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# A theory-driven framework for the design and implementation of successful agri-environmental programmes: results of a realist review

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**ABSTRACT**

In order to tackle biodiversity decline, various Agri-Environmental Programmes (AEPs) have been established in intensive farming countries. Farmers play a crucial role in restoring biodiversity. Therefore, understanding farmers' participation in AEPs is of vital importance. Yet, a theory-driven understanding of what AEP strategies need to be implemented in which context to motivate farmers to work on AEPs is lacking. We aimed to close this gap by identifying Programme Theories (PTs) for the design and implementation of successful AEPs. We performed a realist review to identify causal relationships between agri-environmental strategies (S), their outcomes (O), and the contextual factors (C) and motivational mechanisms (M) that explain how, when and why AEP outcomes were achieved. The identified strategy-context-mechanism-outcome (SCMO) configurations and underlying theories were clustered on the C–M relationship to develop PTs. 47 studies were included. Based on the available evidence on more than 60 AEPs in 17 intensive farming countries, 10 interrelated PTs were identified. These 10 PTs form a theory-driven framework that summarizes the insights into how, when and why farmers work on successful AEPs. Each PT provides practical insights into the agri-environmental strategies and necessary contextual factors and mechanisms to guide farmers' behavioural change toward biodiversity conservation.

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## 1. Introduction

Biodiversity around the world is under pressure and the global assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services has argued that the biodiversity crisis is unprecedented (FAO, 2022; IPBES, 2019). One of the main drivers of biodiversity loss is the intensification and specialization of agriculture (e.g. Zinngrebe et al., 2022).

In order to respond to environmental degradation caused by agricultural intensification and specialization, biodiversity decline in particular, different programmes have been introduced in intensive farming countries aimed at changing agricultural practices. Within these Agri-Environmental Programmes (AEPs) farmers, sometimes in partnership with representatives from the public and private sector (e.g. agri-businesses, NGOs, private developers, researchers), work on Agri-Environmental Measures (AEM). These measures contribute to biodiversity conservation or restoration, and pertain to farm management measures on private land on areas in production (e.g. mixed cropping, reduced tillage or meadow bird management) and areas out of production (e.g. field margins and hedgerows) or on both (Batary et al., 2015; Duru et al., 2015).

AEPs have been extensively researched with many case studies and meta-analyses assessing their ecological effectiveness (e.g. Albrecht et al., 2020; Marja et al.,

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2019). This body of work suggest that results of different AEM and thus AEPs are mixed: some AEPs enhance biodiversity while others fail to deliver. Research has also begun to unravel the causes of the variation in effectiveness. It has been demonstrated that farmers' motivations and execution of AEM are of crucial importance in explaining AEPs' success (e.g. see Batary et al., 2015; McCracken et al., 2015). In addition, programme design and programme-specific conditions also influence farmers' implementation practices, which in turn affect biodiversity outcomes. Since farmer participation is voluntary in most AEPs, it is important to know how, when and why they implement these practices in the first place.

So far research has offered limited insight into how, when and why farmers work on AEPs. There are several reasons for this lack of insight. Firstly, due to the dominance of scientific methods that have primarily focused on establishing the impact of programme strategies, differences in outcomes are attributed to the strategy irrespective of what exactly the strategy consisted of, i.e. what specific aspect of the strategies, such as the provision of financial resources, knowledge or skills resulted into the specific outcome (Dickinson, 2014; Steenkamer, 2020). Therefore, no insights are gained into what resources or opportunities strategies exactly needed to offer (or take away from) farmers, to be motivated to implement these AEM. Secondly, although studies have focused on contextual factors, such as farm- and farmers' characteristics or factors external to the farm, often using a quantitative approach, they failed to provide deeper insights into how contextual factors affect the implementation of a strategy (e.g. Bonke et al., 2021; McGurk et al., 2020). Thirdly, although studies examined farmers' reasoning and motivations (motivational mechanisms) to (not) implement AEM, they did not systematically identify how the reasoning and behaviour of farmers were changed in response to the resources and opportunities strategies offered in certain circumstances (e.g. Brouwer et al., 2015; Nebel et al., 2017). Fourthly, studies that have reviewed previous literature on farmers' adoption of AEM (e.g. Lastra-Bravo et al., 2015; Mills et al., 2021), did not provide insights into the underlying theories of the programmes examined, thereby failing to provide explanations on what 'might cause change'. A deeper understanding of farmers' reasoning and behaviour is necessary as it is farmers, and not strategies or structures, that give meaning to AEPs and their measures (Steenkamer et al., 2020b). Specifically, strategies of the various AEPs work differently in different contexts, because the motivational mechanisms are triggered to a different extent in different contexts.

Therefore, the aim of this study is to generate a theory-driven understanding of what programme strategies work in what circumstances and why these work based on the reasoning and motivations of farmers. To do so, the following research question will be answered: What programme theories and underlying Strategy-Context-Mechanism-Outcome configurations, explain how, when and why farmers work on Agri-Environmental Programmes? Successful AEPs succeed in motivating farmers to change their behaviour toward biodiversity conservation. The programme theories and underlying strategies, contextual factors and motivational mechanisms can help farmers, policy makers, researchers and other involved stakeholders, to design and implement successful AEPs.

## 2. Methodology

### 2.1. Study design and key concepts

A realist review was performed following the RAMESES quality and reporting standards (https://www.ramesesproject.org/) (Wong et al., 2017). Realist review is part of the family of theory-driven synthesis and evaluation and highlights an understanding of the implicit assumptions in the intervention logic of programmes, and how these play out in different contexts (Jagosh, 2019).

Key to realist inquiry is its distinctive understanding of causality (Pawson et al., 2005). Successionist causation is based on the idea of observing correlations between empirical variables and events to infer causation. In contrast, realist inquiry holds to the generative view of causality in which underlying, hidden mechanisms generate outcomes (see Table 1) (Pawson, 2006). Specifically, generative causation pertains to the view that to infer a causal outcome (O) between two variables (X and Y), it is necessary to understand the underlying mechanisms (M) that connects them and the context (C) in which the relationship takes place (Pawson et al., 2005). The specific mechanisms of interest in realist inquiry are 'programme mechanisms', which are the causal powers of programmes that explain how and why programmes contribute to outcomes (Pawson & Tilley, 1997 ) (see Table 1). In conducive contexts, these mechanisms are triggered. The Strategy-Context-Mechanism-Outcome (SCMO) configuration is used in realist analysis to

**Table 1.** Realist concepts used in this study.

| | Definitions |
|---|---|
| Strategy (how) | The intended plan of action (Haynes et al., 2018; Steenkamer et al., 2020a). Strategies underly the AEPs. Strategies aim to create change by offering or reducing resources (e.g. financial resources, information, skills, material resources) in a given context. Strategies are targeted at motivating farmers to change their behaviour toward biodiversity conservation. |
| Context (when) | Refers to the 'backdrop' in which strategies are implemented and which can be understood as any condition that triggers mechanisms (Jagosh, 2019). Contexts refer to the multi-level socio-cultural, economic, political, historical or relational conditions that can inhibit or facilitate change as a result of the implemented programme strategies (Glasgow et al., 2012; Steenkamer et al., 2020a). |
| Mechanism (why) | Generative force that leads to outcomes (Jagosh, 2019). The mechanism refers to the reasoning and motivations of farmers as a response to the intended resources that the strategy offers or takes away in specific contexts. |
| Outcome | The outcome of AEP strategies, which are implemented within a certain context. Outcomes refer to farmers' behavioural change toward biodiversity conservation, i.e. ranging from thinking about biodiversity conservation, adopting biodiversity conservation measures, and sustained working on these measures (after programmes end). Successful AEPs succeed in motivating farmers to change their behaviour toward biodiversity conservation. All outcomes are a result of interactions between the altered contexts and mechanism (Jagosh, 2019). Outcomes could be intended or unintended, and can be proximal, intermediate or final (Jagosh et al., 2014). |
| SCMO configurations | Heuristics that portray the relationships between strategies, context, mechanism, and outcome (Haynes et al., 2018; Steenkamer et al., 2020a). The SCMO configuration is a basic framework for realist causal explanation and used for unpacking generative causation (Jagosh, 2019). The SCMO configurations in the current study present the strategies aimed at motivating farmers to change their behaviour toward biodiversity conservation which, when implemented in a specific context, change this context and consequently trigger mechanisms to cause certain outcomes. |
| Programme Theory | Hypotheses about how a strategy is expected to work, given contextual influences and underlying mechanisms, and what outcomes will be generated (Jagosh, 2019; Pawson, 2013). In contrast to programmes, 'programme theories' are transferable as they suggest that certain programmes are more or less likely to work in certain ways, for certain people, in certain situations (Jagosh, 2019; Pawson, 2013; Saul et al., 2013). |
| Generative causation | Pertains to the idea that underlying, hidden mechanisms generate outcomes (Jagosh, 2019; Pawson, 2006). |

identify elements of context that support (i.e. trigger) or hinder mechanisms (Jagosh, 2019; Steenkamer, 2020): programme strategies (S) implemented in a given context attempt to create changes by offering (or deducting) resources or opportunities in certain contexts (C). As a response, changes in the reasoning and motivations of stakeholders (e.g. farmers) are triggered – the mechanisms (M) – which lead to (un)intended outcomes (O) (see Table 1). By using these SCMO configurations, realists are able to generate so-called 'programme theories' (PTs). These PTs are hypothesis about how a strategy is expected to work, given contextual influences and underlying mechanisms, and what outcomes will be generated (Jagosh, 2019; Pawson, 2006). As such, realist inquiry goes beyond exploring whether programmes 'work' or not, and allows us to understand causality by linking strategies (S), contexts (C), mechanisms (M) and outcomes (O) (see Table 1), asking 'what is it about this AEP strategy that works in this context and why does it lead to specific outcomes?' As such, a realist review goes beyond summarizing existing evidence, as is done in systematic reviews (Booth et al., 2018; Pawson et al., 2005).

In terms of transferability, PTs are hypotheses that suggest that certain programmes are more or less likely to work in certain ways, for certain people, in certain situations (Jagosh, 2019; Pawson, 2013; Saul et al., 2013). By using the realist approach, we are able to generate PTs that account for different types of programmes and settings (e.g. different countries), as insights are provided into what programmes work for farmers in what contexts, how and why (Haynes et al., 2018; Saul et al., 2013). In terms of generalizability, because the findings of realist reviews are context dependent, the generalizability of findings to other settings depends on the operation of similar mechanisms to generate outcomes (Jagosh, 2019; Saul et al., 2013).

### 2.2. Identifying studies

We searched the electronic search engine Web of Science for English language papers published up until January 31 2022 (date of database retrieval). A comprehensive search strategy was developed to identify studies using the following search string:

(TS = (agri∗OR agro∗OR farm∗)AND
TS = (biodivers∗OR nature∗)AND
TS = (adopt∗OR implement∗OR participat∗)AND
TS = (measure∗OR practice∗OR activit∗)).

Studies were identified for eligibility on the basis of inclusion and exclusion criteria (see Appendix A). Studies were quality appraised using the realist principles of rigour and relevance (Wong et al., 2017). Methodological rigour was assessed as to whether the methods used to generate the relevant data were credible (or plausible) and trustworthy. Relevance was assessed by determining how aligned the study was to our review question.

