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The role of behavioural factors and opportunity costs in farmers' participation in voluntary agri-environmental schemes: A systematic review

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Abstract

Agri-environmental schemes (AESs) are increasingly implemented to promote the adoption of environmentally friendly practices by farmers. We use a systematic review to explore the role of behavioural factors and opportunity costs in farmers' decisions to participate in AESs in Australia, Europe and North America. Behavioural factors influence how farmers value and perceive options, while opportunity costs relate to farmers' forgone utility when choosing to participate in schemes. We synthesise insights from 79 articles and over 700 factors explaining the participation in AESs. We find that a set of behavioural factors seem consistently connected to participation, including agricultural training, advice and having positive attitudes towards AESs. Moreover, several factors related to opportunity costs also have a rather consistent relationship with AES participation, including market conditions, implementation efforts, profitability, and management and contract flexibility. However, many relationships of behavioural factors and opportunity costs with AES participation are not as consistent and generalizable as sometimes portrayed and require context-specific interpretation. Those factors with mixed results can still provide insights into farmers' participation decisions as several of them are either 'positively and insignificantly' or 'negatively and insignificantly' related to participation, such as environmental attitude, trust and farm size. These results suggest that their relationship with AES participation depends on other factors or the setting, highlighting interactions and raising important

new research questions. Overall, our results provide several entry points for both researchers and policy-makers, highlighting uncertainties in relationships between factors and participation that should be considered when designing policies.

KEYWORDS
Agri-environmental schemes, Australia, behavioural factors, Europe, North America, opportunity costs, systematic review

JEL CLASSIFICATION
D01, D90, H31, H32, Q01, Q12, Q20

1 | INTRODUCTION

Governments are increasingly using voluntary agri-environmental schemes (AESs) as a tool to combat the degradation of agricultural ecosystems and biodiversity loss (e.g., De Snoo et al., 2013; Isbell et al., 2011; Pe'er et al., 2022; Stoate et al., 2009; Tilman et al., 2002). AESs reward farmers for adopting environmentally friendly practices[1] and delivering positive environmental outcomes. AESs vary widely in design and scope. For example, they can consist of uniform payments to farmers for implementing a certain environmentally friendly practice (i.e., action-based) or delivering a certain environmental outcome (i.e., result-based; e.g., Baylis et al., 2008; Herzon et al., 2018). Additionally, AESs can use auctions to define payment levels, for example, for retiring land. However, despite the efforts of governments, AESs have often failed to meet the expectations of protecting our ecosystems and biodiversity (e.g., Pe'er et al., 2017, 2020), which means that the existing mix and design of schemes needs to be improved to increase their effectiveness. Here, experts advocate focusing on schemes that have been shown to be effective (i.e., evidence-based policies) and include result-based and collective instruments (e.g., Burton & Schwarz, 2013; Elmiger et al., 2023; Pe'er et al., 2020, 2022). These recommendations have been raised specifically for the reform of the EU Common Agricultural Policy (2023–2027; e.g., Pe'er et al., 2020, 2022).

Behavioural factors and opportunity costs are key drivers of farmers' participation in AES as they impact the perception, evaluation and selection of practices (e.g., Dessart et al., 2019; Knowler & Bradshaw, 2007; Schlüter et al., 2017). Thus, these factors are likely critical in understanding and improving farmers' participation in redesigned, more effective and more ambitious AESs. We define behavioural factors as the cognitive, emotional, personal and social factors that influence human behaviour (e.g., environmental attitudes, trust and peer-effect) (Dessart et al., 2019). We take opportunity costs to refer to forgone utility from environmentally friendly practices compared to alternative land uses and practices due to, for example, lower yields or increased labour inputs. The influence of both behavioural factors and opportunity costs depends on the social and bio-physical context (e.g., Schlüter et al., 2017). Countries differ, for example, in public perceptions of what are considered 'good practices', farmers' environmental attitudes, and whether AES specifically compensate for varying opportunity costs. Thus, systematically synthesising the evidence about the relationships of behavioural factors and opportunity costs with farmers' scheme participation, and considering the context of the evidence, is important for policy-makers and researchers.

[1]We define environmentally friendly practices as a set of farming practices with a positive effect on the environment such as the reduction of fertiliser inputs, planting of hedgerows and the late cut of grasslands. AESs can also incentivise the adoption of more than one practice at a time. Yet, AESs are more specific to practices compared to holistic concepts of conservation agriculture or organic farming.

We use a systematic review to explore present evidence about the roles of behavioural factors and opportunity costs in farmers' decisions to participate in voluntary AESs rewarding environmentally friendly practices. Our systematic review focuses on participation in voluntary AESs in Australia, Europe and North America, as regions that have important experience with such schemes, with both specialised and mixed arable crop farms. We screened 3523 articles, from which, 79 articles and over 700 factors are synthesised in our review.

Previous reviews have explored several aspects of farmers' decisions to participate in AESs and adopt environmentally friendly practices (see Table S1, for an overview). Most reviews focused on not incentivised adoption of environmentally friendly practices (i.e., independent of AESs) or included both incentivised (i.e., through AES participation) and not incentivised adoption of environmentally friendly practices. Only Lastra-Bravo et al. (2015) and Tyllianakis and Martin-Ortega (2021) focused on incentivised adoption. However, the differentiation between incentivised and not incentivised adoption of environmentally friendly practices can be important, as different factors drive these decisions (e.g., Lokhorst et al., 2011). Moreover, most reviews have been non-systematic (Ahnström et al., 2009; Baumgart-Getz et al., 2012; Dessart et al., 2019; Kabii & Horwitz, 2006; Knowler & Bradshaw, 2007; Pannell & Roberts, 2015; Prokopy et al., 2008) rather than a systematic approach (Lastra-Bravo et al., 2015; Prokopy et al., 2019; Tyllianakis & Martin-Ortega, 2021). A systematic approach is essential to reduce biases, such as selection and confirmation bias (e.g., Aromataris & Pearson, 2014).

Amongst the previously published reviews, Dessart et al. (2019) focused on several behavioural factors in relatively developed countries[2] but only summarised information that significantly predicted the adoption of 'sustainable practices', including incentivised and not incentivised adoption. Ahnström et al. (2009) focused on farmers' attitudes towards incentivised and not incentivised nature conservation in developed countries and found that attitudes do not in themselves explain farmers' adoption of conservation practices. A meta-analysis by Baumgart-Getz et al. (2012) found that the adoption of agricultural best management practices in the USA was positively linked to environmental attitudes.[3] The partial discrepancy between the findings of those reviews regarding environmental attitudes, highlights the importance of considering studies that find insignificant results, and the explicit separation of participation in AESs and not incentivised adoption of environmentally friendly practices.

Another set of reviews focused on more general factors (e.g., farm and socio-economic characteristics) and design features of AESs (e.g., payment level and contract length) but also considered behavioural factors (e.g., environmental attitudes and risk aversion). These reviews focused on the adoption of conservation agriculture in Africa and North America, considering factors such as farm and bio-physical factors (Knowler & Bradshaw, 2007), adoption of best management practices and conservation practices considering a range of factors (including environmental attitude and information) in the United States (Baumgart-Getz et al., 2012; Prokopy et al., 2008, 2019) and Australia (Pannell & Roberts, 2015), as well as the willingness to participate in AESs (in contrast to observed adoption) focusing on the European Union (Lastra-Bravo et al., 2015; Tyllianakis & Martin-Ortega, 2021).[4]

While all these reviews provide useful information and insights, there has been a lack of systematic synthesis of behavioural factors and opportunity costs that evaluate positive, negative or insignificant responses in a non-biased manner (as facilitated by a formal systematic approach) and over a wide regional context. Prior reviews have also usually not differentiated

[2]Dessart et al. (2019) consider EU member states and non-EU countries in the top quartile of the Human Development Index as relatively developed countries.

[3]Similarly, the review by Prokopy et al. (2019) found that in most cases, environmental attitudes were positively linked to adopting conservation practices in the USA.

[4]Moreover, Kabii and Horwitz (2006), employing a narrative review based on a few studies and a focus on Australia and the USA, summarised factors related to the uptake of land and soil conservation initiatives, agricultural technologies and schemes that set out to retain native vegetation on private land.

between farmers' decisions about the incentivised (i.e., through AES participation) as opposed to more informal not incentivised (i.e., independent of AESs) adoption of environmentally friendly practices. However, this distinction is extremely important for policy-makers as they (re)design AESs to improve participation in effective and ambitious schemes.

We expand this existing literature in four ways, to provide more informed and systematised evidence for policy-makers. First, we generate state-of-the-art knowledge regarding how behavioural factors affect participation in AES using a systematic synthesis of the existing evidence. This paper is one of only a few studies that systematically consider factors that do or do not determine participation in AESs (e.g., vis-à-vis Dessart et al., 2019). Moreover, our focus on environmentally friendly practices under AESs, that is, incentivised practices, is important as those decisions can deviate considerably compared to not incentivised, entirely voluntary environmental practices (e.g., Lokhorst et al., 2011). Within the behavioural factors, we focus on: (i) information, peers, networks and relationships; (ii) attitudes about the environment, business and AES; and (iii) dispositional and cognitive factors. Second, our review also includes an opportunity cost perspective on farmers' participation decisions for the first time. In so doing, we differentiate opportunity costs depending on their origin, that is, related to (a) market conditions, (b) land and environmental factors, (c) farm management, and (d) scheme and contract design. Third, we extend the geographical scope compared to previous systematic reviews and include Australia, Europe and North America (Canada and the USA). We consider that the relationships between factors and participation within those regions may differ due to different economic, social, environmental and political settings. Fourth, using a systemic synthesis of the existing literature, we provide information on how often a factor was analysed in different studies, which helps understand the extent of existing evidence (e.g., Lakens et al., 2018).

The rest of the paper is organised as follows. Section 2 provides a brief background to AESs in the different regions and the motivation for looking at opportunity costs and behavioural factors in our review. Section 3 describes our method and general data description. In Section 4, we present the results and discussions, followed by a summary and conclusion in Section 5.

2 | BACKGROUND

2.1 | The regional focus of the review

We consider three regions: Australia, Europe and North America (Canada and the USA), which all have considerable experience with AESs. Moreover, specialised and mixed crop farming systems are important in those regions, covering large areas (FAO, 2022). However, they each differ in their economic, social, environmental and political setting. These settings warrant the assessment of the relationships between AES participation and factors separately as well as in aggregate. While we do not discuss in detail all these differences, we highlight the major distinctions related to AES designs across regions.

AESs in the Europe Union[5] are primarily designed and implemented by each member state to support the provision of biodiversity as well as environmental goods and services, typically under the umbrella of the provisions of the EU's Common Agricultural Policy. Within each member state AESs usually vary by land use and often by region.[6] However, payments made within AESs frequently are the same per scheme and thus do not differentiate amongst farmers with differing opportunity costs applying for the same scheme (Baylis et al., 2008). In contrast, the US system often employs auctions, which account for varying opportunity costs amongst farmers (Baylis et al., 2008). Some auction-based payments within the US Conservation Reserve Program (CRP)

[5]Note that most of the European countries in our review are part or have been part of the European Union (Figure 2a).
[6]For example, in Germany AESs differ between states.

additionally consider selected factors in the ranking of farmers' bids that affect individual farmers' opportunity costs, such as soil quality. However, not all factors related to opportunity costs are considered, for instance, growing degree days are omitted (Jang & Du, 2018).

