissions from the sector were 20.8 Mt CO_2 eq.

Emissions from agriculture include carbon dioxide, nitrous oxide and methane. Of these, methane is the most potent at trapping heat in the atmosphere, and it is the most prevalent in Ireland due to the scale of our livestock sector (Table 10.1).

Table 10.1 Emissions from agriculture and changes over time

Greenhouse gas	Agricultural activity	Contribution to agricultural emissions in 2023 and trend since 1990
Carbon dioxide	Emissions from liming, the application of urea fertiliser and fuel combustion	6.6% of agricultural emissions Increase of 14.3%
Nitrous oxide	Emissions from manure management and agricultural soils	21.3% of agricultural emissions Decrease of 11.9%
Methane	Emissions from enteric fermentation and manure management	72.1% of agricultural emissions Increase of 4.8%

Source: EPA, 2024a

Under the national Climate Action Plan 2024 (DECC, 2023), the agriculture sector must achieve a 25% reduction in greenhouse gas emissions by 2030. The total emissions from the sector are projected to decrease by between 1% and 18% over the period 2022–2030, depending on the measures that are implemented. Savings are projected from a variety of measures, including limiting usage and switching to different chemical fertilisers, methane reduction measures, and water table management (EPA, 2024b). Significant reductions in chemical nitrogen fertiliser use have already been achieved, from 408,000 tonnes in 2018 to less than 281,000 tonnes in 2023. However, it is projected as part of the modelling carried out to support the Teagasc MACC 2023 that, under the current policy framework, dairy cow numbers are likely to increase between 2022 and 2030 (Lanigan *et al.*, 2023), which will add additional emissions. These will be offset to some degree by further projected declines in beef cow numbers and an overall slight decline in the national herd.

The latest EPA projections suggest that, based on best available knowledge, there is scope to reduce emissions by 18% by 2030 (compared with 2018), through the full implementation of the measures set out in the Climate Action Plan 2024 and the Ag Climatise roadmap[1] produced by the Department of Agriculture, Food and the Marine (DAFM). This means the sector is not on track to meet the 25% emission reduction target by 2030. Further measures still need to be identified and implemented to achieve this goal. Diversification measures are included in the Teagasc MACC 2023, which could save a further 1.5 Mt CO_2 eq by 2030 according to Teagasc; however, policy levers need to be put in place so that the savings proposed can be realised and maintained.

1 www.gov.ie/en/publication/07fbe-ag-climatise-a-roadmap-towards-climate-neutrality/ (accessed 2 September 2024)

The agriculture sector is also a significant contributor to emissions attributed to the Land Use, Land Use Change and Forestry (LULUCF) sector. The LULUCF sector is a net source of emissions in Ireland, in contrast to many EU Member States, where the LULUCF sector is a net remover of CO_2 from the atmosphere. This is as a result of the drainage of grasslands on organic/peaty soils and the exploitation of peat for energy and horticultural uses. Approximately 8% of the Irish grassland area is underlain by organic/peaty soils and is therefore a source of greenhouse gas emissions. Recent research by Teagasc (Tuohy *et al*., 2023) suggests that not all of these grassland soils are effectively drained in practice, which has led to a revision of emission estimates in the most recent national emission inventory estimates. Further research being conducted by the National Agricultural Soil Carbon Observatory[2] will lead to further refinements to emission estimates in future agriculture sector emission inventories. Land and soil are discussed in more detail in Chapters 5 and 6.

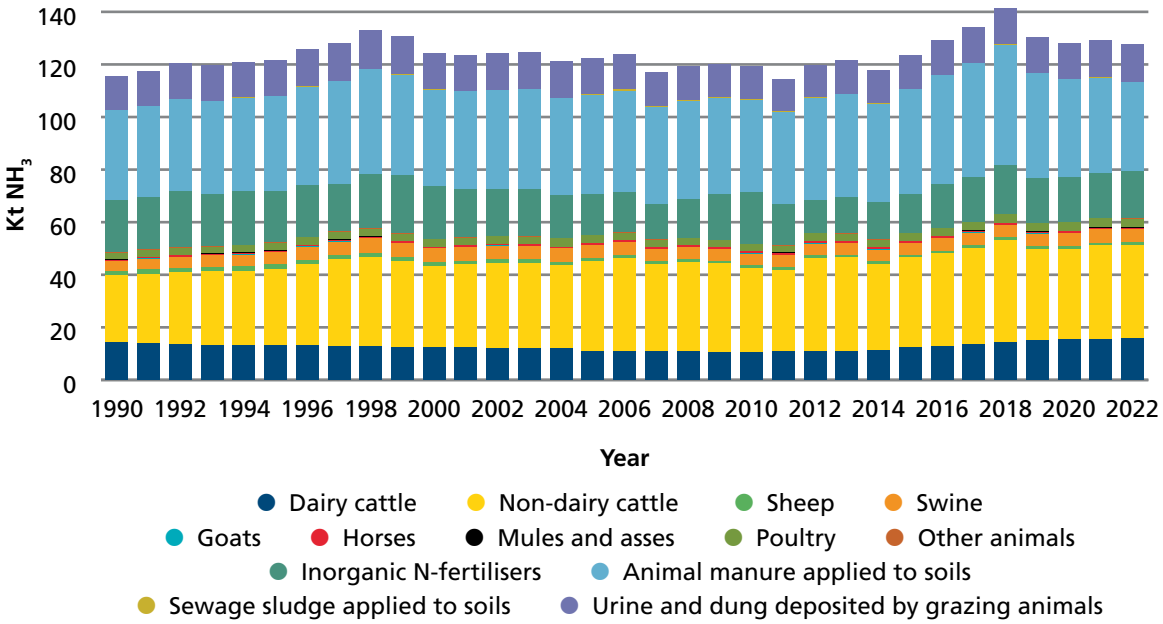
The LULUCF Regulation ((EU) 2018/841) was revised in 2023 and has set land-based net carbon removal targets for the EU that must be implemented via national reduction targets.

Meanwhile, meeting Ireland's 2050 climate neutrality ambition will necessitate the land sector becoming a strong net remover of CO_2 from the atmosphere (Haughey *et al*., 2023). The implied land transformation and farm diversification, including substantial afforestation within Ireland's grassland-dominated landscape, water table management and restoration of peat soils, will require consistent and sustained action through time, guided by a strategic vision for the agriculture and land use sector.

Ammonia and other air pollutants

The agriculture sector is the largest source of ammonia in Ireland (Figure 10.6), accounting for 99% of the national total in 2022 (EPA, 2024c). Total national emissions in 2022 were 128.6 kilo tonnes[3], which is above the current national emission reduction commitment. The trends in ammonia emissions are similar to those of other gaseous emissions from the sector, as they are largely determined by the size of the national cattle herd and the amounts and type of nitrogen fertiliser applied.

Figure 10.6 Trends in ammonia emissions from agriculture, 1990–2022



Source: EPA, 2024c

2 www.teagasc.ie/environment/climate-change--air-quality/soil-carbon/national-agricultural-soil-carbon-observatory (accessed 2 September 2024).

3 One kilo tonne (kt) is 1,000 tonnes.

Ireland's national emission reduction commitment for ammonia for 2020-2029 under the National Emission Reduction Commitments (NEC) Directive (EU 2016/2284) was a 1% reduction compared with a 2005 baseline level. As emissions in 2020, 2021 and 2022 were 3.2%, 4.2% and 3.0% higher, respectively, than the baseline level, Ireland is non-compliant with the emission reduction commitment for 2020-2029. Ireland has not met international emissions commitments for the majority of years over the last decade. In 2023, the European Commission consequently served Ireland with an infringement notice for non-compliance with the directive.[4] Projections of ammonia emissions suggest that achieving the 2030 emission reduction commitment is possible if all measures are adopted, which will require significant policy levers (EPA 2024d). These measures include reductions in chemical fertiliser use, increased use of protected urea, and increased use of low-emission slurry systems.

Agriculture is also a source of a number of other transboundary air pollutants, including nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs) and particulate matter, which have local, regional and transboundary effects. While the contribution of agriculture is smaller than other sources, for example power generation, transport and residential fuel combustion, the sector nevertheless has a role to play in reducing these pollutants.

NO_x and NMVOCs are associated with synthetic fertiliser application, urine and dung deposited by grazing animals, and the application of manures to soils. Agriculture is the second largest source of NO_x emissions in Ireland (after transport), contributing 36.4% of the total in 2022, and the largest source of NMVOC emissions, accounting for 39.1% of the national total in 2022. There are national emission reduction targets in place for each of these pollutants. Ireland was compliant with the 2020 emission reduction commitment for NO_x and, after adjustment with flexibility mechanisms, for NMVOCs (EPA, 2024d).