### 2.3. The data extraction, application of realist principles and synthesis of programme theories

We created a bespoke data extraction form in Microsoft Excel describing for each included study its key characteristics and the programme characteristics put forward in these studies. We further analyzed each included study for postulated causality between AEP strategies (S), contextual factors (C), underlying mechanisms (M) put forward by study authors, and the outcomes of strategies (O) (SCMO configurations), as well as for theories as postulated in studies. In line with Steenkamer et al. (2020a), we used iterative axial coding to relate the identified SCMO configurations to the underlying theories and clustered them on the C–M relationships in order to develop programme theories. The data were regularly shared and discussed within the research team to ensure validity and consistency in the inferences made. Furthermore, the data were shared and discussed within interdisciplinary research settings. Based on these reflections, no adjustments were needed.

## 3. Results

The literature search yielded 4591 potentially relevant studies (see Flowchart in Appendix B). Of these 223 were included on the basis of title and abstract. On the basis of full-text screening, 134 studies were excluded as they, for instance, did not adhere to and build on a theory or a theoretical model, as introduced in their Introduction, Theoretical or Methodological section. From the resulting 89 papers, 42 were excluded as no SCMO configurations could be identified. Finally, a total of 47 academic studies were included.

### 3.1. Study characteristics

The included studies covered 17 different countries (see Appendix C). The majority of the included studies were set in 12 European countries, followed by Australia, United States (US), Canada, and Japan. Three studies focused on programmes in multiple countries (i.e. Burton et al., 2008; Mettepenningen et al., 2013; Villamayor-Tomas et al., 2019). The mostly used theories and theoretical models were socio-psychological theories such as the theory of planned behaviour, Bourdieu's theory of capital, economic theories such as random utility theory, farming styles and agricultural innovation systems (see Table 2). The majority of the studies made use of qualitative and mixed methods and used empirical data directly derived from farmers (e.g. interviews with farmers), except for Vermunt et al. (2022), Barghusen et al. (2021) and Runhaar (2017). Although these studies did not use empirical data directly derived from farmers, they entailed rich descriptions of strategies, contexts, mechanisms and outcomes. Furthermore, the types of AEM that farmers implemented in these programmes pertained to farm management measures regarding areas in- and out of production on private land (Batary et al., 2015; Duru et al., 2015).

### 3.2. Programmes identified in included studies

Within the included studies, more than 60 programmes were identified, covering a variety of 13 different types of programmes based on the used (policy) instrument to reward and/or motivate farmers to change their agricultural practices (see Appendix D). In the majority of programmes, farmers voluntary adopted the AEM. Moreover, most AEPs were action-oriented (farmers receiving payments as long as they respect programme conditions in contrast to result-oriented AEPs in which payments are conditional to actual environmental outcomes) and offered financial incentives. In addition, some AEPs offered, for instance, technical advice, educational material or regulatory incentives. The different types of AEPs include (top-down) programmes initiated by (supra)national governments, such as Agri-Environmental Schemes (AES). Moreover, there are programmes initiated at regional levels, such as Conservation Covenant programmes. Furthermore, examples of programmes initiated by private stakeholders and rolled out regionally are Labelling programmes. Finally, this study includes unsubsidized and place-based AEPs.

**Table 2:** Overview of the 10 Programme Theories with underlying SCMO* configurations, dominant theories-models** and references per PT

*PT 1: Facilitate that farmers can make sense of new, uncertain, or ambiguous situations related to agri-environmental measures, which induces farmers to reason that they can get a better understanding of these measures and as a result, farmers undergo a socio-cognitive shift to transition towards new agricultural practices.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Communicate local monitoring data to farmers and frame issues in terms of personal relevance of biodiversity decline and ecosystem degradation.<br>*Emphasize the benefits of AEM to society in terms of ecosystem-services.<br>*Practically demonstrate the agronomic benefits of AEM by using a functional agrobiodiversity approach. | C+: Distribution of information regarding biodiversity decline and ecosystem degradation, specifically local monitoring data that enables farmers' identification with local landscapes.<br>C+: Lead farmers demonstrate and show their support for AEM and encourage other farmers to sign up for the programme. | *Induces farmers to reason that they can make sense of new and uncertain aspects and situations associated with AEM. | *Farmers are more aware of the problems that biodiversity decline causes and better understand the relevance of the transition towards AEM measures from a personal perspective.<br>*Farmers gain insight into new perspectives and productivity benefits of on-farm biodiversity restoration.<br>*Farmers better understand what a 'good farm' is, better understand the long-term agronomic benefits, and are better able to accept temporary difficulties. | Neo-Institutional Theory<br>Theory of Planned Behaviour (Extended version including Identity Theory)<br>Bourdieu's Theory of Capital (specifically Symbolic Capital) | Barghusen et al. (2021)<br>Birge & Herzon (2019)<br>Burton et al. (2008)<br>Fleury et al. (2015)<br>Home et al. (2014)<br>Ingram (2010)<br>Ingram et al. (2013)<br>Mills et al. (2018; 2017)<br>Ouellet et al. (2020)<br>Schmitzberger et al. (2005)<br>Van Dijk et al. (2016; 2015)<br>Vermunt et al. (2022)<br>Westerink et al. (2020)<br>Yasue et al. (2019)<br>Zwaan & Goverde (2010) |
| | C-: Too few lead farms that can showcase their success to other farmers. | *Induces farmers to feel uncertain about the AES. | *Nature inclusive agriculture is regarded as alien and falls outside of what is considered 'good farming' practice.<br>*Limits farmers' ability to switch to nature inclusive farming. | | |

*PT 2: Stimulate farmers to develop or demonstrate skilled role performance within strategies of agri-environmental programmes, which induces farmers to feel that their new attitudes and behaviour are appreciated by others, based on the recognition of shared symbolic significance, and as a result, farmers are stimulated to adopt new agri-environmental measures.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Acknowledge farmers' skills and knowledge by providing a certain level of flexibility in the programme. | C+: Farmers are given more responsibility and ownership in determining how to execute AEM in result-oriented and mixed programmes.<br>C+: Farmers are given more responsibility and ownership in how to achieve agri-environmental indicators in result-oriented and mixed programmes. | *Induces farmers to feel that their new attitudes and behaviour related to AEM are appreciated by others based on the recognition of shared symbolic significance.<br>*Induces farmers to interpret the greater responsibility and ownership as a sign of acknowledging their skills and knowledge, instead of stigmatizing them. | *The development of symbolic capital i.e. status and prestige of farmers.<br>*Farmers are better able to adapt the measures to the farms' local biophysical and agronomic conditions. | Bourdieu's Theory of Capital (specifically Symbolic Capital) | Birge & Herzon (2019)<br>Burton et al. (2008)<br>Fleury et al. (2015)<br>Groce & Cook (2022)<br>Hammes et al. (2016)<br>Home et al. (2014)<br>Josefsson et al. (2017)<br>Mettepenningen et al. (2013)<br>Moon (2013)<br>Van Dijk et al. (2016; 2015)<br>Yasue et al. (2019) |

(*Continued*)

**Table 2:** Continued.

*PT 2: Stimulate farmers to develop or demonstrate skilled role performance within strategies of agri-environmental programmes, which induces farmers to feel that their new attitudes and behaviour are appreciated by others, based on the recognition of shared symbolic significance, and as a result, farmers are stimulated to adopt new agri-environmental measures.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| | C-: Farmers are expected to act under defined scheme prescriptions in action-oriented programmes. | *Induces farmers to feel they are not able to stand out from other farmers. | *The development of symbolic capital (i.e. status and prestige of farmers) is hindered. | | |
| *Include localized promotional actions (e.g. competitions with ceremonies, including media coverage) to award farmers for showing good agronomic qualities and high biodiversity. | C+: Farmers are assigned a positive role in contributing to the environment. | *Induces farmers to feel they are appreciated as good members of society. | *Localized promotional actions to award farmers lead to raised consumer and citizen interest. | | |

*PT 3: Facilitate farmers' understanding that the new norms and values associated with the new agri-environmental identity, do not downplay or reduce their existing identity, which makes farmers reason that they can incorporate the new identity and adopt agri-environmental measures.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Organize farmers' study groups to facilitate group identification via social learning.<br>*Organize farm visits to facilitate group identification via social learning. | C+: Lead farmers demonstrate and show their support for AEM and encourage other farmers to sign up for the programme.<br>C+: Programmes play into the increasing value that society places on biodiversity and nature. | *Induces farmers to understand that the new identities' norms and values associated with a good farmer and a good farm, do not downplay or replace their own identity. | *Farmers incorporating the new identity and adopting agri-environmental measures.<br>*Seeing good examples lowered the threshold to try something yourself, thereby stimulating farmers' appeal to self-identify with the image of a good farmer and their ambition to become good farmers.<br>*The emergence of a group in which a new culture of a 'good farmer' can develop. | Theory of Planned Behaviour (Extended version including Identity theory)<br>Value-Belief-Norm Theory<br>Conceptual framework on Technical and Social learning<br>Bourdieu's Theory of Capital (specifically Symbolic Capital)<br>Farming Styles | Barghusen et al. (2021)<br>Birge & Herzon (2019)<br>Burton et al. (2008)<br>Fleury et al. (2015)<br>Greiner & Gregg (2011)<br>Hammes et al. (2016)<br>Home et al. (2014)<br>Ingram (2010)<br>Ingram et al. (2013)<br>Josefsson et al. (2017)<br>Leonhardt et al. (2021)<br>Lokhorst et al. (2011)<br>Mills et al. (2018; 2017)<br>Ouellet et al. (2020)<br>Schmitzberger et al. (2005)<br>Van Dijk et al. (2016; 2015)<br>Vermunt et al. (2022)<br>Westerink et al. (2020)<br>Yasue et al. (2019) |
| | C-: Productivist farmers, especially when they are not well networked or not part of any social grouping, are reluctant to compromise their ability to make a profit.<br>C-: Farmers who view the protection of biodiversity restoration as societal issues that are outside their responsibility.<br>C-: Productivist values have | *Induces farmers to feel they have to stick to their own identity as they feel reluctant to make compromises.<br>*Induces farmers to feel they have to stick to their own identity as they dislike outside interference and are concerned to lose control. | *Difficult for farmers to identify with AEM.<br>*Farmers' attitudes and behaviour which are being promoted in the AES approach, cannot be transferred into a new agri-environmental identity culture.<br>*Farmers do not adjust their practices with which they identify themselves strongly. | | |

