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Research article

Investigating bottlenecks hampering the adoption of water quality-enhancing practices for sustainable land management in Ireland

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ABSTRACT

The scaling of adopted measures on farms is often proposed however, the factors that inform non-adoption of advised measures are typically overlooked. Better understanding of these factors could offer important insights for overcoming these bottlenecks and therefore offer important potential with respect to addressing agri-environmental challenges. We investigated the factors hampering the adoption of sustainable land management practices advised by the main agricultural extension of Ireland. A large qualitative dataset (N = 760) containing farmers' reasons for rejection of advised practices was analysed to identify bottlenecks for adoption. Our research showed that rejection can be explained by different underlying reasons. While subsidies exist for the implementation of sustainable land management practices, incentives to implement are insufficient and costs remain the main barrier for the adoption of the sustainable land management practices. Additionally, land ownership challenges and the aging farming population hamper the adoption of sustainable land management practices. Next to an analysis of the reasons for rejection of all advised practices, we investigated three often advised sustainable land management practices in-depth: implementation of riparian buffer zones, preventing cattle access to watercourses and implementation of a nutrient management plan. The differences in barriers for adoption between these practices showed the need for nuanced communication in order to enhance uptake. In order to reach water quality targets through enhanced uptake of sustainable land management practice, advice should be framed and tailored to farmer objectives.

1. Introduction

Across the European Union (EU) agriculture is the biggest source of water pollution today, which predominantly contributes to the non-point pollution of water in the EU (FAO, 2017; Kersebaum et al., 2003). To target water pollution across the EU, the Water Framework Directive (WFD) was adopted by the European Commission (EC) in 2000 (2000/60/EC). It requires integrated management of water resources aiming to ensure all surface water bodies to be of 'good' ecological status by 2027. In parallel, the Nitrates Directive (91/676/EEC) has been introduced to reduce the impact of agriculture on water courses by limiting the use of fertilizers and thereby reducing loss of nutrients from agriculture into water courses (O'Donoghue et al., 2021).

Sustainable land management practices are necessary to mitigate the water quality challenge. O'Sullivan et al. (2022) showed that a large number of actors are communicating with farmers about sustainable land management. Nevertheless, the number of waterbodies with good ecological status across Europe remains unsatisfactory and reaching the WFD aims by 2027 will be a vast challenge. Overall, water quality in Ireland compares favourably to the EU average (European Environmental Agency (EEA), 2012). Nevertheless, surface water and groundwater bodies in Ireland continue to be under pressure from human activities. In particular nitrogen (N) and phosphorus (P) attributable to agricultural activities are a key pressure on water quality (Lu and Tian, 2017; Lun et al., 2018). Both N and P behave differently and have different loss pathways into water courses. N is generally prone to vertical leaching from the soil, and it is mainly transferred via ground water as nitrate into the water courses (Legout et al., 2007; Mellander et al., 2014; Molenat et al., 2008). Meanwhile, P is less prone to leaching as it has a higher adsorption affinity with the soil. P is generally less soluble than N, thus more prone to be transferred to water courses through surface pathways (Sharpley et al., 2008).

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According to Environmental Protection Agency (EPA) (2021), almost half (47%) of Irish river sites have unsatisfactory nitrate concentrations. Currently, 38% of the river sites have rising concentrations of nitrate. Also, 29% of river sites have unsatisfactory total P concentrations and 24% of the sites face increasing phosphate concentration (EPA, 2021). The total load of N and P transferred to the marine environment via rivers increased by 26% and 35% respectively compared to the 2012–2014 monitoring period (EPA, 2021).

Research has shown that the national agricultural advisory body in Ireland is widely trusted in the Irish agricultural context and communicates frequently with farmers (Gorman et al., 2019; O'Sullivan et al., 2022). Nevertheless, uptake of sustainable land management practices is suboptimal, as water quality levels in Ireland remain static and significant improvements are lagging behind (Agricultural Sustainability Support and Advisory Programme (ASSAP) et al., 2020). Therefore, this study will focus on Ireland to understand barriers experienced by farmers to adopt sustainable land management practices in order to improve interventions aimed at reducing the agricultural impact on water quality.

1.1. Knowledge gap

Previous research has explored factors that influence the uptake of sustainable land management practices in Ireland (e.g., Daxini et al., 2018; Micha et al., 2017; Murphy and Meredith, 2015). This has shown, that farm decision-outcomes in Ireland are affected by demographic, social, economic and farm characteristics of the farmer and the environmental performance of the farm (Daxini et al., 2018; Micha et al., 2017; Murphy and Meredith, 2015). However, the factors that hamper farmers to actually implement sustainable land management practices on their farm in order to mitigate their impact on the water quality remains largely unexplored.

Typically, research in the domain of message acceptance is conducted through quantitative surveys, with little room for insight into the reasoning behind acceptance and the decision-making process. This does not allow for investigation of the different layers of acceptance and fails to give a voice to those farmers who reject advice given. It assumes that the reason for not adopting an advised practice is the same for all farmers as they are all assigned to the group 'rejecting farmers'. However, different acceptance rates of advised sustainable land management practices (ASSAP, 2020) suggests different reasons for rejection that may represent different bottlenecks that hamper the uptake of these practices. No comparison between the reasons for rejection for different advised sustainable land management practices was found in the literature.

1.2. Research objective and question

This research aims to explore the existing bottlenecks for acceptance of selected sustainable land management practices widely proposed to improve water quality. These bottlenecks and the reasons for rejection will be investigated to understand how water quality challenges might be better targeted in the future.

As farm management practices have an impact on water quality, understanding the factors hampering the uptake of sustainable land management practices to mitigate agriculture's impact on water quality is of paramount importance. In light of declining water quality status, there is an urgent need to understand the diversity of factors hampering the adoption of sustainable land management practices and where the bottlenecks in the decision-making process are located. In turn, messaging in relation to sustainable land management can be tailored to farmers' needs by policymakers, advisors, and other actors in the agricultural knowledge and information systems (AKIS). Beyond messaging, such information can help to inform development pathways necessary to tackle water quality challenges.

