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Mitigating Agricultural Impacts on Water Quality through Research and Knowledge Exchange

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Rialtas na hÉireann
Government of Ireland

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2. Office of Environmental Enforcement
3. Office of Evidence and Assessment
4. Office of Radiation Protection and Environmental Monitoring
5. Office of Communications and Corporate Services

The EPA is assisted by advisory committees who meet regularly to discuss issues of concern and provide advice to the Board.

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Lead organisation: Teagasc

Identifying pressures

The WaterMARKE project investigated ways in which the complementary use of research and knowledge exchange can achieve greater uptake of farm-level water quality mitigation measures to improve water quality as required by the Water Framework Directive.

Agricultural activities can impact water quality when nutrients, sediments and pesticides leave the soil and enter our waterways. Nutrients such as nitrogen (nitrates) can leach downwards through light soils into groundwater, while phosphorus and sediment can be lost through overland flow over heavy/peat soils. In terms of mitigation, the biological mechanisms of nutrient and sediment loss to water are complex and site specific, making them difficult to overcome. Farm mitigation measures to "break the pathway" may be less technologically complex, but may involve the implementation of new practices, facilitated by advisory supports.

Given this context, uncovering the scientific, economic and behavioural barriers that prevent farmers from adopting practices that can improve water quality is critical so that policymakers can shape future strategies more effectively.

Informing policy

WaterMARKE addressed water quality improvement using a multidisciplinary approach incorporating (1) systems analysis of the actors and incentives that influence farm practices impacting water quality, (2) spatial analysis of the effects of rural activity on water quality, (c) economic analyses of the factors impacting adoption of measures by farmers, and (d) socio-economic and behavioural psychology studies to identify pro-environmental behavioural drivers of water quality improvement.

In particular, the research findings emphasised the importance of innovative and collaborative "system-wide" efforts to foster meaningful change at farm level across government departments, researchers, co-operatives, advisers and farming organisations.

A case study of the impact of increased collaboration and innovation across the system of actors (stakeholders) was documented in a short video by WaterMARKE and CAP Network Ireland, which shows the "systemic" collaboration between the Local Authority Waters Programme, the Agricultural Sustainability Support and Advisory Programme and farmers to improve bathing water quality at Lough Ennell, County Westmeath.

To continue developing such innovations across the water quality improvement system, actors need to allocate time for reflexive thinking to allow for wider participation and the development of trust.

Developing solutions

WaterMARKE demonstrated the importance of behavioural drivers in improving farm-level adoption of mitigation measures.

As expected, financial and transaction (hassle, training) costs were barriers to adoption. Loss of productive area (opportunity costs) varied according to farm system and location.

Know-how and farmer norms were particularly important drivers of behaviour. It was found that farmers required adviser support to identify farm-level water quality risks and to understand the technicalities and time/financial resources required to implement measures. Farmers were also more likely to adopt familiar measures that they felt they had the capacity to undertake and would be approved of by other farmers. Leveraging these positive behavioural drivers could be achieved though group events facilitated by advisers and run jointly with influential farmers who have successfully implemented measures in areas where other farmers are also undertaking measures.

The research highlighted the crucial role of trust between advisers and farmers. However, advisers stated they need support both in upskilling, due to the complexity of water quality mitigation, and in allocating time to addressing water quality awareness and improvement with their farmer clients.

EPA RESEARCH PROGRAMME 2021–2030

Mitigating Agricultural Impacts on Water Quality through Research and Knowledge Exchange

WaterMARKE

(2017-W-LS-15)

EPA Research Evidence Synthesis Report

Prepared for the Environmental Protection Agency

by

Teagasc

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This report is based on research carried out/data from 2018 to 2023. More recent data may have become available since the research was completed.

The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Executive Summary

In Ireland, the primary pressures on water quality from agriculture are nutrient, sediment and pesticide losses to water. Nutrients such as nitrogen (nitrates) can leach downwards through light soils to groundwater, while phosphorus and sediment can be lost through overland flow on heavy/peat soils. While the biological mechanisms of loss are complex and site specific, farm mitigation measures to break loss pathways may be less technologically complex but may involve the implementation of new practices, facilitated by advisory supports. Given this context, it is critical to undertake multidisciplinary research to uncover the scientific, economic and behavioural barriers that prevent farmers from embracing pro-environmental water quality behaviours so that policymakers can shape future strategies more effectively.

WaterMARKE research addresses water quality improvement using a systems approach incorporating a systems analysis of the actors and incentives that influence farm practices that have an impact on water quality, a spatial analysis of the effects of rural activity on water quality, economic analyses of the factors impacting adoption of water quality mitigation measures by farmers, and social and behavioural psychology studies to identify pro-environmental behavioural interventions.

The fundamental message of this report is that mitigating the impact of agriculture on water quality requires (1) developing local solutions and information and incentives; (2) taking an innovation system approach to the problem solution; (3) changing the behaviour of farmers, which may involve changing the behaviour of others upstream within the innovation system, requiring an examination of their incentives and motivations; and (4) providing local information to facilitate local decisions.

Key findings from the research include the following:

- The adoption of a "mission-oriented" perspective spanning the innovation system for water quality improvement has facilitated a range of collaborative initiatives, not least in relation to the adoption of water quality behaviours at the farm level. This has involved changing the behaviours of policy, regulatory, market and knowledge intermediary actors across the innovation system, all of whom influence water quality at the farm level.
- Improving a complex local environmental externality requires localised activity data, supplemented by an improved understanding of nutrient loss pathways. This requires local information, such as the characterisation of risk undertaken by the Local Authority Waters Programme (LAWPRO) and the EPA Catchments Unit, in tandem with research and knowledge exchange, to provide the basis for the "right measure, right place" approach to facilitating local solutions.
  - A case study and short video created by the WaterMARKE project and CAP Network Ireland show the effectiveness of the collaboration between LAWPRO, the Agricultural Sustainability Support and Advisory Programme (ASSAP) and farmers in addressing local water quality issues: https://capnetworkireland.eu/watermarke-the-power-of-collaboration-for-water-quality-improvement/
- The research shows that while farmers are generally positively motivated to improve water quality, they require support in terms of knowledge and resources.
- Key drivers of farmer behaviour change include:
  - recognising the important role of advisors across the agricultural innovation system in raising awareness of water quality issues with farmers;
  - recognising that ASSAP measures with higher technical knowledge requirements result in greater advisor engagement, thus counterbalancing the knowledge challenge and highlighting the importance of localised and individualised support.
- At the farmer and advisor levels, there are barriers that represent both knowledge and technical challenges, along with administrative burdens that carry compliance and psychological costs.
- There is a need for enhanced supports for advisors, emphasising the need to prioritise

pro-environmental water quality advice and the crucial role of trust in successful collaborations between advisors and farmers.
- Farmers with strong behavioural drivers to adopt specific measures are those who:
  - have an awareness of a measure;
  - believe they have the capacity (knowledge) to undertake a measure;
  - believe that other farmers/influences would approve of the measure;
  - live in an area where others have implemented a measure.
- Other farmer/farm characteristics that drive adoption include:
  - large farm size;
  - previous participation in agri-environmental schemes;
  - having a point source pollution issue;
  - agricultural engagement with advisors;
  - agricultural education.
- Farmers are more accepting of measures that incur less cost and have a more immediate visible effect (e.g. drainage ditch remediation).
- Collective knowledge exchange interventions, such as discussion groups led by local “champion” farmers and facilitated by advisors who provide technical knowledge on measures, can capitalise on the strength of these behaviour drivers to increase adoption.
- The cost of implementing measures can be a negative behavioural driver. Measures with high implementation or transaction costs need to be differentially incentivised.
- This study provided evidence-based research that contributed to the justification of the need for the Farming for Water European Innovation Partnership (EIP) collaborative project to compensate farmers for measure implementation when the private cost is high but the social/ environmental benefit is also high.
- Spatial modelling highlights variation in place- and farm-specific implementation costs that must be accounted for in assessing appropriate measures for individual farms.
- Farms with high opportunity costs for loss of land/ productivity may be less likely to engage with mitigation measures.
- The socio-economic research also shows that it is feasible to use a generalised behavioural model that uses attributes of measures to generalise, thereby reducing the need to collect survey data on farmers’ behavioural preferences for every measure.

