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## A systematic review of attributes used in choice experiments for agri-environmental contracts

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**Abstract.** Contract attributes are strong motivators for eliciting farmers' preferences for a particular agri-environmental scheme. Our study aims to conduct a systematic literature review to highlight the attributes used in choice experiment studies of agri-environmental schemes using the PRISMA framework. We obtained 34 studies for an in-depth review, through which we extracted 32 attributes that were classified into five typologies: 'monetary' (7 attributes), 'general' (4 attributes), 'flexibility' (6 attributes), 'prescription' (12 attributes), and 'purpose' (3 attributes). Though monetary attributes should theoretically define farmers' choices; general design and flexibility attributes are more critical for farmers' participation and willingness to accept. The study also discusses the lesser-used attributes that could be potentially explored in future studies. Thus, our review can be used as a reference by future AES studies to select their bundle of choice attributes and test with a broader range of attributes in their choice experiments.

**Keywords:** choice experiment, agri-environmental schemes, willingness to accept, contract attributes, systematic literature review

**JEL codes:** Q15, Q20, Q57.

### 1. INTRODUCTION

Farmers' decision to participate and their willingness to accept (WTA) a particular agri-environmental scheme (AES) is affected by the contract's design. Studies have tried to investigate the choice behaviors of farmers using various methodologies. The choice experiment (CE) methodology, a type of stated preference method, is widely applied in valuation studies and is useful for analyzing different policy scenarios (Kanchanaroek & Aslam, 2018). CEs are based on the theory of consumer choice, which states that individuals' choices depend on utility or value gained from the attributes of the goods being consumed (Lancaster, 1966). Utility generally depends on attributes of the choices and socio-economic characteristics of an individual. So, CEs provide an attribute-based approach that can investigate individual preferences (Chèze et al., 2020) as well as quantify the trade-offs between the alternatives (Hynes et al., 2011). Thus, the CE method is par-

ticularly suited for evaluating choices among different AESs and to elicit farmers' or landowners' preferences for different attributes in a contract (Espinosa-Goded et al., 2010; Horne, 2006; Ruto & Garrod, 2009, etc.). Many studies have reported that even though socio-economic, demographic, or cultural characteristics can influence farmers' preferences, such findings are usually insufficient to quantify these choices (Dachary-Bernard & Rambonilaza, 2012; Dramstad et al., 2006; Swanwick, 2009, etc.). Thus, CEs can be a useful tool to understand specific preferences by evaluating farmers' behavior towards contract attributes.

Studies generally use evidence from previous literature to select the contract attributes and their levels for their CE. There exists a plethora of literature on the motivations and attitudes of farmers exhibiting conservation behavior that the AES studies use while choosing attributes (Greiner, 2016; Le Coent et al., 2017). Few studies have conducted in-depth literature reviews to understand why farmers join a particular AES (like, Lastra-Bravo et al., 2015) and the attractive attributes in a contract that motivate farmers' participation (like, Brandyberry, 2015). Lastra-Bravo et al. (2015) collected 160 variables through a review of AES studies which they classified into five different categories that depicted the socio-economic and demographic conditions of the farm and the farmers. However, they studied trade-offs between attributes within only one category: 'farmers' attitudes towards agri-environmental schemes.' Thus, there is still a substantial knowledge gap in the literature about attribute selection for contract design because of the lack of a definitive catalog of management and policy-based attributes used by previous studies. State of the art has majorly focused on reviewing the measures included in the AESs (e.g., Lastra-Bravo et al., 2015 and Rakotonarivo et al., 2016), but no study has specifically concentrated on reviewing the contract attributes used for designing the CEs. This gap creates a divide between contract attributes studied by researchers and actual attributes preferred by the farmers, which may lead to inefficient contract designs. Also, studies shortlist choice attributes using previous literature, but there is a lack of studies that employ a systematic review approach. Some studies such as Uthes & Matzdorf (2013) reviewed the literature on agri-environmental measures (AEMs). However, they did not use a systematic method, thus, they covered a broad spectrum of AEMs that does not focus on using the CE methodology to examine farmers' choices. One recent study by Mamine et al. (2020) did conduct a meta-analysis of 79 AES studies that use the CE method to evaluate farmers' preferences. However, they did not conduct a systematic review and grouped

the extracted 290 attributes into only two categories – commitments and incentives.