The financial support underpinning the Australian system of AESs is generally more parsimonious than that in both Europe and the USA (Salt, 2016). Most schemes in Australia are increasingly focused on market-based instruments, including conservation auctions (which consider varying opportunity costs), for delivering ecosystem services (Pannell & Roberts, 2015; Salt, 2016). In earlier policy periods, Australian AESs emphasised community-based natural resource management (Salt, 2016; Tennent & Lockie, 2013).[7] The Canadian system is mostly focused on cost-sharing AESs and on reducing nutrient loading as well as providing ecosystem services (Eagle et al., 2015). Compared to Europe and the USA, Canada has relatively less experience with AESs, and funds for such programmes are small (Eagle et al., 2015). The environmentally friendly practices required under AESs can differ substantially between countries and schemes, ranging from converting arable land into grassland or out of production entirely, through using catch crops, to establishing flower strips. Additionally, some schemes pay farmers not based on implementing practices but on achieving certain environmental results ('result-based schemes'; e.g., Elmiger et al., 2023). The required practices or environmental outcomes can have important implications for farmers' participation decisions. Moreover, while all regions share similarities in their farming system and the importance of arable crops (FAO, 2022), they also differ in their cultures and approaches to AESs.

2.2 | Classification of factors

Farmers' participation decisions in a scheme are taken within a certain economic, social, environmental and political setting (e.g., Schlüter et al., 2017). Within this setting, farmers' participation depends on their perception, resources and available options (e.g., Falk et al., 2021; Schlüter et al., 2017), which are affected both by behavioural factors and opportunity costs.

Behavioural factors influence farmers' decision-making at several levels, reflecting farmers' values, the options farmers perceive to be available, and the evaluation of those options, that is, their specific personal assumptions regarding the benefits and costs. Thus, also knowledge of and information about AESs and environmentally friendly practices is a prerequisite for AES participation (see Dessart et al., 2019).[8] In this context, the source of knowledge and information and the relationship to and trust in the source can influence farmers' AES participation. Moreover, farmers' attitudes about the environment, business and AESs can affect their intrinsic motivation for environmentally friendly practices and participation. Furthermore, farmers' AES participation might be linked to several other factors, such as the farmers' personality as well as perception and understanding of the world. Therefore, we summarise the behavioural factors in three categories: (i) information, peers, networks and relationships; (ii) attitudes about the environment, business and AES; and (iii) other dispositional and cognitive factors (see Table 1 for a detailed overview). Dispositional factors subsume behavioural factors that are rather stable internal variables at the individual level (e.g., personality, risk aversion or environmental concerns), and cognitive factors reflect how farmers learn, understand and perceive participation in an AES (following Dessart et al., 2019).

Opportunity costs are clearly important in choosing between two or more options. We define opportunity costs for a farmer following the conventional economic definition as: what

[7]We focused in the background section on the main regional-wide AESs. However, we note that some public schemes at lower regional scales (e.g., state or sub-state-level) and also private schemes exist as well as that benefits from AESs can also be non-monetary (e.g., information transfer and stable prices).

[8]We use here a wider understanding of behavioural factors, following, for example, Dessart et al. (2019).

TABLE 1 Overview of categories and sub-categories of behavioural factors and opportunity costs.

Behavioural factors	Opportunity costs
Information, peers, networks, and relationships (4.1.1)	*Related to market conditions (4.2.1)*
• Clusters and peer effects	*Related to land and environmental factors (4.2.2)*
• Association memberships	• Productivity
• Receiving advice and agricultural education and training	• Production costs
• Information provision, behavioural nudges, and framing	• Others
• Trust and contact with agencies and others	*Related to farm management (4.2.3)*
Attitudes about the environment, business, and AES (4.1.2)	• Change in farm management
• Environmental attitudes	• Other subsidies
• Business and AES attitudes	• Implementation efforts
Dispositional and cognitive factors (4.1.3)	• Economies of scope and scale
• Dispositional factors	• Labour management
Cognitive factors	• Others
	Related to AES and contract design (4.2.4)
	• Required environmentally friendly practices
	• Management flexibility
	Contract inflexibility

a farmer gives up (forgoes) in terms of utility (considering costs and benefits) when pursuing a certain option (including environmentally friendly practices) as compared to an alternative (sensu Mankiw, 2018). For example, a choice between different grassland management intensities implies different costs (e.g., for fertiliser and labour) and benefits (e.g., yields, yield stability, biodiversity and agri-environmental payments). Therefore, opportunity cost (i.e., what is given up) includes benefits and costs that differ between farmers, plots and options (e.g., Sipiläinen & Huhtala, 2013). Various factors contribute to differing opportunity costs, including market conditions (e.g., prices), land and environmental factors (e.g., soil fertility), overall farm management (e.g., management intensity), as well as scheme and contract design (e.g., contract length, required environmentally friendly practice; Table 1).[9] Some factors relate more directly to opportunity costs, such as the profitability of crop production. In contrast, for other factors, the relationship is less direct and depends on the circumstances. For example, how management intensity affects opportunity costs also depends on production costs connected to management intensity.

Furthermore, farmers' decisions about the entire farming system (e.g., specialised vs. mixed arable crop farms or farms focusing on a specific crop or crop selection) can affect and be affected by opportunity costs and behavioural factors. Any farming system comprises a multitude of factors (e.g., production costs, land-related opportunity costs and environmental attitude), so information about farming systems can be helpful in empirical studies to implicitly control for a set of aggregated (but unspecified) opportunity costs and behavioural factors. Moreover, the interpretation of the farming system depends on its definition and the farming system it is compared to in the analysis, which often varies according to the case study (e.g., Zimmermann & Britz, 2016).[10] Given the purpose of our review, we focus on a more disaggregated perspective, which still offers insights about farming systems but excludes aggregated farming system variables used in studies.[11]

[9]Required environmentally friendly practices and environmental outcomes can differ in their opportunity costs, e.g., flower stripes compared to production on the same land versus fallow compared to production on the same land. Furthermore, while payment levels matter, we exclude those from our analysis as higher payments will generally lead to more participation.

[10]The uncertainty about the comparison group for farm type is not present for other factors, such as for farm size, where larger farmers are always compared to smaller farms.

[11]Also, the socio-demographic characteristics of farmers are often considered to be important in farmers' decision-making. Previous reviews dealing with adopting environmentally friendly practices and participating in schemes looked at age, formal education and gender. Their results show that the relationships of age, gender and formal (non-agricultural) education with adoption and scheme participation are ambiguous and often insignificant (Ahnström et al., 2009; Baumgart-Getz et al., 2012; Knowler & Bradshaw, 2007; Lastra-Bravo et al., 2015; Pannell et al., 2006; Prokopy et al., 2019).

In summary, we consider an extended set of behavioural factors (including social, cognitive and dispositional factors) and opportunity costs to identify their influence on participation in AESs. This provides a systematic and comprehensive overview of factors in AES participation and to provide insights into the design of AESs.

3 | METHODS

We synthesise the results of published studies related to our research question using a systematic review (Munn et al., 2018). Using a systematic approach (including predefined study selections) and considering significant and insignificant results likewise reduce biases (e.g., selection and confirmation bias) compared to 'traditional' or 'narrative' reviews (e.g., Aromataris & Pearson, 2014). Thus, such an approach can provide more useful insights into policy designs. Our systematic review is divided into four steps and follows the PRISMA guidelines (Moher et al., 2015): (1) identification of the main research question (in our review: 'What are the behavioural factors and opportunity costs affecting farmers' participation in (public and private) voluntary AES incentivising environmentally friendly practices?'); (2) identification of the relevant studies using predefined criteria and screening process; (3) data extraction; and (4) comparison and synthesis of the data.

3.1 | Search, screening and data extraction strategy

We constructed our Boolean search string in two steps. First, we searched using a search string containing various terms referring to our target system, that is, farmers, AESs and environmentally friendly practices (Table S2). Second, to recover unidentified search terms and eliminate eventual biases introduced by our search term selection, we used text mining and keyword co-occurrence networks of titles, abstracts and keywords of the references retrieved in the first step (Grames et al., 2019; Table S2). For both reference searches, we used three databases: CAB Abstracts and Global Health (access via Web of Science), Web of Science Core Collection (access via Web of Science), and Scopus (access via Elsevier).[12] The final reference list contained 3523 unique items after checking for duplicates using EndNote (Figure 1).

Two of three trained reviewers independently screened the items' titles and abstracts based on the eligibility criteria (see Section 3.2, 'Eligibility criteria') using the software Rayyan (Ouzzani et al., 2016). A third reviewer independently resolved any discrepancies. After this screening stage, 232 items remained (Figure 1). Finally, we screened the full text of these items based on the eligibility criteria, resulting in 79 articles, from which we extracted our data.[13]

For the data extraction, we compiled the general information (e.g., study year, study duration, study location and practices analysed) and information about the factors affecting farmers' scheme participation from each article (Data S1). We also critically assessed each article based on how well the method is explained and the reasons for using a certain method, the description of the data, model choice, sample size, and selection bias of the study population (Data S1). As we focus on behavioural factors and opportunity costs, we clustered the extracted information accordingly, using the categories described in Section 2.2, 'Classification of factors'.

[12]Scopus, Web of Science Core Collection, and Web of Science CABI are commonly used databases for systematic reviews and include a wide range of journals (e.g., Scopus, 2022; Web of Science Group, 2022), especially journals, where papers about the factors influencing the participation in AESs are likely to be published.

[13]The full-text screening and data extraction were performed in two steps. First, all reviewers checked 15 randomly selected articles using Microsoft Excel. Second, after checking the accordance of the reviewers' judgements, one reviewer screened and extracted the data of the remaining articles, and a second reviewer checked those results. Moreover, we added two additional papers that were mentioned in other papers but were not part of our database.