1 Introduction

Agriculture is one of the main pressures on rural water quality. Although some aspects of water quality and supply have improved across Europe, progress has been variable (EEA, 2018), with ecological risks increasing over time (Wolfram *et al*., 2021). The delivery of EU Water Framework Directive water quality targets requires achieving “good” ecological water quality status in all water bodies by 2027 and maintaining water quality in “high status” areas. However, EPA reports show that just over half of Irish water bodies achieved good status or better in 2022, with agriculture identified as a major pressure on water quality (EPA, 2023). Research also shows the differential impacts of nutrient (and sediment) losses in different environmental contexts.

Water quality is an externality, meaning the polluter does not bear all the costs of its activity. In other words, society, through water quality pollution mitigation, bears most of the cost, with little borne by the polluter. Improving water quality is a complex problem, relying on physical interactions across hydrology, local climate and nutrient applications, but also on factors that affect human behaviour in terms of mitigation activities.

In addition, the ever-increasing consumer-driven demand for the sustainable intensification of production in the agri-food sector was noted in the EPA-funded AgImpact Project,[1] which highlighted the importance of the involvement of all value chain stakeholders (“farm to fork” – including farmers, processors, agencies and consumers) in developing an agreed vision to improve integration and ownership of water quality improvement (Carton *et al*., 2015). This is particularly necessary to maximise the economic gain for the whole value chain by co-operating in demonstrating the advantage of buying food produced in a more sustainable manner. Building on the findings of AgImpact, this project addresses water quality improvement using a multidisciplinary approach.

1.1 Objectives and Research Needs

From a knowledge exchange perspective, there is a need to provide information to extension agents to improve and accelerate the uptake of mitigation measures, particularly in areas where water quality is declining. It is challenging to incentivise farmers to adopt new pro-environmental behaviours; however, there is also significant inertia in terms of existing activity. To this end, our project worked closely with the Agricultural Sustainability Support and Advisory Programme (ASSAP)[2] to examine the behavioural and economic factors underlying farmers’ decisions to implement water quality mitigation measures.

The impact of rural activity on water quality varies across different environmental contexts; therefore, it is necessary to explore statistical methodologies that may help provide more localised information and disaggregate agricultural impacts on water quality. A national solution (rules and regulations) to a local problem could result either in the problem not being solved because the regulations are too weak, or in the solution being too expensive for some farmers. This can arise if regulations target the lowest common denominator in applying horizontal rules to improve water quality in areas at high risk of water quality deterioration. However, transaction costs in terms of monitoring, compliance, hassle, education and infrastructure, etc., may well be higher (particularly in low-risk areas) than the cost of a more stringent “general” or national approach to water quality improvement.

Improving resource use efficiency can result in the win–win of improved water quality and reduced input costs. However, the most cost-effective solutions vary across farms and different environmental contexts, meaning that an inflexible approach may result in higher costs for some farmers, suggesting the need to understand differential costs of local mitigation.

1 https://www.epa.ie/publications/research/water/research-175---agimpact-project-identifying-approaches-to-improving-knowledge-exchange-ke-in-the-irish-agrifood-sector-using-expert-opinion.php (accessed 6 June 2024).

2 https://www.teagasc.ie/environment/water-quality/farming-for-water-quality-assap/assap-in-detail/ (accessed 6 June 2024).

Biophysical risk assessment plays a critical role in determining the “right measure, right place” approach to localised farm-level mitigation, as damage to and remediation of water quality can involve time lags between pollution events and the impact of remediation activities. In addition, nutrient loss/pollution is often diffuse in nature, making it difficult to link pollution outcomes directly to inputs. This problem is context specific, dependent not only on the level of activity but also on local issues, such as the hydrology, soil and weather, requiring an in-depth understanding of loss pathways.

While efforts to mitigate the impact of agriculture on water quality are focused largely on incentivising farmers to change their behaviour, there is a need to also examine how the range of actors across the agri-environment system influence water quality mitigation. This project therefore adopted a mission-oriented innovation system approach (Klerkx and Begemann, 2020). The WaterMARKE team consulted with a group of expert stakeholders in 2018 and again in 2023 to chart the progress of innovation across the system of actors that influences water quality improvement at the farm level. The workshop was facilitated by Professor David Pannell, who led a multidisciplinary approach to improving water quality in Gippsland, Australia. The outputs of the mapping process and progress within the innovation system are discussed further in Chapter 8. A key area of agreement that emerged from the workshop helped to refine the WaterMARKE approach, aligning it more closely with needs identified by stakeholders. A “systems” perspective is necessary to incentivise adoption of pro-environmental behaviours and mitigation measures by farmers. This may also involve changing the behaviours of policy, regulatory, market and knowledge actors across the innovation ecosystem who influence farm water quality improvement.

Interestingly, it was noted that the actors attending the workshop had never previously met as a group. The mission-oriented innovation system approach adopted for this research also provided an overarching framework for the seven individual WaterMARKE studies outlined in this report.

2 Farmer Behaviour and Measure Adoption

Research to examine the human behaviours that underpin farmers' adoption of new behaviours and practices is key to achieving accelerated and increased adoption of water quality mitigation measures on farms. The study published by O'Donoghue *et al*. (2024) develops an adapted theory of planned behaviour (TPB) theoretical framework (Daxini *et al*., 2018) using a nationally representative survey of farmers' intentions to undertake five commonly prescribed water quality mitigation measures (soil testing, lime application, nutrient management planning, avoiding spreading organic manure in high-risk areas/at high-risk times and fencing of watercourses). The TPB methodology uncovered farmers' preferences around measure adoption by asking the following questions: (1) Do farmers feel they have enough knowledge to adopt measures (perceived behavioural control (PBC))?, (2) Do other farmers/trusted sources think this measure should be adopted (subjective norms (SN))?, (3) Do farmers have positive attitudes about measures? and (4) Do farmers have the finances (perceived resources) to adopt a measure?

Increasingly, farmers are asked to undertake multiple pro-environmental measures per farm. However, the literature focuses on single-measure models of adoption. This study was innovative in developing a model to examine the adoption of a portfolio of measures: soil testing, nutrient management planning, lime application, avoiding high risk and fencing watercourses. Looking first at the measures individually, the behavioural model reveals that adoption is more likely if others approve of undertaking measures (SN) and if farmers feel they have the capacity/skills to implement measures (PBC). The influence of agricultural education, farming-related media and trusted advisors is also a strong driver of adoption. The study innovated further by moving beyond individual models to a generalised model that can be applied to a specified set of measures using measure-specific attributes (e.g. actual level of uptake of each measure within a region, or a farmer's awareness of a measure). The study found that this enhanced the positive influence of others (SN) and farmers' perceptions of their capacity to undertake measures (PBC). Thus, using a generalised model can reduce the need to collect farmers' behavioural preferences for every measure by focusing on the attributes of measures. Specifically, in the generalised model, SN and PBC significantly and positively influenced farmers' intentions to adopt all five measures. The importance of SN highlighted the value that farmers place on the opinions and consensus of important reference groups, such as friends, family, farming-related media and peers. The positive significance of PBC indicated that farmers' intentions to adopt measures are in part driven by their perception of their ability to do so. The generalised model provided additional information: that measure adoption was greater in local areas where individual measures had already been adopted. There was also greater adoption in areas where farmers had a higher level of awareness of specific measures.