Mamine et al. (2020) haven't been the first to classify contract attributes into different sub-types. Many AES studies that use the CE methodology classify the choice attributes as monetary and non-monetary. Usually, AES studies include a monetary attribute related to payment level (expressed in currency per hectare per year) to estimate the WTA of the various AES designs (Espinosa-Goded et al., 2013; Espinosa-Goded et al., 2010; etc.). The monetary attribute can also be either funding schemes (e.g., climate premium), international price fluctuations, additional incentives, conditional bonus, etc. (Kuhfuss et al., 2015; Pröbstl-Haider et al., 2016; etc.). The various types of non-monetary attributes can either be management attributes (like 'biodiversity' and 'carbon sequestration' as environment management attributes used in the study by Mäntymaa et al. (2018) and 'cover crops area size' as an agriculture-management attribute in the study by Villanueva et al. (2015a), or policy design attributes (like 'collective participation' and 'monitoring' by Villanueva et al. (2015a)), or theory-relevant attributes (like 'recommendation') and policy-relevant attributes (like 'share of farm') (Villamayor-Tomas et al., 2019), etc. Ruto & Garrod (2009) labeled agri-environmental policy options as their key design attributes (like, 'duration of AES contract,' 'per hectare payment rate,' etc.), differentiating them from payment levels. Similarly, Le Coent et al. (2017) categorized the contract attributes as: attributes that have a direct effect on farmers' compliance costs (levels and types of environmental efforts) and attributes related to contract design ('length of contract,' 'contract cancellation options,' 'contract flexibility,' etc.). They extended the categorization to introduce a novel attribute called 'purpose' which they tested via a CE. Dupras et al. (2018) also categorized attributes as either visual aspects (like 'crop diversity') or personal attributes (like 'family heritage,' 'emotional attachment,' etc.). Christensen et al. (2011) also categorized their contract attributes into three categories: flexibility in contract terms ('contract length'), flexibility in practical management ('buffer zone width'), and economic incentive ('subsidy in euro/hectare/year'). These numerous categorizations can be incoherent for future studies when selecting attributes, which calls for comprehensible and practical typologies. One of the ways to do it is by systematically collating all the attributes from previous studies and sorting them according to their usage.

Thus, we aim to conduct a systematic review of AES studies' recent literature that uses CEs to reveal the common attributes they use for testing contract designs and farmers' preferences for those contract features. Our

study also tries to categorize the attributes into broad typologies and highlight the lesser-used attributes that can be explored in future AES studies.

A systematic literature review is used to collect and analyze data from relevant previous studies and identify empirical evidence to satisfy a specific hypothesis or research question (Armstrong et al., 2011; Petticrew & Roberts, 2008; Siddaway et al., 2019). We use a systematic review since it has a considerable edge over a narrative review as it is more organized and has reduced bias (Koutsos et al., 2019). There have been several proposed methods for conducting a systematic review, and they are usually classified by the research discipline. E.g., the EKLIPSE project report on different methodologies suggests using either the Cochrane method (Higgins et al., 2019), Campbell collaboration protocol (Kugley et al., 2017), or the Collaboration for Environmental Evidence (2013) method for conducting a systematic review in the domain of environmental-related sciences (Dicks et al., 2017). Another novel approach is the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) methodology that illustrates the flow of information in different phases of a systematic review. PRISMA has been widely in different research disciplines, and has been cited more than 25,000 times, and endorsed in over 400 journals (Page et al., 2018). In agricultural sciences, systematic reviews have been a recent change from the traditional narrative reviews (Koutsos et al., 2019). Koutsos et al. (2019) proposed a framework for conducting systematic review specifically for agricultural sciences by extending the basic steps of the PRISMA Flowchart (illustrated by Moher et al., 2010). Hence, we use the framework by Koutsos et al. (2019) to identify specific studies that use the CE methodology for AES studies and shortlist the attributes used in such studies.

This paper is organized as follows: in Section 2, we give a detailed account of our methodology and how we shortlisted the studies for the review; in Section 3, we describe our results and then discuss our outcomes in Section 4. We conclude our study in Section 4, highlighting possible future implications of this review.