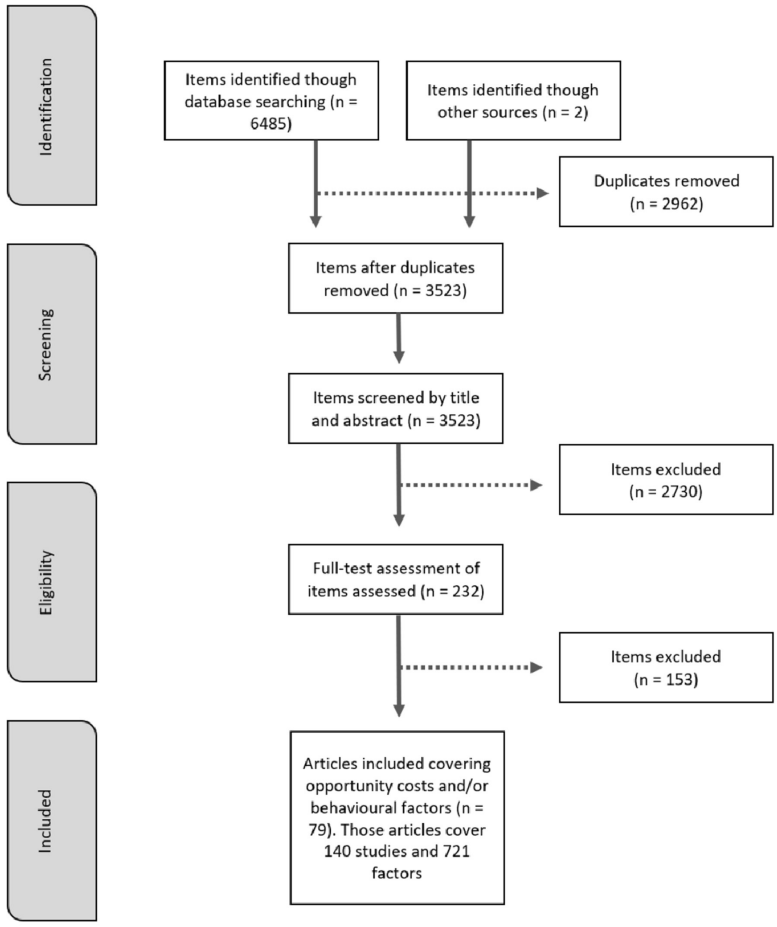

FIGURE 1 Flow diagram of article selection.

3.2 | Eligibility criteria

We include studies that consider behavioural factors and/or opportunity costs in Australia, Europe and North America (Canada and USA) between 2000 and 2021 (retrieved on 1 July 2021). Within our regional coverage, we focus on specialised and mixed arable crop farms that are commercially and formally market-oriented (Guarín et al., 2020). We also include studies that, for example, focused on livestock but also included arable farming. However, we excluded studies that used students as study subjects to ensure direct relevance for policy-makers (e.g., Falk et al., 2013; Grüner et al., 2022). We consider public and private AESs that incentivise environmentally friendly practices and/or positive environmental outcomes.[14] We consider quantitative work using statistical models to analyse primary and secondary data published in English and peer-reviewed journals.

[14]Differing from previous reviews (e.g., Dessart et al., 2019; Lastra-Bravo et al., 2015), we exclude schemes and policies that aim at fundamentally transforming farming systems, e.g., conversion from conventional to organic farming, as we believe that in these cases the decision is different and distinct from AES participation (see, e.g., Meemken & Qaim, 2018; Stolze & Lampkin, 2009).

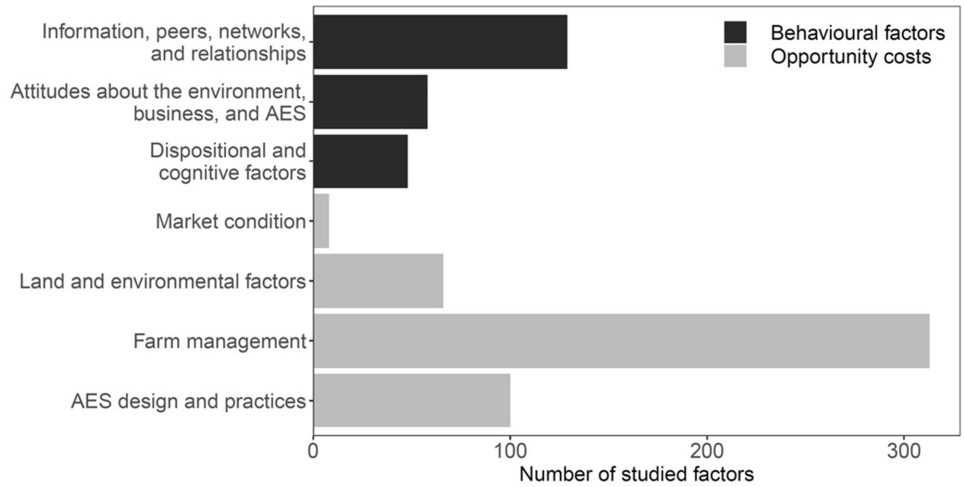

FIGURE 2 Number of times factors related to behavioural factors and opportunity costs were studied.

3.3 | Data description

In total, we identified 140 studies in 79 articles[15] that investigated factors affecting AES participation (for background information about the papers, see Table S3).[16] In those studies, 235 factors are related to behavioural factors and 486 to opportunity costs (Figure 2). Of the behavioural factors, information, peers, networks and relationships are most researched, followed by attitudes about the environment, business and AES. Amongst opportunity costs, those relating to farm management are most often studied, followed by costs related to the AES and contract design, land and environmental factors, and, lastly, market conditions.

The countries with the highest number of studies on farmers' participation decisions in voluntary AESs are the United States, Germany and France (Figure S1). Overall, we find that the number of studies positively correlates with the arable area (Figure S1). However, several countries with large arable areas are not well studied, notably Australia, Canada and Ukraine. Additionally, studies investigated various practices, most commonly related to extensive grasslands, habitat creation and habitat protection practices (Figure S2). The analysed practices in the studies are not explicitly related to geographic regions.

4 | RESULTS AND DISCUSSION

4.1 | Behavioural factors

4.1.1 | Information, peers, networks and relationships

Overview

Most behavioural factors relating to information, peers, networks and relationships are included in about 40% of the articles and either positively or insignificantly linked with farmers' AES participation (Table 2). The most frequent positive factors are: clusters of farmers in a region and

[15]One paper can contain multiple studies. We consider it a separate study when different regions or AESs were separately analysed.
[16]Additionally, the number of factors can be larger than one per study, i.e., when different factors of one category were investigated. We also note that we focus on the main relationships and ignore interactions if they are not central to the study.

peer relationships; agricultural training (but not agricultural education); and receiving advice.[17] Factors with mixed results (i.e., positive, insignificant and negative associations) include information provision and farming-focused association membership. While the latter affects more on how to target groups, the former is more about how to frame information and encourage farmers to participate. For the detailed result presentation, we thus divided the factors presented in this section into (i) clusters and peer effects, (ii) association memberships, (iii) receiving advice and agricultural education and training, (iv) information provision, behavioural nudges and framing, and (v) trust and contact with agencies and others.

Clusters and peer effects

Peer relationships and interactions amongst clusters of farmers are often connected to a higher likelihood of AES participation and included in 9% of the articles (Table 2). Clusters of farmers with the same (environmentally friendly) practices can form as they share information about practices, culture, descriptive norms, favourable bio-physical conditions or economic network effects (e.g., due to spillovers; Arora et al., 2021; Dessart et al., 2019; Läpple & Kelley, 2015; Rode et al., 2015). For example, farmers were more likely to participate in an AES when it was recommended by other farmers (Villamayor-Tomas et al., 2019) or when the participation of others was important (Calvet et al., 2019). Furthermore, Bostian et al. (2020) showed that, for Finnish farmers, the adoption of either one of two incentivised environmentally friendly practices ('accurate nitrogen application and winter cover crops' or 'reduced tillage') depends on which of those practices were implemented by other farmers in the municipality. Similar spatial diffusion patterns were found in Italy for two out of three incentivised practices, which the authors linked to social learning (Pagliacci et al., 2020).[18] Connected, findings by Van Dijk et al. (2015) showed that group norms and identity do not per se increase participation, but participation might depend on how much a group can facilitate participation. Moreover, the enrolment status of neighbouring plots also increased the chance that farmers enrolled their plots in a Swiss case study of an agglomeration bonus (in addition to a base payment; Huber et al., 2021).

Association memberships

Being a member of an association (including 'farming focused', 'cooperative and discussion group', 'non-agricultural' associations) can indicate higher social capital (e.g., Peerlings & Polman, 2009; Simmons et al., 2020) and can influence the amount and quality of information one receives. Previous results showed that being a member of any of such associations is not per se associated with participation rates in AESs (Table 2).[19] Farmers who were members of 'farming-focused' associations[20] were found in studies to have a positive (29%), not significant (29%), and negative (43%) relationship with participation in schemes. How membership in an association links to participation might depend on the association's focus, its services, the country, and the required scheme, as, for example, members of a 'farming-focused' association with the main goal of farm's profit were found to be less likely to participate in a scheme incentivising reducing nitrate pollution in Greece (Giovanopoulou et al., 2011). In contrast, Barreiro-Hurlé

[17]In our study, agricultural education refers to long-term learning about agriculture (e.g., at school or university), whereas agricultural training refers to short-term learning on a specific topic, which is independent of farmers' agricultural education levels. Furthermore, receiving advice describes if farmers received information in terms of technical and agricultural advice from private or public bodies (e.g., extension services).

[18]Pagliacci et al. (2020) argued that the reason they did not find a relationship between spatial diffusion and participation in AES incentivising no-tillage could be because of the specific requirements of the scheme.

[19]Some studies use the membership in a nature or environmental association to define farmers' environmental attitudes. Therefore, we include membership in a nature or environmental association below.

[20]'Farming-focused' associations include farmers' unions, farmers' groups, and professional agricultural associations.

TABLE 2 Overview of studies investigating Information, peers, networks, and relationships as well as the relationship of those factors to AES participation.