Future policies could focus on interventions that positively influence both SN and PBC in particular, for example farmer discussion and knowledge transfer groups with local "champion farmer" guests, where farmers share experiences and opinions on farming practices with the benefit of technical support from farm advisors. Leveraged correctly, these groups could positively influence farmers' SN and PBC in relation to undertaking water quality measures. Finally, this study facilitated the promotion of "suites" of measures with the potential for ecosystem benefits across water and air quality and biodiversity, through the use of a generalised adoption model.

3 Characterising Agricultural Sustainability Support and Advisory Programme Measures and Farmer Adoption

A study by Cullen *et al*. (2024) describes two discrete, complementary analyses of the measures prescribed and later adopted following ASSAP visits to 3400 farms between April 2018 and October 2022. This advisory programme for water quality improvement on Irish farms is a novel collaborative initiative between public and private bodies, comprising a dedicated team of 43 water quality advisors from Teagasc (Ireland's agriculture and food development authority) and dairy co-operatives (Dairy Sustainability Ireland). ASSAP is focused on reducing the impact of agriculture in priority areas for action (PAAs), where EPA and Local Authority Waters Programme (LAWPRO) characterisations have shown that water quality is under threat. Advisors assess specific issues in relation to the potential for loss of nutrients, sediment and pesticides, and develop mitigation plans with individual farmers. Farmer participation is voluntary, relying on the development of relationships between advisors and farmers.

An initial analysis examined the characteristics of ASSAP farms in relation to the water quality risk factors and the set of measure/issue combinations recommended for each farm. Over the period analysed, an average of 5.1[3] issues per farm was identified by ASSAP advisors. The most prevalent issue identified was the need for buffer strips near watercourses and water abstraction points (e.g. wells), where the application of pesticides and chemical and organic manure is prohibited. Mitigation actions to create/maintain buffers to safeguard waterways were recommended on almost 1400 farms. The second most prevalent issue, P loss through overland flow, was the top issue on cattle breeding/sheep farms located on sloped or organic soils in high-rainfall areas. Fencing to prevent livestock access to watercourses and siting livestock drinking points away from watercourses were the next most prescribed measures.

Although voluntary, engagement with ASSAP measures (farmers that had started/completed/had ongoing mitigation measures) varied by system, from 72% of tillage farmers to 93% of dairy farmers. Farms with a point source pollution risk had a higher rate of adoption of mitigation measures (94% on average) than farms with other pollution risks (88% on average). A logistic regression of adoption identified these factors along with farm size and agri-environmental scheme participation as key drivers of adoption. This study also considered in more detail how the uptake of measures relates to the types of issues identified by ASSAP advisors (namely land management, nutrient management and farmyard issues) and the attributes of the recommended measures.

Building on the behavioural study in Chapter 2, the second analysis involved an expert ranking of the characteristics of ASSAP measures recommended to farmers, combining 44 issues and 90 specific measures to produce a total of over 300 combinations, based on their TPB attributes, reflecting farmers' (subjective) norms, knowledge requirement and the cost of implementing each measure. Consistent with the nationally representative survey analysis in Chapter 2, measures that addressed specific issues were more likely to be adopted if they aligned with farmer norms. Upfront costs were notably associated with a lower likelihood of an issue being addressed, and measures that involved loss of productive area were also less likely to be adopted. Interestingly, ASSAP data analysis showed that measures with a high knowledge requirement were more likely to be undertaken. While this was contrary to TPB expectations (where a higher knowledge requirement generally leads to lower adoption), ASSAP measures with higher technical knowledge requirements resulted in greater advisor engagement, thus counterbalancing the knowledge challenge and highlighting the importance of localised and individualised support.

3 This reiterated the need to analyse the adoption of multiple, and not just single, measures in Chapter 2.

4 Spatial Impact of Economic Activity on Water Quality

A key area of agreement from the 2018 WaterMARKE expert panel engagement was that the relationship between farms (and other human economic activity) and water quality is both complex and highly localised. Four analytical studies were undertaken in order to better understand this relationship at national, regional and local spatial scales.

An initial national-level study by O'Donoghue *et al*. (2021) developed a statistical model to understand the relationship between human activity and water quality by linking water quality data with upstream economic activity within river catchments. EPA water quality data (EPA Q-value data with values from 1 (bad) to 5 (high)) were linked spatially to economic and environmental variables from each water quality catchment. These variables were derived from population and agriculture censuses and other databases over three periods: 1990–1991, 2000–2002 and 2010–2011. The findings showed that sectoral emissions from agriculture, households and industry all had a negative relationship with water quality. However, the period 2000–2011 is associated with a reduced nutrient load from agriculture (as animal numbers fell from their 1998 peak). For a given livestock density per hectare, the level of water quality improved, reflecting the impact of on-farm pro-environmental investments, such as agri-environment schemes (AESs), in the 1990s.

The second spatial study used both national and regional models to examine the water quality of "high status" water bodies. O'Donoghue *et al*. (2022) considered three different dimensions: (1) a specific focus on high-status water bodies (with a Q-value of ≥4.5), (2) the natural trends of ebb and flow of high-status water quality over time and (3) an attempt to regionalise understanding of these trends. Geographical information systems were used to map discrete categories of monitoring sites at the national and regional levels, namely those that "maintain high status", those that "enter high status", those that "fluctuate in and out of high status" and those that "exit high status".

The main findings at the national scale were that (1) agricultural activity was significantly and negatively associated with the "maintain" and "fluctuate" status classes and (2) elevation was significantly and positively associated with the "maintain", "enter" and "fluctuate" classes. Moreover, there were significant differences among the four high-status mobility classes. The "exit" class was associated with higher organic N levels, cereal share, population density and septic tank density, and significantly lower afforestation. The "enter" class was associated with notably greater elevation than other classes. The regional outcomes revealed differences in significant pressures across regions. For example, rainfall and elevation had a positive impact on high-status rivers in the north-west region, while organic N had a negative effect in the south-west. This information highlighted the localised complexity of water quality issues and the need for background characterisation by LAWPRO and the EPA Catchments Unit, providing the "right measure, right place" information for ASSAP to co-create localised, tailored solutions with farmers.

Overall, this study highlights high natural variation in water quality, indicating the need for two or more data points to confirm a changed status over time. Thus, the current 3-year EPA data collection at river monitoring sites may mean that it takes 6 years to confirm a changed trajectory. This finding may be a justification for more frequent data collection, particularly in sensitive (high status or declining water quality) catchments, to differentiate between natural variation and temporal trends.

The third spatial study focused on a methodological development to further understanding of the statistical relationship between economic activity and water quality by using geographically weighted regressions that take account of local spatial relationships. As water quality Q-values are ordinal (Q1, Q2, Q3, Q4, Q5), a geographically weighted ordinal regression model was required. This analysis adapted a recently developed method to estimate geographically weighted ordinal regression (Dong *et al*., 2018), adapting it for use in the water quality context. This enabled the estimation of local relationships between economic activity and water quality, using EPA water quality data and agriculture-based load measures from the EPA source load allocation model (SLAM).

The key finding was that the more granular the analysis, the more complex the relationship becomes. In a relatively simple local model, the local statistical significance and explanatory power were higher in areas that had a greater share of agriculture. However, close to urban centres, where there are many other economic activities, the significance and explanatory power fell as the relative importance of other factors (e.g. population density, septic tanks, industry) increased. The implication of this research is that localised activity data need to be supplemented by an improved understanding of nutrient loss pathways to analyse the complexity of the economic, environmental and human interactions that have an impact on water quality.