Taking Ireland as a case study, the research question being explored in this study is: "*What are the bottlenecks hampering farmers' acceptance of advised sustainable land management practices and do these bottlenecks vary between practices?*"

2. Theoretical framework

2.1. Social Judgement Theory

Farm management practices can have an impact on N and P loads in Irish water bodies (Dupas et al., 2017). Practices are things that people do or do not do on a more or less regular basis (Giddens, 1986; Leeuwis, 2004) or "patterns of human action or regular activities" (Leeuwis, 2004). Farming practices are influenced by social interactions with actors in and outside the agricultural production chain (Leeuwis, 2004). Therefore multiple actors in the AKIS are communicating with farmers about sustainable land management practices (O'Sullivan et al., 2022). The process of judgement of this communication is explained by the Social Judgement Theory (C. W. Sherif et al., 1965; M. Sherif and Hovland, 1961). This theory assumes that messages sent from one actor to another whilst communicating with each other are judged by comparing them to the current point of view of the actor. Three zones are identified with attitudes formed towards the received message. In the first zone, the latitude of acceptance, the actor agrees with the statements and so they are accepted. In the second zone, the latitude of rejection, the messages are unacceptable to the actor. The third zone is the latitude of non-commitment, whereby the actor neither agrees nor disagrees with the messages. The width of the latitudes depends upon the relationship between the actors, as well as the standpoint that determines the allocation of messages into the different latitudes (M. Sherif and Hovland, 1961). After receiving a message, either by seeing or hearing the message, the mental process consists of two phases (M. Sherif and Hovland, 1961). In the first phase, the actors evaluate the message based on the content and give it a position relative to their own standpoint. So, the standpoint of the actors themselves governs the evaluation and comparison of messages. Based on this evaluation and comparison, it can be determined whether the message falls within the latitude of acceptance or is in the other latitudes (M. Sherif and Hovland, 1961). Following that, the actors adjust their standpoint towards or away from the message in the second phase.

2.2. Conceptualising acceptance

Messages are accepted by farmers on varying levels (Leeuwis, 2004). Externally introduced innovations, like advice on sustainable land management practices, are accepted to five layers of acceptance as described by Leeuwis (2004, adapted from Aarts (1998) (Fig. 1) explained below (2.2.1–2.2.5). An externally introduced innovation is introduced by a sending actor, a person or organisation communicating information about the sustainable land management practices with the farmer.

2.2.1. Acceptance of the perceived underlying problem definition

The layer of acceptance of the perceived underlying problem definition relates to the extent to which a farmer agrees or personally identifies with the proposed problem definition underlying the advised sustainable land management practices. The problem definition is often implicitly connected to the proposed solution. If a problem is not recognized by the farmer, it is less likely the proposed solution is accepted by the farmer (Leeuwis, 2004).

2.2.2. Acceptance of the legitimacy of the intervention and the actor

This layer of acceptance focuses on the perceived justice and acceptability of social pressures and interventions from an outside actor. If a solution, (e.g., an advised sustainable land management practice) is proposed by someone who has no 'right' to interfere in this particular affair according to the farmer, it will be less likely that the solution is

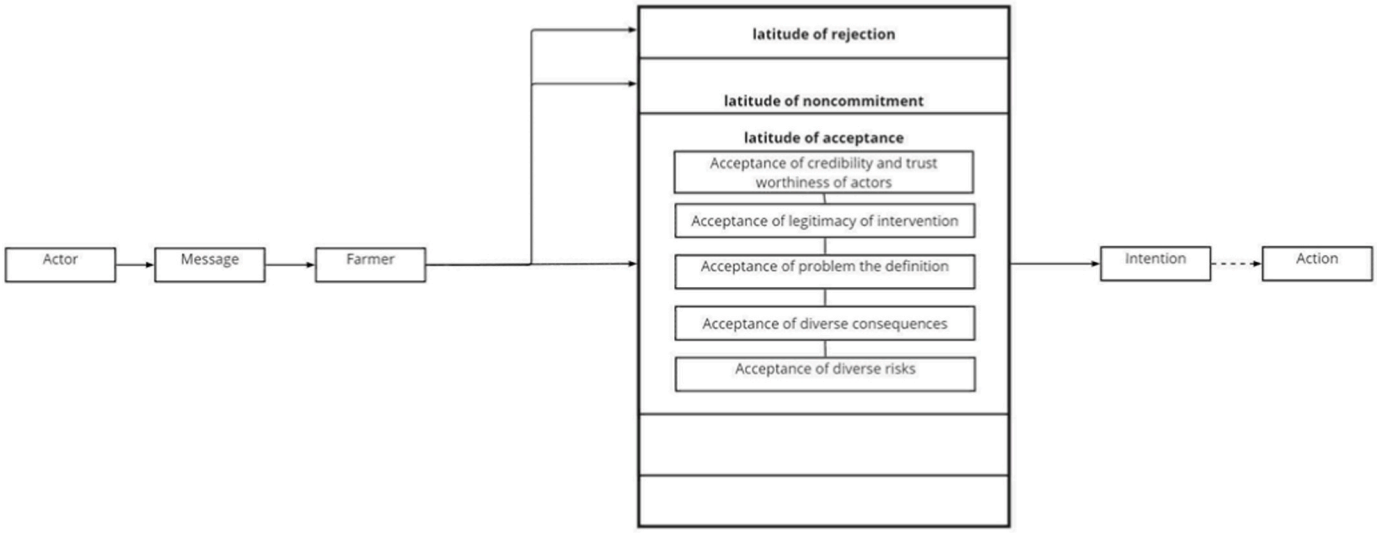

Fig. 1. Conceptual framework adapted from M. Sherif and Hovland (1961) and Leeuwis (2004).

accepted (Leeuwis, 2004).

2.2.3. Acceptance of the credibility and trustworthiness of the intervening actor

This layer of acceptance focuses on the actor introducing the solution to the farmer. The credibility and trustworthiness of this actor and the introduced solution are the determining factors in this layer.

Trust is an implicitly mentioned concept in the Social Judgement Theory as well. Sherif and Hovland (1961) describe that the biggest changes in standpoint might happen between comparable groups with different standpoints, as comparable groups are more likely to be trusted. Therefore, a non-trusted actor is less likely to be taken seriously when proposing a solution (Leeuwis, 2004).

2.2.4. Acceptance of the diverse perceived consequences

In this layer of acceptance, the acceptance of the consequences is described. This asks for an evaluation of the perceived outcomes of the proposed solution by the farmer. Farmers typically consider (Leeuwis, 2004).

- Technical and economic effectiveness and efficiency
- Fairness of the consequences
- Political desirability
- Cultural acceptability
- Practical feasibility

The technical and economic effectiveness and efficiency, evaluates the technical or economic consequences that could hamper the adoption of the proposed solution. In the fairness of the consequences, the farmer evaluates whether it feels fair to the farmer that a solution is proposed to them. The political desirability evaluates the legislative consequences of the proposed solution. Additionally, cultural acceptability evaluates the consequences of social interactions and social norms in the surroundings of the farmer resulting from the proposed solution. Lastly, in the practical feasibility layer, farmers reflect on whether they will be able to carry out the proposed solution in practice. This is different from the technical and economic effectiveness and efficiency, as the effectiveness and efficiency of the proposed solution are not questioned by the farmer, but the accessibility of the proposed solution is questioned by the farmer.