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Papers**
(i) Clusters and peer effects															
Cluster and peer relationships	11			10								1		Finland, France, Greece, Ireland, Italy, Switzerland	Bostian et al. (2020); Calvet et al. (2019); Cullen et al. (2020); Damianos and Giannakopoulos (2002); Huber et al. (2021); Pagliacci et al. (2020)
(ii) Association memberships															
Association membership—'farming-focused'	14		1	3				6				4		Australia, Belgium, Czech Republic, Finland, France, Germany, Greece, Italy, the Netherlands, Spain, UK	Barreiro-Hurlé et al. (2010); Ducos et al. (2009); Espinosa-Goded et al. (2010); Giovanopoulou et al. (2011); Pascucci et al. (2013); Peerlings and Polman (2009); Polman and Slangen (2008); Simmons et al. (2020)
Association membership—'cooperative and discussion group'	3			1								2		Ireland, Italy, Spain	Cullen et al. (2020); Espinosa-Goded et al. (2013); Pascucci et al. (2013)
Association membership—'non-agricultural'	6			3								3		Belgium, Czech Republic, Finland, France, Italy, the Netherlands	Peerlings and Polman (2009); Polman and Slangen (2008)

(Continues)

TABLE 2 (Continued)

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Papers**
(iii) Receiving advice and agricultural education and training															
Agricultural education and training	6		1	2								3		Belgium, Canada, Czech Republic, Finland, France, Germany, Greece, Italy, the Netherlands, Poland, Spain, UK	Damianos and Giannakopoulos (2002); Ducos et al. (2009); Espinosa-Goded et al. (2013); Mante and Gerowitt (2009); Wąs et al. (2021); Yiridoe et al. (2010)
Receiving advice (e.g., from extension services)	12		1	8		1						2		Australia, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Italy, the Netherlands, Poland, Spain, Sweden, UK	Blackmore and Doole (2013); Christensen et al. (2011); Ducos et al. (2009); Espinosa-Goded et al. (2010); Hasler et al. (2019); Lienhoop and Brouwer (2015); Yiridoe et al. (2010)
AES and related knowledge	6				2[a]			1		1		3[a]		Australia, Belgium, Denmark, Greece, USA	Blackmore and Doole (2013); Gachango et al. (2015); Giovanopoulou et al. (2011); Loftus and Kraft (2003); Mettepenningen et al. (2013)
(iv) Information provision, behavioural nudges, and framing															

TABLE 2 (Continued)

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Papers**
Information provision	8			1	1			5					1	France, Germany, Poland, USA	Czajkowski et al. (2021); Czap et al. (2019); Pellegrin et al. (2018); Sponagel et al. (2021); Wallander et al. (2017)
(v) Trust and contact with agencies and others															
Trust	18			7								11		Belgium, Czech Republic, Finland, France, Germany, Greece, Italy, the Netherlands, UK, USA	Calvet et al. (2019); Damianos and Giannakopoulos (2002); Ducos et al. (2009); Laney and Moses (2021); Peerlings and Polman (2009); Polman and Slangen (2008)
Frequency of contact with informing and other bodies	4				2								2	USA	Blackmore and Doole (2013); Gachango et al. (2015); Giovanopoulou et al. (2011); Jayalath et al. (2021); Loftus and Kraft (2003); Mettepenningen et al. (2013)

[a]Mettepenningen et al. (2013) studied two factors of farmers from Belgium and the USA, which are here counted for both countries but only once for the number of total factors.

et al. (2010) found that exchange with a farmers union in Spain increased the likelihood of participating in schemes incentivising environmental fallow and changes in crop rotation. Moreover, non-agricultural association memberships increased participation in landscape management contracts but not in biodiversity or input reduction contracts, which might be because social capital is more decisive in landscape management contracts (Peerlings & Polman, 2009; Polman & Slangen, 2008).

Receiving advice and agricultural education and training

Agricultural education and training and receiving advice (about general agriculture or environmentally friendly practices) can improve knowledge and contribute to network effects. Studies looking at agricultural education (only two) found it had no relationship with scheme participation (Ducos et al., 2009; Mante & Gerowitt, 2009). In contrast, studies looking at agricultural training found a positive relationship with scheme participation in three out of four cases (Damianos & Giannakopoulos, 2002; Espinosa-Goded et al., 2013; Yiridoe et al., 2010). The only insignificant relationship between agricultural training and participation was found in a Polish case study (Wąs et al., 2021). The authors linked the results to the fact farmers might already have been informed enough about schemes without attending additional training, as they received extensive information after Poland's accession to the European Union. Furthermore, we find that in most cases (i.e., 9 out of 12 cases; Table 2), providing information in terms of technical and agricultural advice increased the likelihood of farmers participating in AESs, though most of these findings were based on a choice experiment. Studies based on actual (not hypothetical) schemes showed no significant relationships between receiving advice and participation (Ducos et al., 2009). It was argued that this might be because of the existence of alternative advisory services than the one they considered (Hasler et al., 2019) or that farmers want to be independent of agency involvement and administrative burdens coming with the scheme participation (Blackmore & Doole, 2013). Finally, knowledge related to AES was most often found to have an insignificant relationship with participation, amongst the few studies examining this factor.

Information provision, behavioural nudges and framing

Information provision, behavioural nudges and framing can be used by policy-makers to encourage farmers to participate in AESs. However, the weight of the literature showed that in most cases, information provision had no effect on, or even reduced, farmers' likelihood of participating (Table 2). Czajkowski et al. (2021) found a negative relationship between information provision and willingness to accept, suggesting that the reservation price of farmers who received information about the aims and benefits of an AES was higher than that of farmers without information. They argued that the information increased farmers' valuation of the ecosystem services provided by the AES. Furthermore, in a large-scale field experiment within the CRP, sending letters to promote the participation of farmers who had not been participating so far in the programme did not yield higher bids than when not sending letters, whereas it did for farmers who had an expiring contract (Wallander et al., 2017). In contrast, a field experiment within the US Conservation Stewardship Program, conducted in select counties within Nebraska that had historically low scheme participation rates, showed that sending letters to farmers in order to encourage enrolment had a strong positive impact (Czap et al., 2019).

Furthermore, framings of schemes were found to increase participation, area enrolled, or bids. These include, for example, framings that appealed to people's empathetic tendencies by using a handwritten phrase in letters (Czap et al., 2019), framing the scheme as one focusing on creating positive private rather than public benefits (i.e., soil vs. water conservation framing; Villamayor-Tomas et al., 2019), framing the scheme as a biodiversity improvement as opposed to compensating biodiversity losses (Le Coent et al., 2017), and framing the scheme as farmers

being part of the solution[21] (Thomas et al., 2019). In contrast, under different framings, participation, bids or area enrolled did not increase, such as when a scheme change was framed as a financial loss event (Thomas et al., 2019), and social norms (i.e., farmers' role as stewards in providing ecosystem services and peer comparison) are leveraged to encourage behaviour change (Wallander et al., 2017).

The source of information and its evaluation can influence farmers' participation decisions. For example, information from peers was shown to be more important than information from scientists (Villamayor-Tomas et al., 2019). Moreover, Peerlings and Polman (2009) and Polman and Slangen (2008) found that using public extension services was linked to a higher probability of signing contracts for biodiversity protection or input reduction, while using private extension services either had no significant or a negative relationship with contracting. Frondel et al. (2012), studying three information channels,[22] found no significant effect of providing information through any of those three channels nor differences between the channels. However, their small sample size may have restricted their statistical inference as the authors acknowledged. Furthermore, obtaining information from financial institutions increased farmers' likelihood of participating, which was argued to be because it reduces administrative transaction costs (Barreiro-Hurlé et al., 2010; Espinosa-Goded et al., 2013).

Signalling motives of farmers represent farmers' motivation to improve their local public image or status (Dessart et al., 2019) and can be used in nudges and framings of schemes. Amongst signalling motives, Trenholm et al. (2017) found, in a choice experiment with Canadian farmers, that public recognition for participation via stewardship banquets and awards can reduce willingness to accept participation for some groups. The negative relationship might be due to farmers' concerns about their privacy and public access to their land (Trenholm et al., 2017). Also, other signalling motives, such as personal reparation and social status, were not significantly or negatively associated with farmers' participation in schemes (Table S4).[23]

Trust and contact with agencies and others

Articles (7% of all articles) examining the relationship between trust and participation in AESs considered various levels of trust, including trust in people in general, in the state and in institutions (administration and companies linked to AESs). Trust in institutions and the state was connected either positively or not at all to farmers' participation in schemes, while general trust in people has not been found significant. Calvet et al. (2019) argued that trust plays a particularly important role in participation in schemes that are less familiar to farmers, such as biodiversity offsets where contract partners are companies or public agencies act as private partners, compared to more familiar schemes, such as AESs implemented by European Union agencies. Moreover, they found that when farmers believe that the Chamber of Agriculture has a positive opinion on less common schemes, that is, biodiversity offsets, farmers' intention to participate in such schemes increases (Calvet et al., 2019). Additionally, Grammatikopoulou et al. (2016) showed that farmers' attribution of the importance of information from different official bodies increases their likelihood to participate in AESs. Furthermore, the frequency of contact with the paying agency can, but not always, increase the chances of farmers' participation in an AES (Table 2). Similarly, having a good relationship with the paying agency was shown, in an Australian case study regarding tenders, to play a positive role (Blackmore & Doole, 2013). In contrast,

[21]Framing the scheme as farmers being part of the solution only had a positive relationship to participation when farmers felt that they do something good when they implement environmentally friendly practices.

[22]The three information channels include communication via local agricultural authorities in information meetings, direct communication by the scheme provider, or an NGO as an intermediary.

[23]Some behavioural factors considered as social factors (Dessart et al., 2019) are not discussed here in greater detail as they were studied only once or a few times (see Table S4).

it was not relevant in a German case study of an AES that incentivises field margins in an intensive arable region (Mante & Gerowitt, 2009).

4.1.2 | Attitudes about the environment, business and AES

Overview

Farmers' attitudes can be important for their participation decision on the AES as they influence farmers' motivation to participate in schemes and adopt practices. The observed attitudes (included in 30% of the articles) fall into three categories: (i) environmental attitudes, (ii) business attitudes (e.g., production and economic farming motivation), and (iii) positive attitudes towards AESs (e.g., perceived efficacy and fairness of the scheme). Attitudes across all these categories were either positively or not connected to a higher likelihood of scheme participation. However, more positive environmental attitudes did not significantly relate to higher participation in more than 50% of the cases, and business attitudes were not at all significantly related to higher participation. In contrast, a positive attitude towards AESs seemed to be most often positively related to scheme participation.

Environmental attitudes

When dealing with voluntary AESs, stronger environmental attitudes related to agriculture and farmers' agricultural practices were either not significantly (52%) or positively (48%) associated with farmers' participation. We do not observe that the positive relationships between participation and environmental attitudes is particularly linked to certain practices or regions (compare Table 3 and Table S2). When environmental attitudes were measured not related to agriculture but in general, we observe almost exclusively no significant relationships with participation. Indeed, more case-specific and less general questions about environmental attitudes might help better differentiate between farmers' environmental attitudes (see also Calvet et al., 2019).

Amongst the environmental attitudes related to agriculture, we noticed that there is a wide range of how environmental attitudes were measured, which include questions specific to the environmentally friendly practice (Yeboah et al., 2015), whether farmers' main goal is to protect the environment (Giovanopoulou et al., 2011), composites of multiple questions (e.g., Huber et al., 2021), and factor analysis to identify latent classes (e.g., Cullen et al., 2020).[24]

Furthermore, our finding that environmental attitudes are often not significantly related to AES participation might be because extrinsic motivation (e.g., a payment) crowds out or reduces the role of intrinsic motivations (e.g., Lokhorst et al., 2011; Wang et al., 2022).

Business and AES attitudes

A more favourable business attitude was never significantly associated with participation in AESs in the eight studies including this factor. Farmers' positive attitude towards AESs (and environmental legislation) was most often positively linked (68%) to participating in an AES compared to not significantly (28%) or negatively (4%)[25] linked (Table 3). A positive AES attitude might be especially important when farmers need to be proactive to participate in a scheme (Josefsson et al., 2017).

[24]We highlighted the methodological differences for environmental attitudes as they are often a subject of the scientific and policy debate, and their relationship with participation is often communicated as consistent. However, these methodological differences also apply to other factors.

[25]The authors that found a negative relationship between AES attitude (i.e., about its effectiveness) and farmers' willingness to participate acknowledged that those findings are counterintuitive (Calvet et al., 2019).