## 2. METHODOLOGY

PRISMA is an evidence-based method for reporting in systematic reviews and meta-analyses. It has been published in several journals to encourage its dissemination and citation (like BMJ, Plos, Springer, etc.). In this study, we use the PRISMA flowchart and checklist downloaded from Moher et al. (2010) and apply it to our study as explained for agricultural science reviews

by Koutsos et al. (2019). Koutsos et al. (2019) tested the framework on a simple case to assess the methodology's ease and efficacy and thus, promote its adoption among agro-scientists. Their framework included the following six steps which we also used in this study:

### 2.1 Scoping

We set the following research questions to achieve the objective of this review.

- **RQ1:** How many and what are the common contract attributes used by studies while designing a CE for eliciting farmers' preferences for AESs?
- **RQ2:** What are the different typologies that the attributes can be classified into?
- **RQ3:** How can the lesser-used attributes influence farmers' WTA?

### 2.2 Planning

We conducted an extensive search to identify the studies relevant to our RQs. For that, we shortlisted keywords (and Boolean operators) and selected the digital database for the search. We tested a range of keywords before finalizing on the following: 'choice experiment', 'agri-environmental', 'contracts', 'schemes', 'measures.' We chose two digital databases for our search: Scopus Database (<https://www.scopus.com/>) and Web of Science (WOS) (<https://apps.webofknowledge.com/>).

### 2.3 Identification

We performed the search (query execution) using various combinations of keywords. We also decided to use no additional filters (like year, subject area, document type, document language, etc.) for the search. We executed the query in May 2020. In total, we found 110 documents (from Scopus and WOS).

#### Scopus search

- Search string: choice AND experiment AND agr\*-environmental AND contracts OR schemes OR measures
- Outputs: 56 documents from 2006–2020; included 55 Articles and 1 Conference Paper.

#### WOS search

- Search string: "choice experiment" AND agr\*-environmental schemes OR "choice experiment" AND agr\*-environmental contracts OR "choice experiment" AND agr\*-environmental measures.

- Outputs: 54 documents from the years 2006 – 2020; included 51 Articles, 2 Reviews, and 1 Conference Paper.

## 2.4 Screening

We assessed the quality of the resulting documents from the search query by first deleting 40 duplicated documents, and then conducting initial screening of the remaining 70 documents by skimming through titles and abstracts. Out of the 70 studies, we excluded 12 publications. Some of the common reasons for exclusion were either the document was completely unrelated to the search query, or the study did not use the CE method. E.g., two studies (Bartkowski & Bartke, 2018 and Dessart et al., 2019) are reviews of other empirical studies related to AESs, but not related to AESs that use CE methodology, hence were excluded.

## 2.5 Eligibility

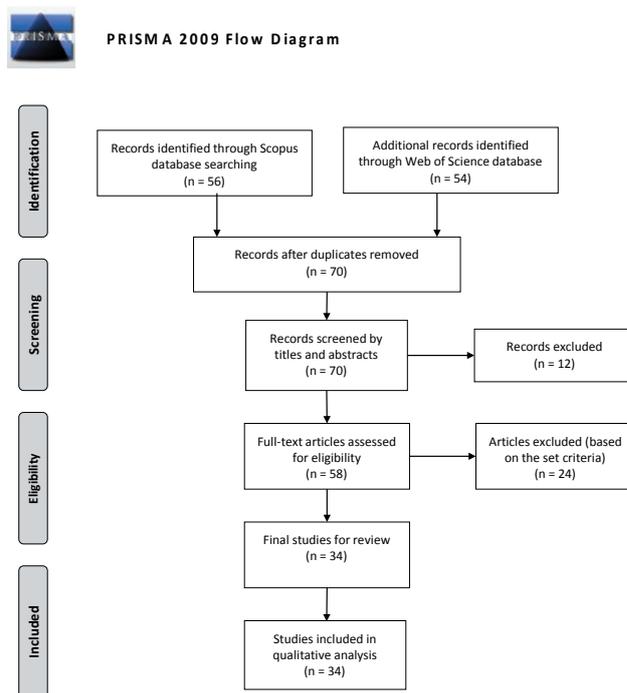
We applied content-based quality checks of the full paper for the remaining 58 documents to make sure the selected studies aligned with our objectives. For that, we set inclusion/exclusion criteria for effective checks, as suggested by Khan et al. (2003). The inclusion/exclusion criteria we applied to the studies were as follows:

- The study should have used a CE to explore farmers' willingness to participate in or accept an AES
- The survey respondents should be specifically farmers
- The study should have recorded AES for public goods, not private benefits

Based on our criteria, 34 studies were finally selected for review with specific reasons for exclusion, like, study design, study measures, type of survey respondents or sample-type, etc., with specific reasons for the exclusion provided in Appendix 1.