The final analytical spatial study also had a methodological focus. By again using spatial relationships across water quality statuses (unsatisfactory (Q1–3.5), relative to satisfactory (Q4–5)), trends in water quality over four Census of Agriculture periods (those mentioned earlier, with the addition of the recent 2020–2002 census) were decomposed into trends relating to six factors. These were (1) a time-specific component, (2) population factors (e.g. population density/septic tank density), (3) variables describing population-related factors, (4) farm-related activity (using organic N/ha as a proxy for animal numbers) and cereal share (as a proxy for tillage fertiliser inputs), (5) variables describing farm-related activity (6) point-specific spatial heterogeneity.

The analysis reaffirmed the findings of O’Donoghue *et al*. (2021) in the first three census periods. However, in the recent census period (2020–2022), the relationship between agricultural activity (in particular) and water quality weakened, with localised place-specific drivers becoming more important. This points to a trend where the explanatory power of the agricultural activity variable is weakening over time, reaffirming the growing complexity in the relationship with water quality across time (and not only across space, as indicated in the third spatial study). The implication here is that managing the water quality challenge will require improved data and information, such as finer spatial granularity than census district level and finer temporal variation. For example, the Census of Agriculture is carried out on a 10-year cycle. However, it is clear that considerable change occurred across the 10 years between 2010 and 2020. Finally, this analysis shows that the declining trend in water quality from 2010 to 2020 would have been about 20% worse if the investments made in the 1990s (with improved management practices as a result of regulation and voluntary AES) had not been implemented on farms.

5 Spatial Variability: Cost-effectiveness of Measures

As some of the nutrients applied to farmland are lost to water through leaching or overland flow, farmers end up applying additional fertiliser (at additional cost) to maintain production. However, with greater nutrient use efficiency, farmers can optimise the use and spreading of animal manures to avoid nutrient losses, thereby achieving an environmental and economic win–win.

The preceding ASSAP and spatial chapters highlighted the localised nature of nutrient losses and catchment-level issues and the requirement for effective mitigation measures that are specific to the local environment of each farm. Both the behavioural and ASSAP studies also highlighted the importance of cost as a barrier to the adoption of mitigation measures. However, as both cost and effectiveness of measures vary spatially, analysis of the cost-effectiveness of water quality mitigation measures at the local (river catchment) level requires a farm-level framework with the capacity to assess the cost and impact at the catchment or spatial level. This requires (1) information about the existing (agricultural) activity at the local level, (2) economic data that are consistent with both the activity and the local environmental context, (3) information on the cost of water quality mitigation measures at farm scale (as opposed to an aggregate (average) scale) and (4) information on the environmental impact of the measure.

As there is no single database that includes all these variables, it was necessary to synthetically construct a database and develop a framework to bring all the necessary data together. This study drew on a WaterMARKE literature review and the expert panel stakeholder consultation, along with a theoretical framework of the cost-effectiveness of water quality improvement measures. The framework was used to estimate the cost-effectiveness or marginal abatement cost (MAC) of measures, requiring estimates of the cost of specific measures and the potential impact/effectiveness of these measures on water quality.

While the costs of pathway mitigation measures are farm specific, it is possible to provide reasonable estimates for individual measures. However, the provision of meaningful and transferable estimates of heterogeneous effectiveness or uptake of measures in different catchments (in the absence of water quality monitoring) is challenging. To account for this spatial heterogeneity, a simulation model of the local economy (SMILE) was utilised to produce a synthetic national dataset of farms with the full information of the Teagasc National Farm Survey combined with the spatial granularity of the Census of Agriculture. A particular methodological innovation in SMILE for the purpose of this study was the development of the capacity to determine the impact of different agronomic drivers (measures) on farm-level stocking rates, outputs and costs using spatially granular farm data where activity, costs and incomes are consistent with the local environment in terms of soil, weather, altitude, distance to sea, etc. (Haydarov *et al*., 2024).

Next, for each farm (within its spatial context), a cost analysis was undertaken for individual water quality mitigation measures at different levels of implementation/uptake, selecting from the main measures suggested by ASSAP advisors. These were fertiliser usage, fertiliser application method, fencing of watercourses, slurry storage investments, animal number management, nitrates derogation levels, feed additives and lime application. The model highlighted significant variation in costs across farm types and across space, emphasising the difficulty in drawing simple conclusions from aggregate or stylised analyses and the importance of individualising advice to different farmers in different settings.

MAC indicators were then developed. These conditioned the cost of the change in a particular biological or pollution variable, using a MAC in terms of N load at the farm level. The use of N load limited the scope of this analysis, as many ASSAP measures were phosphorus focused or generated other co-benefits for greenhouse gas abatement or biodiversity, and were therefore beyond the scope of this study. The conclusion in relation to the spatial variation of both the cost and effectiveness of measure implementation across farms and catchments was, however, important. It reaffirmed not only that it is important to have the "right measure in the right place" from an environmental point of view, but also that there are cost-related place and farm-specific implications. This needs to be accounted for in assessing appropriate measures to be undertaken on individual farms.

The final aspect of this study was future facing. Working with a global expert in the field, Professor David Pannell, a blueprint for the economic impact evaluation of water quality mitigation measures was developed, adapting the Australian Gippsland Lakes P Tool (Roberts *et al*., 2012) for the Irish context. Comparing the accumulated information and modelling capacity in Ireland and Australia in relation to the level of local activity information and associated economic drivers, it was evident that the development of behavioural information and load modelling was greater in Ireland. However, there is a major gap in the linkage of economic and load information to the hydrological pathways by which nutrient loads have an impact on the environment.

Pannell and colleagues successfully linked economic activity, load and behavioural analysis to their catchment hydrological model. There are recommendations that could assist in the development of this analytical capacity in Ireland, the most important being the capacity to link farm-specific nutrients with farm-specific economics. This would require a variant of the Department of Agriculture, Food and the Marine's Animal Identification and Movement–Land Parcel Identification System (DAFM AIMS–LPIS) data, which incorporate nutrient load data and animal type information, as the latter is an important driver of the economics. Secondly, while load modelling capacity has been developed at the national scale, lessons could be learned from the Australian experience in developing capacity to include loss pathways, erosion and sedimentation at the landscape scale.

6 Biophysical Risk Identification and Remediation Measures

Agricultural drainage networks can provide connectivity between P sources and surface waters, increasing the risk of P loss to water bodies. A study by Moloney *et al*. (2020) devised a farm-scale risk assessment that categorised drainage ditches in terms of P loss risk based on connectivity and physico-chemical characteristics. Ten pilot farms were selected to characterise drainage networks through ground surveys and sediment and water sampling. Five drainage ditch categories were derived based on landscape setting and connectivity. Each category recorded soluble and reactive P concentrations above environmental water quality standards. To assess the risk of surface ditches as a connectivity vector between agricultural P and surface waters, ditches were ranked from 1 to 5 (low to high risk) based on the magnitude of connectivity in transferring point and diffuse sources of P to nearby surface waters, based on landscape position.

Elevated sediment P with high equilibrium P concentration was associated with ditches connected to farmyards and in sediment sampled at ditch outlets, suggesting P deposition over time, which is indicative of a legacy P source. The study showed that surface ditches can act as a P source and that ditches that provide a direct connection between farmyards, a point source and surface waters pose the greatest risk. Conversely, ditches associated with diffuse sources and/or that have low connectivity to the drainage network pose incrementally lower P loss risks. Furthermore, surface ditches allow the implementation of these measures without incurring the costs associated with taking agricultural land out of production.

Ideally, nutrient loss to surface waters should be mitigated by balancing P across the farm through careful nutrient management planning; however, this is a long-term option and can incur significant financial costs in the initial phases. Farmers and landowners are more likely to be accepting of measures that incur lower costs and have a more immediate visible effect, such as those commonly associated with drainage ditch remediation, offering an opportunity for more targeted implementation of mitigation measures.