Grazing in the Burren.

4 ec.europa.eu/commission/presscorner/detail/EN/inf_23_142 (accessed 31 May 2024).

The agriculture sector's contributions to emissions of particulate matter arise from manure management, fertiliser application to soils, and both on-farm and off-farm handling and transport of bulk agricultural products. Agriculture contributes 8.6% of total suspended particulate emissions, which includes 7.9% of total national emissions of fine particulate matter <2.5 µm in diameter ($PM_{2.5}$). National emission reduction targets are in place for $PM_{2.5}$ for 2020 and 2030 under the National Emission Reduction Commitments (NEC) Directive. Ireland currently projects compliance with the targets if the adoption of all measures is achieved. Air pollution is further discussed in Chapter 2.

Biodiversity

Biodiversity in the food system provides critical ecosystem services such as creating and maintaining healthy soils, pollinating plants, controlling pests and providing habitat for wildlife, plants, fish and domesticated species that are vital to food production and sustaining agricultural livelihoods. Biodiversity makes food production systems more resilient to external shocks and stresses, such as droughts, flooding and temperature extremes, which will all become more frequent with climate change. Diverse production systems, for example using multi-species swards and different crop and animal species and breeds, and integrating the use of crop, livestock, forestry and aquatic biodiversity in landscape systems, help to promote resilience, improve livelihoods and support nutritious, secure food production (FAO, 2019). A large part of our landscape and our biodiversity has been shaped over millennia by agricultural activities, and agricultural practices play an important role in managing and protecting them. For further discussion on nature and biodiversity, see Chapter 7.

The pressures on biodiversity from farming include land use change such as land drainage and reclamation of wetland and key habitats, such as species-rich and semi-natural grasslands, and other habitats such as scrub; air and water pollution; overuse of external inputs such as fertilisers and chemicals; and intensification of farming systems that lead to a loss of biodiversity. Ireland's most recent formal report on the condition of our protected habitats and species outlined that 85% of our protected habitats were at unfavourable conservation status (NPWS, 2019), almost half of which show ongoing declines, including marine, peatland, grassland and woodland habitats. When it comes to protected species, 57% were deemed to be currently at favourable conservation status, with 72% stable or improving. Of our bird species, 63% were found to be declining, particularly breeding waders and upland and farmland birds (Gilbert *et al.*, 2021).

Three key biodiversity indicators associated with agriculture in Ireland illustrate the challenges (NBDC, 2023):

1. One in every three bee species is threatened with extinction.
2. Thirty-seven species of bird are of high conservation concern, including species such as curlew, hen harrier, twite and yellowhammer. There has been a 59% decline in the hen harrier population since 2000, with just 85 breeding pairs recorded in the most recent national survey (Ruddock *et al.*, 2024), and a 98% decline in the curlew population since the 1980s, with 104 breeding pairs recorded in the most recent national breeding survey (Colhoun *et al.*, 2022). The corn bunting became extinct around 2000, and the once widespread corncrake is largely restricted to the western extremities of counties Donegal and Mayo.
3. Two of our iconic freshwater fish, the Atlantic salmon and the European eel, have suffered catastrophic population declines, and the freshwater pearl mussel, Ireland's longest-living animal, is facing extinction.

A yellowhammer, one of 37 bird species of high conservation concern

In 2023, the Court of Justice of the European Union ruled that Ireland has failed to fulfil its obligations under EU biodiversity conservation laws (CJEU, 2023). While the case was based on the situation in Ireland in January 2019 and progress has been made since then, with, for example, the renewal of the National Parks and Wildlife Service, the ruling highlighted that there is significant work to do to improve biodiversity outcomes.

A prioritised action framework for the period 2021–2027 has been published (NPWS, 2021), which sets out and prioritises the measures that are needed, with links to funding mechanisms, to 'maintain and restore, at a favourable conservation status, natural habitats and species of EU importance, while taking account of economic, social and cultural requirements and regional

and local characteristics'. The total cost of the measures that are required is estimated to be €1.14 billion over the period 2021–2027 (NPWS, 2021).

In 2023, the Citizens' Assembly on Biodiversity Loss (see Chapter 7) agreed on 159 recommendations centred on the need to 'take prompt, decisive, and urgent action to address biodiversity loss and restoration and to provide leadership in protecting Ireland's biodiversity for future generations' (Citizens' Assembly, 2023). In relation to agriculture, the group agreed 17 specific recommendations, recognising that biodiversity is currently undervalued in our agriculture production system and policy framework and that, as the custodian of the land, the agriculture industry can make the most impact on conserving and restoring biodiversity. The agriculture recommendations focused on key themes such as the need for improved, more ambitious, joined-up policies that are grounded in a community-led, results-based ethos; greater emphasis on managing soil health, growing the organic sector and farming more in tune with nature; and the need for education, awareness and deeper engagement with consumers.

Water quality

Slightly over half (54%) of Ireland's surface waters have the good or better ecological status that is needed to support healthy aquatic ecosystems. Under the Water Framework Directive (2000/60/EC), all Member States are expected to have achieved at least good ecological status to support healthy waters in all water bodies by 2027 at the latest. Agriculture is the most widespread pressure causing the impacts – the latest assessment to 2021 found that just over 1000 water bodies were affected by agricultural activities, representing little change since the previous assessment.

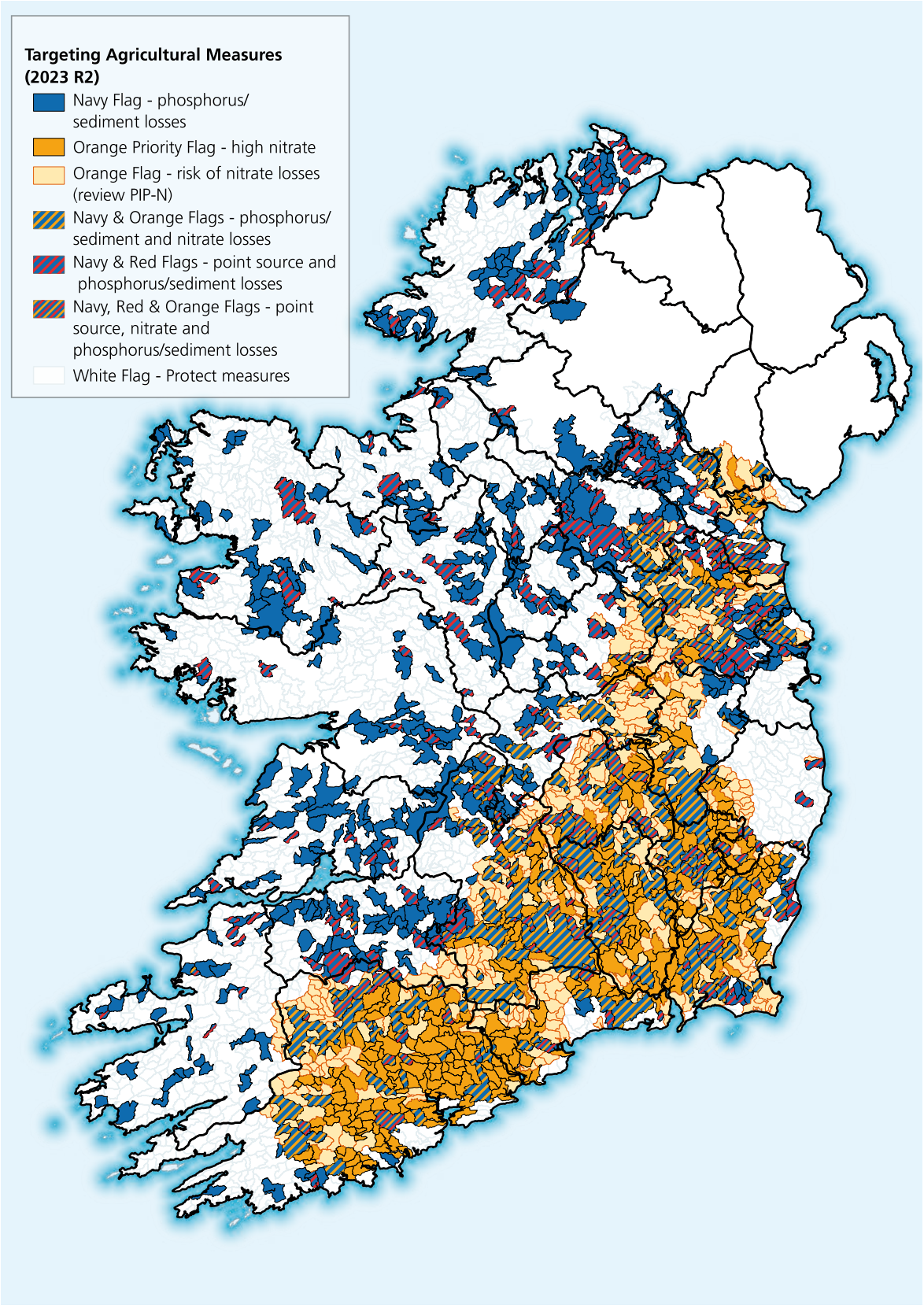
The key water quality issue arising from farming is the loss of excess nutrients (nitrogen and phosphorus) from artificial and organic fertilisers to waters. This leads to eutrophication or the excess growth of plants and algae, especially in our estuaries. Nitrate concentrations are too high to protect aquatic ecosystem health in 42% of river sites and in 17% of estuarine and coastal water bodies nationally, particularly in a number of key catchments of concern in the south and south-east (EPA, 2024e). The ecologies of estuaries and coastal waters are particularly sensitive to nitrogen, and the scale of the declines in the quality of these waters since the early 2010s, when nitrogen concentrations were at their lowest in the last three decades, is a significant concern.