## 2.6 Presentation

We concluded the review by presenting the evidence, summarizing it, and interpreting it to answer our research questions. Using the PRISMA flowchart (extracted from Moher et al., 2010), we mapped out the number of articles identified included or excluded (Figure 1). We tabulated the study characteristics and choice attributes and their levels found in each study for data synthesis to answer the research questions (Appendix 2). Similar attributes were grouped and the frequency



**Figure 1.** Prisma Flowchart filled with study results. Source: Moher et al. (2010).

of their occurrence was noted using MS Excel (Appendix 3). We then classified the attributes on basis of different typologies, which are discussed in the following sections.

## 3. RESULTS

We derived 177 attributes in total from the 34 reviewed studies (Appendix 3). The duplicated attributes are collated together, and the resulting 32 unique attributes are depicted in Table 1. By categorizing similar attributes, five main typologies emerge: 'monetary attributes,' that can be used as a means to calculate potential monetary trade-offs among attributes ('payment,' 'bonus,' 'fine,' etc.); 'general attributes,' that outline the general preferences of a contract ('area,' 'duration,' etc.), 'flexibility attributes,' that indicate contract flexibilities (over a duration, over an area, over prescriptions, etc.), 'prescription attributes,' that include management, technical, and policy-related specifications across alternative contracts ('communal participation,' 'risk,' 'farmer recommendation,' 'eco-label,' 'monitoring,' etc.), and 'purpose attributes' that define the purpose of the AESs and have a direct effect on farmers' compliance costs (either through chemical reductions or through

**Table 1.** Attributes found in the review.

	Attributes	Frequency	Relation with WTA
<b>MONETARY ATTRIBUTES</b>			
1	Payments (€/ha/year) or compensation; for animals (€/animal/year)	34	Same as WTA
2	Conditional Bonus/Incentive	6	+
3	Potential price fluctuation	2	-
4	Cost ceiling for compensation	1	+
5	Gross margin (€/ha/year) or (%)	1	+
6	Compost price per trolley (in currency)	1	+
7	Fine (in case of infringement)	1	-
<b>GENERAL ATTRIBUTES</b>			
8	Duration of contract	17	-
9	Area enrolled in contract (%)	15	-
10	Availability of technical training/ scheme support/assistance	8	+
11	Average time spent on paperwork/ administration	2	-
<b>FLEXIBILITY ATTRIBUTES</b>			
12	Flexibility over adherence to scheme prescriptions	11	+
13	Flexibility over what areas of the farm are entered into the scheme	7	+
14	Flexibility of duration or cancellation of contract	6	+
15	Flexibility to change agricultural practice (fertilizers, pesticides, manure)	6	+
16	Non-participation: flexibility to opt-out	2	+
17	Flexibility of dates for working on fields	3	+
<b>PRESCRIPTION ATTRIBUTES</b>			
18	Monitoring	9	Not significant
19	Communal participation or compensation	7	+/-
20	Maximum grazing (stocking density)	4	+
21	More labor days for work	2	-
22	Coordination with neighbors	1	+
23	Recommendation	1	+
24	Likelihood of complete crop failure (time in years)	1	-
25	Data provision type	1	+/-
26	Process optimization	1	+
27	Input risk	1	-
28	Conservation Outcome risk	1	-
29	Eco-label	1	+
<b>PURPOSE ATTRIBUTES</b>			
30	Allocation of land to some environmental activity(s)	15	+/-
31	Ecological focus areas (%)	5	-
32	Reduction of chemicals (%)	4	-

other environmental efforts like ‘biodiversity conservation’). We found 7 monetary attributes, 5 general attributes, and 5 attributes related to flexibilities in contracts.

We also found 11 prescription attributes and 3 purpose attributes that are specific to the purpose of the AES. We discuss the attributes below in detail and how they

impact farmers' participation and WTA. The lesser-used attributes have been used in only one study, and we also discuss their potential for future studies.