Putting the findings into practice, the biophysical research team devised training for ASSAP advisors on incorporating the drainage ditch (1–5) risk assessment classification developed in this study into the ASSAP water quality mitigation farm plans.

7 Behavioural Psychology: Barriers and Facilitators

Throughout this research project, there has been a focus on changing farmer behaviour, but also on providing information to help change the behaviours of those who influence farmers. This behavioural psychology study examined the barriers to and facilitators of pro-environmental water quality behaviours of different actors. Three discrete behavioural studies examined the motivations and interactions of actors within the agricultural innovation system, using the capability, opportunity and motivation behaviour (COM-B) model (Michie *et al.*, 2011) as a framework for the interpretation of findings and policy recommendations. In the COM-B model, "capability" refers to the knowledge of a given behaviour, or having the physical skills to implement a new behaviour, i.e. a water quality mitigation measure. "Opportunity" refers to peer influences, if the given behaviour is widespread at the social level, or if an individual has the resources (e.g. money or time) for the behaviour to occur. "Motivation" refers to habits, having experience of the behaviour, being used to the behaviour or having personal interest in the behaviour. Barriers and facilitators identified using the COM-B components were aligned with a behaviour change wheel matrix (Michie *et al.*, 2011) to suggest intervention functions and policy recommendations.

In the first behavioural study, farmer focus groups were used to explore barriers to and facilitators of pro-environmental water quality behaviour. Using qualitative interviews, this investigation captured the perspectives of farmers recruited by ASSAP advisors, revealing their insights into the lost opportunities or barriers that impede progress and the capability and motivational factors that facilitate change. The study revealed that barriers predominantly stemmed from social and physical opportunity factors, highlighting the challenges for farmers in accessing supportive environments and resources. Conversely, facilitators were largely associated with psychological capability and motivation, indicating that farmers perceive their knowledge, skills and intrinsic drive to foster pro-environmental water quality behaviours as sufficient. The study suggested that, while farmers in general are positively motivated to improve water quality, they require support in terms of knowledge and resources.

In the second study, involving separate advisor focus groups, a reflexive thematic approach (Braun and Clarke, 2019) was used to explore the views of specialist Teagasc ASSAP water quality advisors and mainstream agricultural (business and technology) advisors to determine the barriers and facilitators experienced by advisors in supporting farmers' pro-environmental water quality behaviours. The study revealed a range of barriers, including advisors' inability to prioritise water quality in their daily work, competing interests, self-perceived deficiencies in competency and advisors' perceptions of farmers' interests, knowledge, finances, age and habits. The sole identified facilitator was the presence of dedicated ASSAP advisors who specifically address environmental pressures. These findings underscore the need for enhanced support for advisors, emphasising the need to have the capacity to prioritise pro-environmental water quality advice within their workload, and the crucial role of trust in successful collaborations between advisors and farmers.

The third psychology study analysed farm characteristics and farm water quality issues to predict farmer behavioural readiness to engage with pro-environmental water quality behaviours, using an anonymised bespoke quantitative assessment conducted by 21 Teagasc and dairy co-operative ASSAP advisors on 1402 farms. ASSAP advisors conducted farmer screenings of farm characteristics, farm water quality issues and farmer behavioural readiness, informed by the COM-B components (Michie *et al.*, 2011). The findings were consistent with the analytical ASSAP study, revealing that familiarity with environmental measures through AES participation is a valid predictor of farmers' motivation and that farmers operating larger farms tend to exhibit higher levels of preparedness. Conversely, farmers involved in activities that contribute to diffuse P losses displayed lower levels of psychological capability, signifying a potential gap in their knowledge regarding water quality. Farmers with a high risk of diffuse N loss, even if they have adequate physical resources, face challenges in terms of skills, habits and peer or professional support in engaging with pro-environmental water quality behaviours. Furthermore, livestock farmers exhibit lower levels of behavioural readiness to adopt mitigation measures. Overall, this study highlights that at both the farmer and advisor levels there are administrative burdens that act as barriers and carry compliance and psychological costs.

8 Improving Water Quality: The Role of Local Actors and Ecological Factors in “Mission-Oriented” Agricultural Innovation Systems

Given the impact of agriculture on rural water quality, it may seem that efforts to improve water quality should be concentrated on changing farmer behaviour. However, the complex nature of the problem warrants a systemic approach to examine the range of influences that drive transformational improvement in water quality (Blackstock *et al*., 2010; Wanzenböck *et al*., 2020). This supports the concept of “mission-oriented” innovation, where innovation is focused on solving far-reaching societal and environmental challenges (Klerkx and Begemann, 2020). Missions exist where there is clear ambition and vision for what agri-food system transformations should look like (Mazzucato, 2016). These missions should be supported by comprehensive “innovation bundles” (Barrett *et al*., 2020), i.e. complementary sets of technological, social and institutional innovations, as well as “policy mixes” (Klerkx *et al*., 2023) that support transformation. A study by van Laren *et al*. (forthcoming) describes the process of examining the Irish Innovation System for water quality improvement using a mission-oriented lens.

A mapping process of the innovation ecosystem for water quality in Ireland was undertaken by WaterMARKE and expert stakeholders in 2018 and again in 2023, informed by a review of the scientific and socio-economic literature, prepared by WaterMARKE researchers. The process analysed the roles of “influencing actors” across regulation and policy, market, information and research, and intermediaries in improving water quality (Figure 8.1 presents the actor categories and roles). The experts first looked at farmers as the actors most directly involved before analysing the roles of the institutional actors, categorising them in relation to their function. The analysis also charted the level of connectivity and collaboration among the actors, along with progress towards greater innovation in the period 2018 to 2023.

Farmers. The mapping process recognised differential issues for different types of farmers, categorising them as intensive (high livestock density) or extensive (lower stocking rates and income levels), and also in relation to high- and low-risk contexts, based on biophysical factors. This categorisation means that the application of more targeted regulations and policy support needs to account for localised transaction and implementation costs that vary with farming intensity and risk, along with the spatial heterogeneity of measure application as identified in the cost-effectiveness study.

Regulation. A key element in changing the regulatory or public incentive system is behavioural change, not only among farmers but also among policymakers, to facilitate a move towards a more localised approach. Following on from reviews of previous nitrates action programmes, the Department of Housing, Local Government and Heritage and the Department of Agriculture, Food and the Marine engaged in public consultations and developed Ireland’s Fifth Nitrates Action Programme (2022–2025), which reflects greater environmental ambition at the national and EU levels. This iteration of the Nitrates Action Programme acknowledges the need for more targeted, localised measures in relation to N and P loss in their respective critical source areas in catchments where there are water quality issues related to N and P. Teagasc Agricultural Catchments Programme research highlights the difference in water quality outcomes for similar on-farm organic loadings in catchments with different soil and hydrological conditions. This research has been embedded into EPA maps of N and P critical source areas, and areas where agricultural measures need to be targeted. These tools are being used in PAAs by LAWPRO and ASSAP to target voluntary measures. A natural further consequence could be the possibility of identifying nitrate vulnerable zones, depending on local circumstances, within which different regulatory rules could apply. However, applying solutions differentially across the country is challenging, as different regulations/public policies in different areas across the country can have different