Elevated nitrogen concentrations in drinking water can also cause a public health issue, although the nitrate standard to protect drinking water quality is less stringent than it is for protecting aquatic ecosystem health. In 2023, 12 public water supplies had exceedances of the nitrate standards (EPA, 2024f).

The main source of nitrogen in our waters is leaching from mineral and organic fertilisers and manures from agricultural activities. Substantial reductions in nitrate leaching will be required in some catchments in the south-east to bring nitrogen concentrations back to where they need to be to support healthy aquatic ecosystems (EPA, 2021). The key types of measures involve reducing the nitrogen surplus, i.e. excess nitrogen lost to the environment, either by increasing the efficiency of nitrogen use so that less is available to leach and/or by reducing the overall nitrogen loading on farm. Measures need to be targeted in the freely draining soils in the catchment areas of water bodies where nitrogen is a pollutant of concern. The EPA has produced a national map to help target agricultural measures to protect and restore water quality (Figure 10.7). The EPA has also developed nitrogen pollution impact potential maps[5], which are freely available and are being used by the Local Authority Waters Programme (LAWPRO) and the Agricultural Sustainability Support and Advice Programme (ASSAP) to identify the critical source areas, or hotspots, for targeting measures locally within key areas.

5 www.catchments.ie/next-generation-pollution-impact-potential-maps-launched/ (accessed 31 May 2024).

Figure 10.7 Targeting agricultural measures to protect and restore water quality



Glencar Waterfall, Co. Leitrim

Phosphorus concentrations are too high in 28% of rivers and 36% of lakes, which in turn have an impact on the ecological health of our freshwaters. Phosphorus levels and the biological quality of our rivers and lakes have generally been stable in recent years; water quality is improving in places, but this is being offset by declines elsewhere. The sources of phosphorus on farm include mineral and organic fertilisers and manures, which run off when it rains, often in association with excess fine sediment. The key measures are eliminating the point source losses from farmyards and intercepting diffuse run-off pathways from fields that deliver the pollutants to waters. The EPA has produced phosphorus pollution impact potential maps[6] that show where the risky areas are for phosphorus losses from agriculture; these are currently being used to target measures.

The agriculture sector also has an important role to play in keeping the physical condition of aquatic habitats in the beds and banks of water bodies stable and healthy. Excess fine sediment arising from run-off, bank erosion and in-stream channel maintenance can reduce the light availability and create poor habitat conditions for some species, as well as causing difficulties for drinking water treatment processes. Physical habitat conditions are also altered with drainage, channel and vegetation maintenance. Good management practice includes keeping bankside or riparian vegetation and stream channels intact to provide shade, food sources and habitat diversity. The Farming for Nature initiative has published a best practice guideline for watercourse management[7] for farmers, and an increasing number of projects and results-based payment schemes are now supporting farmers to implement best practice.

The careful management of chemicals, including herbicides, pesticides and veterinary medicines (e.g. sheep dip), is also critical. They are toxic to aquatic life, and a tiny amount can affect drinking water quality. Teagasc has produced guidance on pesticide use for farmers,[8] which highlights that a single drop of pesticide lost to a typical small stream can be enough to breach the legal limit for pesticides in drinking water along 30 km of its length. The number of public water supplies with pesticides detected increased from 17 in 2022 to 23 in 2023. Further work is needed to engage with pesticide users in water catchments to ensure that these substances are used safely and in accordance with the manufacturers' recommendations. The herbicide MCPA (2-methyl-4-chlorophenoxyacetic acid), which is often used to control rushes, ragwort and thistles, continues to cause the biggest problems (EPA, 2024f). The new Drinking Water Regulations,[9] which came into effect in Ireland in 2023, include a requirement to conduct risk assessments and implement measures in these water catchments to protect drinking water quality at source, before it reaches the abstraction point. Innovative schemes such as the 'Let it Bee'[10] campaign by the National Federation of Group Water Schemes is helping to raise awareness in drinking water catchment areas.

6 www.catchments.ie/next-generation-pollution-impact-potential-maps-launched/ (accessed 31 May 2024).

7 www.farmingfornature.ie/your-farm/resources/best-practice-guides/watercourse-management/ (accessed 31 May 2024).

8 www.teagasc.ie/media/website/crops/crops/2015_08_FarmersProfessionalUsers_LowResWeb.pdf (accessed 31 May 2024).

9 S.I. No. 99/2023.

10 nfgws.ie/let-it-bee-project/ (accessed 31 May 2024).

3. Key strategies, plans and programmes

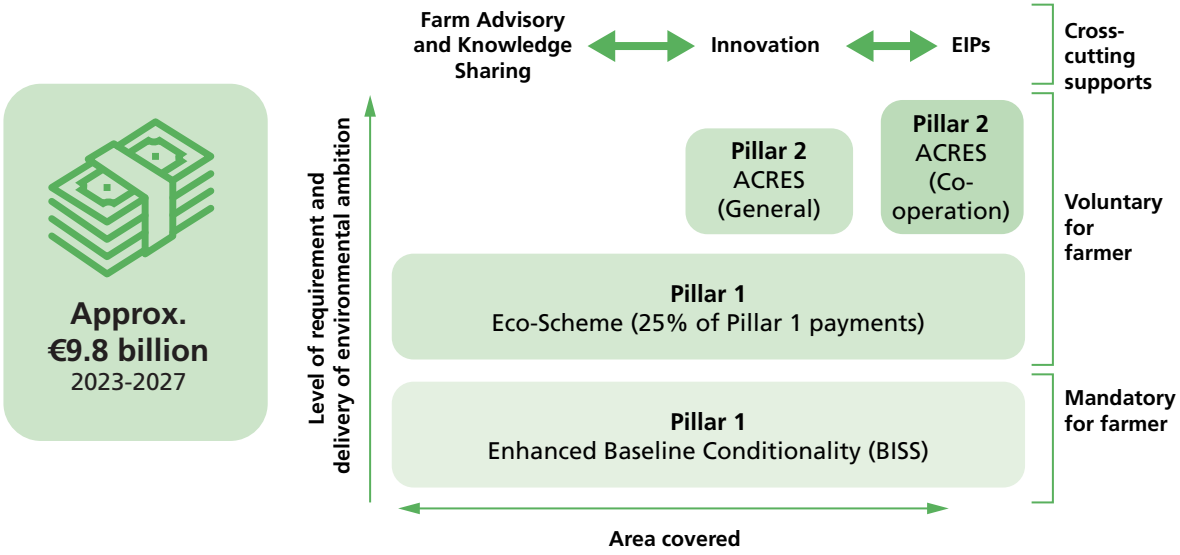
The European Green Deal

The European Green Deal is a set of policy initiatives by the European Commission that aims to make the EU climate neutral by 2050. It has had a significant influence on recent policies underpinning the agri-food sector in Europe and in Ireland, including the CAP, and various other strategies and policies designed to improve environmental outcomes.

The most significant of these initiatives for agriculture is the Farm to Fork Strategy (EC, 2020), which has been in place since 2020 and aims to reduce the environmental and climate impact of primary production while ensuring fair economic returns for farmers. Several other plans and strategies that are in place, in development or under consideration, such as the Zero Pollution Action Plan, the EU Biodiversity Strategy for 2030, the EU Nature Restoration Law, the EU Soil Health Strategy for 2030 and the Integrated Nutrient Management Action Plan, are related plans that share the underlying objective of achieving improved environmental conditions across Europe. Three of the key objectives across these international plans and strategies, which have followed through into Irish plans and strategies, are to reduce both nutrient and chemical pollution from agricultural practices and to increase biodiversity on farms.