### 3.1 Monetary attributes

Monetary attributes signify those contract features that are specified in monetary terms. These include contract payments that promote farmers' participation and keep agricultural policy budgets under control (Villamayor-Tomas et al., 2019), or economic incentives that motivate farmers' adherence to the terms of the contract (like 'fine') (Alló et al., 2015). We observed 7 attributes that could fall under this typology.

#### 3.1.1 Payment

A typical contract dictates farmers modify their farming practices for per-hectare (annual) payments. So, every CE includes a monetary cost/benefit attribute called 'payment' that allows for evaluating welfare estimates, i.e., willingness to pay (WTP) or willingness to accept (WTA) compensation, for changes in the levels of contract attributes (Birol, 2012). The monetary attribute can not only evaluate the farmer preferences, but it can also help estimate the public expenditure needed for each new design of a contract. Thus, 'payment' is an essential attribute for informing AES policy design (Espinosa-Goded et al., 2010). We observed that all reviewed studies used this attribute, and it is generally depicted in currency per hectare per annum. Though farmers' WTA for changes in different attribute values can be calculated using payment as an attribute in CEs, payment can also cover the combination of opportunity costs, management costs, monitoring cost, risk premium, and profit margin in an AES (Greiner et al., 2014) which a respondent needs to be aware of while choosing AES options.

However, the impact of other attributes affects payment amounts hugely. The trade-offs the farmers are willing to make in exchange for different levels of payments are interesting to analyze. E.g., Ruto & Garrod (2009) observed that farmers would easily trade-off approximately 10% of their current payments in exchange for increased flexibility over what lands to enter in the contract or what measures to enroll in the AES. Similar results have been noticed in other studies. Espinosa-Goded et al. (2010) also observed that relaxing the restriction on grazing areas could increase farmer participation and decrease the budget of the contract. Similarly, Santos et al. (2016) noted that technical sup-

port is more important for the farmers than subsidy amounts. The same study estimated that farmers would give up around 400€ per hectare per year for increasing the cattle density by one livestock unit per hectare, reflecting the high opportunity costs of extensification of grazing in Portuguese *montados* (Santos et al., 2015). Furthermore, Wainwright et al. (2019) observed a non-linear relationship between payment values and farmers' participation, which indicates the high significance of other contract attributes. Villanueva et al. (2017) also observed that farmers required higher compensation for programs with very high levels of demand and low flexibilities. Pröbstl-Haider et al. (2016) also observed that, farmers are not ready to sway from intensive cropping even with higher compensations. Thus, even though payment is the only monetary attribute in most of the AES studies, farmers' preferences depend on a wider set of factors than just the monetary factors.

#### 3.1.2 Conditional Bonus/Incentives (one-time only)

A conditional bonus is paid in addition to the annual compensation payments per hectare as an incentive to farmers to favor higher participation rates and land enrolment in AESs and achieve higher targets of contract purposes. Kuhfuss et al. (2015) and Roussel et al. (2019) used the attribute on the condition of additional chemical reductions per year. Similarly, Villanueva et al. (2017) offered a fixed incentive at the end of the contract period (after 5 years) on the condition of improvements in the provision of biodiversity and soil functionality. This attribute should theoretically positively affect farmers' participation; however, it is highly influenced by other contract features. Since the bonus is conditional, farmers may not agree to stringent conditions of the contract. Roussel et al. (2019) observed a high preference of the farmers towards the bonus. In contrast, Kuhfuss et al. (2015) observed higher initial participation but, the bonus had no effect on the individual area enrolled in the scheme. Only if the bonus would be used as in collective performance, it efficiently increased the total area enrolled, which signifies the use of this attribute for analyzing collective contract types. Some studies also showed that additional bonus was insignificant for farmers, and they would instead prefer higher flexibilities in contracts than additional payments. E.g., the attribute 'premium for results' used by Villanueva et al. (2017) had no significance on farmers' participation. Also, Chang et al. (2017) observed that farmers are reluctant to reduce fertilizer consumption even when incentivized with additional payments.