TABLE 3 Overview of studies investigating attitudes about the environment, business and AES as well as the relationship of those factors to AES participation.

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Papers**
Environmental attitude (farm-level)[a]	21			5	5					2		9		Australia, Denmark, France, Germany, Greece, Ireland, the Netherlands, Sweden, Switzerland, USA	Calvet et al. (2019); Cullen et al. (2020); Gachango et al. (2015); Giovanopoulou et al. (2011); Huber et al. (2021); Josefsson et al. (2017); Lienhoop and Brouwer (2015); Lokhorst et al. (2011); Ma et al. (2012); Mante and Gerowitt (2009); Simmons et al. (2020); Thomas et al. (2019); Van Dijk et al. (2015); Yeboah et al. (2015)
Environmental attitude (general)[b]	9				2					1		5[c]	2[c]	Australia, Belgium, Czech Republic, Finland, France, Germany, Italy, the Netherlands, UK, USA	Calvet et al. (2019); Ducos et al. (2009); Jayalath et al. (2021); Mettepenningen et al. (2013); Palm-Forster et al. (2017); Simmons et al. (2020); Thomas et al. (2019); Yeboah et al. (2015)
Business attitude (economic and production)	8									3		3	2	Australia, Finland, Ireland, UK, USA	Cullen et al. (2020); Dutton et al. (2008); Grammatikopoulou et al. (2016); Jayalath et al. (2021); Simmons et al. (2020)
Positive attitude towards AES (and legislation)	23	1		11[c]	4			1				5	2[c]	Australia, Belgium, Denmark, France, Ireland, the Netherlands, Poland, Sweden, UK, USA	Blackmore and Doole (2013); Calvet et al. (2019); Cullen et al. (2020); Gachango et al. (2015); Josefsson et al. (2017); Lokhorst et al. (2011); Ma et al. (2012); Mettepenningen et al. (2013); Rakotonarivo et al. (2021); Van Dijk et al. (2015); Vanslembrouck et al. (2002); Wąs et al. (2021)

[a]Includes problem awareness, e.g., awareness of nitrate problem in their area (Giovanopoulou et al., 2011) and self-identify, e.g., asked in form of 'AES nature conservation is part of who I am' or 'AES nature conservation is typical for me' (Josefsson et al., 2017).

[b]Includes membership in environmental groups, including group carrying out nature-based actives as it is often included as measure for environmental attitude.

[c]Mettepenningen et al. (2013) studied two factors of farmers from Belgium and the USA, which are here counted for both countries but only once for the number of total factors. Two variables of their study relate to attitude towards AES.

4.1.3 | Dispositional and cognitive factors

Overview

For those dispositional and cognitive factors that were studied in more than one study, we generally find either (i) positive and no relationships or (ii) negative and no relationships with scheme participation (Table 4). While they still provide some guidance for AES design, we find that most dispositional and cognitive factors not discussed in previous sections are only studied explicitly in one or few cases, making it difficult to generalise results.

Dispositional factors

Farmers' risk aversion was most often connected to a higher probability of participating in an AES and was, together with open-mindedness, most often studied amongst other dispositional factors (Table 4).[26] AESs, such as those in the CRP, are linked to lower year-to-year variability combined with high policy certainty, making it more attractive for more risk-averse farmers (Chang & Boisvert, 2009b). We found no studies investigating other economic dispositions besides risk aversion and trust (e.g., patience, reciprocity and altruism). Open-mindedness was either positively or insignificantly related to the participation in AESs (for other dispositional factors, see Table 4).

Cognitive factors

The most studied cognitive factors not discussed above[27] were perceived behavioural control[28] and perception of risk or stability of schemes over time, which were positively or not connected to participation in AESs (Table 4). Other cognitive factors showed, if studied more than once, either positive and insignificant or negative and insignificant relationships with scheme participation. However, these were even less frequently studied in the literature (for other cognitive factors, see Table 4).

4.2 | Opportunity costs for farmers

4.2.1 | Opportunity costs related to market conditions

Overview

We find that farmers rather consistently react in their decision to participate in AES to opportunity costs related to market conditions (Table 5), following what we would expect under profit maximisation. In times of increasing changes in market conditions, especially increasing input and output prices (Commission, 2022; Elkin & Durisin, 2021), understanding farmers' reactions to those opportunity costs is highly important. However, only a few studies explicitly investigated market condition-related opportunity costs, and the spatial coverage is restricted to three countries (Germany, Switzerland and the USA; Table 5).

[26]Loss aversion studied in two cases was not significantly connected to participation in AES (Table 4).
[27]Many cognitive factors were discussed above, for example, farmers' information status and source of information (influencing perception).
[28]Perceived behavioural control indicates farmers' subjective perception of being able to perform a behaviour.

TABLE 4 Overview of studies investigating other dispositional and cognitive factors as well as the relationship of those factors to AES participation.

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Paper**
(i) Dispositional factors															
Risk aversion	4			1	2							1		Greece, Poland, USA	Chang and Boisvert (2009a, 2009b); Giovanopoulou et al. (2011); Wąs et al. (2021)[a]
Loss aversion	2									1		1		Australia, Germany	Simmons et al. (2020); Thomas et al. (2019)
Open-mindedness	6			3								2	1	Germany, Greece, Spain, UK, USA	Barreiro-Hurlé et al. (2010); Dutton et al. (2008); Giovanopoulou et al. (2011); Jayalath et al. (2021); Mante and Gerowitt (2009)
Conservative	1											1		Ireland	Cullen et al. (2021)
Ethics index	1		1											Canada	Nebel et al. (2017)
Self-enhancement[b]	1	1												Australia	Yasué and Kirkpatrick (2020)
Self-transcendence[b]	1					1								Australia	Yasué and Kirkpatrick (2020)
Autonomous motivations	1									1				Australia	Yasué and Kirkpatrick (2020)
Non-autonomous motivations	1					1								Australia	Yasué and Kirkpatrick (2020)
(ii) Cognitive factors															

(Continues)

TABLE 4 (Continued)

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Paper**
Perceived behavioural control	7			5								2		Italy, the Netherlands, Sweden	De Snoo et al. (2013); Defrancesco et al. (2008); Josefsson et al. (2017); Van Dijk et al. (2015)
Perceived risk reduction due to the AES	1	1												Australia	Blackmore and Doole (2013)
Stable policy belief	6			2								4		Belgium, Czech Republic, Finland, France, Italy, the Netherland	Peerlings and Polman (2009); Polman and Slangen (2008)
Perceived easiness to manage	1	1												Australia	Blackmore and Doole (2013)
Perceived adequacy of scheme length	1									1				Australia	Blackmore and Doole (2013)
Perceived adequacy of monitoring	1					1								Australia	Blackmore and Doole (2013)
Control aversion	1											1		Germany	Thomas et al. (2019)
Perceived benefits of participation for others	1	1												Australia	Blackmore and Doole (2013)
Perceived fit of the scheme	1	3						2				1		Poland	Czajkowski et al. (2021)

Note: The table only includes aspects that were not included in previous chapters.

[a]Note that Giovanopoulou et al. (2011) only used a dummy variable to measure risk, while the other studies are based on continuous measures. Moreover, while they found no connection between risk aversion and participation, they found a positive relationship between risk aversion and level of participation.

[b]Note that these also relate to social factors and not exclusively to dispositional factors. For explanation and definition of the factors presented in Table 4 see Table S5.

Market conditions

Higher output prices increase the opportunity costs of participating in AES. These were negatively associated with participation in AESs in Switzerland and the USA (Table 5: Finger & El Benni, 2013; Jang & Du, 2018). Similar findings were shown in the USA when directly assessing the value of the output sold (output price × output; Isik & Yang, 2004). However, when including an extra crop in the crop rotation, a willingness to pay study showed that its relative price compared to other crops in the rotation did not significantly affect participation but did, in one out of two cases, affect the degree of participation (Ma et al., 2012). Furthermore, given that intensive management of agricultural land usually requires more agrochemical inputs (e.g., fertiliser or pesticides) than environmentally friendly practices (either lower intensity or taking land out of production), higher agrochemical input prices should decrease opportunity costs, thus, increase participation in AES. Jang and Du (2018) found that participation in the US CRP increases in relation to higher fertiliser prices. These authors also showed that higher land rental prices discourage farmers from using their land for environmentally friendly practices, but rather encourage them to rent land out (Jang & Du, 2018). Similarly, Sponagel et al. (2021) found that farmers are less likely to participate in a scheme (or need higher compensation) when participation is expected to reduce the market value of the land.

4.2.2 | Opportunity costs related to land and environmental factors

Overview

The relationships between opportunity costs related to land and environmental factors and farmers' participation are often not generalisable across regions, or environmentally friendly practices (Table 6). Overall, the empirical literature (24% of the articles) looked at factors that can be separated into those related to (i) potential productivity, (ii) potential production costs, and (iii) others.[29]

Productivity

Factors that influence potential productivity, and consequently opportunity costs, include, for example, growing degree days, soil quality and the riskiness of the production. The US CRP considers some of those in their payment level, such as soil quality, while others are not considered, for example, growing degree days (Jang & Du, 2018). Jang and Du (2018) found that more growing degree days were linked to lower participation in the US CRP, while higher soil quality at the field level led to higher participation. Similarly, others found a positive relationship between regional land quality and CRP participation (Chang & Boisvert, 2009a, 2009b). Within those regions, more productive land might still be used for agricultural production (Chang & Boisvert, 2009a, 2009b). In contrast, Isik and Yang (2004) and Mishra and Khanal (2013), studying CRP participation at the county- and farm-level, respectively, found a negative relationship between participation and county soil quality. Furthermore, Mishra and Khanal (2013) showed that land was more likely to be enrolled in the US Environmental Quality Incentives Program[30] when soil quality was higher. In Ireland and Switzerland, where farmers are not compensated for varying opportunity costs, farmers with better soil quality were either less likely (Hynes & Garvey, 2009) or not significantly differently likely (Murphy et al., 2014) to participate in AES.

[29]Outside of these four categories, the location of the farmland can also be relevant in terms of opportunity costs; for example, farmers might have different plans for their land or income opportunities when the land is close to urban areas. Here, findings differed amongst countries and depending on the incentivised environmentally friendly practice, but, overall, its proximity to urban areas had either no or a negative relationship with AES participation (Table S6).

[30]The land enrolled in the Environmental Quality Incentives Program can still be used for agricultural purposes (Mishra & Khanal, 2013).

TABLE 5 Overview of studies investigating opportunity costs related to market conditions and the relationship of those costs to AES participation.

		The relationship with AES participation is													
		Positive and significant				Negative and significant				Insignificant					
	Total	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Countries	Papers
Output prices	1								1					USA	Jang and Du (2018)
Output prices compared to agri-environmental premiums	1								1					Switzerland	Finger and El Benni (2013)
Output price ratio	2												2[a]	USA	Ma et al. (2012)
Agricultural output value	1								1					USA	Isik and Yang (2004)
Input prices	1				1									USA	Jang and Du (2018)
Land rental prices	1								1					USA	Jang and Du (2018)
Expected market value loss	1								1					Germany	Sponagel et al. (2021)

[a]We only included studies for which this ratio is relevant, see Ma et al. (2012).