Many of these plans and strategies will be very challenging to implement, and there are significant concerns across the EU agriculture sector about how they will impact farming. Some ambitious proposed plans and policies, for example the plan to reduce the use of chemical pesticides in the EU by 50% by 2030 and the Nature Restoration Law, have faced significant pushback and/or amendments at the final approval stages. It is important that farmers are properly supported in adjusting to these challenges and that there is a just transition to a healthy EU environment in the long term.

Figure 10.8 The green architecture of the Common Agricultural Policy 2022–2027 as applied in Ireland



EIP, European Innovation Partnership

Source: James Moran, Atlantic Technical University, 2024

The Common Agricultural Policy

The CAP is a system of subsidies and support programmes for agriculture funded from EU and national budgets. It was originally developed in 1962 as a partnership between agriculture and society, and between what was then European Economic Community and its Member States' farmers. The main aims of the policy at that time were primarily to support farmers financially to deliver security of food supply for European citizens. Since 1992, the CAP has increased the focus on the use of these public funds to deliver environmental outcomes as well as food security. Current subsidies are conditional on achieving good agricultural and environmental conditions on a farm – three of the conditions explicitly relate to climate, biodiversity and general environmental policy objectives.

Ireland's current CAP Strategic Plan 2023–2027 (DAFM, 2022b) includes the provision to support environmental protection and climate change action through the new green architecture (or structure of the funding support streams), with an emphasis on payments for results and performance (Figure 10.8). The total CAP budget allocation is €9.8 billion over 5 years, which includes significant national funding support of €2.3 billion to support rural development measures, including agri-environmental measures. The plan aims to achieve a higher level of climate and environment ambition through the new Agri-Climate Rural Environment Scheme (ACRES), a new eco-scheme, and significant growth in the organic farming sector. Measures to support the development of the arable sector, to protect wetlands and peatlands, and to further develop the Agricultural Knowledge and Innovation System will also be implemented.

While the new green architecture of the CAP offers significant opportunities to raise the overall environmental performance of the agriculture sector, it is essential that measures introduced under the new CAP can show quantifiable and verifiable environmental gains. Agri-environmental measures need to be adapted and adequately targeted to a range of farm intensities and physical settings across the country to ensure their attractiveness and effectiveness for achieving the required outcomes. However, the new CAP alone will not provide all of the solutions to the growing pressures from agriculture on water, climate, air pollution and biodiversity. A whole-of-sector approach is required in which the whole industry (from livestock and land management to the food industry, agricultural education and government) is closely involved in establishing effective and accountable programmes and initiatives that will deliver on environmental targets and sustainability but also underpin on-farm efficiencies and market access. This challenge cannot be underestimated and will need collaboration right across the industry.

Food Vision 2030

In 2021, DAFM published a new 10-year strategy for the agri-food industry called Food Vision 2030 (DAFM, 2021a). The strategy aims to adopt an integrated food systems approach to establish Ireland as a world leader in sustainable food systems by 2030. The four pillars of the strategy consider climate, resilience, food safety and innovation (Figure 10.9). The strategy has the objective of achieving a climate-neutral food system by 2050, with verifiable progress achieved by 2030, encompassing emissions, biodiversity and water quality, as well as a range of other targets for forestry, fisheries, organic farming and food waste.

The monitoring and implementation process of Food Vision 2030 is key to ensuring delivery of the strategy and is a key part of implementing measures to improve water quality, greenhouse gas emissions, ammonia emissions and biodiversity. Tracking and frequent reporting on progress will be critical for building confidence and for enabling adaptive management approaches should adequate progress not be made.

Figure 10.9 Food Vision 2030: Four missions

Source: DAFM, 2021a

The National Biodiversity Action Plan

The fourth National Biodiversity Action Plan was published in 2024 and is a whole-of-government, whole-of-society plan to conserve and restore biodiversity. The plan recognises that, through the ecosystem services it provides, biodiversity underpins the sustainability and productivity of the agricultural, forestry and fisheries sectors, as well as the many businesses and industries that depend on the natural environment or on natural raw materials. The plan includes a number of targets relevant to agriculture, with associated actions to deliver the outcomes, and indicators for monitoring progress. Some examples of the relevant actions and their targets include:

- Incentivising habitat creation and maintenance on farm through the CAP Strategic Plan 2022–2027 and the associated rural development plan. Relevant schemes include the results-based payment agri-environmental scheme (ACRES) and associated farm sustainability plans; Farming for Nature initiatives; and initiatives in Northern Ireland through the Shared Island Fund. The targets include optimising opportunities under agriculture and rural development, forestry and other relevant policies to benefit biodiversity by 2027 and having at least 4% of agricultural land with biodiversity-rich landscape features by 2030.
- Supporting farmers' transition to organic farming, with the aim of increasing the land area under organic farming to 10% by 2030.
- Implementing existing and new measures to reduce chemical pesticide use, with the aim of reducing the use and risk of pesticides by 50% by 2030.
- Having multiple institutions working together to develop measures and support tools to maintain and enhance biodiversity and the ecosystem services associated with agro-ecology systems, including high nature value farming and farmland, by 2027.

Water Action Plan 2024

Ireland's Water Action Plan 2024, which was developed and updated in accordance with the criteria set out in the Water Framework Directive, draws together the programme of measures for agriculture and all the other sectors that are having an impact on water quality. In summary, the key measures for agriculture are:

- implementing the Nitrates Action Programme
- developing and implementing an enhanced local authority agricultural inspections programme with oversight from the EPA
- continuing the LAWPRO and ASSAP approaches to addressing specific water quality issues in an increased number of priority areas for action
- providing a new funding mechanism for farmers for on-farm measures to protect and restore water quality (the Farming for Water project)
- implementing the ACRES agri-environmental schemes and the eco-schemes as required under the CAP Strategic Plan
- Teagasc developing an online web-based tool to deliver farm sustainability plans.

It is critical that all these measures are implemented in full. With the significant water quality challenges that remain across a range of pressures, it is very unlikely that the targets for achieving at least good ecological status in all water bodies by 2027 will be met.

The Nitrates Action Programme

The Nitrates Action Programme, incorporating the Good Agricultural Practice for Protection of Waters Regulations (S.I. 113/2022), is the primary instrument in Ireland for managing the impacts of agriculture on water quality. Nationally, the water quality evidence shows that four successive Nitrates Action Programmes have not delivered the desired water quality outcomes. The Teagasc Agricultural Catchments Programme was established in 2009 to assess the effectiveness of the Nitrates Action Programme measures in six demonstration catchments that have intensive monitoring, research and farm advisory programmes in place. With water quality remaining unsatisfactory in four of the six catchments (Mellander *et al.*, 2022), it is clear that there are still gaps that need to be addressed. Measures have been further strengthened in the fifth Nitrates Action Programme for the period 2022–2025 (DHLGH, 2022).

A commitment was made in the fifth Nitrates Action Programme to conduct an interim review of water quality in 2023 and to apply additional measures if specific water quality criteria set out by the Commission (Decision (EU) 2022/696) were not met. The outcome of the assessment was that additional measures are required over much of the country (DAFM, 2023a; EPA, 2023). The additional measures must include a reduction in the maximum allowable loading of organic manure from 250 kg/ha to 220 kg/ha on farms that have a derogation to farm more intensively than advised in the EU Nitrates Directive (91/676/EEC). The derogation reduction has been in place since 1 January 2024 and further measures are under consideration as part of the interim review.

Under the fifth Nitrates Action Programme, the EPA has been given strengthened responsibilities in the oversight of the local authority agriculture inspections regime. A national agricultural inspections programme is being developed and implemented in a phased approach that sets out inspection priorities and expectations with regard to numbers of farms inspected. Inspections will be risk based and targeted and there will be a stronger focus on enforcement and follow-up. A training programme is also being developed.

The Teagasc marginal abatement cost curves

Teagasc has published, and is continuing to update, MACCs, which quantify, using the best available research, the economic costs and the environmental benefits of a range of mitigation measures for ammonia (Buckley *et al.*, 2020) and greenhouse gas (Lanigan *et al.*, 2023) emissions. For ammonia, the key findings are that 80% of the mitigation potential can be achieved by the full implementation of low-emission slurry spreading techniques and by switching to using protected urea. For greenhouse gas emissions, improvements in carbon sequestration through land use management and land use change, changing fertiliser type, improving the genetic breeding of the dairy herd and the use of feed additives are the key actions. Full implementation of these measures will be required to meet the overall targets.