**Table 2:** Continued.

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| | been dominant since World-War II and are exacerbated by narratives about threats to food security.<br>C-: AES in Europe insufficiently integrate the old (i.e. productivist farming) and new AEM as schemes prescribe the management of specific conservation areas, separate from their conventional fields. | | | | |
| *PT 3: Facilitate farmers' understanding that the new norms and values associated with the new agri-environmental identity, do not downplay or reduce their existing identity, which makes farmers reason that they can incorporate the new identity and adopt agri-environmental measures.* | | | | | |
| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
| *Develop horizontal knowledge networks. (target farmer peer-groups rather than individuals) | C+: Peer pressure in farmers' networks.<br>C+: Farmers who host other farmers' visits. | *Induces farmers to feel inspired and confident. | *Emergence of a social learning community between farmers and the spreading of new practices.<br>*Farmers feel affinity to the group and camaraderie.<br>*Farmers are stimulated to improve their AEM achievements.<br>*Even more hesitant farmers are starting off a new AEM. | Social Network Theory<br>Conceptual framework on Technical and Social learning<br>Theory of Planned Behaviour (Extended version including Identity theory)<br>Agricultural Innovation Systems | Barghusen et al. (2021)<br>Borremans et al. (2018)<br>Burton et al. (2008)<br>Fleury et al. (2015)<br>Ingram (2010)<br>Jongeneel et al. (2008)<br>Kishioka et al. (2017)<br>Mettepenningen et al. (2013)<br>Mills et al. (2017)<br>Moon (2013)<br>Ouellet et al. (2020)<br>Runhaar & Polman (2018)<br>Schömers et al. (2015)<br>Siebert et al. (2010)<br>Van Dijk et al. (2016)<br>Vermunt et al. (2022)<br>Villamayor-Tomas et al. (2021; 2019)<br>Westerink et al. (2020)<br>Yasue et al. (2019) |
| *Develop vertical knowledge networks. | C+: Extension professionals, advisors, intermediaries, (conservation) scientists and governmental actors being locally embedded.<br>C+: Extension professionals, advisors, intermediaries, (conservation) scientists and governmental actors having farming backgrounds.<br>C-: Implementation of the programme in an area with high levels of mistrust in the government. | *Induces farmers to feel inspired and confident, as professionals are recognized, known, and approachable by farmers particularly with respect to their capacities and competencies in AEM.<br>*Induces farmers to feel more confident based on relational trust.<br>*Induces farmers to feel they do not know what types of knowledge they need to switch to AEM. | *The social network between farmers and other professionals is likely to help influence farmers' cognition and thus the decision-making regarding their willingness to adopt AEM.<br>*Could cause tunnel vision and block new information.<br>*Negatively influences farmers' participation in AEP. | | |

(*Continued*)

**Table 2:** Continued.

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *PT 4: Stimulate interaction within horizontal and vertical knowledge networks, which makes farmers feel inspired and more confident in adopting agri-environmental measures.* | | | | | |
| | C-: Farmers not having access to independent extension services and highly depending on commercial actors.<br>C-: Educational systems predominantly offer education according to the productivist model and lack sufficient teaching material on AEM. | | | | |
| *PT 5: Stimulate engagement in experimentation with agri-environmental measures - leading to tangible results, which induces farmers to feel more ownership and more empowered to adopt agri-environmental measures.* | | | | | |
| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
| *Encourage experimentation by demonstrating (long-term) tangible results of AEM. | C+: Farmers gaining insight into the effectiveness and benefits of AEM, e.g. via long-term experimental plots.<br>C+: Universities undertaking monitoring activities on farmers' lands. | *Induces farmers' feelings of ownership and empowerment. | *Stimulates farmers to adopt the AEM.<br>*Shifts farmers' perspectives of a risky decision to motivation to continue, trusting the AEM to be successful and not having unforeseen negative consequences.<br>*Catalyses farmers' interest in the environment. | Theory of Planned Behaviour (Extended version including Identity Theory)<br>Conceptual framework on Technical and Social learning<br>Agricultural Innovation Systems | Birge & Herzon (2019)<br>Borremans et al. (2018)<br>Burton et al. (2008)<br>Fleury et al. (2015)<br>Groce & Cook (2022)<br>Home et al. (2014)<br>Ingram (2010)<br>Jongeneel et al. (2008)<br>Kishioka et al. (2017)<br>Kolinjivadi et al. (2019)<br>Mills et al. (2017)<br>Moon (2013)<br>Reimer & Prokopy (2014)<br>Runhaar (2017)<br>Schömers et al. (2015)<br>Vermunt et al. (2022)<br>Westerink et al. (2020)<br>Yasue et al. (2019) |
| | C-: The cause-effect evidence is not always straightforward or cannot be provided in the short-term (difficult for result-oriented programmes).<br>C-: Ecological research insufficiently takes into account the problems farmers face when implementing effective AEM.<br>C-: Farmers lack financial buffers to experiment with AEM.<br>C-: High land prices, short lease contracts and small margins. | *Induces farmers to wish for more precise monitoring systems – more insights into the effects of (their) farming practices to feel more ownership and empowerment. | *Hinders farmers from experimenting or transitioning towards extensification and AEM. | | |

**Table 2:** Continued.

*PT 6: Invest in pre-contractual trust-building, which makes farmers view the contracting partner as trustworthy, to foster long-term cooperation around agri-environmental measures.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Invest time in building face-to-face relationships and pre-contractual trust. | C+: Perspective of a long-term cooperation with a contracting partner whose reputation has proven to be trustworthy. | *Induces a feeling of trust. | *Establishing contractual arrangements. | Incomplete Contract Theory<br>Loss Aversion Theory<br>Lancaster's Theory of consumer choice<br>Random Utility Theory | Barghusen et al. (2021)<br>Borremans et al. (2018)<br>Home et al. (2014)<br>Jongeneel et al. (2008)<br>Le Coent et al. (2017)<br>Mante & Gerowitt (2009)<br>Moon (2013)<br>Mitchell et al. (2015)<br>Yasue et al. (2019) |
| | C-: The government has an historical record of modifying their policy. | *Induces farmers to feel the government not to be a long-term trustworthy contracting partner. | *Farmers are apprehensive in adopting AEM as they feared the government would breach or change the contract again.<br>*Farmers fear the possibility of lock-in effects. | | |

*PT 7: Introduce financial arrangements that make farmers weigh the risks and benefits in such a way that they feel confident enough to participate in agri-environmental programmes.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Offer financial incentives as long as farmers respect programme conditions (action-oriented programme).<br>*Provide farmers with a basic rate for establishing the programme, and reward farmers for achieving (biodiversity) goals (mixed action- and result oriented programme) | C+: Farmers are guaranteed an income. | *Induces farmers to weigh the financial risks and benefits. | *Stimulates farmers to adopt AEM.<br>*Farmers delivering more environmental activity than they were receiving payment for.<br>*Restoration became 'addictive' to farmers.<br>*Payments are used as financial buffers. | Random Utility Theory<br>Lancaster's Theory of consumer choice<br>Theories of economic value<br>Self-Determination Theory<br>Farming Styles | Barghusen et al. (2021)<br>Birge & Herzon (2019)<br>Borremans et al. (2018)<br>Burton et al. (2008)<br>Czajkowski et al. (2021)<br>Fleury et al. (2015)<br>Greiner & Gregg (2011)<br>Groce & Cook (2022)<br>Guillem & Barnes (2013)<br>Hammes et al. (2016)<br>Hansen et al. (2018)<br>Home et al. (2014)<br>Ingram (2010)<br>Ingram et al. (2013)<br>Josefsson et al. (2017)<br>Kishioka et al. (2017)<br>Kolinjivadi et al. (2019)<br>Lakner et al. (2020)<br>Leonhardt et al. (2021)<br>Lokhorst et al. (2011)<br>Mante & Gerowitt (2009)<br>Mettepenningen et al. (2013)<br>Mills et al. (2018; 2017)<br>Moon (2013)<br>Moon et al. (2012)<br>Reimer & Prokopy (2014)<br>Reimer et al. (2012) |
| | C+: Farms with lower profitability that depend on income diversification.<br>C+: Mixed farms. | *Induces farmers to feel they are provided with financial security that they need for farm survival.<br>*Induces farmers to feel they have low opportunity costs and therefore perceive AEM as a means to improve their economic performance. | *Farms can survive.<br>*Farmers can enhance their economic performance. | | |
| | C+: Large (efficient) farms, using AEM as subsidiary income. | *Induces farmers to feel they can use the payments as compensating for the loss of what was already perceived as marginal land. | *Farmers do not undergo a socio-cognitive shift.<br>*They do not undertake more environmental activity than required by the programme unless for clear agronomic reasons. | | |

(*Continued*)

**Table 2:** Continued.

*PT 7: Introduce financial arrangements that make farmers weigh the risks and benefits in such a way that they feel confident enough to participate in agri-environmental programmes.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| | C-: Farmers' high land costs, small margins, short lease contracts, lack of access to funds that cover transitions costs. | *Induces farmers to feel that the switching costs are too high. | *Farmers are hindered in participating in AEP. | | Runhaar (2017)<br>Runhaar et al. (2017)<br>Schmitzberger et al. (2005)<br>Schömers et al. (2015)<br>Siebert et al. (2010)<br>Van Dijk et al. (2016)<br>Was et al. (2021)<br>Yasue et al. (2019)<br>Vermunt et al. (2022)<br>Westerink et al. (2020)<br>Zwaan & Goverde (2010) |
| | C-: Farmers' negative attitudes towards biodiversity and nature conservation. | *Induces farmers to perceive conservation as an external interference to their farm. | *These farmers cannot be persuaded by financial compensation to adopt AEM. | | |
| | C-: Costs of AEM are not sufficiently covered by programmes. | *Especially productivist farmers do not automatically belief that the programmes provide enough compensation for potential losses. | *No adoption of AEM. | | |
| | C-: Farmers not sufficiently being rewarded for AEM.<br>C-: European AES cannot exceed compensatory levels.<br>C-: EU state-aid regulations. | *Induces farmers to feel that they are not sufficiently rewarded for AEM. | *Farmers think they are not being appreciated for the ecosystem services they offer society. | | |
| | C-: Programme requirements that require time investments. | *Induces farmers to feel that the time investments needed for programme requirements, such as paperwork or ongoing contract maintenance, are burdensome. | *Do not prevent farmers from participating in AEP. | | |
| | C-: High transaction costs for farms that have very specific and valuable assets (e.g. machinery). | *Induces farmers to feel that the transaction costs are too high. | *Farmers are hindered from participating in AEP. | | |
| *Offer financial incentives once farmers achieve (biodiversity) goals (result-oriented programme) | C-: Farmers are not guaranteed an income. | *Induces farmers to perceive AEM as risky. | *Farmers are apprehensive to enter result-oriented programmes. | | |
| *Offer farm advisory visits, educational support and material – in case no financial support is offered (unsubsidized programme) | C+: Farmers having norms and values that pertain to environmental concerns and being intrinsically motivated to protect nature. | *Induces farmers to feel that the AEM are of agronomic convenience. | *Nature loving farmers participate more in unsubsidized programmes than other farmers.<br>*Farmers derive pleasure from working on AEM. | | |

**Table 2:** Continued.

*PT 7: Introduce financial arrangements that make farmers weigh the risks and benefits in such a way that they feel confident enough to participate in agri-environmental programmes.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Contract lengths: | | | | | |
| 1. Start with 1-year contracts that can be prolonged or ended, without additional costs. | C-: Farmers who implement AEM for the first time or who perceive AEM as risky. | *Induces farmers to perceive AEM as risky. | *Farmers that perceive AEM as risky can overcome their initial reservations. | | |
| 2. Offer longer contracts. | C+: Farmers are provided with long-term financial security. | *Induces farmers to weigh the financial risks and benefits as they view the payments as providing them with long-term financial security. | *Farmers are motivated to participate in AEP.<br>*Farmers use the payments for farm survival. | | |