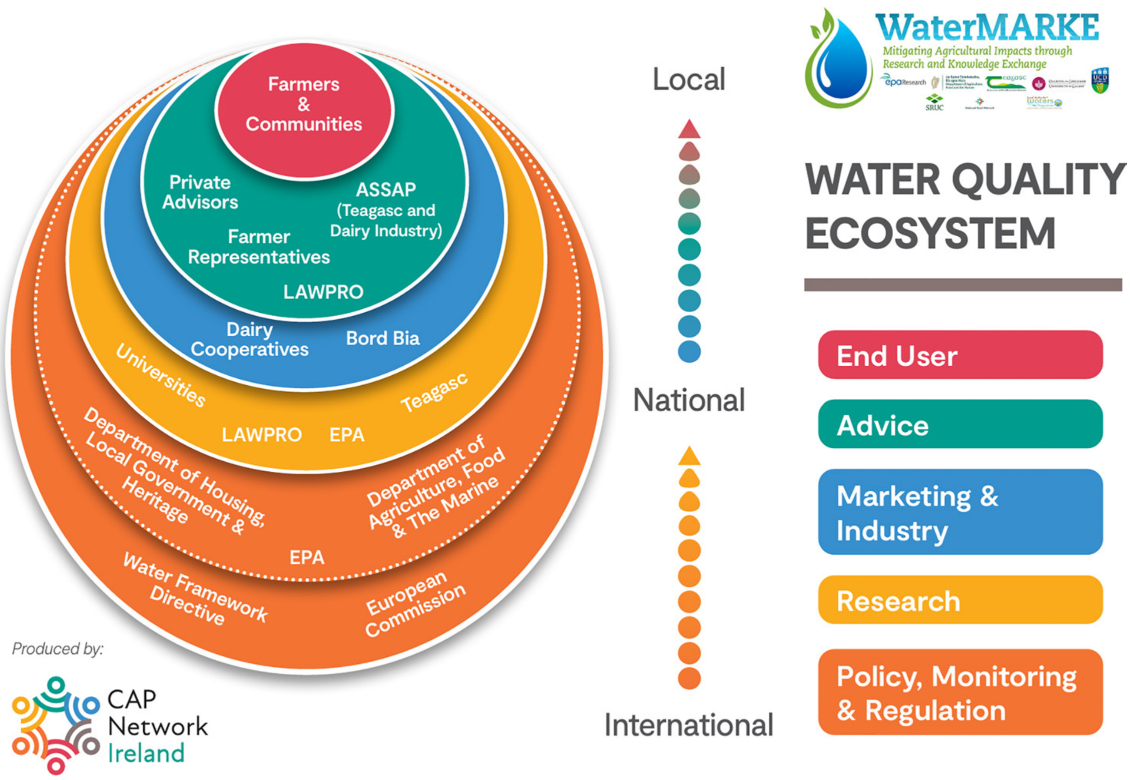

Figure 8.1. The innovation ecosystem for water quality improvement in Ireland (2018–2023). Source: CAP Network Ireland (https://capnetworkireland.eu/watermarke-the-power-of-collaboration-for-water-quality-improvement/).

outcomes for neighbours, with the potential to create collective winners but also individual losers.

Policy. There has been considerable progress in the design of AESs over the last 20 years, with a move from paying farmers to undertake pro-environmental actions to targeting areas for payment and paying for results of actions. While the 2023 Agri-Climate Rural Environment Scheme (ACRES) is primarily focused on addressing biodiversity decline, farms in areas with high-status water objectives and PAAs are prioritised, with a range of specific technological changes to positively influence water quality, including riparian buffer strips or zones, management of intensive grassland next to watercourses, planting trees in riparian buffer zones and low-input grassland. However, “payments for results” are primarily focused on biodiversity measures. While AESs incentivise technological changes, schemes are costed based on income forgone and costs incurred, without incorporating transaction or opportunity costs. As a result, extensive beef and sheep farms with lower costs are typically more likely to engage than farmers with intensive dairy enterprises.

Enterprise. While actors such as dairy co-operatives have become more involved in the water quality innovation ecosystem, it is challenging to deliver on both market-oriented and mission-oriented policies for innovation. In the case of water quality, the market gains for improving water quality are not clear for enterprise actors. Certifying (and thus ensuring that it is economically rewarding) water quality is not easily done in comparison with other agri-environment products (such as livestock or crops). Further research is required to overcome the challenges faced by enterprise actors to co-create innovative solutions for the market to directly reward measures to improve water quality.

Information and research. The resources required to solve these problems are considerable. The availability of large-scale, close-to-real-time data will require the development of research in new areas such as data analytics to streamline the approach of converting data to usable information, along with enhancing the spatial and temporal resolution of the sensor network, particularly in at-risk catchments. Improved information can also leverage enhanced research and more targeted advice, thus improving know-how and allowing continuation of the trajectory seen in the nitrates regulations of enhancing the spatial differentiation of regulatory policy. Developing localised solutions to locally defined problems requires improved data, combined with knowledge generation and knowledge exchange processes that can convert these data into water quality improvements.

Intermediaries. By 2018, the need for innovative dedicated water quality intermediaries had been recognised with the establishment of LAWPRO and ASSAP (with the involvement of Dairy Sustainability Ireland). ASSAP has since expanded, more than doubling the size of the advisory team, with a high level of farmer engagement across PAAs, despite participation being voluntary (Cullen *et al.*, 2024). While the analysis of ASSAP data was focused largely on undertaking research and developing tools to facilitate greater adoption of measures, WaterMARKE research uncovered many ways to improve measure uptake but highlighted the barrier presented by the high implementation cost of many measures.

This cost barrier was addressed in 2023, when a consortium of the primary water quality mitigation actors, led by LAWPRO with support from a range of new stakeholder actors, was awarded €60 m funding for a Water European Innovation Partnership (EIP) to address nutrient, sediment and other farm-related losses to water. The Farming for Water EIP enables payments to farmers to undertake measures when the financial cost is high but the social/environmental benefit is also high.[4] However, the average payment per farm is likely to be less than typical AES payments. In addition, unless the opportunity cost of undertaking measures is sufficiently factored into payments for water quality measures, those farmers with higher opportunity costs are less likely to engage, as happened in earlier AESs. These constraints may make it difficult to adequately reward farmers for adopting the right measures in the right places.

Nevertheless, the Farming for Water EIP is a significant step forwards for the water quality innovation ecosystem and the sector as a whole, and is an exemplar of how farmers, communities, advisors, scientists, and enterprise, regulatory and policy actors have responded to the "mission" of water quality improvement, in a locally led, bottom-up, participatory and collaborative partnership (as presented in Figure 8.2). The broadening of the actor groups in the EIP is also representative of the increased engagement from more diverse stakeholders since the original 2018 WaterMARKE expert panel.

Summary

- Intermediary actors (such as ASSAP advisors) play a key role in localising innovation solutions and facilitating feedback loops between scales within the innovation system. Advisors who are committed and trusted by farmers can go a long way in tackling a significant global challenge such as water quality in contexts where agriculture is a significant contributor to water pollution. Linking local advisors to local and national research institutes is key for generating feedback loops and improving innovation support services for farmers.
- Farm-level mitigation measures need to be flexible, realistic and simple, to improve adoption. ASSAP advisors typically recommend five mitigation measures to farmers out of a potential menu of over 300 context-specific measures that vary with farm level and catchment characteristics.
- The private sector and enterprise actors have an important role to play, even if the market incentives for water quality are not clear. In the case of Ireland, funding from the dairy co-operatives has allowed for a considerable expansion in the number of ASSAP advisors.
- Bringing innovation system actors together is crucial. A key, but surprising, finding of the 2018 WaterMARKE expert panel stakeholder consultation was that it was the first time that these stakeholders had met. Subsequent programmes such as ASSAP and the Farming for Water EIP have significantly enhanced interactions and improved trust among actors.