4. Supporting farmers to make changes

There are many projects, schemes and other mechanisms in place that are working to support farmers to make the necessary changes. Many positive actions are being carried out on farm, but it is as yet unclear whether collectively they will be adequate to achieve the level of environmental improvement that is required.

The Agricultural Sustainability Support and Advice Programme (ASSAP)

ASSAP is a free, confidential and voluntary advisory programme established to work with farmers to improve water quality. It was established under the River Basin Management Plan 2018–2021, and it is co-funded by the government and industry. There are currently well over 40 advisers operating under the programme, including 20 from Teagasc and the remainder from Dairy Industry Ireland. The ASSAP advisers work closely with the Local Authority Waters Programme (LAWPRO) catchment science team, which carries out local scientific investigations in priority water bodies where water quality is unsatisfactory. Armed with the evidence of specifically what and where the agricultural water quality issues are from the LAWPRO team, the ASSAP advisers then engage with the relevant farmers to agree farm actions to improve water quality. The LAWPRO team also engages with other relevant bodies where non-agricultural sources of pollution are identified, for example local authorities, the DAFM Forestry Division, Coillte and Uisce Éireann. This approach ensures that an integrated catchment-specific approach is taken to address the issues.

ASSAP reports that the rate of engagement of farmers in the programme is very high, with 96% of farmers approached agreeing to take part. Farmers receive advice on land management, nutrient management and farmyard management, with issues categorised according to their risk of having an impact on water quality. The key issues requiring action are the management of nutrients, especially diffuse losses of phosphorus and sediment in surface run-off, and the management of farmyards, including manure storage and reducing nitrogen leaching. Action plans are drawn up with each farmer to mitigate the issues (Teagasc, 2021a).

The Tirlán Farming for Water: River Slaney Project is building on the ASSAP approach to provide additional support to farmers in the Slaney catchment, which has been identified in EPA water quality reports as a catchment of concern. The project is a collaborative approach in which Tirlán advisers are working with suppliers in key areas to create individual tailored plans to reduce nutrient losses. Farm sustainability payments are also available for undertaking specific actions on farm.

Further work is needed to collect sufficient information on the measures that have been implemented to provide direct evidence linking farmers' actions to water quality outcomes to demonstrate the effectiveness of these programmes.

Agri-environmental schemes

The flagship agri-environmental scheme as part of the current CAP Strategic Plan is known as ACRES.[11] The scheme came into effect in 2023 and replaced the previous scheme known as the Green, Low carbon, Agri-environmental Scheme or GLAS. The ACRES scheme is backed by €1.5 billion of public funding over 5 years and is targeted at improving the delivery of ecological services on farm through two separate streams: ACRES General and ACRES Cooperation. ACRES General is accessible to all farmers and offers a range of actions for individual farmers, both targeted and general. ACRES Cooperation is available to farmers in defined high-priority geographical areas, and involves results-based payments and bespoke farm and landscape actions. ACRES Cooperation farmers are supported by a project team. Both approaches require the preparation of a farm sustainability plan that is completed and submitted by an accredited ACRES farm adviser. A total of 46,000 farmers were approved to participate under the first tranche of ACRES, and a further 9000 farmers in tranche 2, greatly surpassing the original target of 30,000 farmers in total. In addition, there are some other smaller schemes and projects in place that are targeted specifically at improving biodiversity and other environmental assets on farm, for example the National Parks and Wildlife Service Farm Plan Scheme.

11 www.gov.ie/en/service/f5a48-agri-climate-rural-environment-scheme-acres/ (accessed 31 May 2024).

The European Innovation Partnership, LIFE and other locally led environmental projects

The European Innovation Partnership Scheme funds projects that allow farmers, scientists and other experts to collaborate to develop new practices that are environmentally friendly and economically sustainable.[12] The aim of these innovation partnerships is to road-test new ideas and practices that can then be used more widely by farmers and others to improve productivity and enhance resource efficiency. Many of the projects have been designed to be locally led and results based, so that farmers are rewarded for actions undertaken in addition to positive environmental outcomes on their farms. Some key examples include the BRIDE Project[13] in Cork, the SUAS Project[14] in Wicklow, the Mulkear Project[15] in Limerick, and the larger scale Hen Harrier Project[16] and Freshwater Pearl Mussel Project.[17] The findings from these projects have informed the design and implementation of the ACRES agri-environmental scheme, which is a significant advance on earlier agri-environmental schemes that were based on payment for action models. Two new large-scale projects that will provide funding for farmers were also awarded in 2024: the €25 million Breeding Wader European Innovation Partnership[18] project, which aims to secure existing wader populations at key sites and support population recovery via wider landscape management and policy development; and the €60 million Farming for Water[19] European Innovation Partnership project, which will support the LAWPRO and ASSAP teams to ensure that measures to improve water quality are implemented. Ireland has also been awarded significant EU funding under the LIFE Programme for a number of relevant projects that are also results-based payment schemes to support farmers to implement measures to protect the environment. Two of the more significant ones are the Wild Atlantic Nature Project[20] and Waters of LIFE[21] project.

The Teagasc Signpost Programme

In 2021, Teagasc launched the Signpost Programme to point the way towards a climate-smart farming future. The programme is a partnership of over 30 companies and organisations from across the Irish agriculture sector, with the common goal of working with Irish farmers to reduce greenhouse gas emissions, reduce ammonia emissions, reduce nutrient losses, enhance biodiversity, reduce farmers' costs and improve the efficiency of food production (Teagasc, 2021b). At the core of the programme is a network of Signpost farms that are serving as demonstration farms to showcase the latest science-based technologies to reduce emissions, act as a national network of farms for examining carbon sequestration and act as hubs for climate-friendly advisory support (Figure 10.10). Significant resources[22] are now available and the programme is being demonstrated in practice on the Signpost farms to help farmers learn about and embrace climate-friendly best practice.

The Teagasc Signpost Advisory Programme builds on the network of Signpost demonstration farms by providing enhanced advisory and training support to farmers to commit to, select and implement climate and sustainability actions that will be appropriate and impactful on their farms. An online sustainability digital platform, AgNav, has been developed that calculates the greenhouse gas emissions for a farm and allows farmers to see and understand their carbon emissions and sequestration profile as a baseline from which to act.

12 www.gov.ie/en/service/18a855-european-innovation-partnership-scheme/ (accessed 31 May 2024).

13 www.thebrideproject.ie (accessed 31 May 2024).

14 wicklowuplands.ie/suasproject/ (accessed 31 May 2024).

15 www.mulkeareip.com/ (accessed 6 September 2024).

16 www.gov.ie/en/service/82e360-hen-harrier-programme/ (accessed 31 May 2024).

17 www.pearlmusselproject.ie (accessed 31 May 2024).

18 www.gov.ie/en/press-release/3b3b7-hackett-and-noonan-announce-25-million-nationwide-project-on-breeding-waders-under-the-european-innovation-partnership-programme/ (accessed 31 May 2024).

19 www.gov.ie/en/press-release/468aa-ministers-mcconalogue-hackett-and-noonan-launch-60-million-farming-for-water-eip/ (accessed 31 May 2024).

20 www.wildatlanticnature.ie (accessed 31 May 2024).

21 www.watersoflife.ie (accessed 31 May 2024).

22 www.teagasc.ie/environment/climate-change--air-quality/signpost-programme/publications-/ (accessed 31 May 2024).

Figure 10.10 Engagement channels mobilised in the Signpost Programme advisory campaign

Source: Teagasc, 2021b

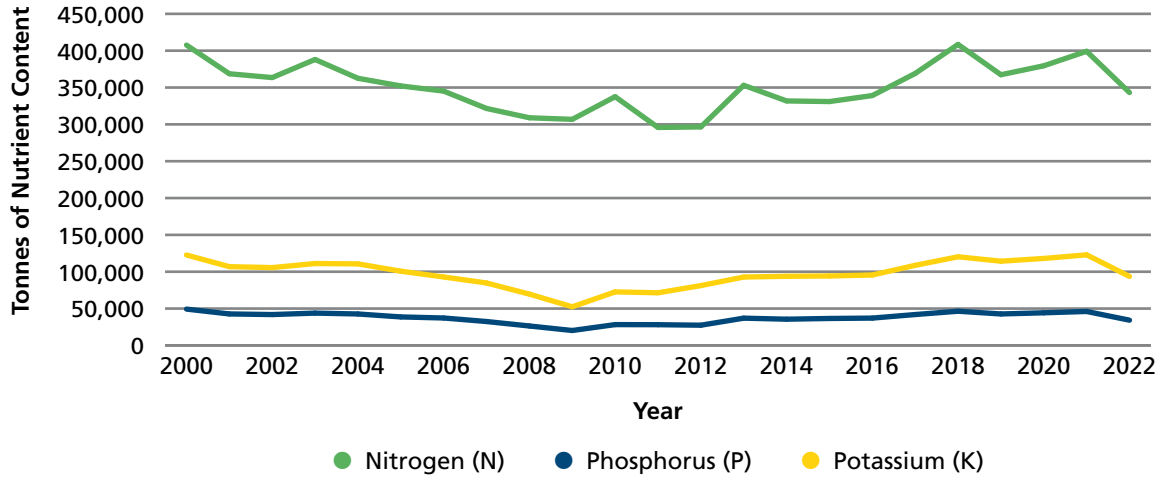
Positive actions being taken on farm

Reducing artificial fertiliser use. Our food systems have grown and developed over the last century with a dependency on the use of artificial fertilisers. At a global level, research has shown that the use of artificial nitrogen and phosphorus has exceeded the limits of the safe operating space of the Earth system's planetary boundaries for humanity and the natural world (Raworth, 2017; Richardson *et al*., 2023; Rockström *et al*., 2023). While nitrogen is relatively readily available, the supply of rock phosphate, which is required to produce phosphorus, is finite (Cordell and White, 2014).