*PT 8: Include supply chain stakeholders and consumers within programmes, which induces a sense of fairness and reciprocity within farmers in light of new incentives that reward farmers to maximize positive impacts of agri-environmental programmes.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Reward farmers for their AEM via labels or certificates.<br>*Reduce the number of intermediaries.<br>*Lobby at supermarkets or food processers for sustainable agricultural products that include labels.<br>*Explicitly target consumers. | C+: Stakeholders in the supply chain and consumers take responsibility for biodiversity restoration.<br>C+: Via labelling farmers receive a premium on their agricultural products if they comply with sustainability criteria. | *Induces farmers' feeling of fairness and reciprocity as not only farmers, but also other stakeholders in the supply chain and on the demand side of the market take responsibility for biodiversity restoration. | *Farmers are rewarded for performing AEM.<br>*The labelling works as an intrinsic reward of self-identity for farmers. | Agricultural innovation systems<br>Conceptual framework of Runhaar<br>Theory of Planned Behaviour (Extended version including Identity Theory) | Barghusen et al. (2021)<br>Borremans et al. (2018)<br>Greiner & Gregg (2011)<br>Home et al. (2014)<br>Kishioka et al. (2017)<br>Kolinjivadi et al. (2019)<br>Mills et al. (2017)<br>Moon et al. (2012)<br>Moon (2013)<br>Reimer & Prokopy (2014)<br>Runhaar & Polman (2018)<br>Runhaar (2017)<br>Runhaar et al. (2017)<br>Van Dijk et al. (2015)<br>Vermunt et al. (2022)<br>Villamayor-Tomas et al. (2019)<br>Westerink et al. (2020)<br>Zwaan & Goverde (2010) |
| | C+: Supermarkets and food processors become interested in sustainable agricultural products.<br>C+: PR activities targeting consumers (e.g. fairs, farm tours, food education seminars, school lunches). | | *The legitimacy of sustainable agricultural products is enhanced, resulting in a (niche) market. | | |
| | C-: Low consumer demand for sustainable agricultural products or unclarity to what extent consumers are willing to pay for these products.<br>C-: Farmers not receiving the appreciation of the public for their contribution to the ecological value of agricultural areas or if consumers are not willing to pay more for their products. | *Induces farmers to feel discouraged.<br>*Induces farmers to feel they are price-takers with limited power to negotiate with other agri-businesses. | *Farmers' high dependency on other stakeholders limits their freedom to shift to AEM and to participate in AEP. | | |

(*Continued*)

**Table 2:** Continued.

*PT 8: Include supply chain stakeholders and consumers within programmes, which induces a sense of fairness and reciprocity within farmers in light of new incentives that reward farmers to maximize positive impacts of agri-environmental programmes.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| | C-: Supermarkets lack the willingness to pay price premiums.<br>C-: Alternative revenue models tend to favour local production and short value chains, which make agri-businesses, but also the global trade and processing industry, resistant to change.<br>C-: Agricultural practices which negatively impact biodiversity, are not taxed. | | | | |

*PT 9: Create a programme governance structure that reflects regional or local representation, which induces farmers to feel ownership and shared responsibility, resulting in the enhanced legitimacy of the programme.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Create a programme structure that is characterized by regional or local representation of the farming community. | C+: Strategies linking up with existing social networks that mobilize the entire farming community.<br>C-: Programmes offered by governmental actors that generally propose one-size-fits-all solutions.<br>C-: Programme administrators not locally embedded. | *Induces farmers' feelings of attachment and ownership for and trustworthy towards the programme.<br>*Induces farmers to feel sceptical as members did not have a deep understanding of the community, whether from an environmental, historical, economic or cultural standpoint. | *The legitimacy of the AEP is enhanced.<br>*Programmes are adapted to the specific needs of the community.<br>*Farmers do not feel the local embeddedness of the programme and feel they cannot determine how outcomes are to be achieved. | Proximity Analysis framework<br>Adaptive Governance of social-ecological systems | Barghusen et al. (2021)<br>Fleury et al. (2015)<br>Mills et al. (2017)<br>Mitchell et al. (2015)<br>Moon (2013)<br>Ouellet et al. (2020)<br>Schömers et al. (2015)<br>Siebert et al. (2010)<br>Yasue et al. (2019) |

*PT 10: Align programmes with agri-environmental policies and regulations at different levels of government, which induces farmers to gain trust in and a better understanding of the programme, leading to clear expectations about what is expected of farmers concerning agri-environmental measures.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| *Ensure that programme strategies are unambiguous and aligned with agri-environmental policies and regulations. | C+: Clarity about what is expected of farmers regarding sustainable agriculture in general, and biodiversity restoration in particular. | *Induces farmers to feel they could trust and understand the programme. | *Farmers' participation in AEPs.<br>*Clear expectations of what is expected of farmers in terms of biodiversity restoration. | Neo-Institutional Theory<br>Agricultural Innovation Systems | Borremans et al. (2018)<br>Hammes et al. (2016)<br>Home et al. (2014)<br>Mills et al. (2017)<br>Moon et al. (2012)<br>Kishioka et al. (2017) |

**Table 2:** Continued.

*PT 10: Align programmes with agri-environmental policies and regulations at different levels of government, which induces farmers to gain trust in and a better understanding of the programme, leading to clear expectations about what is expected of farmers concerning agri-environmental measures.*

| Strategy | Context (Enabling (C+); Inhibiting (C-)) | Mechanism | Outcome | Dominant theory-model per PT | References |
|---|---|---|---|---|---|
| | C-: When different governmental levels are involved in the programme which attribute different meanings to ambiguous legislation (e.g. EU state-aid regulations).<br>C-: A lack of a shared vision at different governmental levels, civil society (e.g. NGOs) and farmers associations on AEM. Exacerbated by conflicting visions and policymaking in silos.<br>C-: Programme regulations being overly complex.<br>C-: AEM are foremost voluntary. | *Induces farmers to feel unsure as they do not understand what is expected of them. | *Farmers do not know what is required from them in the future.<br>*Delays in the implementation of programmes.<br>*Stakeholders distrust each other, which refrains them from entering programmes.<br>*Farmers' participation in programmes is hampered. | | Lakner et al. (2020)<br>Mitchell et al. (2015)<br>Runhaar (2017)<br>Runhaar et al. (2017)<br>Vermunt et al. (2022)<br>Zwaan & Goverde (2010) |
| | C-: Legislation around AEM is complicated or little transparent. | *Induces farmers to fear that they might be sanctioned in the future.<br>*Induces farmers to fear that AEM would encourage 'red list' species and consequently attract sanctions. | *Refrains farmers from participating in AEP. | | |

**Strategy (S) - Context (C) - Mechanism (M) - Outcome (O) configuration

**A theory/theoretical model is defined as a system of interconnected ideas, which condenses and organizes knowledge about the social world (Neuman, 2011). It explains how some aspect of the social world works and why.

### 3.3. Identified programme theories

This review identified 10 Programme Theories (PTs), that explain how, when and why farmers work on AEPs. We discuss each PT in turn by first explaining AEP strategies and the resources they offer farmers, the specific mechanisms that are triggered, and the enabling and inhibiting contexts that influence farmers' behavioural change toward biodiversity conservation. See Table 2 for a granular overview of the PTs with underlying SCMOs and dominant theories and theoretical models per PT.

This review identified three PTs (PT 1, 2 & 3) that are of importance in changing farmers' awareness and attitudes toward AEM and changes in farmer's norms, values and identity as to what a good farmer entails in light of these new practices. Moreover, our review found that the strategies associated with these PTs should be implemented successively.

> PT 1: Facilitate that farmers can make sense of new, uncertain, or ambiguous situations related to agri-environmental measures, which induces farmers to reason that they can get a better understanding of these measures and as a result, farmers undergo a socio-cognitive shift to transition toward new agricultural practices.

Our review found that farmers were insufficiently able to make sense of AEM and lacked an understanding of a long term perspective of these practices, i.e. what objectives of AEM are, what indicators of good agri-environmental management exist and how to go about achieving the production of these indicators (Barghusen et al., 2021; Burton et al., 2008; Home et al., 2014; Ingram et al., 2013; Van Dijk et al., 2015; Vermunt et al., 2022; Westerink et al., 2020; Yasue et al., 2019; Zwaan & Goverde, 2010). Our review identified three strategies that need to be implemented in this regard. Firstly, strategies need to invest in increasing problem awareness of biodiversity decline, by communicating local monitoring data to farmers and framing the issue in terms of personal relevance (i.e. ecosystem degradation) (Barghusen et al., 2021; Schmitzberger et al., 2005). Secondly, strategies are to emphasize the benefits of AEMs to society in terms of ecosystem-services: thereby countering farmers' perception that biodiversity restoration is equal to non-productivity by expanding the definition of production, i.e. producing nature (Birge & Herzon, 2019; Home et al., 2014; Ingram et al., 2013). Thirdly, strategies need to highlight the agronomic benefits of AEM to farmers' businesses by practically demonstrating what (functional) agri-environmental management approach to take, corresponding to PT5 (Burton et al., 2008; Home et al., 2014; Mills et al., 2018; Schmitzberger et al., 2005).

The mechanism through which these strategies work is that farmers reason that they can make sense of new or uncertain situations associated with AEM. Specifically, our review showed that these strategies led to farmers gaining insight into new perspectives and productivity benefits of (on-farm) biodiversity restoration (Burton et al., 2008; Home et al., 2014). This insight stimulated farmers to undergo socio-cognitive shifts as they better understood what a 'good farm' is, better understood the long-term agronomic benefits, and were better able to accept temporary difficulties.

This review identified two enabling contextual factors. Firstly, farmer's evaluation of the local monitoring data enables them to identify with local landscapes (Barghusen et al., 2021; Mills et al., 2017). A second contextual factor is the presence of lead farmers: they play an important role as trusted leaders that can showcase, for instance, how to go about achieving new indicators related to good agri-environmental management (Barghusen et al., 2021; Fleury et al., 2015; Ingram, 2010; Ouellet et al., 2020; Van Dijk et al., 2016; Vermunt et al., 2022). A disabling contextual factor is the scarcity of lead farms (Ingram, 2010; Vermunt et al., 2022). Not being able to see the success of AEM makes farmers hold on to practices they are familiar with.

> PT 2: Stimulate farmers to develop or demonstrate skilled role performance within strategies of agri-environmental programmes, which induces farmers to feel that their new attitudes and behavior are appreciated by others, based on the recognition of shared symbolic significance, and as a result, farmers are stimulated to adopt new agri-environmental measures.

This PT highlights the importance of strategies facilitating the development of symbolic capital, i.e. farmers' skilled role performance within AEM, which acknowledges farmers' status and prestige (Birge & Herzon, 2019; Burton et al., 2008; Fleury et al., 2015; Hammes et al., 2016; Home et al., 2014; Josefsson et al., 2017; Van Dijk et al., 2015; 2016; Yasue et al., 2019). Firstly, programme strategies need to acknowledge farmers' skills and knowledge by providing a certain level of flexibility in the programme, i.e. giving farmers opportunities to determine how to go about executing AEM or achieving AEM goals

(Birge & Herzon, 2019; Burton et al., 2008; Fleury et al., 2015; Home et al., 2014). Secondly, strategies need to include localized promotional actions (e.g. competitions with ceremonies, including media coverage) to award farmers for showing good agronomic qualities and high biodiversity, leading to raised consumer and citizen interest, which corresponds to PT 8 (Birge & Herzon, 2019; Fleury et al., 2015). The mechanism through which these strategies work is that farmers feel that their new attitudes and behaviour are appreciated by others based on the recognition of shared symbolic significance.

Our results imply that, in contrast to result-oriented and mixed programmes, in action-oriented European AES, farmers experience less flexibility as they are expected to act under defined scheme prescriptions- an inhibiting contextual factor which hinders farmers' possibilities to show their skills (e.g. possessing higher levels of conservation expertise) (Birge & Herzon, 2019; Burton et al., 2008; Fleury et al., 2015; Home et al., 2014; Van Dijk et al., 2015). Consequently, they do not feel that they are able to stand out from other farmers, which hinders the development of symbolic capital (i.e. status and prestige) (Burton et al., 2008; Home et al., 2014; Van Dijk et al., 2015). Our review has shown that this inflexibility specifically applies to top-down action-oriented programmes in the EU and Australia, and less so to US governmental programmes (Mettepenningen et al., 2013; Moon, 2013; Yasue et al., 2019).