### 3.1.3 Other monetary attributes

Pröbstl-Haider et al. (2016) studied the influence of the attribute ‘potential price fluctuations’ in their CE since international market prices are of increasing importance in their study region (March–Thaya floodplains, Vienna). Their study observed that farmers chose an AES on the basis of price fluctuations play rather than on the value of the environmental premium.

Another attribute that is important for exploring in future studies is ‘Fine.’ Alló et al. (2015) used it in their study to analyze the farmer’s moral hazard and free-riding behavior under an AES. Though the ‘fine’ attribute is similar to ‘monitoring’; however, unlike monitoring, it is a monetary attribute, and will expectedly increase the WTA, but has not been tested sufficiently in AES studies.

Other market-based monetary attributes like ‘gross margin’ and ‘cost ceiling’ have been used in individual studies as an addition to the payment attribute to test the effect of additional monetary factors on WTA. They also positively impact WTA; however, they are contract-specific attributes that reflect farmers’ profits rather than the policy design of an AES.

## 3.2 General attributes

We found 4 general attributes including the basic contract design elements (such as ‘contract length,’ ‘contract area,’ etc.). Every contract has at least one general attribute, which defines the basic contract regulations. Even though theoretically, monetary attributes are of the highest importance to farmers while choosing an AES, many studies have observed the general attributes could sway farmers’ preferences for an AES (Christensen et al., 2011; Greiner, 2016; Hasler et al., 2019; Lienhoop & Brouwer, 2015). The basic design elements of a contract can thus influence farmers’ WTA significantly.

### 3.2.1 Duration of contract

The contract duration is an important attribute to determine farmers’ WTA. We observed 17 out of selected 34 studies used this attribute in their CEs. In almost all the studies, the farmers preferred shorter contracts, except in the study by Franzén et al. (2016), wherein it was insignificant. Most studies show that increasing contract duration requires higher compensation by the farmers. E.g., Ruto & Garrod (2009) observed that farmers demand an increase of 1% of the current payments for a year’s increase in the contract duration.

### 3.2.2 Area enrolled in contract (%)

We observed 15 studies used this attribute to test its impacts on contract design, and 8 out of those showed that farmers prefer to enroll shorter areas into the contracts, while 6 showed no role of significance. Studies have indicated this as a conflict between agricultural intensification and conservation (De Salvo et al., 2018; Espinosa-Goded et al., 2010; Villamayor-Tomas et al., 2019; Villanueva et al., 2015a). Farmers also have a high reluctance and strong disutility for larger conservation areas or larger forest sizes. E.g., Lienhoop & Brouwer (2015) noted that farmers do not find large-scale afforestation projects attractive and demand very high costs for such a contract. Other studies also proved that farmers are willing to accept smaller subsidies for smaller areas enrolled in the contracts. Hasler et al. (2019) observed that the Danish farmers required an increase of 1% in their payments for every additional 1% of arable land enrolled in the contract, thus making this attribute important for considering payment amounts. Similarly, Villanueva et al. (2015) also reported that only 44% of the farmers surveyed would accept a low-to-medium increase in compensation amounts for 1% of the increase in cover crops area, while the rest would either not enroll more areas or ask for higher compensation amounts. Enrolling larger areas into the contract increases the probability of adopting more restrictive measures, so farmers prefer to enroll smaller areas (Roussel et al., 2019).

### 3.2.3 Availability of technical training/ scheme support

We found 8 studies that used ‘technical training/ scheme support’ as an attribute for analyzing farmers’ WTA. The majority of the studies observed that technical support is welcomed by farmers and can lead to higher participation and lower compensation payments (Christensen et al., 2011; Espinosa-Goded et al., 2010; Hasler et al., 2019; Kuhfuss et al., 2015; Ruto & Garrod, 2009). However, farmers did not consider scheme support important for a conservation program in some studies (Franzén et al., 2016; Wainwright et al., 2019). Furthermore, the attribute is highly preferred when it is provided free of cost (Christensen et al., 2011; Kuhfuss et al., 2015). Santos et al. (2016) attributed technical support as the second most observed factor influencing farmers’ participation in future AESs, though it was not included as an attribute in their CE.