In line with this theory of Leeuwis (2004), Daxini et al. (2019) confirmed that in the Irish agricultural context cultural acceptability (subjective norm), as well as the practical feasibility (experienced difficulties), played a role in the uptake of adopting a nutrient management plan as a sustainable land management practice (Daxini et al., 2019).

2.2.5. Acceptance of perceived risks

The extent to which perceived risks of the proposed solution are accepted is central in this layer of acceptance. The risks associated with the proposed solution might be diverse, in the technical socio-economic and social-organisational fields (Leeuwis, 2004). The perceived risks are different from the 'acceptance of the diverse perceived consequences' as the perceived risk results from the consequence and the probability of occurrence of the undesired event. The possibility of a consequence is mentioned, but presented by the farmer as a possibility but not as a fixed consequence of the practice.

3. Methods

3.1. Case study

Ireland has a total number of 137,500 farms with an average farm size of 32.4 ha. As the largest land use in the country, agriculture has a significant impact on water quality (CSO Ireland, 2021). From the 4.45 million hectares of agricultural land, 4.1 million are utilized as grassland, which makes grass the most important land usage (CSO Ireland, 2021; O'Sullivan and Creamer, 2018). Ireland has 7.2 million cattle, whereof 1.5 million cattle for dairy farming purposes especially located in the south and southeast of Ireland (CSO Ireland, 2021). Next to that, there are 5.1 million sheep on the grasslands (CSO Ireland, 2021). Nitrogen (N) and phosphorus (P) are key nutrient inputs into these grasslands through organic and chemical fertilisers (Ruane et al., 2014; Wall et al., 2018).

High nitrate levels are predominantly found in the south and southeast of the country where intensive agriculture is over freely draining soils (EPA, 2021). These free draining soils have high infiltration rates and allow water to percolate quickly through soils. Applied N will leach away to groundwater if applied in excess at the wrong time (Wall et al., 2018). Phosphorus losses occur on poorly draining soils with a high clay content that saturate quickly. Soluble P and P attached to soil particles from fertiliser application will be washed off to the drainage network (Daly et al., 2006; Wall et al., 2018).

To implement the European WFD on a national level, the River Basin Management plan 2018–2021 (RBM) was formed. Together with EPA, the Local Authority Waters Programme (LAWPRO) catchments were

selected as priority areas for action (PAAs), where the status of the water is at risk (Fealy et al., 2010) (Fig. 2). Approximately 20,400 farms are located within the PAAs.

In these priority areas for action, the Agricultural Sustainability Support and Advisory Programme (ASSAP) was established to provide tailored advice for farmers in order to minimalize agricultural pressures on the water quality. The ASSAP programme was developed as a whole sector approach in collaboration with farmers, to meet the challenging water quality targets Ireland is facing.

The ASSAP programme introduced a new approach in which close contact with farmers is crucial. Therefore, all farmers in the priority catchments received an offer for a free farm visit from an ASSAP advisor. Since the start of the ASSAP in 2018, 2410 farm visits were carried out and registered in 2021. The difference between the farms located within the PAAs (20,400) and the visited farms by ASSAP, is that visited farms are those that were referred by LAWPRO to the ASSAP programme on the basis of the severity of water quality damage in the PAA and the influence of these farms on water courses.

A total of 12,992 issues were identified across the farms assessed and categorized into 45 main issues by the 29 advisors from the ASSAP programme. Examples of these issues are 'N leaching from light soils' or 'Riverbank erosion'. Based on identified issues, targeted advice to adopt a specific sustainable land management practice to mitigate the water quality risk was provided, in total 120 mitigation actions were advised to farmers. Between 2018 and 2021, 12,862 pieces of advice were given by the advisors of which 11,993 were agreed upon and carried out by the farmers. The advisors all received the same training and worked in small groups initially for consistency of assessment. ASSAP advisors completed a follow-up meeting to track progress. If a practice had been agreed upon initially but not been adopted by the farmer during the interim period, the advisor recorded the reason(s) for not adopting the proposed measures. The advisors used a standardized form with open-ended questions to identify issues, recommend mitigation actions and track the progress of implementation. The form was completed by the advisor after each farm visit.

3.2. Dataset

Due to the difficulties in data collection posed by the COVID-19 pandemic, no primary data could be collected. Thus, the large-scale qualitative ASSAP programme dataset was used. It is important to note, that initially, these data were not collected for research purposes,