4 WaterMARKE research provided the evidence-based research to justify the need for the Water EIP.

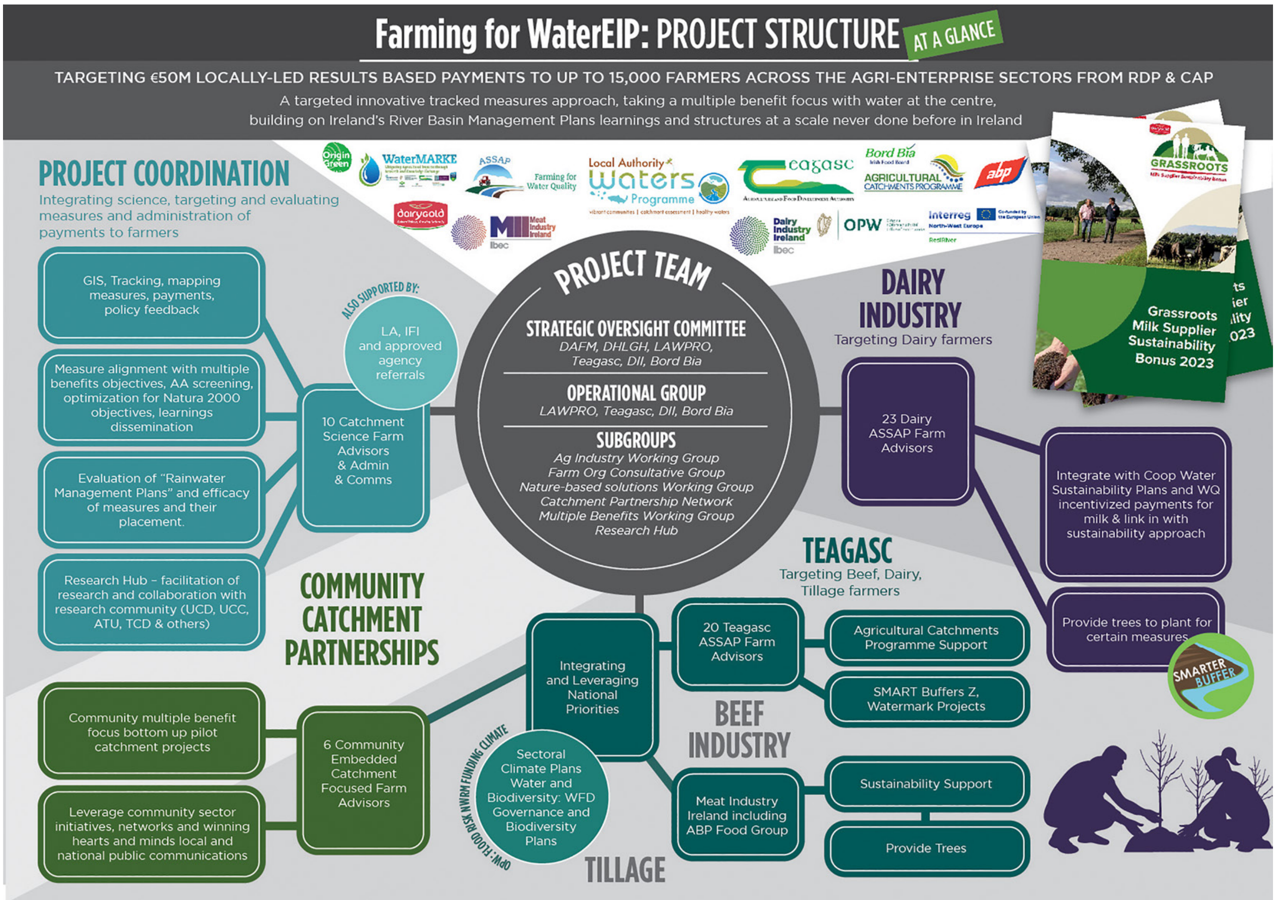

Figure 8.2. Farming for Water EIP: the innovation ecosystem for water quality in Ireland (2023). Source: Farming for WaterEIP.

9 Conclusions and Policy Recommendations

WaterMARKE research has laid a crucial foundation for navigating the path towards sustainable agricultural practices and safeguarding the planet's most valuable resource – water. Its implications extend beyond academia, impacting the broader realm of policymaking and reinforcing the urgent need to address these vital issues with a more comprehensive approach. The pressing need to enhance farmers' adoption of pro-environmental water quality behaviours arises from the urgent task of mitigating the detrimental impacts of agriculture on water quality. This research has brought to light the existing limitations, both direct and indirect, that hinder farmers' adoption of these crucial behaviours. Addressing this issue requires a multilevel approach involving various actors to maximise the effectiveness of pro-environmental policies. The exploration of these perspectives sheds light on the broader implications for the agricultural innovation system and the formulation of effective policies. The research findings underscore the need for holistic approaches that address the multifaceted dynamics among farmers, advisors, advisory and research organisations, regulators, enterprise and policymakers, emphasising the importance of collaborative "system" efforts in fostering meaningful change.

As the underlying science, context and potential solutions are highly complex, greater know-how is required at farm level to mitigate differential or diffuse pathways of loss to water. Developing localised solutions to locally defined problems requires improved data and the knowledge generation and knowledge exchange processes that can convert these data into usable information.

Drawing on social psychology, the research clearly demonstrates the importance of behavioural drivers in increasing measure adoption. Know-how and farmer norms are particularly important, along with resources (costs) and attitudes. In this context, joint farmer activities (such as discussion groups) are particularly important in developing and improving positive behavioural drivers of adoption. The advisor–farmer relationship is also critical in relation to knowledge and trust. These lessons are also relevant across the wider innovation system.

In developing the innovation system further, it is important to continue to engage with farm organisations and develop trust across the innovation system, continuing to generate more positive norms around water quality improvement. Of particular focus is the development of trust between agents to facilitate co-ordinated actions.

The resources required to solve the problems highlighted are considerable: the investment needs for some measures are high. However, policymakers/policy regulators also need to consider not only direct costs but also opportunity costs. These vary not just across farms but also across space, depending on the measures that are required. However, given the co-benefits of nutrient load reduction measures in terms of other public goods, such as mitigating climate change and increasing biodiversity, there may be potential for costs to be spread across other ecosystem co-benefits. Where transaction costs are higher than the cost of implementation locally, it may also make sense to focus on less targeted measures, particularly in areas with lower risk.

Broadening the scope of legislation-based agricultural data-sharing agreements for research analytical purposes, while remaining General Data Protection Regulation (GDPR) compliant, would considerably augment research modelling capacity. For example, it could facilitate the quantification of the economic implications of EPA Catchments Unit analyses.

Moving to results-based policy targets that are locally defined (along the same lines as biodiversity) to improve the targeting of actions would ensure that resources are targeted at activities in areas where there is a need and also at the farmer cohorts that can deliver the most improvement.

Linking behavioural drivers with pro-environmental nudges may be an area with potential to further develop the knowledge base in this field, and future research could provide a platform for policy recommendations capable of fostering significant behavioural change. This would serve to align scientific best practice with behavioural psychology, which could drive farmer intentions to adopt measures that are win–win for both the farmer and the environment.

Within climate change policy, there have been proposals to develop emissions trading schemes. These allow those who can benefit from production to purchase emissions permits from others. A similar approach could be developed for water quality, but implementation would need to be at the catchment scale rather than the national scale.

A necessary condition of emissions trading schemes is the ability to identify the emissions limits that can be absorbed. In carbon trading schemes, businesses can purchase emissions trading permits (combined with "free" emissions allocations and grand-parented emissions) up to national emissions targets, thereby limiting total national emissions. However, for water quality, the potential load limit would have to be defined at the catchment scale. This is different from the Nitrates Directive, which sets a national limit regardless of the hydrology, supplemented by a derogation for farmers who engage in additional measures.

An emissions trading programme such as this would enable resources to be shared more equally, facilitating a more just transition. For example, provided the biophysical and risk contexts of the catchment allowed for expansion, a programme could allow dairy farmers to expand, given the higher return to land and investment from dairy than from other sectors, but with resources transferring to the holders of emissions permits. It would facilitate a just transition, as high-income farmers compensate others, such as beef farmers, within the catchment. Limits would need to be set at a level consistent with good water quality in a catchment. Since dairy quotas were abolished, dairy incomes have risen, but overall farm viability levels have stayed static or fallen as the viability level of beef farmers has continued to fall.