### 3.3 Flexibility attributes

The flexibility in a contract is one of the key factors that facilitate its adoption. Flexibility can be in plot selection, prescription selection, or withdrawal from the contract (Christensen et al., 2011; Kuhfuss et al., 2015; Ruto & Garrod, 2009; etc.), which can influence compensation amounts immensely. Usually, studies have noted that higher flexibilities in contracts can lead to lower WTA. E.g., Lienhoop & Brouwer (2015) observed that only a smaller percentage of farmers were influenced by the payment levels of the AESs, as compared to more farmers preferring to have the option to return to agriculture after the contract ends.

#### 3.3.1 Flexibility over adherence to scheme prescriptions

Flexibility in scheme prescription measures or the choice of choosing management type is another attribute many studies deem as important for their CEs. It generally has a positive correlation with farmer participation. The 11 studies that use this attribute observed that farmers preferred higher flexibility. Latacz-Lohmann & Breustedt (2019) observed that offering flexibility to farmers like allowing organic fertilizer to be used (compared to no fertilization) reduced the compensation requirement by 127.40€. Even the studies not using this attribute have reported farmers' preferences for higher flexibility in measures and management practices (Christensen et al., 2011; Espinosa-Goded et al., 2010; Villanueva et al., 2015b, etc.)

#### 3.3.2 Flexibility over what areas of the farm are entered into the scheme

The flexibility of the area under contract has a positive significance in most studies (e.g., Alló et al., 2015; Christensen et al., 2011; Greiner, 2016; Ruto & Garrod, 2009). Though 7 studies have mainly used this attribute, other studies have analyzed it through the attribute 'area size under contract.' However, this attribute is different from contract area size enrolled as it allows the farmers to choose the area size, conservation activity on that area, and the duration of being enrolled for that area. Thus, this attribute is an integration of different flexibility options which can lead to higher participation and lower compensation amounts. E.g., Christensen et al. (2011) observed that an average farmer could give up 43€/ha/year for flexible buffer zone width.

#### 3.3.3 Flexibility of duration or cancellation of contract

Many farmers consider the opportunity to terminate the contract at any time to be an important pre-condition for participation (as shown in studies by Broch & Vedel, 2012; Christensen et al., 2011; Hasler et al., 2019, etc.). Generally, this attribute has a positive correlation with farmer participation. Farmers prefer this possibly because canceling the contract at will would allow them to switch to more intensive farming when market prices increase (Mariel & Meyerhoff, 2018). This attribute can also be used as an incentive for participation (Greiner, 2016; Hasler et al., 2019).

#### 3.3.4 Flexibility to change agricultural practices (fertilizers, pesticides, manure)

Studies have shown that flexibility in contract regulations is more important for farmer participation than pre-determined changes in agricultural practices. Studies provide this choice of changing agricultural practices at will in their CEs to determine the trade-offs between compensation amounts and conservation efforts. E.g., Kuhfuss et al., (2015) observed that farmers would not include their whole vineyard in the contract unless they have the flexibility to use chemicals in some farm areas. Similarly, Latacz-Lohmann & Breustedt (2019) observed that allowing organic fertilizers, instead of prohibiting all fertilization, reduced the compensation amount by 127.40€. Likewise, Villanueva et al. (2017) also observed that compensation amounts were reduced with increasing levels of insecticidal treatments allowed in the contracts. Their study showed that farmers' WTA is lowest for limited treatment and highest for non-treatment, indicating that farmers are reluctant to give up chemical treatments altogether. However, only 6 studies used this attribute; thus, there is a greater scope of experimenting with different conservation options.

#### 3.3.5 Non-participation: flexibility to opt-out

Though all the studies (like Broch & Vedel, 2012; Christensen et al., 2011; Espinosa-Goded et al., 2010; Kuhfuss et al., 2015; Ruto & Garrod, 2009; etc.) use it in their choice cards when conducting a CE; however, only 2 studies used it specifically as an attribute for the CE (Le Coent et al., 2017 and Roussel et al., 2019). Not including it as an attribute could be because the coding of variables in the CE testing model with an opt-out option poses several challenges (Le Coent et al., 2017). The opt-out option is generally used in CE to give the

farmers the voluntary choice of choosing an AES. Villamayor-Tomas et al. (2019) noted that 37% of farmers chose the opt-out option; however, he suggested exploring further whether this would affect the main findings. Roussel et al. (2019) studied the attribute to understand farmers' preference to keep their current practices. This attribute generally positively correlates to farmers' preferences since it avoids them facing a forced choice.