Our review identified two enabling contextual factors for result-oriented or mixed programmes – see also PT 7 (Birge & Herzon, 2019; Burton et al., 2008; Fleury et al., 2015; Home et al., 2014). Firstly, the flexibility these programmes offer allow for contexts in which farmers feel more freedom to determine how to execute AEM. Consequently, our review has shown that in more flexible programmes, farmers were better able to adapt the AEM to the farms' local biophysical and agronomic conditions (Groce & Cook, 2022; Home et al., 2014; Mettepenningen et al., 2013; Moon, 2013). Secondly, some of these programmes allow farmers to participate in the development of simple agri-environmental outcome indicators (Fleury et al., 2015). Farmers interpreted this responsibility and ownership as a sign of acknowledgement of their skills and knowledge, as no one had prescribed to them (in a stigmatizing manner) how to go about achieving these indicators (Birge & Herzon, 2019; Burton et al., 2008; Fleury et al., 2015). These indicators work particularly well when they are easily measurable and quantifiable, and readily appropriated and observable for others as a symbol for new agricultural practices.

Regarding promotional action strategies, our review identified one enabling contextual factor: the staging of farmers positive role (Fleury et al., 2015). In France, for example, for the result-oriented 'Flowering Meadows' AES, specific flowers had become an emblem of biodiversity. This was due to the simplicity of identifying the species (no complicated species' names or abstract definitions) and the social values that were given to these flowering meadows. As such, they functioned as an example of the positive role farmers played in contributing to the environment, eventually even leading to raised consumer and citizen interest.

> PT 3: Facilitate farmers' understanding that the new norms and values associated with the new agri-environmental identity, do not downplay or reduce their existing identity, which makes farmers reason that they can incorporate the new identity and adopt agri-environmental measures.

Our review showed the importance of strategies providing an opportunity for the generation of a new culture of farming – identity of a 'good farmer' (Birge & Herzon, 2019; Burton et al., 2008; Greiner & Gregg, 2011; Hammes et al., 2016; Home et al., 2014; Josefsson et al., 2017; Mills et al., 2017; Westerink et al., 2020). Programme strategies need to facilitate group identification via social learning to stimulate farmers to adjust their underlying values, the image of themselves and their perception of the aesthetics of cultivated fields (Barghusen et al., 2021; Birge & Herzon, 2019; Mills et al., 2017, 2018; Schmitzberger et al., 2005; Yasue et al., 2019). Our review identified two strategies that enhanced social learning, namely the organization of farmers' study groups and farm visits (Fleury et al., 2015; Ingram, 2010; Mills et al., 2017; Ouellet et al., 2020; Van Dijk et al., 2016; Vermunt et al., 2022; Westerink et al., 2020) (also see PT 4). The mechanism through which these strategies work is that farmers reason that they can adjust their identities, as they understand that the new identities' norms and values associated with a good farmer and a good farm, do not downplay, reduce or replace their own identity. Farm visits, for instance, enable farmers to see good examples of how AEM are incorporated into the image of a 'good farmer'. As such, participation in programmes can facilitate the emergence of a group in which a new culture of a 'good farmer' can develop (Westerink et al., 2020).

However, our review found that a pitfall of many AES strategies in Europe, is that it insufficiently integrates the old (i.e. productivist farming) and new AEM, as schemes prescribe the management of specific conservation areas separate from farmers' conventional and productivist fields (Burton et al., 2008). Consequently, the attitudes and behaviour which are being promoted in the AES approach, cannot be transferred into a new agri-environmental identity culture (Burton et al., 2008; Home et al., 2014). In contrast, in unsubsidized AEPs, for which there is no extrinsic reason to adopt these practices, farmers considered themselves as 'the kind of persons who do this', leading to the incorporation of AEM in their identity (Lokhorst et al., 2011; Van Dijk et al., 2015, 2016).

Our review identified two enabling contextual factors. A first factor is the presence of lead farmers (Barghusen et al., 2021; Fleury et al., 2015; Ingram, 2010; Ouellet et al., 2020; Van Dijk et al., 2016; Vermunt et al., 2022). These farmers play an important role in obtaining a new identity as they are an appealing example for farmers (i.e. group identification). Secondly, programmes playing into the increasing value that society places on biodiversity and nature, also function as an external societal pressure on farmers (Barghusen et al., 2021; Home et al., 2014).

Our review found three inhibiting contextual factors that make it difficult for farmers to identify with AEM. Firstly, the group of farmers who are most difficult to engage and have a more negative attitude toward AEM, have strong self-identities related to food production (Burton et al., 2008; Home et al., 2014; Ingram et al., 2013; Leonhardt et al., 2021; Mills et al., 2017; Schmitzberger et al., 2005; Westerink et al., 2020). These so-called productivist farmers perceive nature enhancement interventions as clashing with their identity as producers. Our review found that these farmers are not well networked or part of any social grouping, and may therefore be more immune to wider community level influences and consequently lack information (Mills et al., 2017). Secondly, farmers who view the protection of biodiversity restoration as societal issues that are outside their responsibility, also cannot identify with AEM (Home et al., 2014). Thirdly, productivist values have been dominant since World-War II and are exacerbated by narratives about threats to food security (Mills et al., 2017). These contextual factors make it difficult to self-identify with AEM.

This review identified two PTs (PT 4 & 5) that are of importance in fostering the knowledge around AEM.

> PT 4: Stimulate interaction within horizontal and vertical knowledge networks, which makes farmers feel inspired and more confident in adopting agri-environmental measures.

In terms of horizontal knowledge networks, our review found that farmers interacting with other farmers is often found to be the best approach to learning (Burton et al., 2008; Fleury et al., 2015; Ingram, 2010; Mills et al., 2017; Ouellet et al., 2020; Runhaar & Polman, 2018; Westerink et al., 2020; Yasue et al., 2019) (also see PT 3). AEP strategies that offer farmers possibilities to interact and connect through farmer-to-farmer networks, facilitate an environment in which farmers can discuss and share knowledge, ideas, and experiences with regard to AEM. The mechanism through which these strategies work is that interaction is a way of gaining inspiration and confidence based on relational trust, as interaction enables sharing experiences such as technical difficulties with other farmers, encourages discussion and debate about outcomes and is a way to celebrate progress.

This review found two enabling contextual factors for these strategies. Firstly, farmers who host other farmers' visits take pride in their systems, and sharing their experiences can give confidence to those more hesitant farmers starting off a new AEM (Ingram, 2010). This leads to a social learning community between farmers and the spreading of new practices as seeing good examples lowers farmers' thresholds to try something themselves (Ingram, 2010; Westerink et al., 2020). Secondly, farmers experienced peer pressure in these networks, which stimulated them to improve their AEM achievements (Barghusen et al., 2021; Mills et al., 2017; Van Dijk et al., 2016; Westerink et al., 2020). Increased social interaction in these networks enhanced farmers' affinity to the group, built trust over time and led to a sense of camaraderie, which corresponds to our findings in PT 3 (Barghusen et al., 2021; Mills et al., 2017; Westerink et al., 2020). Therefore, strategies aimed at changing farmers' agricultural practices are more effective if they target farmer peer-groups rather than individuals (Barghusen et al., 2021; Mills et al., 2017; Villamayor-Tomas et al., 2021; Yasue et al., 2019).

In terms of vertical knowledge networks, the review reveals that strategies stimulate farmers to

interact with extension professionals, advisors, intermediaries, (conservation) scientists and governmental actors in these networks (Barghusen et al., 2021; Borremans et al., 2018; Jongeneel et al., 2008; Kishioka et al., 2017; Mettepenningen et al., 2013; Mills et al., 2017; Moon, 2013; Ouellet et al., 2020; Schomers et al., 2015; Siebert et al., 2010; Vermunt et al., 2022; Villamayor-Tomas et al., 2019; Yasue et al., 2019). The mechanism through which these strategies work equals that of the horizontal network. The triggering of the mechanism depends on five contextual factors.

Firstly, when these actors or entities were locally embedded, farmers adopted these practices as the interaction facilitated relational trust and confidence (Borremans et al., 2018; Kishioka et al., 2017; Mills et al., 2017; Ouellet et al., 2020; Schomers et al., 2015; Yasue et al., 2019). For instance, in Germany, for an AES, a field manager provided farmers with information and assistance – especially ex ante contract signing, and built relational trust by using their contacts with farmers. The field managers' soft skills led to the bridging of social capital (Schomers et al., 2015). However, such intensive service provision could not be made available to the total number of AES participants. In contrast, farmers in a stewardship programme in Australia, felt that the government was 'throwing money' at them as they were offered financial incentives without relationship building (see also PT 7). Secondly, mistrust in the government could hamper the successful implementation of AEP strategies (Jongeneel et al., 2008; Mettepenningen et al., 2013; Moon, 2013). For example, governmental-led programmes in Australia were not successful in terms of participation in areas with high levels of mistrust in the government (Moon, 2013). In these areas, private sector organizations could be in the lead to improve participation. Thirdly, designers of AEP strategies should be aware that farmers are more trusting of intermediaries or advisors with farming backgrounds (Barghusen et al., 2021; Mills et al., 2017; Siebert et al., 2010; Villamayor-Tomas et al., 2019). However, this could cause tunnel vision and block new information (Borremans et al., 2018). Fourthly, farmers not having access to an independent extension service and highly depending on commercial actors (e.g. suppliers and other agribusinesses) for knowledge acquisition, feel that they do not know what types of knowledge they need to switch to AEM (Vermunt et al., 2022). Fifthly, educational systems predominantly offering education according to the productivist model and lacking sufficient teaching material on AEM (Borremans et al., 2018; Vermunt et al., 2022). As agricultural education is still heavily focused on conventional productivist models, students growing up on conventional farms, still feel the need to demand education in line with what they have experienced so far (Borremans et al., 2018; Vermunt et al., 2022). This indirectly leads to a lack of clarity for farmers on knowledge requirements in light of AEM, which negatively influences farmers' participation in AEP (Vermunt et al., 2022).

> PT 5: Stimulate engagement in experimentation with agri-environmental measures - leading to tangible results, which induces farmers to feel more ownership and more empowered to adopt agri-environmental measures.

AEP strategies in which farmers are stimulated to experiment and are demonstrated (long-term) tangible results, thereby showing farmers that AEM make sense, stimulate farmers to adopt these measures as they feel more empowered (Birge & Herzon, 2019; Borremans et al., 2018; Burton et al., 2008; Home et al., 2014; Ingram, 2010; Kishioka et al., 2017; Mills et al., 2017; Reimer & Prokopy, 2014; Runhaar, 2017; Vermunt et al., 2022; Westerink et al., 2020). The mechanism through which farmers are motived is that the insights into the effectiveness of AEM, e.g. through monitoring data, and experimenting with AEM on their own land, enhances farmers' feelings of ownership and empowerment (Birge & Herzon, 2019; Borremans et al., 2018; Burton et al., 2008; Fleury et al., 2015; Ingram, 2010; Mills et al., 2017; Moon, 2013; Vermunt et al., 2022; Westerink et al., 2020). Farmers expect firm evidence, without which their beliefs are difficult to change (Westerink et al., 2020).