The Farm to Fork strategy (EC, 2020) has set a target to reduce synthetic fertiliser use by at least 20% and to reduce nutrient losses by at least 50% by 2030, while ensuring no deterioration in soil fertility. These nutrient reduction targets have also been embedded in the national Food Vision 2030 strategy. Separately, there is a target in the national Climate Action Plan to cut nitrogen fertiliser use to a maximum of 300,000 tonnes annually by 2030, while the fifth Nitrates Action Programme for 2022–2025 has also set a target to reduce the maximum allowance of chemical fertiliser use by 10%, followed by a possible further 5% pending the interim review.

While it is unclear how these various targets interact, and whether they will achieve the required environmental outcomes, they nevertheless send a clear message that the use of chemical nitrogen in particular needs to be reduced. For Irish farmers operating in a largely grass-based system, reducing the use (and losses) of chemical fertiliser is a key action that can reduce greenhouse gas emissions, achieve air quality targets, and improve water quality and biodiversity. There are also clear economic benefits. However, achieving water quality benefits is dependent on achieving genuine reductions in overall nitrogen surpluses on farm; if chemical nitrogen reductions are simply replaced by increases in nitrogen imports in concentrate feed and/or nitrogen fixation from clover, there will be little change in the overall nitrogen load on farm, and therefore little change in nitrogen losses, unless there are significant improvements in the efficiency of nitrogen use at the same time.

Figure 10.11 Fertiliser sales by nutrient, 2000-2022



Source: CSO, 2023a

The use of synthetic fertiliser nationally has reduced substantially since 2018 (Figure 10.11). In 2022, the nitrogen content of fertilisers sold was 14% lower than in 2021 at just under 345,000 tonnes; phosphorus content fell by 26% to almost 35,000 tonnes (CSO, 2023a). DAFM reported further reductions in chemical nitrogen fertiliser use in 2023 to 281,000 tonnes. The war in Ukraine and the subsequent significant increase in fertiliser prices, plus increased awareness and uptake of the use of nitrogen-fixing clover in grass swards, have been key driving factors in this progress.

At the same time, lime sales increased by 4% to 1.4 million tonnes, the highest it has been during the period 2000–2022 (CSO, 2023a), which reflects a growing awareness of the need to optimise soil pH as part of good nutrient management. Lime application rates fell as low as less than 0.6 million tonnes per annum in the 2000s and early 2010s, which was well below the rates needed. The Teagasc MACC has set a target of 2.5 million tonnes of lime applied per annum to build and maintain optimum soil pH levels.

The reduction in nitrogen fertiliser use will contribute to a reduction in greenhouse gas emissions, and the increase in the use of lime should lead to improvements in soil fertility. However, potential benefits for water quality will not be achieved unless the reductions are targeted at key catchments where water quality is affected by excess nitrate (EPA, 2021).

Reducing the use of pesticides. The Sustainable Use of Pesticides Directive (2009/128/EC) governs the use of pesticides and aims to reduce the risks and impacts of pesticide use on human health and the environment. Herbicides, followed by fungicides and plant growth regulators, are the most common plant protection products sold in Ireland (CSO, 2023b).

The Farm to Fork Strategy (EC, 2020) set two targets in relation to pesticides: one to reduce overall pesticide use by 50% by 2030 compared with the baseline of 2015–2017, and a second to reduce hazardous pesticide use by 50% by 2030. While the 2030 reduction in overall use target was withdrawn from the strategy in 2024, it is nevertheless included in the Irish Biodiversity Action Plan 2024. Ireland is one of only three countries in the EU that has already met the overall use target,[23] and some progress has also been made in reducing the use of hazardous pesticides. Successes such as these could be better linked to environmental outcomes for biodiversity and water quality if adequate spatial data on pesticide use were collected. This would help encourage further uptake of the measures.

Use of clover and multi-species swards. Teagasc research over the last two decades has demonstrated the clear environmental, agronomic, economic, productivity and animal welfare benefits of adding clover to monoculture perennial ryegrass swards and/or replacing them with multi-species mixes (Humphreys *et al.*, 2007; Phelan *et al.*, 2015; Cummins *et al.*, 2021; Moloney *et al.*, 2021; Baker *et al.*, 2023). The deeper rooting species in the mixes are also beneficial in drought

23 food.ec.europa.eu/plants/pesticides/sustainable-use-pesticides/farm-fork-targets-progress/member-states-trends_en#Ireland (accessed 31 May 2024).

conditions and may be important in the years ahead as a climate change adaptation measure. Recent Teagasc plot trials have demonstrated that nitrogen application can be substantially reduced without affecting grass growth or productivity where clover and mixed-species swards are sown. Further research is under way to develop a blueprint for low, or zero, nitrogen fertiliser use for low-emission pasture-based dairy farming (Teagasc, 2022), and further research is needed to improve the medium and longer term persistence of some of the species in the multi-species swards. New research has been initiated investigating the nitrogen leaching and agronomic aspects of plantain, for example, and the role of red clover is growing in conservation-based systems. All farms under a nitrates derogation are required to include 5 kg of white clover per hectare when reseeding swards, and a new expanded multi-species sward measure and a red clover silage measure were rolled out in 2023 to encourage farmer uptake of multi-species and clover swards (DAFM, 2023b).

Use of low-emission slurry spreading and protected urea. The use of low-emission slurry spreading techniques and protected urea are key measures to mitigate the impacts of ammonia and greenhouse gas emissions. The Teagasc Farm Sustainability Report for 2022 (Buckley and Donnellan, 2023) reported that an average of 14% of total chemical nitrogen fertiliser use on dairy farms, which are the biggest users, was in the form of protected urea, while the figure for cattle farms was substantially lower at 4.3%. In 2023, over half of straight chemical nitrogen used was in the form of urea, 34,000 tonnes (22%) of which was protected urea. In 2022, almost 75% of slurry on dairy farms and less than 34% of slurry on cattle farms was spread using low-emission slurry spreading. These figures all represent an improvement since the previous year but nevertheless demonstrate the challenges ahead if full implementation is to be achieved.

Sustainable farming initiatives. There has been an increased focus in Ireland in recent years on environmentally sensitive farming practices. A number of networks, projects and farming strategies have been established that seek to educate, encourage and promote good practice in farming with nature. Some of these include the Farming for Nature[24] initiative, BASE Ireland[25] and Regenerative Farming Ireland.[26] There are also ambitious policy targets in place to grow the organic farming sector from 2.32% of utilisable agricultural area in 2022 to 7.5% of land being farmed by 2027, through the Organic Farming Scheme[27] (DAFM, 2023c). Carbon farming may bring potential future opportunities for Irish farmers, but it will be important that a data management and verification framework, and independent auditing, is established (Teagasc, 2023b).

Farm sustainability action, incentive and bonus payments are increasingly being offered by the dairy cooperatives to encourage their suppliers to carry out a range of environmental actions on farm. The cooperatives also support the ASSAP team with a number of dairy industry advisers who focus on water quality issues on their suppliers' farms. Origin Green,[28] the food and drink sustainability programme run by Bord Bia, operates at a national level and includes farmers and primary producers, processors and retailers. Many producers are also certified members of the Bord Bia quality assurance programmes. While these quality assurance schemes are welcome and have the potential to raise environmental standards, the emergence of some Origin Green-certified food and drink facilities on the EPA's list of national priority sites for enforcement action, due to their poor compliance and environmental performance records, is not sustainable and needs to be addressed.