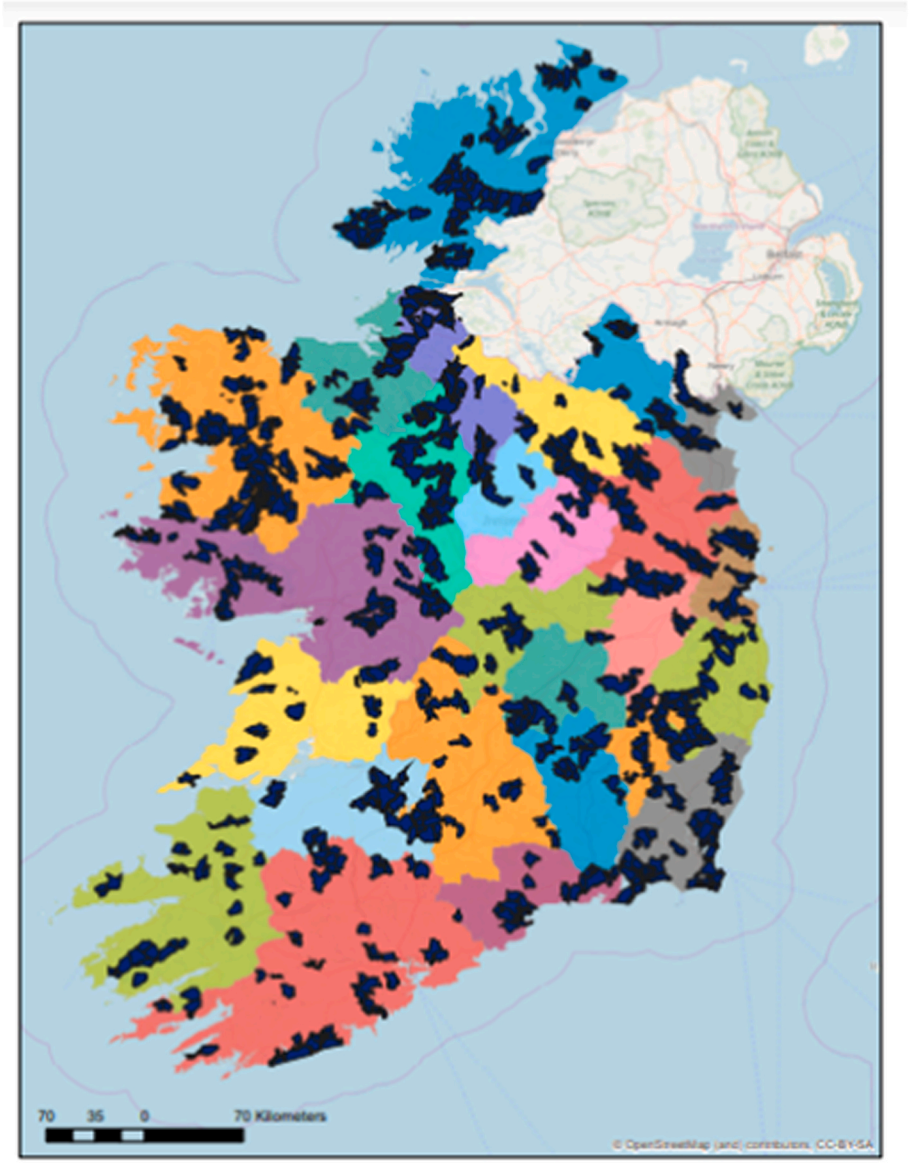

Fig. 2. Identified priority areas for action where the status of the water is at risk (Teagasc & Dairy Sustainability Ireland, 2019).

but to register progress in the ASSAP programme. Accordingly, we systematically evaluated the dataset following the reflective six-step approach of Stewart and Kamins (1993) for secondary data evaluation. This approach is effectively an evaluation of the quality and appropriateness of the data set by answering six questions: (1) What was the purpose of the study? (2) Who collected the information? (3) What information was actually collected? (4) When was the information collected? (5) How was the information obtained? (6) How consistent is the information with other sources? The evaluation of the first four steps of this approach is described in the case study description (3.1). Furthermore, the fifth step was crucial for the evaluation of the used secondary dataset. As described above, the advisors who collected the data all received the same training, used standardized formats and conducted their first assessments together with other advisors for consistency of data collection and calibration of the assessment data. The sixth step of the approach required comparison with other data sources, which was difficult to achieve due to a lack of comparable studies. Accordingly, expert judgement was applied, an expert on Irish agricultural extension in relation to sustainable land management practices for water quality, qualified that the data set reflected their experiences in the field. On this basis and with all of these steps taken into account, the data set was determined to be suitable and appropriate to answer our research question. In this research, we explored the data on advised management practices that were not adopted, and the reasons cited by farmers for non-adoption. The data included 911 data entries, which were collected in a time span from January 2019 to November 2021. Data cleaning and quality processing consisted of the removal of partial data entries. To be included, data entries had to contain a reason for non-adoption of the advised management practice. Resulting in a total of 760 data entries.

3.3. Identified practices

Besides analysing the practices, we will focus on the three most recommended practices aimed at addressing the key water quality issues: implementing a riparian buffer zone, preventing livestock access to watercourses, and implementing a nutrient management plan. Based on consultation with experts engaged within the national advisory body (Teagasc) and the literature, these practices were identified as most significant for the Irish context to investigate their acceptance levels. Over 120 practices were advised to farmers, which makes it more suitable to categorize the reasons for rejection for practices that were more often advised and/or more often rejected than practices that were less often advised or more often accepted. In addition to acceptance overall, this focussed assessment provides an opportunity to highlight how impact pathways of the main recommendations might be increased.

Riparian buffer zones are an interception approach to capture nutrients after they have been mobilised (Buckley and Carney, 2013). A buffer zone is a vegetative strip of land alongside the watercourse aiming to hinder the run-off of nutrients, sediment and other organic matter directly into the watercourse (Ramilan et al., 2010 in Buckley et al., 2012). Establishment of riparian buffer zones has gained high priority from some policymakers, due to extensive research showing their positive effect on water quality under optimal hydrological conditions (Lynch et al., 2001).

Cattle access to watercourses has an impact on aquatic ecology, geomorphology, sediment entrance and the integrity of the above-mentioned riparian buffer zones in addition to water quality issues. Research has shown the need in Ireland to prevent cattle access to watercourses to manage local habitat quality and downstream water quality issues in Ireland (Conroy et al., 2016; O'Sullivan et al., 2019). Multiple management practices are effective in preventing cattle access to watercourses e.g., providing alternative drinking stations for cattle or fencing alongside the watercourse.

The purpose of implementing a nutrient management plan is to ensure that nutrient application on farmland is done in the right quantities, at the right moment, on the right land and from the right source (Genskow, 2012; Roberts and Johnston, 2015). Nutrient management plans intend to prevent overuse and inefficient use of nutrients, whilst encouraging farmers to improve production (Daxini et al., 2019).

3.4. Data analysis

The dataset was analysed using a deductive coding approach. Ten codes were derived from the theoretical framework. Additionally, two codes were added as the literature showed an influence of demographics and farm characteristics on decision making processes (Table 1). Whilst more factors are shown to be of influence on decision making processes (e.g. social networks and farmer characteristics), information about these factors was not available in the dataset. Therefore, these factors are not included as codes. The codes were used by the main author to categorize the reasons for not adopting a practice into the different layers of acceptance. One reason in the dataset could contain multiple codes if multiple reasons were given for not adopting the advised practice. In case a response did not fit within the coding scheme, it was coded as "other" and described further in the result section.

Following the analysis, reasons for not adopting advised sustainable land management practices (hereafter referred to as 'advised practices') were allocated to the different codes.

4. Results

Table 2 presents the number of reasons for not adopting an advised practice per acceptance level. Fig. 3 shows percentage of reasons allocated to the layers of acceptance. All advised practices are included.

4.1. Acceptance of the problem definition

'Acceptance of the problem definition' consisted of 51 reasons for not adopting advised practices, which related to farmer acceptance of the problem underlying the solution. The first reoccurring topic in this layer related to farmers who mentioned that this issue did not apply to them despite the identified problem by the advisory. A lack of incentive was a reason given by farmers who did not see the benefits of the advised practice for them. Examples recorded by advisors included:

> "Farm is very lowly stocked and only used for summer grazing. Not an intensive enterprise so farmer doesn't see the value in soil sampling."