The first enabling contextual factor pertains to farmers observing the long-term tangible benefits in time (also see PT 1), which shifts their perspective of a risky decision (as transition takes time and entails risk of failure) (see PT 7), to motivation to continue, trusting the strategy to be successful and not having unforeseen negative consequences (Borremans et al., 2018; Home et al., 2014; Reimer & Prokopy, 2014; Yasue et al., 2019). Secondly, when universities, for instance, undertake monitoring activities on farmers' lands, farmers' interests in the environment could be catalyzed as farmers get insights into the effectiveness of AEM (Mills et al., 2017; Westerink et al., 2020).

Our review has identified four inhibiting contextual factors that hinder AEP strategies and farmers' ability to experiment. Firstly, the cause–effect evidence of AEM is not always straightforward or cannot be provided in the short-term, which is especially difficult for result-oriented AEPs (Burton et al., 2008; Kishioka et al., 2017; Mills et al., 2017; Runhaar, 2017; Westerink et al., 2020). Secondly, farmers need specific (scientific) knowledge that they may lack, which could be facilitated through AEP strategies via extension professionals or (conservation) scientists (Mills et al., 2017; Runhaar, 2017; Schomers et al., 2015; Vermunt et al., 2022). However, ecological research insufficiently takes into account the problems farmers face when implementing effective AEM (Runhaar, 2017). Farmers have knowledge needs that are less abstract and better fit their on-farm context (Runhaar, 2017; Vermunt et al., 2022). Thirdly, farmers lack financial buffers to experiment with AEM (Borremans et al., 2018; Vermunt et al., 2022). This lack is due to farmers' structural budget shortages (attributed to a lack of financial incentives and to high capital intensity), farmers' vulnerable position in the value chain, depreciation costs of land, lack of funds that could cover these transition costs, and a lack of access to finances from banks (also see PT 7). Fourthly, high land prices and short lease contracts, combined with small margins, hinder farmers from experimenting or transitioning toward extensification and AEM (Borremans et al., 2018; Groce & Cook, 2022; Jongeneel et al., 2008; Kolinjivadi et al., 2019; Reimer & Prokopy, 2014; Vermunt et al., 2022; Westerink et al., 2020).

Regarding financial arrangements, this review identified two PTs (PT 6 & 7) that highlight the importance of contractual relationships and financial arrangements to motivate farmers to enter into these programmes.

> PT 6: Invest in pre-contractual trust-building, which makes farmers view the contracting partner as trustworthy, to foster long-term cooperation around agri-environmental measures.

Our review indicated that the building of social relationships between contracting partners played an important role in establishing new contractual arrangements that foster long-term cooperation around AEM (Barghusen et al., 2021; Jongeneel et al., 2008; Le Coent et al., 2017; Mante & Gerowitt, 2009; Mitchell et al., 2015; Moon, 2013; Yasue et al., 2019). Therefore, strategies should invest time in building face-to-face relationships and pre-contractual trust. The mechanism through which farmers are motivated to enter these contracts, is trust in the contracting party. Our review has shown that farmers could be mistrusting based on fear of breach of contract, the government adjusting contractual requirements over time, and fear of loss of autonomy (Borremans et al., 2018; Home et al., 2014; Jongeneel et al., 2008; Moon, 2013).

A facilitating contextual factor is a contracting partner with a trustworthy reputation (Barghusen et al., 2021; Le Coent et al., 2017). Specifically, when farmers contract with the government, there must be a high level of trust in the governments' reliability, corresponding to our findings in PT 4 (Moon, 2013; Jongeneel et al., 2008). An inhibiting contextual factor is that farmers have experienced that the government can modify policy or change the rules of the game (Moon, 2013; Jongeneel et al., 2008). These changes have particular effects on farmers' earlier investments regarding AEM and could therefore lead to lock-in effects, which could make farmers apprehensive in adopting AEM.

> PT 7: Introduce financial arrangements that make farmers weigh the risks and benefits in such a way that they feel confident enough to participate in agri-environmental programmes.

Our review found that strategies should provide financial support to accommodate farmers' weighing the financial risks and benefits (Barghusen et al., 2021; Birge & Herzon, 2019; Borremans et al., 2018; Czajkowski et al., 2021; Fleury et al., 2015; Greiner & Gregg, 2011; Groce & Cook, 2022; Guillem & Barnes, 2013; Hammes et al., 2016; Hansen et al., 2018; Home et al., 2014; Ingram et al., 2013; Josefsson et al., 2017; Kishioka et al., 2017; Kolinjivadi et al., 2019; Lakner et al., 2020; Leonhardt et al., 2021; Mante & Gerowitt, 2009; Mills et al., 2017, 2018; Moon, 2013; Reimer et al., 2012; Reimer & Prokopy, 2014; Runhaar, 2017; Schmitzberger et al., 2005; Schmitzberger et al., 2005; Siebert et al., 2010; Van Dijk et al., 2016; Was et al., 2021; Yasue et al., 2019). The mechanism through which these strategies work is that farmers are more motivated to enter programmes if they reason they are able to weigh the financial risks and benefits.

This review identified five programme strategies. Firstly, strategies providing financial payments – as long as farmers respect the programme conditions, which are usually offered in action-oriented

programmes (Ingram et al., 2013; Was et al., 2021). Some of these strategies also include costs for maintenance or compensation for yield losses (Borremans et al., 2018; Runhaar et al., 2017). Secondly, providing financial payment to farmers once they achieve (biodiversity) goals, a strategy usually offered under result-oriented programmes (Birge & Herzon, 2019; Burton et al., 2008; Fleury et al., 2015; Home et al., 2014). Thirdly, strategies that provide farmers with a basic rate for establishing the programme, and that reward farmers for achieving (biodiversity) goals with a bonus payment, usually offered under mixed programmes that include action- and result elements (Birge & Herzon, 2019; Fleury et al., 2015; Home et al., 2014). Fourthly, unsubsidized AEP strategies that do not offer financial support to farmers, but that offer farm advisory visits or education support (Ingram, 2010; Josefsson et al., 2017; Lokhorst et al., 2011; Mills et al., 2017, 2018; Van Dijk et al., 2016). Fifthly, strategies offering contract lengths that appeal to farmers' weighing the financial risks and benefits. These strategies could offer farmers the option to start with a 1-year contract that can be prolonged if the AEM proves to be feasible or terminate the contract without additional costs (Czajkowski et al., 2021; Hansen et al., 2018; Mante & Gerowitt, 2009). This will help farmers who perceive AEM as risky or who will be implementing AEM for the first time, to overcome their initial reservations. However, there is also evidence that longer contracts (e.g. 10 or 30 years) are perceived by farmers to provide them with long-term financial security (Ingram et al., 2013; Runhaar et al., 2017).

Nevertheless, this review revealed that AEP strategies offering financial incentives, are necessary but insufficient to motivate farmers to adopt AEM (Barghusen et al., 2021; Greiner & Gregg, 2011; Groce & Cook, 2022; Guillem & Barnes, 2013; Hammes et al., 2016; Hansen et al., 2018; Home et al., 2014; Ingram et al., 2013; Leonhardt et al., 2021; Mills et al., 2017, 2018; Moon, 2013; Reimer et al., 2012; Reimer & Prokopy, 2014; Schmitzberger et al., 2005; Schomers et al., 2015; Siebert et al., 2010; Was et al., 2021; Yasue et al., 2019). Additional incentives that AEP strategies offer, and that change farmers' contexts, are required – as found in PT 1–6 and 8–10, such as extension professionals investing in relationship-building with farmers (e.g. Moon et al., 2012; Schomers et al., 2015; Yasue et al., 2019), providing on-ground advice and offering adequate information to farmers to make informed choices (e.g. Home et al., 2014; Mills et al., 2017; Moon et al., 2012).

This review found three enabling contextual factors for the aforementioned strategies. Firstly, farmers who have norms and values that pertain to environmental concerns, who place importance on their relationship with nature, and have strong stewardship aspirations (Greiner & Gregg, 2011; Guillem & Barnes, 2013; Josefsson et al., 2017; Leonhardt et al., 2021; Mills et al., 2018; Van Dijk et al., 2016; Was et al., 2021). These farmers have an intrinsic motivation to work on AEM and therefore participate more in AEP. This especially applies to unsubsidized programmes that do not offer monetary compensation. Secondly, programmes that incorporate action-oriented elements, for instance in the form of annual payments, provide farmers with contexts that guarantee an income (Fleury et al., 2015; Ingram et al., 2013; Was et al., 2021). Moreover, some (productive) farms have even regarded the financial incentive as providing them with a financial buffer, thereby helping the development of the farm (Ingram et al., 2013; Yasue et al., 2019). Thirdly, in line with the former, the higher the share of AEM payments to the farms' income, the higher the participation of farmers in AEPs. Farms with lower profitability and that depend on income diversification, welcome the financial security provided by payments, as these are seen as relatively considerable and needed for farm survival, or they have lower opportunity costs and perceive AEM as a means to improve their economic performance (Home et al., 2014; Ingram et al., 2013; Was et al., 2021). However, the results also show that larger (efficient) farms that regard AEM as a subsidiary income stream, adopt AEM because they can often spare some of their less productive land (Hammes et al., 2016; Lakner et al., 2020; Mills et al., 2017). In a similar fashion, our review found that some farmers would use AEM only if it could be implemented in a profitable way, e.g. by taking marginal land out of production and regarding the payments as compensating for the loss of what was already perceived as marginal land (Birge & Herzon, 2019; Hammes et al., 2016; Kolinjivadi et al., 2019; Reimer & Prokopy, 2014). Consequently, it appears that these farmers do not undergo a socio-cognitive shift needed to move toward biodiversity conservation (Mills et al., 2017).

Furthermore, some farmers feel that programmes – despite offering financial incentives – do not allow them to weigh the financial risks and benefits. In addition to the third and fourth inhibiting contextual factors identified in PT 5, the following five factors

play a role. Firstly, farmers who perceive conservation as an external interference into their farm – affecting their autonomy, cannot be persuaded by financial compensation to adopt AEM (Hammes et al., 2016; Schmitzberger et al., 2005; Yasue et al., 2019). Secondly, if the costs for AEM are not sufficiently covered by programmes (Czajkowski et al., 2021; Groce & Cook, 2022; Guillem & Barnes, 2013; Lakner et al., 2020; Runhaar, 2017; Runhaar et al., 2017; Yasue et al., 2019). Especially productivist farmers do not automatically belief that the programmes provide enough compensation for potential losses (Guillem & Barnes, 2013; Ingram et al., 2013; Leonhardt et al., 2021; Mills et al., 2017; Reimer et al., 2012; Schmitzberger et al., 2005; Westerink et al., 2020). Thirdly, farmers not being sufficiently rewarded for their AEM efforts – corresponding to PT 8 (Guillem & Barnes, 2013; Runhaar, 2017; Vermunt et al., 2022; Was et al., 2021). The payments for programmes that fall under the European Common Agricultural Policy (CAP), such as AES, cannot exceed compensatory levels (generally covering costs and income forgone), and due to the EU state-aid requirements, market-based prices for farmers performing AEM cannot be provided (Home et al., 2014; Runhaar, 2017; Westerink et al., 2020; Zwaan & Goverde, 2010). Therefore, rewarding farmers with private money and including supply chain stakeholders and consumers in programmes is important – see also PT 8 (Runhaar et al., 2017; Westerink et al., 2020). Fourthly, the time investments needed for some programme requirements, such as burdensome application paperwork or ongoing contract maintenance, were perceived by farmers as a cost to participating (Borremans et al., 2018; Mante & Gerowitt, 2009; Mettepenningen et al., 2013; Reimer & Prokopy, 2014; Siebert et al., 2010). However, this inhibiting factor was not enough to prevent farmers from participating. Fifthly, if farmers perceive the transaction costs of adjusting the farm to AEM requirements as too high, which especially applies to farms that have very specific and valuable assets (e.g. machinery), farmers feel hindered to participate in AEP (Was et al., 2021; Schomers et al., 2015). Interestingly, our review has shown that subsidized activity can also be a trigger for more unsubsidized activity (Mills et al., 2018; Yasue et al., 2019). In Tasmania, whereas financial incentives firstly acted as a 'foot in the door' for some farmers in the stewardship programme, conservation became 'addictive' later on, corresponding to PT 3 (Yasue et al., 2019).