Challenges relating actions to outcomes. Despite all the positive actions being taken on farm in recent years, it is unclear what has been achieved in terms of environmental outcomes. While the National Farm Survey and Bord Bia audits do provide some evidence on the implementation and adoption of measures, particularly in relation to climate change, there is a lack of sufficient, spatially explicit evidence on where measures are being implemented on farms, and on how farm practice has changed, that can be directly and geographically related back to the resulting environmental improvements that may have occurred. To determine whether measures are working in terms of environmental improvements, there needs to be data and evidence available on the actions and their progress in terms of implementation and an assessment of their effectiveness. The lack of evidence of measures being implemented to support biodiversity was an important element of the recent Court of Justice of the European Union case against Ireland for failing to fulfil its obligations under EU biodiversity conservation law (CJEU, 2023). Similarly, a recent European Court of Auditors report on the environmental outcomes of the EU's expenditure on climate action through the CAP showed that it has delivered little reduction in agricultural emissions since 2010 (European Court of Auditors, 2021).

24 www.farmingfornature.ie (accessed 31 May 2024).

25 www.baseireland.ie (accessed 31 May 2024).

26 www.regenerativefarmingireland.com (accessed 31 May 2024).

27 www.gov.ie/en/service/d46aec-organic-farming-scheme/ (accessed 31 May 2024).

28 www.bordbia.ie/farmers-growers/origin-green/ (accessed 31 May 2024).

Slurry spreading setback, Cullaun Lake, Co. Clare

Capturing the evidence on measures being implemented, and relating it back to key environmental indicators that the measures have been designed to support, must be a key action in all agri-food sector plans going forward, so that their contribution to positive environmental outcomes can be demonstrated.

It is also largely unknown whether all these actions will collectively deliver the scale of environmental outcomes that is needed. Policy integration and coherence must be improved to ensure that the multitude of plans and programmes are joined up and that there is no pollution swapping or perverse outcomes arising in which a measure that is considered positive for one plan is detrimental for another. Crucially, most mitigation actions to date have focused on technical abatement and efficiency improvements, which are important but may simply lead to more production. A narrow focus on efficiency without considering the associated levels of production compatible with sustainable levels of pollution loading (e.g. nutrient loading at catchment scale or greenhouse gas emissions at national scale) will fail to deliver desired outcomes. Key to this will be the development of a shared, long-term vision, out to 2050, of how Ireland wants to shape its landscape and its food system to deliver all the ecosystem services that society needs. The vision will need to focus on building resilience for a changing climate and incorporate strategies for adaptation. A robust ongoing monitoring and reporting framework will be essential.

5. Farming for the future

Ireland's farmers are facing increasing economic, social and environmental challenges, which are likely to intensify under future climate change conditions. A stronger focus on adapting farming practices to build resilience to the climate and weather challenges ahead will be important. Challenging environmental targets have been set nationally to reduce greenhouse gas and ammonia emissions, improve water quality and reverse the trend in farmland biodiversity, all of which will be expected in an era of increasing global food demand and increasingly uncertain climate change influences. There is a risk that, while these targets may move the food system more closely towards where it needs to be, they will not be adequate to deliver a healthy environment.

There are many competing demands for the use of land, and there is a need to balance the production of food with the need to achieve environmental objectives important for current and future generations (Topic Box 10.3). Phase 1 of the Land Use Review was published in 2023 and aimed to determine the environmental, ecological and economic characteristics of land types across Ireland (Chapter 5). Phase 2 is currently under way and will consider the policies, measures and actions that will need to be taken in the context of the government's wider economic, social and climate objectives.

Topic Box 10.3 Envisioning a climate-neutral agriculture and land sector

The Climate Action and Low Carbon Development (Amendment) Act 2021[29] commits Ireland to reaching a legally binding target of climate neutrality no later than 2050. This will necessarily involve very large reductions in emissions from agriculture and land use, alongside 'carbon dioxide removal' to offset the inevitable residual emissions (especially from biological systems producing food, for which limited technical abatement options are available). Carbon dioxide removal could include various technologies such as bioenergy with carbon capture and storage, direct air capture, afforestation, artificial weathering of rock and enhanced sequestration of carbon in soils. Many of these options require significant areas of land, and the most suitable proven and scalable option for Ireland – a country with already carbon-rich soils and low forest cover – is afforestation. It is increasingly recognised that bioenergy with carbon capture and storage is also likely to be needed to achieve climate neutrality, once it can be commercially scaled up (DECC, 2023). Ireland has a land area of 70,273 km^2. This cannot be increased. Therefore, carbon dioxide removal will increasingly compete with other land uses, including producing food, renewable energy and bioeconomy feedstocks and providing habitats for enhanced biodiversity (IPCC, 2019). In fact, given the limited potential to abate emissions from animal and soil processes, maintaining high levels of milk and/or beef production for export into the future will necessitate large areas of land being dedicated to carbon dioxide removal (preferably alongside the delivery of other ecosystem services in a manner that optimises a multifunctional land use approach). This requires urgent planning if it is to be deployed in a timely and efficient manner.

The EPA and DAFM co-funded a research project SeQUEsTER, led by the University of Galway, University of Limerick and Teagasc sought to explore what levels of future agricultural production could be supported within the constraints imposed by achieving climate neutrality and the land areas available for organic soil rewetting/water table management and afforestation (Styles *et al*., 2024).

The analysis remains highly uncertain owing to ongoing developments in inventory estimates for land sector emissions and potential alternative approaches to defining 'climate neutrality' (Bishop *et al*., 2024). Nonetheless, indicative 'climate-neutral' scenarios that maintain high levels of milk output clearly demonstrate the magnitude of land use transformation that will be required to achieve climate neutrality. Grassland used for animal production would need to decline from 58% of national land cover to 26%, while forest cover would need to increase from 11% to 32%, under internationally agreed 'GWP100' (100 year global warming potential) accounting. Even if methane is set a separate non-zero target in future to represent its short residence time in the atmosphere compared with other greenhouse gases, achieving climate neutrality would require huge changes in agriculture and land use (e.g. a doubling of forest area, and farmed grassland area reducing from 56% to 32% of land cover). For more information about land cover and use, see Chapter 5.

29 www.irishstatutebook.ie/eli/2021/act/32/section/15 (accessed 5 June 2024).

Topic Box 10.3 Envisioning a climate-neutral agriculture and land sector (continued)

Based on the latest analysis, it is clear that a focus on efficiency and emissions abatement in the agriculture sector, while important, will be inadequate to deliver climate neutrality (in the agriculture and land use sector) and would need to be accompanied by all of the following: (1) at least moderate diversification away from milk and/or beef production; (2) restoring degraded peatlands; (3) water table management across tens of thousands to hundreds of thousands of hectares of organic soils under grassland; and (4) planting at least 500,000 ha of new forest (Styles *et al*., 2024). Maintaining climate neutrality post 2050 will require measures including extended storage of carbon in biochar, wood products and geological storage via bioenergy with carbon capture and storage (Forster *et al*., 2021). Biogenic carbon could become a highly valued resource in a (nearly) fossil fuel-free world, not least because it offers a unique pathway towards negative emissions.

To date, there has been a lack of integrated, holistic and spatially explicit evidence gathered on areas of overlap and conflict across competing demands on land, including food production, climate action, biodiversity and catchment management for water quality. For example, replacing cattle with anaerobic digestors for bioenergy generation could play an important role in reducing greenhouse gas emissions from both the agriculture and energy sectors but may bring challenges for biodiversity and water quality owing to the need for high grass growth rates and potentially high ammonia emissions from digestate application to soils. It is likely that complementarities can be prioritised, and trade-offs minimised, if actions can be targeted to the most appropriate geographical contexts.

As climate change manifests itself, existing food and land systems may become stressed and new systems may become viable in particular regions (IPCC, 2019). Given the long time lag involved in environmental equilibration to land use changes, it is important to incorporate both climate change adaptation and climate change mitigation into land use strategies. Empowering farmers and other landowners to be positive agents for change requires clear policy signalling based on the big picture and the long view.