TABLE 6 Overview of studies investigating opportunity costs related to land and environmental factors and the relationship of those costs to AES participation.

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Papers**
(i) Productivity															
Growing degree days	1								1					USA	Jang and Du (2018)
Soil and land quality indicator	9				4			2	2			1		Ireland, USA	Chang and Boisvert (2009a, 2009b); Hynes and Garvey (2009); Isik and Yang (2004); Jang and Du (2018); Mishra and Khanal (2013); Murphy et al. (2014)
Land is in less-favoured area and farm participates in support programmes for these areas[a]	25			17								8		Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, UK	Bostian et al. (2020); Gailhard and Bojnec (2015); Unay-Gailhard and Bojnec (2016); Wąs et al. (2021); Zimmermann and Britz (2016)
Soil erodibility indicator	2				1								1	USA	Lambert et al. (2007)
Perceived risk of soil erosion	1											1		Poland	Wąs et al. (2021)
Risk of flooding	3			1				1				1		Poland	Czajkowski et al. (2021)
Uncertainty about future water availability	1												1	USA	Yehouenou et al. (2020)

(Continues)

TABLE 6 (Continued)

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Papers**
(ii) Production costs															
Distance of plot to farm	3			1				2						Germany, Switzerland	Huber et al. (2021); Lakner et al. (2020)
Slope of plot	4			2								2		Denmark, Germany, Switzerland	Gachango et al. (2015); Huber et al. (2021); Lakner et al. (2020)
Size of plot	1											1		Switzerland	Huber et al. (2021)
Eligible area is drained	1												1	USA	Loftus and Kraft (2003)
(iii) Others															
Environmental Benefits Index[b]	3				3									USA	Chang and Boisvert (2009a, 2009b); Czajkowski et al. (2021); Isik and Yang (2004)

[a]In the European Union, the less-favoured area classification describes land that is disadvantaged due to its natural conditions (e.g., low quality soils, lack of water, climate, altitude and steepness).

[b]Environmental Benefits Index is based on the relative environmental benefits for the land offered and includes aspects such as wildlife, water quality and erosion (USDA, 2021).

Next to the so far discussed specific land and environmental factors, land that is considered as less favourable due to its natural conditions (e.g., low-quality land, mountain location or lack of water) is linked to lower productivity, thus, to lower opportunity costs. European farmers in less favoured areas[31] and receiving payments for less-favoured land are often more likely to participate in AESs or at least not significantly different likely than farmers who do not use such land or receive such payments (Table 6). Bostian et al. (2020) found that Finnish farmers receiving payments for less-favoured areas are more likely to enrol their land to accurate (i.e., reduced) nitrogen application (which might already confirm with lower nitrogen targets) but not to winter cover crops and reduced tillage (where adoption is not linked to a less-favoured classification).

The relationships between opportunity costs that come with more or less risky production conditions and farmers' AES participation are not often studied, and the findings are mostly negative or insignificant. For example, Lambert et al. (2007) studied the enrolment of land to the US CRP as retired and working land. They found that if the soil erodibility of land was high (measured at the county-level), the land was more likely to be enrolled as retired land but not as working land. Lambert et al. (2007) linked these results to the fact that the compensation for retired land but not for working land was related to soil erodibility. In contrast, a study looking at the perceived soil erosion risk in Poland found no connection between it and participation in AES (Wąs et al., 2021).

Production costs

Factors that influence the potential production costs are more widely studied than those influencing potential productivity, including the variables distance of plot to farm, the slope of the plot, the size of the plot, and if the eligible area is drained. The relationship of those factors with participation is either according to what we would expect given the opportunity costs or not significant (Table 6) and interpreting them often requires looking at specific schemes. For example, more distant fields from the farm were less likely to be enrolled in a Swiss alpine agri-environmental agglomeration scheme (Huber et al., 2021). This scheme rewards practices with lower travel costs[32] to the farmer than commercial farming practices, such as less intensive grassland use. In contrast, a German case study looking at a scheme encouraging a more work-intensive environmentally friendly practice compared to the baseline found a negative distance-participation-relationship due to higher travel costs (Lakner et al., 2020). Both these findings align with profit maximisation considering opportunity costs when setting them into context, even if the findings appear to contrast. Furthermore, relationships that are not significant might be because studies looked at more than one factor describing similar connections between production costs and participation; for example, Huber et al. (2021) found a positive relationship of plot steepness with participation decision but did not find such a relationship for plot size.

Others

In the US CRP, the maximum payment farmers can receive for enrolling land depends on the land's Environmental Benefits Index. The index depends both on land characteristics and farmers' management proposals (Jacobs et al., 2014). Thus, farmers with higher scores due to land

[31]The variable used in studies to identify less favourable land is either directly the area of land or the amount of payments received for those lands.

[32]Farmers need to commute from the farm to their field to work on them. The costs that occur when commuting is linked to the distance between the field and the farm. Thus, when commercial or environmentally friendly practices require farmers to commute more or less often to the field it affects their costs.

characteristics have lower opportunity costs for enrolling their land. Farmers with higher scores are indeed often observed to be more likely to participate in the CRP.[33]

4.2.3 | Opportunity costs related to farm management

Overview

For management-related opportunity costs, our main insights are three-fold (Table 7). First, many factors cannot be generalised, and their context is important to understand if a positive or negative relationship with scheme participation is expected. Second, the relationships between many factors at the farm management level and opportunity costs depend on other factors. For example, how management intensity influences opportunity costs depends on production costs associated with the management intensity. In these cases it is often the case that either a positive and insignificant or negative and insignificant relationship can be expected, which we find in our review (e.g., management intensity, farm size and organic farming). However, this is also not without exceptions (e.g., productivity). Third, for those factors allowing a very direct relationship, thus, less dependent on other variables, we find consistent relationships (e.g., profitability).[34] In the following, we distinguish here opportunity costs related to farm management by whether they belong mostly to (i) change of farm management, (ii) other subsidies, (iii) implementation efforts of environmentally friendly practices, (iv) economies of scope and scale (of farm size), (v) labour management, and (vi) others.

Change in farm management

We find that higher farm profitability, and thus higher opportunity costs, were linked to lower participation in AESs (Table 7). In contrast, the relationship between productivity and participation in AESs is less consistent: eight studies found a positive (Cullen et al., 2021; Gailhard & Bojnec, 2015; Murphy et al., 2014; Trenholm et al., 2017), five a negative (Finger & El Benni, 2013; Gailhard & Bojnec, 2015), and four an insignificant (Blackmore & Doole, 2013; Trenholm et al., 2017; Unay-Gailhard & Bojnec, 2016; Wąs et al., 2021)[35] relationship between participation and productivity. Murphy et al. (2014) explain that their positive relationship between productivity and AES participation might be because business-minded low-intensity farmers with limited production potential that join AESs push their productivity (within the boundaries of the scheme) more than those (not business-minded) extensive farmers that have limited production potential but do not join a scheme. Connected to this, one study showed that farmers are less likely to participate in schemes when they believe that the environmentally friendly practices should not reduce production (Mante & Gerowitt, 2009).[36] Management intensity (measured on the basis of fertiliser use, pesticide use, hours power, stocking rate and/or irrigation) has a negative relationship with AES participation, that is, more intensive farms are less inclined to participate, in 46% of the cases. However, in 42% of the cases, studies do not find a significant relationship between intensity and participation in AES and 12% of the case

[33]Higher Environmental Benefits Index scores were positively and insignificantly connected with higher bids, depending on the county in a study in Iowa, Minnesota, Montana, North Dakota and South Dakota (Jacobs et al., 2014). Higher bids reduce the chance of winning an auction, but higher Environmental Benefits Index scores increase it. Moreover, exogenous changes in the score were shown to reduce farmers' bids (Jacobs et al., 2014).

[34]We do not include all management-related factors and all factors that describe the 'general characteristics' of a farm that can be linked to opportunity costs. These factors include farm succession and land tenure, which are often discussed in the literature. Studies showed no general relationship based on the future expectation of farm continuity and tenure; 57% (35%) of the studies showed no (a negative) relationship between those factors and scheme participation (Table S6).

[35]The results by Blackmore and Doole (2013) should be interpreted cautiously as they are based on a very small sample size (23 landholders) and possibly inherent a high selection bias.

[36]We mention perceived efficacy here as it provides contextual insights despite being a behavioural factor.

TABLE 7 Overview of studies investigating opportunity costs related to farm management and the relationship of those costs to AES participation.

		The relationship with AES participation is													
		Positive and significant				Negative and significant				Insignificant					
	Total	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Countries	Paper
(i) Change in farm management															
Profitability	3							3						France, Italy, Poland	Borsotto et al. (2008); Calvet et al. (2019); Wąs et al. (2021)
Productivity	17			5			3	5		1	1	2		Australia, Canada, Finland, Ireland, Poland, Slovenia, Switzerland	Blackmore and Doole (2013); Cullen et al. (2021); Finger and El Benni (2013); Gailhard and Bojnec (2015); Grammatikopoulou et al. (2016); Murphy et al. (2014); Trenholm et al. (2017); Unay-Gailhard and Bojnec (2016); Wąs et al. (2021)
Management intensity	102			12				46	1			43		Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK, USA	Barreiro-Hurlé et al. (2010); Cullen et al. (2021); Czajkowski et al. (2021); Espinosa-Goded et al. (2013); Finger and El Benni (2013); Huber et al. (2021); Hynes and Garvey (2009); Isik and Yang (2004); Lakner et al. (2020); Mack et al. (2020); Mante and Gerowitt (2009); Murphy et al. (2014); Pagliacci et al. (2020); Pascucci et al. (2013); Polman and Slangen (2008); Yang et al. (2014); Zimmermann and Britz (2016)
Production costs	1				1									USA	Isik and Yang (2004)
(ii) Other subsidies															

(Continues)

TABLE 7 (Continued)

		The relationship with AES participation is													
		Positive and significant				Negative and significant				Insignificant					
	Total	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Countries	Paper
Other subsidies	9			1					4			2	2	Slovenia, USA	Chang and Boisvert (2009a, 2009b); Gailhard and Bojnec (2015); Isik and Yang (2004); Lambert et al. (2007)
(iii) Implementation efforts															
Organic	11			6	1			1				3		Belgium, Finland, France, Germany, Italy, the Netherlands, Switzerland, USA	Borsotto et al. (2008); Lakner et al. (2020); Mack et al. (2020); Peerlings and Polman (2009); Pellegrin et al. (2018); Yehouenou et al. (2020)
Conservation experience[a]	2			1	1									Germany, USA	Lienhoop and Brouwer (2015); Yeboah et al. (2015)
Implementation costs	6	1						3		1			1	Australia, Germany, France, USA	Blackmore and Doole (2013); Calvet et al. (2019); Lakner et al. (2020); Simmons et al. (2020); Yehouenou et al. (2020)
(iv) Economies of scope and scale															