PT 8: Include supply chain stakeholders and consumers within programmes, which induces a sense of fairness and reciprocity within farmers in light of new incentives that reward farmers to maximize positive impacts of agri-environmental programmes.

Our review identified the importance of AEP strategies that include supply chain stakeholders and consumers, to create a level playing field in the market in which externalities from conventional farming are priced and AEM are rewarded (Barghusen et al., 2021; Borremans et al., 2018; Kolinjivadi et al., 2019; Moon, 2013; Moon et al., 2012; Runhaar et al., 2017; Runhaar & Polman, 2018; Van Dijk et al., 2015; Vermunt et al., 2022; Villamayor-Tomas et al., 2019; Westerink et al., 2020). The mechanism through which these strategies work is that it induces a feeling of fairness and reciprocity as not only farmers, but also supply chain stakeholders and consumers take responsibility for biodiversity restoration.

Our review identified four types of AEP strategies. Firstly, AEP strategies making use of labels or certificates via which farmers receive a premium on their products if they comply with sustainability criteria (Runhaar et al., 2017). Use could be made of bonus-malus arrangements to reward or penalize farmers for good or bad performance. Motivations for stakeholders, such as agri-businesses or banks, to join these programmes is their Corporate Social responsibility (Runhaar et al., 2017). Secondly, some of these labelling programmes have also adopted strategies via which they aim at creating short value chains by reducing the number of intermediaries (Borremans et al., 2018; Westerink et al., 2020). Thirdly, strategies include lobbying at supermarkets or food processers to create a market and establish legitimacy for sustainable products that include labels (e.g. 'meadow bird friendly dairy') (Runhaar & Polman, 2018). Fourthly, strategies that explicitly target consumers (Kishioka et al., 2017). In Japan, the prefectural government had started PR activities for consumers in the form of fairs, farm tours and food education seminars, and promoted the locally produced food for school lunches with the concept 'local production, local consumption', corresponding to PT 2 (Kishioka et al., 2017). Moreover, the labelling works for farmers as an intrinsic reward of self-identity, corresponding to PT 3 (Barghusen et al., 2021). Our review identified other examples of programmes that aim to internalize externalities, such as competitive tenders and auctions in Australia, the US and the Netherlands (Moon, 2013; Moon et al., 2012; Reimer &

Prokopy, 2014; Runhaar et al., 2017; Zwaan & Goverde, 2010). However, these programmes do not (sufficiently) include supply chain stakeholders and consumers.

Our review revealed that programmes that reward farmers with new incentives run up against five constraining contexts. Firstly, low consumer demand for sustainable agricultural products and unclarity to what extent consumers are willing to pay for these products make agri-businesses reluctant to introduce these products into the market (Borremans et al., 2018; Home et al., 2014; Kolinjivadi et al., 2019; Mills et al., 2017; Vermunt et al., 2022; Westerink et al., 2020). Secondly, farmers feel discouraged to participate in programmes if they would not receive the appreciation of the public for their contribution to the ecological value of agricultural areas or if consumers are not willing to pay more for their products (Home et al., 2014; Kolinjivadi et al., 2019; Mills et al., 2017). Thirdly, supermarkets lack the willingness to pay price premiums, due to the intense price competition among themselves and the resulting focus on cost-reduction (Vermunt et al., 2022). Fourthly, programmes that encourage the development of alternative revenue models tend to favour local production and short value chains (Borremans et al., 2018). These models make agri-businesses, but also the global trade and processing industry resistant to change (Borremans et al., 2018; Greiner & Gregg, 2011; Kolinjivadi et al., 2019; Runhaar & Polman, 2018). Their revenue model depends on farmers producing for the bulk market at persistently low prices. Therefore, efficiency measures, such as cost reduction and scale enlargements remain the dominant business strategies for agri-businesses, including farmers. Farmers feel they are price-takers with limited power to negotiate with other agri-businesses (Borremans et al., 2018; Kolinjivadi et al., 2019; Runhaar, 2017; Vermunt et al., 2022). Their high dependency on other stakeholders limits their freedom to shift to AEM and to participate in AEPs (Kolinjivadi et al., 2019; Vermunt et al., 2022). Fifthly, agricultural practices which negatively impact biodiversity, are not taxed (Vermunt et al., 2022). Agri-supplychain stakeholders feel not obliged to account for biodiversity and ecosystem services in product prices, and to pay for negative externalities like water pollution or soil depletion. Our review revealed that despite programmes' appeal to the responsibility ofsupply chain stakeholders and consumers, regulation and binding agreements which would oblige these stakeholders to account for biodiversity and ecosystem services in product prices and to pay for negative externalities, seem to be necessary (Kolinjivadi et al., 2019; Vermunt et al., 2022; Westerink et al., 2020).

> PT 9: Create a programme governance structure that reflects regional or local representation, which induces farmers to feel ownership and shared responsibility, resulting in the enhanced legitimacy of the programme.

Our review found that when AEP strategies create a programme structure that is characterized by regional or local representation of the farming community, their legitimacy is enhanced (Barghusen et al., 2021; Fleury et al., 2015; Mills et al., 2017; Mitchell et al., 2015; Ouellet et al., 2020; Schomers et al., 2015; Siebert et al., 2010; Yasue et al., 2019). Regional or local representation refers to the geographic proximity of the programme members and to the local embeddedness of the programme. The governance design is an important aspect of the programme as it includes 1. The extent to which the programme enables farmers to determine how outcomes are to be achieved; 2. Efficiency and utility of monitoring and compliance provisions, and 3. Accountability mechanisms for financial support (Mitchell et al., 2015). The mechanism through which this strategy works is that farmers feel more ownership and more responsible for the programme.

An enabling contextual factor for AEP strategies is linking up with existing social networks that mobilize the entire farming community (Barghusen et al., 2021; Fleury et al., 2015; Mills et al., 2017; Mitchell et al., 2015; Ouellet et al., 2020; Schomers et al., 2015; Siebert et al., 2010; Yasue et al., 2019). For instance, in Canada, the Alternative-Land-Use-Services (ALUS) programme is governed by local farmers and regional environmental organizations (Ouellet et al., 2020). Although members did not know each other personally, there was an understanding that participants had a deep understanding of the community with similar environmental concerns and a similar local focus. The local embeddedness was appreciated by farmers as it induced a feeling of shared ownership and responsibility, leading to the adaptation of projects to their specific needs.

The two identified inhibiting contextual factors pertain to firstly, programmes that are offered by governmental actors, which generally operate from outside the community and tend to propose one-size-fits-all solutions (Ouellet et al., 2020). Secondly,

our review found that if programme administrators are not locally embedded, they at least must be regarded as trustworthy, credible and practical by the local farming community – corresponding to PT 4 (Moon, 2013).

> PT 10: Align programmes with agri-environmental policies and regulations at different levels of government, which induces farmers to gain trust in and a better understanding of the programme, leading to clear expectations about what is expected of farmers concerning agri-environmental measures.

Our review found that AEP strategies should be non-ambiguous and corresponding to the policies and regulations at different governmental levels, in order for farmers to better understand what is expected of them regarding AEM (Borremans et al., 2018; Kishioka et al., 2017; Mitchell et al., 2015; Runhaar et al., 2017; Vermunt et al., 2022; Zwaan & Goverde, 2010). The mechanism through which farmers are motivated to participate is trust in – and understanding of the programme.

Our review indicated five inhibiting contexts for the implementation of programmes. Firstly, when different governmental levels are involved in the programme that attribute different meanings to ambiguous legislation, e.g. concerning EU state-aid regulations (Zwaan & Goverde, 2010). This difficulty is exacerbated when there are complex power relationships between the different governmental levels, which could even make stakeholders that are involved in the different levels mistrust each other. Moreover, it could lead to much delay in the implementation of the programme and disappointment of the stakeholders involved. Secondly, a lack of a shared vision at different governmental levels, civil society (e.g. NGOs) and farmers associations on AEM makes farmers unsure about what is required from them in the future (Borremans et al., 2018; Kishioka et al., 2017; Mitchell et al., 2015; Runhaar et al., 2017; Vermunt et al., 2022; Zwaan & Goverde, 2010). Specifically, conflicting visions, such as governmental visions adhering on the one hand to nature-inclusive farming, while also endorsing scale enlargement and export, make farmers and other stakeholders distrust each other and refrains them from entering programmes (Mills et al., 2017; Runhaar, 2017). The lack of a shared vision is further complicated by regional differences in soil type and landscape characteristics (Borremans et al., 2018; Mitchell et al., 2015; Runhaar, 2017; Vermunt et al., 2022). Moreover, the lack of a shared vision on sustainable agriculture is exacerbated by policy-making 'in-silos', e.g. within national ministries (e.g. compartmentalization of dossiers on issues like biodiversity, nitrogen and phosphate), between ministries, and between different governmental levels (regional, national, European) (Borremans et al., 2018; Vermunt et al., 2022). Thirdly, when legislation around AEM is complicated or little transparent (Borremans et al., 2018; Home et al., 2014). For instance, in Belgium, agroforestry farmers felt uncertain about the possibility that harvesting their trees might result in them being obliged to replant or pay a financial compensation (Borremans et al., 2018). Fourthly, programme regulations being perceived by farmers as overly complex, e.g. involving multiple agencies (Hammes et al., 2016; Lakner et al., 2020; Moon et al., 2012). Fifthly, AEM are foremost voluntarily, which shows a lack of visionary ambition at the regulatory level and affects farmers' participation in AEP (Vermunt et al., 2022). These inhibiting contextual factors show that a shared multi-level vision and transparent legislation would aid farmers' participation in programmes. In addition, AEM should be legally required instead of these practices taking place on a voluntary basis.

## 4. Discussion

This review presents 10 Programme Theories (PTs) drawn from the available evidence on more than 60 Agri-Environmental Programmes (AEPs), covering 13 different types of programmes in 17 intensive farming countries. These 10 PTs are considered key for the design and implementation of AEPs to guide farmers' behavioural change toward biodiversity conservation. Together the PTs form a theory-driven framework that summarizes the insights into how, when and why farmers work on successful AEPs.

We believe this to be the first study presenting an overview of PTs for AEPs using a realist methodology. It goes beyond summarizing the factors that influence or motivate farmers to adopt Agri-Environmental Measures (AEM) (e.g. Bonke et al., 2021; McGurk et al., 2020), as it provides a theory-driven insight into what AEP strategies work in what circumstances and why these work based on the reasoning and motivations of farmers. Moreover, the range of theories that underpinned the Strategy-Context-Mechanism-Outcome (SCMO) configurations stemmed from different scientific disciplines. While stemming from

different ontological perspectives, the mechanisms underpinning each PT were consistent.