We need transformational change in the food system. Key objectives include:

- Develop a long-term, integrated, cross-departmental shared vision and leadership for a future thriving, resilient, productive and verifiably sustainable food system out to 2050.
- Set clear trajectories explicitly linked to the required outcomes that reflect the pace and scale of change that is required, while acknowledging the levels of uncertainty, the need to make progress and the importance of supporting farmers to make the necessary changes.
- Farm in harmony with nature and within the safe limits of healthy functioning ecosystems.
- Adapt, diversify, innovate and build resilience into our farm systems to cope with future climate and environmental challenges.
- Take advantage of the opportunities and multiple benefits of the circular bioeconomy; for example, forestry can contribute to climate action in the LULUCF sector by acting as a carbon sink, and it can also be a bioeconomy feedstock.
- Recognise that, while optimisation and efficiency gains play important roles in the food system to reduce the environmental footprint of the food being produced, they must be complemented by reductions in absolute emissions to achieve environmental outcomes.
- Significantly reduce food waste, optimise the use of land, resources and nutrients, and maximise nutrition and health.
- Collate the evidence, track progress, and actively and adaptively manage the transition to a truly sustainable food system. Adequately support farmers and other landowners to make the necessary changes in practice, while delivering fair economic returns as part of a just transition.

Many of Ireland's farms already display a high degree of vulnerability and may be particularly vulnerable to climate change directly and to the policy and market responses that will accompany it. Just over 25% of beef and sheep farms are economically viable; livestock rearing is often loss-making and dependent on direct payments (Buckley and Donnellan, 2023). This is in stark contrast to the 93% of dairy farms and 79% of tillage farms that are viable economically. For many beef and sheep farmers, forestry can generate higher returns per hectare than livestock rearing, while many extensive farmers already deliver an array of ecosystem services valued by society, yet they are not directly rewarded for doing so. There is an economic imperative to explore diversification options, safeguarding more efficient food production while ensuring that viable farms are handed down to the next generation. There are new opportunities emerging in the circular bioeconomy for the sector to use renewable biological resources to grow valuable materials, crops for bioenergy and food (see Chapter 15). There are ambitious plans, for example to produce biomethane from aerobic digestion, which will require feedstocks from the agriculture sector. Nutrient-rich digestate will then be produced that can be reused on farm (see Chapter 12).

A recent paper by the National Economic and Social Council recommended four key areas of action to support an effective, fair and inclusive transition in the agriculture and land use system. These include the need for (1) socially inclusive dialogue and participation, including with farmers, as the foundation for ensuring a fair process of transition; (2) a transition that is opportunity led, underpinned by a robust means of valuing and accounting for ecosystem services and natural capital; (3) fair, equitable and sustainable distribution of effort and cost sharing; and (4) coordinated action to govern the transition so that it can deliver real change in a balanced, inclusive and just manner (NESC, 2023).

Research supporting the transition to a more environmentally friendly agri-food sector

Significant research is under way nationally to provide the evidence base to support the changes in policy and action that are needed to deliver a sustainable agri-food sector.

In recent years, the EPA has funded more than 40 projects of relevance to agriculture, with a total value of more than €10 million. These have included several peatland-related projects on rewetting, water table management, carbon sequestration and methane emissions in organic agricultural soils (e.g. WET-PEAT, CO2PEAT and PEATCH4); a number of projects on soils and soil health (e.g. MUCKISOILS, AMRSOIL, TellSoilBio and MMeSH); several projects supporting the development of agricultural emissions inventories with Ireland-specific data and emissions factors and impacts on air quality, (such as AIRN2K, ENCORE and IMAGE); and projects looking to agriculture and land use under future climate scenarios (e.g. WaterFutureS, SeQUEsTER and LandingZoNES).

In addition, the EPA has funded significant research to support policy and action from the agriculture sector to improve water quality, including tools and models that are subsequently used in house for EPA assessments.

DAFM awarded close to €25 million of funding for research projects on a range of topics under the banner of sustainable management of natural resources over the period 2010–2021. A further €24 million in research grants was announced at the end of 2023 to support 20 projects across the agri-food, forestry and bioeconomy sectors. Some key examples of relevant projects in recent years include the development of the greenhouse gas and ammonia MACCs and supporting projects; PASTURE-NUE and FaSTEN, which are aiming to improve nitrogen use on farms; and a project on multi-species swards (Multi4More).

The Teagasc Agricultural Catchments Programme, which was established in 2008 to assess the water quality outcomes of the Nitrates Action Programme, is now in its fifth phase. The organisation's research programme has expanded to reflect the increasing need to improve water quality and reduce greenhouse gas and ammonia emissions while increasing soil carbon sequestration. The Teagasc agri-environmental research programme is ongoing but was given a renewed focus in 2023 with the establishment of a virtual National Climate Centre. The objective of the centre is to coordinate climate research and innovation and to lead the agri-food sector to climate neutrality in 2050. There will be a focus on bringing in new technologies to support that objective to deployment stage.

6. Conclusions

Agriculture is an integral part of the fabric of Irish society, but our food systems are not currently meeting our sustainability targets and need urgent transformational change. Over the last decade, two successive ambitious agricultural growth policies have delivered economic benefits, but challenges remain with associated environmental impacts that need to be addressed:

- The latest EPA projections indicate that greenhouse gases from agriculture are likely to reduce by up to 18% (compared with 2018 levels) depending on the measures that are implemented. Pathways to implementing all the measures identified in Teagasc MACC 2023 must be identified to meet the 2030 targets of a reduction in emissions of 25%. Ireland's commitment to the Paris Agreement will require transformational change across agriculture and the wider land sector by 2050.
- The application of artificial fertilisers and the management of manures are key contributors to air pollution in Ireland. National targets to reduce ammonia emissions are not being achieved. Continued implementation of on-farm abatement measures, such as reduced use of chemical fertilisers, increased use of protected urea and increased use of low-emission slurry systems, and research on new measures, is needed to bring Ireland back into compliance with the current 2020-2029 national emission reduction commitment and to meet the 2030 emission reduction commitment targets.
- Almost half of our surface waters have unsatisfactory water quality, and agriculture is the most widespread significant pressure causing the impacts. Successive Nitrates Action Programmes have not achieved the desired water quality outcomes to date. There needs to be full implementation of the Nitrates Action Programme through compliance promotion and targeted agricultural inspections with follow-up action and enforcement. High rates of engagement and uptake of voluntary measures through ASSAP, the Farming for Water European Innovation Partnership project, the Waters of LIFE project, and various other projects and agri-environmental schemes, will be essential for targeting the right measure in the right place.
- Our farming landscape is currently having a significant impact on biodiversity. The majority of our protected habitats, and many protected species, are at unfavourable conservation status and in significant decline. There is a need to further develop agro-ecological approaches to farming to enhance biodiversity on farms.
- Farm viability and the social fabric of rural communities are under pressure. Many farmers face economic challenges and generational renewal is becoming increasingly challenging. Ensuring fair economic returns for farmers that reflect the true cost of food production and deliver a standard of living that is comparable with other sectors, while providing support for rural development, is important for sustaining agriculture and rural livelihoods.

There are many EU and national policies and strategies to improve the food system under the broad umbrella of the European Green Deal. Key challenges include policy integration and coherence, a robust ongoing monitoring and reporting framework, and the development of a shared vision setting out what Ireland should look like beyond the horizon of Food Vision 2030.

There is a welcome progression in the agri-food sector towards more sustainable farming practices, and there are many positive actions being taken on farm; while improvements are being made in places, they are not at the scale and pace that is needed. There are opportunities for gains to be made throughout the food system that will benefit the environment, farmers and the rural economy, for example by using fewer inputs, adopting carbon farming and embracing the circular economy. However, where these actions are not sufficiently targeted and joined up as a coherent package, there is a risk that they will not deliver the required environmental outcomes. It is vital that the evidence is collected to assess and demonstrate the environmental outcomes of the actions being taken. Ireland has declared a climate and biodiversity crisis, and in that reality we must implement adaptive management programmes, supported by well-designed monitoring programmes that can feed into timely review and revision.

Driving the transition to a more climate-resilient and environmentally friendly agriculture sector that is fit for purpose in 2050 will require vision and leadership. The scale of land transformation necessary requires sustained and consistent action, but, given the time lags involved, implementation must begin urgently. Our farmers are the custodians of the land, and a thriving agriculture sector is key to delivering a climate-neutral, biodiverse economy. The agriculture sector can play a key role as part of the solution to addressing our climate, biodiversity and wider environmental challenges. Farmers must be supported to make the changes that are needed.

Key chapter messages

1. Agriculture is an integral part of the fabric of Irish society. It has a key role in delivering, and depends on, a healthy environment. However, our food systems are not currently meeting our sustainability targets and need urgent transformational change.

2. There are many plans and programmes in place, with positive actions being implemented at farm scale, but there is no clear evidence that the current measures will collectively achieve the scale of environmental outcomes that are needed.

3. A shared vision for 2050 for land use and the food system is urgently required. A clear pathway for the agriculture and land use sector, and adequate supports to achieve it, must be put in place. Implementation and an evidence base for assessing progress must be a priority.

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