> "Outside farm with cattle rarely present, does not deem it necessary"

> "Farmer is lowly stocked & doesn't feel it's necessary."

The second topic occurring in this layer was the existence of different beliefs, which consists of reasons in which underlying beliefs or knowledge of the farmer were inconsistent with the advised practices. An example is recorded by an advisor who recommended preventing animal access to water courses to a farmer who believed animal access to water courses stimulated water fauna:

> "Believes animal access points is good for developing spawning grounds for fish"

4.2. Acceptance of legitimacy of intervention

Fewer responses (N = 23) were allocated in the layer 'acceptance of legitimacy of intervention' in which the legitimacy of the advisor or the intervention was questioned. The *legitimacy of the intervening actor* was not mentioned by farmers, while the *legitimacy of the intervention* was mentioned as a reason for not adopting advised practices (N = 23). In these cases, the legitimacy of the advised practice was questioned and another more appropriate solution was brought up by the farmer. The advised solution was not accepted as the intervention was doubted, but

Table 1
Codes used to analyse the dataset and their descriptions.

	Code	Description	Source
Layers of Acceptance			(Leeuwis, 2004 adapted from Aarts, 1998)
Acceptance of problem definition	A1	Reasons where the need for a solution is questioned or the underlying problem definition is not accepted by the farmer.	
Acceptance of legitimacy of intervention	A2	Reasons where the legitimacy of the sending actors is mentioned, as well as the legitimacy of the proposed intervention itself.	
Acceptance of credibility and trustworthiness	A3	Reasons where the trust or credibility of the sending actor is mentioned, as well as the trust or credibility in the advised intervention.	
Acceptance of diverse consequences	A4	Reasons where the outcomes of the implementation of the practice are mentioned as barrier to adoption. With a consequence being defined as a result of something that will happen when adopting the advice.	
- **Technical and economic effectiveness & efficiency**	A4_1	Reasons where technical or economic consequences specifically are mentioned to hamper adoption of the practice.	
- **Fairness of the consequences**	A4_2	Reasons where the fairness of the consequences for farmer when implementing the advised practice was questioned.	
- **Political desirability**	A4_3	Reasons where legislative matters were mentioned as a barrier to adoption.	
- **Cultural acceptability**	A4_4	Reasons where social interactions of the farmer or social norms in the environment of the farmer were mentioned to hamper the adoption of the practice.	
- **Practical feasibility**	A4_5	Reasons where practical feasibility, like accessibility of equipment, were mentioned to not adopt the practice. A willingness is shown to adopt the measure, but a practical, non-economic issue hinders adoption.	
Acceptance of perceived risks	A5	Reasons where risks and negative previous experiences of risks were mentioned as a barrier to adopt the practice. With a risk being defined as the possibility of something bad happening at some time in the future if the advice would be adopted.	
Diversity in decision making			(Daxini et al., 2018; Micha et al., 2017; Murphy and Meredith, 2015)
Farm characteristics	Farm characteristics	Reasons where farm characteristics were mentioned as the barrier to adoption.	
Demographics	Demographics	Reasons related to the personal characteristics of the farmer.	
Other	Other	Reasons that did not fit into the above-mentioned categories.	

another solution was proposed by the farmer. For example, if certain equipment was advised, the farmer proposed another tool (e.g., Möscha spreader) that would be better according to the farmer.

> "Trialling Mocha [sic] spreader at the moment"

4.3. Acceptance of credibility and trustworthiness

Acceptance of credibility and trustworthiness was less frequently mentioned (N = 18). In these cases, farmers valued advice given by actors outside of the advisory higher than the advice from the advisory to implement a sustainable land management practice. If another actor previously told the farmer their farm was doing well on sustainability indicators, the farmer mentioned this as a reason to not adopt the practice advised by the advisory. Examples of advisory records are:

> "Said that he had been inspected before and they had no problem with what he had, […]"

> "Historic advice that area not suitable for trees"

Trust and credibility in the advised intervention was more often mentioned than the trust and credibility of the sending actor. Farmers mentioned that the advised products or equipment were unsuitable or not effective. For these farmers, a lack of trust in the products and equipment was hampering the adoption of the practice. An example of records in this category is when the farmer did not trust a product as they did not have knowledge about the new product.

> "Do not know enough about it as new product."

4.4. Acceptance of the diverse consequences

The dominant bottleneck hampering the uptake of advised practices was the *acceptance of the diverse consequence,* with the highest number of reasons allocated to this layer of acceptance (N = 494). As shown in the theoretical framework, the layer of acceptance of diverse consequences is a broad layer, subdivided in five topics.

The technical and economic effectiveness and efficiency were the most mentioned reasons for not adopting practices advised (N = 355).

Table 2
Number of reasons for not adopting an advised practice per acceptance level.

	N	(A1) Acceptance of problem definition	(A2) Acceptance of legitimacy of intervention	(A3) Acceptance of credibility and trustworthiness	(A4) Acceptance of diverse consequences	(A4_1) Technical and economic effectiveness & efficiency	(A4_2) Fairness of the consequences	(A4_3) Political desirability	(A4_4) Cultural acceptability	(A4_5) Practical feasibility	(A5) Acceptance of perceived risks	Demographics	Farm characteristics	Other
All practices	**760**	**51**	**23**	**18**	**494**	355	4	26	26	85	**16**	**45**	**52**	**75**
Riparian buffer zones	**44**	**5**	**2**	**0**	**33**	22	0	4	1	6	**1**	**2**	**3**	**3**
Preventing livestock access to watercourses	**196**	**9**	**2**	**0**	**178**	130	4	3	3	38	**2**	**7**	**7**	**2**
Nutrient management plan	**37**	**2**	**0**	**12**	**6**	4	0	0	0	2	**0**	**0**	**1**	**17**

The main reason mentioned was the costs of the practices advised, these included the costs of introducing the practice on the farm as well as the maintenance of the practice and the opportunity costs. Another reason was seeking financial support in the implementation of the practices, either by waiting or looking for financial compensation or environmental schemes.

"Waiting to see if there will be a new environmental scheme first."

"Not financially viable."

"Can't afford at moment"

The fairness of the consequences was not mentioned as a reason for not adopting practices, whilst political desirability was mentioned (N = 26) as a reason by farmers. Political desirability refers to the degree to which the advised practice is required by governing bodies. The existence of programmes like ASSAP that are governmentally supported, would suggest high political desirability. However, especially the absence of legal requirements was mentioned as a reason for not adopting the advised practices.