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Abbreviations

AES	Agri-environment scheme
ASSAP	Agricultural Sustainability Support and Advisory Programme
COM-B	Capability, opportunity and motivation behaviour
EIP	European Innovation Partnership
LAWPRO	Local Authority Waters Programme
MAC	Marginal abatement cost
PAA	Priority area for action
PBC	Perceived behavioural control
SN	Subjective norms
TPB	Theory of planned behaviour

An Ghníomhaireacht Um Chaomhnú Comhshaoil

Tá an GCC freagrach as an gcomhshaol a chosaint agus a fheabhsú, mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ar thionchar díobhálach na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialáil: Rialáil agus córais chomhlíonta comhshaoil éifeachtacha a chur i bhfeidhm, chun dea-thorthaí comhshaoil a bhaint amach agus díriú orthu siúd nach mbíonn ag cloí leo.

Eolas: Sonraí, eolas agus measúnú ardchaighdeáin, spriocdhírithe agus tráthúil a chur ar fáil i leith an chomhshaoil chun bonn eolais a chur faoin gcinnteoireacht.

Abhcóideacht: Ag obair le daoine eile ar son timpeallachta glaine, táirgiúla agus dea-chosanta agus ar son cleachtas inbhuanaithe i dtaobh an chomhshaoil.

I measc ár gcuid freagrachtaí tá:

Ceadúnú

- Gníomhaíochtaí tionscail, dramhaíola agus stórála peitril ar scála mór;
- Sceitheadh fuíolluisce uirbigh;
- Úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe;
- Foinsí radaíochta ianúcháin;
- Astaíochtaí gás ceaptha teasa ó thionscal agus ón eitlíocht trí Scéim an AE um Thrádáil Astaíochtaí.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

- Iniúchadh agus cigireacht ar shaoráidí a bhfuil ceadúnas acu ón GCC;
- Cur i bhfeidhm an dea-chleachtais a stiúradh i ngníomhaíochtaí agus i saoráidí rialáilte;
- Maoirseacht a dhéanamh ar fhreagrachtaí an údaráis áitiúil as cosaint an chomhshaoil;
- Caighdeán an uisce óil phoiblí a rialáil agus údaruithe um sceitheadh fuíolluisce uirbigh a fhorfheidhmiú
- Caighdeán an uisce óil phoiblí agus phríobháidigh a mheasúnú agus tuairisciú air;
- Comhordú a dhéanamh ar líonra d'eagraíochtaí seirbhíse poiblí chun tacú le gníomhú i gcoinne coireachta comhshaoil;
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Dramhaíola agus Ceimiceáin sa Chomhshaol

- Rialacháin dramhaíola a chur i bhfeidhm agus a fhorfheidhmiú lena n-áirítear saincheisteanna forfheidhmithe náisiúnta;
- Staitisticí dramhaíola náisiúnta a ullmhú agus a fhoilsiú chomh maith leis an bPlean Náisiúnta um Bainistíocht Dramhaíola Guaisí;
- An Clár Náisiúnta um Chosc Dramhaíola a fhorbairt agus a chur i bhfeidhm;
- Reachtaíocht ar rialú ceimiceán sa timpeallacht a chur i bhfeidhm agus tuairisciú ar an reachtaíocht sin.

Bainistíocht Uisce

- Plé le struchtúir náisiúnta agus réigiúnacha rialachais agus oibriúcháin chun an Chreat-treoir Uisce a chur i bhfeidhm;
- Monatóireacht, measúnú agus tuairisciú a dhéanamh ar chaighdeán aibhneacha, lochanna, uiscí idirchreasa agus cósta, uiscí snámha agus screamhuisce chomh maith le tomhas ar leibhéil uisce agus sreabhadh abhann.

Eolaíocht Aeráide & Athrú Aeráide

- Fardail agus réamh-mheastacháin a fhoilsiú um astaíochtaí gás ceaptha teasa na hÉireann;
- Rúnaíocht a chur ar fáil don Chomhairle Chomhairleach ar Athrú Aeráide agus tacaíocht a thabhairt don Idirphlé Náisiúnta ar Ghníomhú ar son na hAeráide;
- Tacú le gníomhaíochtaí forbartha Náisiúnta, AE agus NA um Eolaíocht agus Beartas Aeráide.

Monatóireacht & Measúnú ar an gComhshaol

- Córais náisiúnta um monatóireacht an chomhshaoil a cheapadh agus a chur i bhfeidhm: teicneolaíocht, bainistíocht sonraí, anailís agus réamhaisnéisiú;
- Tuairiscí ar Staid Thimpeallacht na hÉireann agus ar Tháscairí a chur ar fáil;
- Monatóireacht a dhéanamh ar chaighdeán an aeir agus Treoir an AE i leith Aeir Ghlain don Eoraip a chur i bhfeidhm chomh maith leis an gCoinbhinsiún ar Aerthruailliú Fadraoin Trasteorann, agus an Treoir i leith na Teorann Náisiúnta Astaíochtaí;
- Maoirseacht a dhéanamh ar chur i bhfeidhm na Treorach i leith Torainn Timpeallachta;
- Measúnú a dhéanamh ar thionchar pleananna agus clár beartaithe ar chomhshaol na hÉireann.

Taighde agus Forbairt Comhshaoil

- Comhordú a dhéanamh ar ghníomhaíochtaí taighde comhshaoil agus iad a mhaoiniú chun brú a aithint, bonn eolais a chur faoin mbeartas agus réitigh a chur ar fáil;
- Comhoibriú le gníomhaíocht náisiúnta agus AE um thaighde comhshaoil.

Cosaint Raideolaíoch

- Monatóireacht a dhéanamh ar leibhéil radaíochta agus nochtadh an phobail do radaíocht ianúcháin agus do réimsí leictreamaighnéadacha a mheas;
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha;
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta;
- Sainseirbhísí um chosaint ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Ardú Feasachta agus Faisnéis Inrochtana

- Tuairisciú, comhairle agus treoir neamhspleách, fianaise-bhunaithe a chur ar fáil don Rialtas, don tionscal agus don phobal ar ábhair maidir le cosaint comhshaoil agus raideolaíoch;
- An nasc idir sláinte agus folláine, an geilleagar agus timpeallacht ghlan a chur chun cinn;
- Feasacht comhshaoil a chur chun cinn lena n-áirítear tacú le hiompraíocht um éifeachtúlacht acmhainní agus aistriú aeráide;
- Tástáil radóin a chur chun cinn i dtithe agus in ionaid oibre agus feabhsúchán a mholadh áit is gá.

Comhpháirtíocht agus Líonrú

- Oibriú le gníomhaireachtaí idirnáisiúnta agus náisiúnta, údaráis réigiúnacha agus áitiúla, eagraíochtaí neamhrialtais, comhlachtaí ionadaíocha agus ranna rialtais chun cosaint chomhshaoil agus raideolaíoch a chur ar fáil, chomh maith le taighde, comhordú agus cinnteoireacht bunaithe ar an eolaíocht.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

Tá an GCC á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóir. Déantar an obair ar fud cúig cinn d'Oifigí:

1. An Oifig um Inbhunaitheacht i leith Cúrsaí Comhshaoil
2. An Oifig Forfheidhmithe i leith Cúrsaí Comhshaoil
3. An Oifig um Fhianaise agus Measúnú
4. An Oifig um Chosaint ar Radaíocht agus Monatóireacht Comhshaoil
5. An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tugann coistí comhairleacha cabhair don Ghníomhaireacht agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.