As far as we know, this is the first explorative study that has unearthed an overview of the explanatory powers of programmes – the different mechanisms – that play a role in bringing about farmers' behavioural change toward biodiversity conservation. Each PT is linked to specific mechanisms. We add to the existing literature on AEP design and implementation (e.g. Bazzan et al., 2023; Dessart et al., 2019; Mills et al., 2021), by contributing to a mechanistic understanding of causality, i.e. which mechanisms lead to behavioural outcomes within an interplay between AEP strategies and their implementation contexts. In addition, our results also seem to suggest that the different mechanisms should not be considered in isolation, e.g. farmers weighing financial risks and benefits (PT 7) is necessary but insufficient to make them change their practices. This finding is in line with the international literature (e.g. Lastra-Bravo et al., 2015; Siebert et al., 2006; Tyllianakis & Martin-Ortega, 2021). Further research could explore which combinations of mechanisms are necessary, and which are sufficient for behavioural change in which implementation phase and context. Furthermore, it is reassuring that the identified mechanisms pertain to widely recognized behavioural elements, such as sensemaking (PT 1), weighing risks and benefits (PT 7), trust within relationships (PT 6, 10) or feelings of ownership (PT 5, 9) (e.g. Scott, 2001; Steenkamer et al., 2020b; Tajfel, 1972). For instance, in the scientific literature, sensemaking is defined as an innate drive to becoming aware of new, uncertain or ambiguous situations. Indeed, similar mechanisms have been identified in theory-driven syntheses and evaluations in other sectors, such as health care, energy or mobility (Loorbach et al., 2017; Sengers et al., 2016; Steenkamer, 2020). To increase the external validity of our findings, future research can further verify whether these causal mechanisms hold across other contexts as AEPs evolve and hold across other sectors than the beforementioned.

Regarding contexts, this review identified basic contextual factors that induce specific mechanisms, for instance social interaction, which we identified in our review as being important for triggering feelings of confidence (PT 4) and trust within relationships (PT 6, 10). In a programme implementation setting, these basic contextual factors were expressed in different ways. For example, social interaction was expressed via farmers talking to lead farmers, or farmers talking to extension workers, advisors or governmental actors. Furthermore, some inhibiting contextual factors require AEP strategies that deploy bigger investments than others. For example, the socio-cognitive and normative shift that productivist farmers need to undergo to move toward biodiversity conservation is more intense or requires a longer time, as shown in PTs 1–5 and 7. Moreover, some contexts are beyond the influence of individual AEPs, as these contexts play out at various governmental levels or in society in general, such as the lack of a shared vision on sustainable agriculture. We add to the existing literature by unpacking and disentangling AEP strategies and contexts, and how mechanisms causally link AEP strategies and their implementation contexts to outcomes (e.g. Bredemeier et al., 2022; Kelemen et al., 2023; Sattler et al., 2023). As AEPs are in development, for example in terms of making use of innovative contracts regarding mixed – or result-oriented AEPs, new insights into new contextual conditions will arise, which need to be taken into account for successful AEPs.

With regard to AEP strategies, our review found that AEP strategies first need to focus on a socio-cognitive and cultural shift before a normative shift can take place. This finding is in line with the scientific literature on system change (Scott, 2001; Steenkamer, 2020; Suddaby, 2010). Specifically, strategies first need to focus on changing farmers' awareness and attitudes toward AEM (PT 1), and consequently build symbolic capital that acknowledges farmers' new role performance within AEM (PT 2) before implementing strategies that focus on changing farmers' norms and values toward a new identity of what a good farmer entails (PT 3). Our findings are also supported by reviews on farmers' adoption behaviour, which found that farmers' environmental awareness and attitudes toward and concern for the environment were significant for adoption behaviour (e.g. Baumgart-Getz et al., 2012; Dessart et al., 2019; Klebl et al., 2023). However, others found mixed or non-significant results (e.g. Schaub et al., 2023; Thompson et al., 2023), though the latter results were based on the assessment of only one type of programme, namely AES. Moreover, while the above findings regarding successive implementation of strategies of the various PTs are of importance, in other domains there is evidence regarding which strategy investments need to be emphasized in which phase of the behavioural change (Erickson et al., 2017; Steenkamer, 2020; Van Vooren et al., 2020). Therefore, more research is needed to gain insight into which strategy

investments are needed in which phase of AEP implementation to motivate farmers to move toward biodiversity conservation.

Our review also highlights that AEPs that facilitate a mix between action- and result oriented programme strategies, seem to address farmers' behavioural change toward biodiversity conservation better than strategies solely adopting an action- or result oriented approach. Hence, mixed programme strategies not only motivate farmers to adopt AEM via financial incentives but also appeal to the socio-cognitive and normative shift needed for behavioural change. While these findings are in line with the scientific literature, their focus is mainly on strategies that need to be implemented or on factors that need to be addressed, for example, in CAP policy design (e.g. Pe'er et al., 2022; White & Sadler, 2012). Our review adds to this knowledge by providing specific insights into which specific strategies need to be implemented in which specific contexts to trigger specific underlying mechanisms in a way that increases the likelihood that farmers adopt AEM.

The 10 PTs reflect the importance of AEPs taking into account the technological, sociological, economic, psychological and institutional elements that play a role in guiding farmers' behavioural change toward biodiversity conservation. In addition, our review has shown that the 10 PTs are interrelated. While the scientific literature acknowledges that farmer's decisions to participate in AEPs are based on a complex interplay of social, cultural, economic and policy influences (e.g. Lastra-Bravo et al., 2015; Mills et al., 2021; Pannell et al., 2006), our review adds to this literature by showing how farmer's decision to participate in AEPs and changing their behaviour toward biodiversity conservation, is the outcome of a complex interplay between strategies, contextual factors and mechanisms. Furthermore, the 10 PTs can be regraded as transferable hypotheses that suggest that certain programmes are more or less likely to work in certain ways in certain contexts (Jagosh, 2019; Pawson, 2013; Saul et al., 2013). Moreover, the 10 PTs correspond to other theory-driven frameworks underlying system transitions in health care, energy or mobility (Loorbach et al., 2017; Sengers et al., 2016; Steenkamer, 2020). In these sectors, learning environments were developed to facilitate the system transition. For a system transition within the agri-environmental sector to come about, AEPs could follow the transitional paths in the aforementioned sectors. Specifically, AEPs could function as learning environments in which farmers, farmers' organizations, programme managers, knowledge institutions, agri-businesses, banks, NGOs, and the national and regional governmental levels work together (PT 1–4, 8–10), thus connecting the horizontal and vertical networks (PT 4) to bring the actual needs to the surface and subsequently tackle the systemic problems. Furthermore, experiments regarding new incentive models and contracts (PT 6, 7), new combinations of action- and result-oriented programmes and investments in learning environments that include data monitoring and encourage knowledge-exchange (PT 1–5), can be addressed. To this end, the learning environments can benefit from the 10 PTs and the insights into their underlying strategies, mechanisms and contextual factors. Therefore, in order to enhance farmers' behavioural change, it would be most effective to take account of the 10 PTs when designing and implementing programmes.

The strength of this review lies in the realist methodology, via which the causal relationships between strategies, contexts, mechanisms and outcomes of AEPs and their underlying theories were uncovered. In doing so, this approach has provided insights that other forms of synthesizing evidence would not have given. The 10 PTs suggest routes for designing and implementing AEP strategies. Thereby they provide guidelines for the creation of the structures and processes needed to effect change in the contexts in which AEPs operate, in such a way that it most likely stimulates farmers to work on AEM. Moreover, in terms of the practical applicability of the 10 PTs, this review (i.e. Table 2) offers per PT a detailed level of granularity by providing an overview of the underlying AEP strategies, inhibiting and facilitating contextual factors, that influence the reasoning and motivations of farmers (mechanisms), and to which outcomes these lead. Programme managers, policy makers, NGOs, agri-businesses, and farmers' organizations can draw from these insights in designing and implementing AEPs in specific contexts. In this sense, Table 2 could be regarded as a 'living document' that can be complemented with configurational insights as AEPs evolve.

This study also has a number of limitations. Firstly, the included studies' countries in which AEPs were operationalized were foremost intensive farming countries. However, by using the realist approach, we were able to generate the 10 PTs based on the synthesis of the different types of programmes and settings, and thus different countries. Using this

approach, the PTs can be considered as transferable hypotheses that suggest that certain programmes are more or less likely to work in certain ways in certain circumstances (Jagosh, 2019; Pawson, 2013; Saul et al., 2013). Therefore, we expect the 10 PTs to be transferable to less and non-intensive farming countries. Further research can verify if the expected transferability will hold. In addition, as mentioned above, follow-up research can investigate the generalizability of our findings by further verifying whether the identified mechanisms hold across other contexts. Secondly, identifying what caused something to happen in open systems such as the implementation of AEPs is complex (Steenkamer et al., 2020b; Jagosh, 2019). The conditions, i.e. the changed context and the mechanisms that make the outcomes possible, were in some papers more elaborately described than in others, thereby affecting the quality of the evidence on the identified SCMOs. Nonetheless, by using a bespoke data extraction form that we developed and by analyzing the papers very precisely for postulated causality between AEP strategies, contexts, mechanisms and outcomes, we were able to gain insight into what specific aspect of the AEP strategy had changed the contexts, and how this consequently influenced farmers' reasoning and behaviour. Thirdly, this review has mainly focused on the reasoning and motivations of farmers as they are the owners and conservers of the land and therefore, have a crucial role to play in restoring biodiversity. Further research could uncover the reasoning and motivations of other stakeholders involved in AEPs, such as supply chain stakeholders, as biodiversity conservation is not solely farmers' responsibility, but pertains to all stakeholders involved in developing sustainable food production. Fourthly, this review does not provide insights into the ecological effectiveness of AEM and AEPs regarding biodiversity conservation. Ecological studies so far do not provide rich descriptions of contexts and causal mechanisms leading to specific ecological outcomes. Hence, this review has focused on farmers' behavioural change as a necessary step toward biodiversity conservation. We have defined successful AEPs as programmes that succeed in motivating farmers to change their behaviour, but future research could expand this definition by including specific ecological outcomes as a result of the behavioural change. In a follow-up study, we will adopt a mixed methods approach to gain configurational insights into how farmers' behavioural change directly affects biodiversity restoration.

Evidence-informed theorizing about how and in what circumstances AEPs works should be an ongoing pursuit. Therefore, more research is needed to gain further insight into the conceptualization and operationalization of AEPs. The 10 PTs need to be applied in practice by empirically evaluating the design and implementation of AEPs. Using the 10 PTs, future research could further investigate the interrelatedness of the PTs and also the relative importance and sequence of implementation of the individual PTs in different settings. As a 'living document', Table 2 can be further refined and enriched with configurational insights as AEPs evolve.

## 5. Conclusion

This realist review identified 10 Programme Theories (PTs) considered to be key for the design and implementation of successful Agri-Environmental Programmes (AEPs) that guide farmers' behavioural change toward biodiversity conservation. These 10 PTs were based on the available evidence on more than 60 AEPs, covering 13 different types of programmes in 17 intensive farming countries. The 10 interrelated PTs together form a theory-driven framework that provides practical insights into how AEP strategies are expected to bring about farmers' behavioural change, given contextual influences and underlying causal mechanisms. The PTs can be regarded as guiding principles for farmers, farmers' organizations, policy makers, programme managers, agri-businesses, banks, NGOs and researchers. Future research should study the PTs in practice in order to refine and enrich them to further successfully guide AEPs.

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## Glossary

Agri-Environmental Programme (AEP)
Agri-Environmental Measures (AEM)
Alternative-Land-Use-Services (ALUS)
Agri-Environmental Schemes (AES)
Common Agricultural Policy (CAP)
European Union (EU)
Programme Theory (PT)
United States (US)

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