"Not a regulatory requirement and too costly at the minute"

"No regulatory requirement for buffers, not convinced to leave more than necessary"

The cultural acceptability was mentioned (N = 24) by farmers for not adopting advised practices. Cultural acceptability refers to the acceptance of the farmers' social environment regarding the advised practice. This was mentioned in the context of social connections the farmer had to align with in order to be able to implement the advised practices. The connected actors had different norms or beliefs than the farmer regarding the practices. The cultural acceptability touches upon and overlaps with ownership challenges of the farm and land, which will be later discussed in more detail in relation to the farm characteristics (*3.7*). Examples recorded by the advisory included:

"Father & son not agreeing on need for shed. Probably will not go ahead"

"Has rented the yard to another farmer. He will discuss this with him."

"Share farming in operation so will depend on other farmer as well - not in full control of decisions"

Practical feasibility of the advised practices was mentioned 87 times by farmers as a reason for not adopting and implementing the advised practice. This ranged from not being able to access the products required to implement the practices, to time and distance barriers, and a lack of alternatives available on the farm.

"Could not get access to protected urea"

"[..] All silage produced on this outside farm has to be drawn a long-distance home."

"No other source of water"

4.5. *Acceptance of the diverse risks*

Few responses were allocated to the layer acceptance of diverse risks (N = 16). Despite the low number of responses allocated to this layer, the reasons mentioned by farmers are diverse with a broad range of topics. A reoccurring topic is an unwanted increase of production. Improved nutrient management could increase production. This increase is not always preferred by the farmer due to e.g., low stocking rates.

"Thinks he has too much grass already - low stocking rate"

"Farming at a very low stocking rate. Extra production not currently wanted."

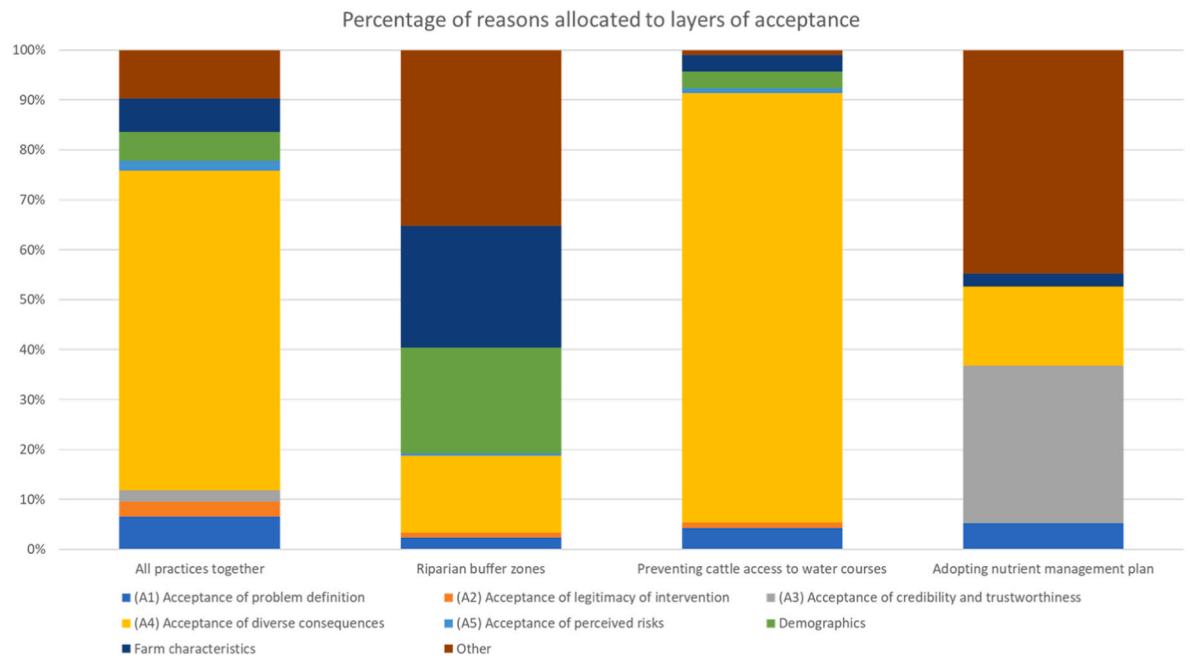

Fig. 3. Percentage of reasons allocated to the layers of acceptance.

Other responses in this layer are related to previous experiences that negatively influence current decision-making processes. Examples of records of the advisory are:

"Tried it before and was not happy with clean outs"

"Not possible to fence off all access points - previously had it fenced, and horses bolted through the fence and got injured. Farmer willing to fence off somewhere risk is lower."

Moreover, the perceived risks for future production as a result of the advised practice are mentioned as a reason for farmers to not adopt the practice. Advisory recorded for example:

"Does not want to reduce spring grass cover as it helps earlier turnout in spring."

"Considers the risk of drought too high when spring reseeding, as farming on shallow soils close to the coast."

4.6. Demographics

All responses allocated to the category 'demographics' (N = 45) had to do with ageing and health condition of the farmer. Being close to retiring age was the most often mentioned, sometimes in relation to the lack of someone to take over the farm after retirement.

"Farmer in 80's it has been tradition, too old to change"

"Said that he's going to be 70 soon so it isn't worth his while investing"

"The farmer considers himself too old to be putting up loose housing for cattle."

In some cases, the health condition of the farmer makes the communication so complicated that advised practices cannot be communicated to the farmer. In other cases, ill-health is mentioned as the main driver for not adopting advised practices.

"Farmer is old & very hard of hearing. Communication was difficult."

"X near retirement & investment depends on if kids will farm"

"He is in poor health."

4.7. Farm characteristics

Under the category 'farm characteristics' several reoccurring topics emerge. The first topic mentioned by farmers as a bottleneck hampering adoption is land ownership. Specifically, the lack of land ownership hampers the willingness to invest in the land and the possibility to invest in facilities available on the farmland.

"Rented land, not going to invest money with no security of tenure"

"Putting infrastructure on conacre land prohibitive financially, leaving as is"

"Conacre land, not long-term agreement, no financial incentive"

Besides, a changing situation on the farm is mentioned as a bottleneck to adopt practices. Farmers who are planning to change their farm management in the future, appeared unwilling to invest in the improvement of the current impact of the farm on water quality. An example of this is when the farmer is planning to stop raising cows. Even though this process is not started yet, investments in farm management are not considered.

Part-time farming was mentioned as a reason for not adopting practices, since part-time farmers often do not have time or money to invest in their farm management. An example of a record by the advisory:

"Part time farmer. Stocking rate didn't justify cost of sampling soil or spreading lime."