TABLE 7 (Continued)

		The relationship with AES participation is													
		Positive and significant				Negative and significant				Insignificant					
	Total	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Countries	Paper
Farm size	72		2	34[b]	7[b]			3	1			24	3	Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK, USA	Borsotto et al. (2008); Calvet et al. (2019); Chang and Boisvert (2009a, 2009b); Cullen et al. (2021); Cullen et al. (2020); Damianos and Giannakopoulos (2002); Ducos et al. (2009); Gachango et al. (2015); Grammatikopoulou et al. (2016); Hounsome et al. (2006); Huber et al. (2021); Hynes and Garvey (2009); Jang and Du (2018); Lakner et al. (2020); Loftus and Kraft (2003); Lokhorst et al. (2011); Mack et al. (2020); Mante and Gerowitt (2009); McGurk et al. (2020); Mettepenningen et al. (2013); Mishra and Khanal (2013); Murphy et al. (2014); Nebel et al. (2017); Pagliacci et al. (2020); Palm-Forster et al. (2017); Pascucci et al. (2013); Peerlings and Polman (2009); Polman and Slangen (2008); Santos et al. (2015); Thomas et al. (2019); Unay-Gailhard and Bojnec (2016); Van Dijk et al. (2015); Vanslembrouck et al. (2002); Wąs et al. (2021); Yehouenou et al. (2020); Yiridoe et al. (2010); Zimmermann and Britz (2016)

TABLE 7 (Continued)

		The relationship with AES participation is													
		Positive and significant				Negative and significant				Insignificant					
	Total	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Countries	Paper
(v) Labour management															
Total labour	10			6				1				3		Belgium, Czech Republic, Finland, France, Germany, Ireland, Italy, Netherlands, Poland, UK	Czajkowski et al. (2021); Defrancesco et al. (2008); Ducos et al. (2009); McGurk et al. (2020); Murphy et al. (2014); Yang et al. (2014)
Full-time farmer[c]	13			1				1	2			9		Denmark, Germany, Portugal, Switzerland, UK, USA	Chang and Boisvert (2009b); Gachango et al. (2015); Huber et al. (2021); Jang and Du (2018); Lakner et al. (2020); Mack et al. (2020); Mante and Gerowitt (2009); Santos et al. (2015); Thomas et al. (2019); Yang et al. (2014)
Hired labour	11			2				1				8		Ireland, Italy, Poland, Slovenia, Switzerland	Gailhard and Bojnec (2015); Hynes and Garvey (2009); Mack et al. (2020); Pascucci et al. (2013); Unay-Gailhard and Bojnec (2016); Wąs et al. (2021)
(vi) Others															
Option value	1								1					USA	Isik and Yang (2004)

TABLE 7 (Continued)

		The relationship with AES participation is													
		Positive and significant				Negative and significant				Insignificant					
	Total	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Australia	Canada	Europe	USA	Countries	Paper
Diversified farm business	1											1		Germany	Thomas et al. (2019)
Share of off-farm income[d]	20			7	1		1					8	3	Belgium, Canada, Czech Republic, Finland, France, Italy, the Netherlands, Poland, Slovenia, Switzerland, USA	Defrancesco et al. (2008); Finger and El Benni (2013); Gailhard and Bojnec (2015); Groeneveld et al. (2019); Lambert et al. (2007); Loftus and Kraft (2003); Nebel et al. (2017); Peerlings and Polman (2009); Polman and Slangen (2008); Wąs et al. (2021); Yeboah et al. (2015)

[a]Conservation experience does not include past experience from AES participation as this is part of the behavioural factors result section.

[b]Mettepenningen et al. (2013) studied farmers from Belgium and the USA, which are here counted for both countries but only once for the number of total factors.

[c]Full-time farmer includes the inverse value of the variable 'farmer works off-farm'.

[d]Share of off-farm income includes the inverse value of the variable 'share of total income from farming'.

studies report a positive relationship (Table 7). We believe that this suggests that the relationship of management intensity with opportunity costs and thus participation is often more complex than expected and that participation depends on interactions of management intensity with other factors (e.g., land, farm or farmers' characteristics). Furthermore, the relationship between production costs (per area) and enrolment in the US CRP was found to be positive (Table 7).

Other subsidies

Whether other subsidies besides agri-environmental subsidies increase or decrease the opportunity costs depend on their purpose[37] and are not often considered in AES participation studies. Subsidies that support increased productivity or direct income payments for farmed land generally increase the opportunity costs of implementing environmentally friendly practices. This is because, under such subsidies, farmers need to consider changes in other subsidy payments when participating in an AES next to changes in productivity and income from selling their production. Government payments per area linked to land in production either decreased (Chang & Boisvert, 2009a, 2009b; Isik & Yang, 2004), or had no relationship with (Lambert et al., 2007) AES participation (Tables 7 and S7). However, when farmers in the European Union received rural development subsidies (including adopting environmental standards and using extension services), the likelihood of participation in an AES was higher (Gailhard & Bojnec, 2015).

Implementation efforts

Opportunity costs of organic farms and farms that already use environmentally friendly practices might have a farming system that makes implementing environmentally friendly practices both easier and cheaper, with lower opportunity costs (e.g., Mack et al., 2020).[38] Our review shows that these farmers are more likely to also participate in AESs in most of the relatively few studies considering them (69%). A negative relationship between organic farming and scheme participation was found only once, that is, when it was about signing landscape management contracts, which the authors suggest could be because organic farming and these contracts compete for resources (Peerlings & Polman, 2009). Similarly, Mack et al. (2020) observed that organic farmers were more likely to participate in action- and result-based payments but not in multi-actor-based payments. They argue that the latter do not depend on the individual farmer's opportunity costs (and hence the individual farmer's choice to produce organically), in contrast to action- and result-based payments, which depends on the individual farmer's opportunity costs. Other variables linked to implementation costs[39] of environmentally friendly practices also had a negative or neutral relationship with participation in AES, as expected. Only Blackmore and Doole (2013) observed a positive relationship between implementation costs and the likelihood of future participation in an Australian tender programme. This counterintuitive result was explained by landholders who had previously adopted environmental practices continuing to do so but without subsidy support to avoid administrative and transaction costs.

Economies of scope and scale (of farm size)

Opportunity cost can also be linked to farm size. For example, because of economies of scope (i.e., lower cost to produce a variety of outputs, including those incentivised under schemes; sensu Panzar & Willig, 1981) larger farms might have lower opportunity costs due to more labour and

[37]Note that we consider subsidies for less-favoured area as a proxy for low land productivity.

[38]Such farmers are also likely to be more open to environmentally friendly practices as they are often more concerned about the environment (e.g., Best, 2010; Gabel et al., 2018).

[39]This includes the inverse value of the variable 'whether an environmentally friendly practice fits the current farm management'.

machinery flexibility or are more likely to have some land of low productivity, thus, with lower opportunity costs compared to smaller farms. Alternatively, economies of scale (lower cost with higher production quantity) could lead to larger farmers having lower production costs per unit of output, thus higher opportunity costs. However, evidence for economies of scale is mixed with some suggestion that unit production costs do not decrease above a certain size (e.g., Alvarez & Arias, 2003; Duffy, 2009; Mosheim & Lovell, 2009). Many AES participation studies account for farm size, and most (58%) find a positive relationship between farm size and agri-environmental scheme participation (Table 7), although no significant relationship was observed in about a third (38%) of the cases. This generally supports a greater influence of economies of scope than of scale. Yet, the farm size-participation relationship might not be linear, in that beyond a certain farm size further size increase will not affect the likelihood of participation (Cullen et al., 2020). This can also depend on the specifications of the AES design, as some scheme designs require implementation across the entire farm but are only paid for a maximum area (e.g., early phases of the Irish Rural Environment Protection Scheme; e.g., Murphy et al., 2014). Moreover, this relationship between farm size and participation might also depend on the scheme requirements, as, for example, Lakner et al. (2020) found in Germany that farm size increased the participation probability for incentivised less-restrictive measures but not for those that are more-restrictive, and Mack et al. (2020) showed for Switzerland that farm size increased the likelihood of participation for action- and multi-actor-based schemes but not for result-based schemes.

Labour management

Previous studies analysed various aspects of labour related to opportunity costs. For example, with respect to total labour available at the farm level, whether a farmer is a full-time farmer, and the amount of hired labour, which can influence opportunity costs as it affects the flexibility of labour assignment. Of those labour-related variables, only total labour available was regularly in line with what we would expect, considering opportunity costs (i.e., positive relationship) and informative about participation in AESs in Europe (60%; Table 7). Thus, perhaps farms that lack disposable labour resources have no time to implement AESs or change their management. In contrast to the European studies, two studies from the USA found that full-time farm work reduced the likelihood of participation in the CRP (Chang & Boisvert, 2009b; Jang & Du, 2018). Indeed, farmers might use the CRP (a long-term scheme) to reduce farm labour requirements (Jang & Du, 2018).

Others

Other factors that might affect the uptake of AESs include the option value, that is, the value of postponing the decision to enrol in a scheme, which is linked to temporal opportunity costs (Musshoff & Hirschauer, 2008) and was found to reduce farmers' willingness to enrol in the US CRP (Isik & Yang, 2004). However, a diversified farm business (e.g., having an agrotourism next to the farm business) and farmers that work off-farm, which might be expected to entail different opportunity costs (due to different dependencies on agricultural production), did not appear to have a consistent relationship with scheme participation (Table 7).

4.2.4 | Opportunity costs related to AES and contract design

Overview

We find that scheme and contract design features often relate to farmers' AES participation according to opportunity cost-based expectations (Table 8). These features can be distinguished into three main categories: (i) environmentally friendly practices required under an AES, (ii) management flexibility, and (iii) contract inflexibility. The connection of these categories, espe-

cially practices required under an AES, to opportunity costs can vary amongst farmers, farming systems (e.g., specialised vs. mixed arable crop farms), markets and countries. Only one study explicitly communicated *ex-ante* the opportunity costs associated with practices. However, providing such insights would improve interpretation, especially when comparing different farming practices and countries.

Required environmentally friendly practices

Environmentally friendly practices can differ in terms of opportunity costs, depending on how much land and labour is required, and their effects on agricultural production. Studies found that farmers are less responsive to incentives to participate in a scheme when environmentally friendly practices (i) had a larger negative effect on production and (ii) become more comprehensive (e.g., in addition to leaving cereal stubbles after the harvest also growing alfalfa on cropping land; Alló et al., 2015; Bougherara et al., 2021; De Salvo et al., 2018; Ma et al., 2012; Sponagel et al., 2021). Moreover, the choice between environmentally friendly practices and their opportunity costs can also depend on labour availability in certain periods (Palm-Forster et al., 2017). When evaluating opportunity costs and comparing different practices, it also is important to consider the context. For example, when converting arable lands to grasslands the opportunity costs are influenced by the regional importance of ruminants, the feeding value of the yields of converted grassland, or the availability of equipment for grassland management (Sponagel et al., 2021). This example highlights the interaction of required practices with market and contextual conditions. Moreover, the choice between different practices can differ between countries and farming systems as, for example, opportunity costs and also cultural preferences vary (Czajkowski et al., 2021; Hasler et al., 2019).