Besides part-time farming, low stocking rates on farms in general were mentioned as bottleneck for adoption of advised practices. Farmers with low stocking rates can have a negative impact on water quality like farmers with higher stocking rates. This is particularly the case on more economically vulnerable farms in marginal land if sustainable land management practices are not taken into account due to lacking essential infrastructure or if farmers are less engaged in adopting more sustainable techniques. For example, the implementation costs of fencing off water courses relative to income are higher as opposed to a farmer with higher stocking rates. Moreover, the higher production rates resulting from implementing advised practices are not always desirable if there is no demand for increased production. Furthermore, farmers

with low stocking rates might believe that they are doing little harm or have limited impact on water quality, which causes rejection of the environmental benefit.

> "Farming at a very low stocking rate. Extra production not currently wanted."

4.7.1. Other

In the 'other' category (N = 75) most responses are related to external influences hampering the adoption of the advice. These were external influences in the form of waiting for other experts, waiting for the weather to be suitable, or waiting for a certain season in which the advised practice should be adopted. Examples of records by the advisory included:

> "Waiting for consultant to take samples"

> "Weather broke in September, and he had to cancel two loads of lime ordered."

> "No liming done since due to poor weather came when he had planned to do it."

4.8. Zooming in on specific practices

As for general trends in bottlenecks hampering adoption, the results reveal that the dominant trends for individual practice differ (Fig. 3).

4.8.1. Implementing riparian buffer zones

For the acceptance of riparian buffer zones, the responses for not adopting were relatively more often related to acceptance of the problem definition than the responses for the other practices. The acceptance of diverse consequences was the major bottleneck for adoption of this advised practice. In particular, the costs were the biggest factor hampering the implementation of this practice, which is in line with the overall results described previously. The lack of legal requirements was also mentioned as a reason for not adopting this practice.

4.8.2. Preventing cattle access to watercourses

In relation to preventing cattle access to watercourses, unlike the other practices, cultural acceptability (acceptance of diverse consequences) is mentioned by farmers (N = 3). According to the farmers, social relations play a role in the implementation of this practice as they have to work together with landowners or neighbours to put fencing in place. If the other actor does not agree with the importance or practical implications of the practice, the farmer who received the advice is less able to adopt it despite acceptance of the advice. Land ownership also hampers the adoption of this advised practice. Farmers with short-term land rental contracts were not willing to invest in fencing and installing alternative drinking points for the cows. This is in line with the implementation costs of the practice that form a major barrier for adoption.

4.8.3. Adoption of a nutrient management plan

Strong bottleneck differences were found between the adoption of a nutrient management plan and the other practices. The most hampering factors for adopting a nutrient management plan were external factors and dependency on others (other). This included unforeseen changes in the weather, waiting on advisors to take soil samples and waiting on advice on the nutrient management plan. Moreover, the need for more information about advised products was mentioned by farmers to increase their willingness to use these products.

5. Discussion

This research aimed to investigate the bottlenecks hampering the adoption of advised sustainable land management practices. To do so, a qualitative approach was utilized where farmers' reasons for not adopting were categorized into the layers of acceptance and factors of diversity (Daxini et al., 2018; Leeuwis, 2004; Micha et al., 2017; Murphy and Meredith, 2015).

Overall, it can be concluded that the adoption of advised sustainable land management practices aiming at water quality improvement are most impeded by the diverse consequences perceived by the farmer, the aging farmer population and land ownership challenges. In the acceptance of the diverse consequences especially the costs and practicality associated with the advised practice were considered barriers for adoption. Nevertheless, nuances should be considered as our research showed that dominant bottlenecks vary for different practices advised.

5.1. Societal and political implications

A limited number of responses were related to the acceptance of the problem definition. Agricultural advisors can help farmers by providing technical expertise (Daxini et al., 2018). Since all farmers interviewed had been in contact with agricultural advisors in order to be included in the dataset, this could explain the limited number of responses related to this layer of acceptance.

Few reasons for not adopting practices were related to the second and third layers of acceptance, the legitimacy of intervention and trust and credibility of the sending actor respectively. This is consistent with previous research showing high levels of trust indicated by Irish farmers in their advisors (Gorman et al., 2019). However, this might be subject to a bias in our research since the data was collected by advisors from the same agency as the intervening actor advising the farmer. An implication of this could be that the farmer could have been reluctant to share a lack of trust in someone else from the agency. Nevertheless, Daxini et al. (2019) found that contact with agricultural extension affected intentions towards adopting a sustainable land management practice positively in Ireland.

Economic and regulatory incentivisation are most commonly utilized to incentivise sustainable land practices across the EU (McNeill et al., 2018). Consistent with this, our research shows that the barriers to the adoption of sustainable land management practices are especially related to compliance and economic considerations. In our research, farmers mentioned a lack of legal requirements as a barrier to adoption. Whereas some economic incentivisation is often put in place to encourage farmers to go above and beyond the legal requirements (McNeill et al., 2018), results showed that the implementation costs of sustainable land management practices are the major reasons for farmers to not adopt the advised practice.

Possibilities for (financial) compensation of implementing different practices are or have been available, such as the Green, Low-Carbon Agri-Environment Scheme (GLAS) or the Targeted Agriculture Modernisation Schemes (TAMS). However, from our results costs still emerged as a major barrier for the uptake of advised practices.

This raises the question of whether sustainable land management practice should be mandatory or voluntary. Previously, Segerson (2013) showed the requirements for voluntary approaches in agriculture, like the ASSAP advice, to be effective. The sustainable behavioural norms should be clearly identified and the outcomes should be monitored (Segerson, 2013). The ASSAP provides advice on specific practices with behavioural requirements and an explanation on how to conduct the practice. Moreover, the uptake of the advices are monitored, hence the dataset utilized for this research. Other requirements for effective voluntary approaches in agriculture are market demands for the related product characteristics, significant public funding committed to pay for the voluntary action and the possibility to impose mandatory regulations if the voluntary approach fails (Segerson, 2013). Based on this dataset we cannot make statements about the market demands, but our results point to insufficient public funding to pay for the adoption of the advice and potential for mandatory regulations currently, as both a lack of legal requirements and the implementation costs are mentioned as barriers for adoption.

In addition to implementation costs, related are the challenges with land ownership and the aging farmer population. Lack of land ownership, as well as being a farmer close to retirement both showed to hamper the willingness to invest in sustainable land management practices. Insecurity of the period of rental of the land causes hesitation to invest in the land. Despite existing subsidies, the costs of implementing these practices are perceived too high to invest on land that might not belong to the farmer in the future. In this way, short term land tenure reduces investment in sustainable land management practices with long term benefits.

The findings regarding demographics as being a bottleneck for adoption of practices, are situated in a larger context of an ageing farming population in Ireland and the EU as a whole (Conway et al., 2018; McNeill et al., 2018). Entry of young people into farming in Ireland is perceived as inflexible, due to the dependency on inheritance or purchase of highly inflated prices of farmland. Leasing of land or partnership arrangement is not as widely practised, as in other countries around the world (Gillmor, 1999; Hennessy and Rehman, 2007). This current lack of land mobility does not only prevent young farmers to engage in farming (Bogue, 2012), but may be impeding high environmental performance due to the impact of an ageing farmer population in relation to the adoption of sustainable land management, as shown in this research.

Farmers communicate about land management practices within a broad social network (O'Sullivan et al., 2022). Our research shows that trust in advised practices becomes a barrier for adoption if different actors within the network give contradicting advice to the farmer. This asks for greater alignment between advising actors in the Irish AKIS. Besides alignment between different actors, we revealed that nuanced and tailored messaging is required to increase uptake of sustainable land management practices. Between practices, different bottlenecks for adoption were revealed, as well as differences in barriers for adoption amongst farmers with different farming systems and farm characteristics. This questions the relevance of generalized messaging, and points to an increasing need for personalized advice adapted to the needs and vision of the farmer. For example, one farmer might not be willing to increase productivity due to low stock numbers and would therefore reject the practice. In contrast, another farmer might reject a practice because of reduced productivity. In communication with these different farmers, the same message should be framed in different ways and objectives of the farmer should be taken into account when formulating the advice.

Additionally, Living Labs are gaining more attention as means to accelerate a transition towards sustainable land management on a community level. As we found that individual farmers mostly have a logical reason to reject certain sustainable land management, these Living Labs might be helpful to understand the value of community-level interventions through peer-to-peer learning.

5.2. Theoretical implications

Overall, there is a high diversity of reasons to reject an advised practice. Within the theoretical framework of the Social Judgement Theory (M. Sherif and Hovland, 1961), the latitude of rejection is taken as one outcome, next to the latitude of acceptance and non-commitment. However, this research showed that the latitudes should be considered as being a continuum rather than a black and white distinction between the three latitudes. Whilst one farmer could reject the underlying problem definition, another farmer might accept the problem definition but reject the diverse consequences. Both farmers would end up in the same latitude within the Social Judgement Theory, while having diverse reasons underlying the rejection. Rejection in this research turned out to be a heterogeneous concept representing a diversity of reasons even within the different layers of acceptance, as well as between different practices. Moreover, this research highlighted that most farmers had a logical reason for rejecting advised practices. This shows the inaccuracy of the line of thought that farmers are misinformed or unaware about sustainable land management.

5.3. Limitations and future research needs

Despite attempts to collect primary data through surveys, secondary data has been utilized due to covid-19 related data collection difficulties. The use of secondary qualitative data can be beneficial, as original survey research rarely uses all of the collected data, and unused data can provide answers to other research questions. Nevertheless, the secondary dataset used was not collected to answer the research questions posed. This poses 'the problem of not having "been" there' (Heaton, 2008). To minimalize this problem, expert consultation took place to give insight into the data collection and context.

To our best knowledge, this was the first research that utilized a combination of the latitude of acceptance and the layers of acceptance as a framework for coding qualitative data entries. The theoretical framework did not provide a sharp distinction between categories in all cases. Therefore, we added these distinctions and decision-making rules in the coding table to operationalize the theoretical framework. To develop a validated operationalization of the theoretical framework applicable for other qualitative research regarding acceptance, these categories and decision-making rules need to be further validated.

Although the dataset included some cases of multiple reasons for non-adoption, our analysis focuses on assessing these reasons separately. To better understand the relations between factors of non-adoption, future research could focus on investigating which different reasons for non-adoption co-occur.

6. Conclusion

The scaling of adopted sustainable land management practices on farms is often proposed however, the factors that inform non-adoption of advised measures are typically overlooked. We have operationalised the non-adoption of advised sustainable land management practices for the first time. In this research, we identified the main bottlenecks for adoption of sustainable land management practices advised by agricultural extension in Ireland.

To analyse the concepts of rejection and acceptance in-depth, we utilized the layers of acceptance. Our research showed that rejection represented a multitude of underlying reasons. The *acceptance of the diverse consequences* of the advised practices was the most often mentioned bottleneck for adoption of the advised practices. Especially the costs concerned with the implementation of the advised practice were considered a barrier to adoption by farmers. Nevertheless, the reasons for not adopting differentiated between different sustainable land management practices.

For implementing riparian buffer zones, the ageing farmer population and a lack of land ownership were a bigger bottleneck for adoption than in the other sustainable land management practices. The prevention of cattle access to the watercourses was most often hampered by the implementation costs. The factors hampering the adoption of a nutrient management plan, were different from those hampering the adoption of other practices. Here, the dependence on others to carry out the practice and the lack of trust in the products were most hampering bottlenecks for adoption.

Although Ireland is used as a case study in this research, in order to meet the water quality target from the European Water Framework Directives, this research showed target areas for policy and the advisory and considerations for broader application across the EU. By identifying the main barriers for adoption of advised sustainable land management practices, the bottlenecks can guide direction on how to enhance uptake of advised practices. Land ownership challenges and the ageing farming population hamper the adoption of sustainable land management practices. Additionally, while subsidies exist for the implementation of practices, incentives to implement are lacking and costs remain the main

barrier for the adoption of the sustainable land management practices. The different barriers for the diverse practice showed the need for nuanced communication in order to enhance uptake. In order to enhance greater uptake, advice should be framed according to the objectives of the farmer. To improve water quality outcomes across the EU, this research therefore recommends a universal need for nuanced advice that takes into account the context specific needs and objectives of farmers. Consideration of bottom-up demands could shed light on how national target settings relates to changes in management practices at farm level and also better understanding of farm level needs to meet national targets. Altogether, this approach could shed light on pathways to enhance sustainability elsewhere, similar to that demonstrated in this work.

Credit author statement

Lisa M. van den Berg: Conceptualization, Methodology, Validation, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Project administration. Elsa L. Dingkuhn: Conceptualization, Validation, Writing – review & editing, Supervision, Project administration. Noel Meehan: Resource provision, Investigation, Data curation. Lilian O'Sullivan: Conceptualization, Methodology, Validation, Writing – review & editing, Resource provision, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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