Management flexibility

Management flexibility (e.g., the flexibility of choosing the environmentally friendly practice and area share enrolled) relates to opportunity costs as with higher flexibility farmers can better adjust the management to their farm conditions, hence reducing opportunity costs. Seventeen out of nineteen studies showed that management flexibility positively matters for farmers' participation in an AES (Table 8).

Contract inflexibility

Contract inflexibility (e.g., contract length and contract restrictions), which reduced farmers' options to react to changes in market conditions, was in most studies (79%) linked to reduced willingness to participate in AESs. In some cases, the degree of flexibility can matter as Hasler et al. (2019) showed that when contracts could be cancelled but with repayment of previous rewards, there were mixed effects on farmers' willingness to participate. However, when no repayment was required, flexibility consistently increased willingness to participate. Moreover, other factors might interact with how inflexibility affects participation. For example, it was shown that renting land, being impatient, risk aversion, and coordination requirements with other farmers were associated with a lower willingness to take up more inflexible schemes (Bougherara et al., 2021; Le Coent et al., 2017; Vaissière et al., 2018; Villamayor-Tomas et al., 2019).

5 | SUMMARY AND POLICY IMPLICATIONS

We have systematically synthesised published research on the relationships of behavioural factors and opportunity costs with farmers' participation in voluntary AESs in Australia, Europe and North America in mixed and arable crop farming systems. Understanding these relationships can help to adjust public and private incentives and target certain farmer groups and thus increase AES participation and reduce pressure on agricultural ecosystems and biodiversity. This

TABLE 8 Overview of studies investigating opportunity costs related to AES and contract design and the relationship of those costs to AES participation.

		The relationship with AES participation is													
		Positive and significant				**Negative and significant**				**Insignificant**					
	Total	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Australia**	**Canada**	**Europe**	**USA**	**Countries**	**Paper**
Management flexibility	19	1		15	1			1				1		Australia, Belgium, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Switzerland, UK, USA	Alló et al. (2015); Blackmore and Doole (2013); Calvet et al. (2019); Christensen et al. (2011); Espinosa-Goded et al. (2010); Le Coent et al. (2017); Lienhoop and Brouwer (2015); Ruto and Garrod (2009); Santos et al. (2015); Sponagel et al. (2021); Villamayor-Tomas et al. (2019); Wachenheim et al. (2018)
Contract inflexibility (contract length and contract restrictions)	34			2[a]				25[b]	2			4	1	Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, the Netherlands, Poland, Portugal, Sweden, UK, USA	Bougherara et al. (2021); Broch and Vedel (2012); Christensen et al. (2011); Czajkowski et al. (2021); Hasler et al. (2019); Lienhoop and Brouwer (2015); Ruto and Garrod (2009); Santos et al. (2015); Sponagel et al. (2021); Vaissière et al. (2018); Wachenheim et al. (2018); Yeboah et al. (2015); Yehouenou et al. (2020)

[a]Those positive relationships are linked to contract termination options with refund (Hasler et al., 2019; see text).

[b]Sponagel et al. (2021) reports that the relationship differs for those survey participants that answered online and not in person.

understanding is particularly important to ensure farmers' participation in more effective and ambitious AESs, which is required given that these schemes have frequently failed to meet the expectations of protecting ecosystems and biodiversity (e.g., Pe'er et al., 2017, 2020). We find that many relationships between factors and AES participation are not as straightforward as often hypothesised and communicated. We do not find that the observed heterogeneity in the relationships can be explained by the study region but rather that relationships are often case and context specific.

Our study provides several important policy implications. While many results are more ambiguous than expected, some factors show rather consistent patterns, and many others are often related to AES participation as expected, or insignificantly related to it. Thus, they can be used to promote participation in AESs.

Amongst those behavioural factors showing rather consistent patterns are (i) agricultural training and receiving advice, (ii) cluster and peer relationships, and (iii) a positive attitude towards AES. Many of those aspects can be directly taken up in policy designs, for example, by providing training and advice to farmers, building a positive perception of farmers towards AESs, and facilitating cluster and peer relationships. Agricultural training and advice may also become even more important over time as we experience changes in public, administrative and governmental requirements for agriculture (e.g., Ehlers et al., 2022; Pe'er et al., 2020; Schaub et al., 2020), which create new challenges for farmers and require additional information. The existence and promotion of clusters and relationships amongst farmers in a region can facilitate AES participation and might be especially important for schemes requiring cooperation amongst farmers. Indeed, increasing the required cooperation between farmers can be important to conserve and restore ecosystems and biodiversity (e.g., Estrada-Carmona et al., 2022; Maurer et al., 2022). Furthermore, if environmental outcomes are considered a result of farmers' skills, farmers might increase their social capital and standing amongst peers when participating in AESs (e.g., Burton & Schwarz, 2013). Such a 'conservation as a product' perspective could further strengthen the relationship of clusters and peer relationships with AES participation. This perspective could be facilitated by implementing result-based payment schemes (e.g., Burton & Schwarz, 2013).

Opportunity costs with rather consistent patterns are those related to (i) market conditions, (ii) implementation efforts (e.g., organic farmers and farmers with already some environmentally friendly practices in place), (iii) profitability, and (iv) AES and contract design. Therefore, considering those opportunity costs is important for tailoring schemes to increase the cost-efficiency of AESs and reduce the deadweight loss (see, e.g., Claassen et al., 2008; Latacz-Lohmann & Breustedt, 2019). This is because (i) farmers with high opportunity costs need higher incentives compared to farmers with lower costs, and (ii) farmers with high opportunity costs are potentially those with intensive management practices and more adverse environmental impacts. The latter can, for example, be the case for farmers with high fertiliser use, which is linked to high yields (thus, high opportunity costs) and potentially higher adverse environmental effects (e.g., reduction in plant species or nitrogen runoffs into waterbodies; e.g., Hawkesford, 2014; Socher et al., 2012). The tailoring of schemes to opportunity costs could be achieved by different options, such as using conservation auctions or schemes with payment differentiation depending on farmers' opportunity costs. The differentiation based on opportunity costs could be based on land and environmental factors, or explicitly on factors related to opportunity costs and high adverse environmental effects. Moreover, using inflation-adjusted payments to consider general price movements without distorting the market might increase farmers' AES participation, especially when the participation requires long-term commitment or when farmers expect increases in output prices. Furthermore, increased management and contract flexibility or providing different environmentally friendly practices farmers can choose from could increase participation. However, those flexibilities often conflict with policy aims of improving environmental conditions; thus, these tradeoffs need to be considered by policy-makers. For example, shorter

contracts or contracts that let farmers choose the degree of management changes can conflict with grassland restoration, as grasslands can take years to recover after the cessation of intensive management (e.g., Isbell et al., 2011).

Furthermore, while we separate the presentation of our results between opportunity costs and behavioural factors, they need to be considered jointly in policy design. For example, management and contract flexibility or stable income from AES payments might especially increase the participation of more risk-averse farmers. Similarly, considering potential increases in output prices in the scheme design would reduce risk and could increase participation, especially amongst risk-averse farmers.

Factors that were mostly as expected or unrelated to AES participation can still be useful for policy-making as they provide policy-makers with tools that, under consideration of the context, might still be effective. These factors include environmental attitude (farm-level but not general), trust, farm size, management intensity, total labour and other subsidies. For example, while we find no relationship between environmental attitudes and participation in more than half the cases, leveraging them in policy design might still be important when payments are low or when the adoption of practices is not financially compensated. Indeed, it has been observed that intrinsic motivation can be crowded out by increasing payments, which can be relevant to the influence of environmental attitudes and other behavioural factors (e.g., Lokhorst et al., 2011; Wang et al., 2022). Moreover, environmental attitudes might be important for the quality of implementation of environmentally friendly practices, which is important for the environmental outcomes, such as the conditions of hedgerows (see, e.g., Graham et al., 2018; McCracken et al., 2015). In this case, they would still be important when payment levels are high. However, our finding of no clear positive relationship between environmental attitudes and AES participation is contrary to common belief and communication (e.g., Dessart et al., 2019; Hasler et al., 2022). Moreover, building trust in agencies and government can be an important tool for increasing participation, but again depends on the setting. It might be especially relevant when farmers are less familiar with a scheme or the scheme-providing agency, or other farmers' payment depends on other farmers' actions, such as in agglomeration payments and multi-actor-based AESs. Furthermore, heterogeneity amongst farmers (e.g., with respect to farm size, management intensity and total labour) is an important consideration for policy-makers to target farmers according to their opportunity costs. However, we highlight that interaction between factors also affects participation, which needs to be taken into account by policy-makers. Lastly, concurrently running subsidies connected to the land in production might prevent AES participation as opportunity costs increase with those subsidies; depending on policy-makers' goals avoiding such conflicts should be targeted.[40]

While we can derive several important insights for policy-makers, we also want to highlight three limitations. First, several factors are only explicitly studied in a few cases, such as opportunity costs related to market conditions or some land and environmental factors. Increasing the spatial coverage and the frequency of investigation of those explicit factors could provide better information about the robustness and transferability of the existing evidence.[41] Second, several factors (especially related to opportunity costs) are often only included as control factors in analyses, which can affect the quality of their inference. Analyses that focus on establishing the rela-

[40]Policy-makers can also learn from factors that show ambiguous results, such as framing and provision treatment, as setting it in context can often bring additional insights. For example, sending out letters to encourage participation might be more successful if participation in a region was initially low, whereas otherwise, it might be more useful to remind farmers who had already participated to re-enrol. In contrast, informing farmers about the value of the ecosystem they produce might increase their demanded compensation. Indeed, ambiguous results of information provision, nudges and framing are also found in other contexts (such as healthy diets; e.g., Laiou et al., 2021).

[41]Researchers might have still implicitly controlled in their analysis for several opportunity costs and behavioural factors at an aggregated level by using information about farming systems, as the farming system can comprise information about opportunity costs and behavioural factors.

tionship of a single factor or sets of factors with participation (while controlling for confounders) and which provide causal inferences would contribute substantially to the design of future policies. Moreover, analyses should also invest in testing the sensitivity of their results, for example, to the omission of unobserved confounders or sampling bias (e.g., Broderick et al., 2020; Diegert et al., 2022; Oster, 2019). Third, how different factors are measured varies substantially amongst studies and can sometimes be quite coarse. We highlighted the variety of how the factors were measured for environmental attitudes. Using a standardised measure for factors (for environmental attitudes, see, e.g., Dunlap et al., 2000; Sparks et al., 2022), stating explicitly the dimension of a factor (for environmental attitudes, e.g., if the attitude is about environmentally friendly practices specifically, generally about agriculture, or independent of agriculture), and improving the quality of variables can improve the quality of insights and make them more comparable across studies and regions. These limitations highlight important future research avenues.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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