### 3.4 Prescription attributes

Most of the attributes in the reviewed studies were prescription attributes that defined the technical and management aspects of the contracts. We found 16 such attributes used in 5 or less than 5 studies; however, most are uniquely used (only in one study) and are also discussed under lesser-used attributes in the Discussions section. Researchers use attributes like 'monitoring' are to check for non-compliance among farmers (9 studies use this attribute). However, monitoring is costly, and the balance between non-compliance and monitoring is often ignored (Vedel et al., 2015). We observed that the monitoring attribute was insignificant in most of the studies indicating that it plays a minor role in farmers' choice of participating in an AES (Greiner, 2016; Rodríguez-Entrena et al., 2019; Villanueva et al., 2015b, 2015a; Villanueva et al., 2017). However, only Broch & Vedel (2012) and Vedel et al. (2015) observed that monitoring had a significantly negative impact on respondents' utility and led to increased WTA. The reason for the negative attitude towards monitoring could be the farmer's mistrust of the system or the farmer's perception of the system controlling him (Broch & Vedel, 2012).

'Communal participation' or 'communal schemes' are also attractive to farmers since they induce a 'neighbor-effect' among farmers, leading to increased participation in the AES. Communal management can have mixed results on farmers' WTA. Studies such as Hope et al. (2008) and Villanueva et al. (2017) reported a positive correlation to farmers' preferences. Hope et al. (2008) reported that farmers prefer working as a group rather than as individuals. Villanueva et al. (2017) reported that older farmers (> 60 years) show a higher willingness for collective participation than younger farmers in olive groves of plain areas. Even though only 7 studies have used this attribute, many other studies mention similar factors that indicate that farmers' have high utility for community participation and management. E.g., Aslam et al. (2017) observed that social pressure and social networks could increase farmers' acceptance for contracts. Similarly, Alló et al. (2015) tested the variable 'social trust' to evaluate whether farm-

ers believe their neighbors fully comply with the contract terms, and observed that majority of respondents think that their neighbors will comply. This compliance indicates that the attribute should be tested in CEs for collective contract types. However, some studies also observed that farmers prefer individual management and discrete compensation, like Rodríguez-Entrena et al. (2019) noted that collective participation leads to a higher degree of uncertainty among the farmers. Similarly, Villanueva et al. (2015a) suggested that most farmers showed medium to high WTA for collective participation because they anticipated loss of freedom of their farm management due to community participation.

Other attributes that span under the umbrella of 'neighbor-effect' include 'coordination with neighbors' and 'recommendation.' Neighbor-effect generally positively correlates with farmers' participation. Villanueva, et al. (2017) noted that farmers are more willing to participate at lower transaction costs if the neighbors also participate. Also, the attribute 'farmers' recommendation' used by Villamayor-Tomas et al. (2019) exhibited a positive significance to farmers' acceptance, whereas the attribute 'scientist recommendation' had no significant impact. The attribute is also similar to 'communal participation', with the only difference being that this tests the farmer's preferences to his immediate neighbor's preferences, whereas the latter is on the level of the whole community. De Salvo et al. (2018) suggested that neighbor-effect can improve acceptability of AESs and achieve cost-effectiveness of contracts, and hence farmers' preferences for 'local context' should be considered by policymakers.

'Grazing intensity' or 'Stocking density' is another attribute that 4 studies included for testing farmers' preferences for a reduction in grazing intensity or the number of animals per hectare. The studies (Breustedt et al., 2013b; Latacz-Lohmann & Breustedt, 2019; Santos et al., 2015) show that stricter prescriptions for lesser grazing lead to higher compensations, thus higher WTA.

Non-monetary incentives have also been overlooked by all the studies except one. Chang et al. (2017) used the 'eco-label' attribute to incentivize farmers who successfully complied with the AES standards and observed that farmers would readily exchange an eco-label for lower compensation amounts. So, including non-monetary incentives like eco-label can also help lower the farmers' WTA.

'Risk' is another attribute that has been used in the study by Star et al. (2019) that explored how input or outcome risk limits the farmers' willingness to implement environmental measures. Their study reported that higher levels of either risk would reduce participation

and increase the compensation amount. This attribute should be extensively tested especially in the face of climate and socio-economic uncertainties.

### 3.5 Purpose attributes

These attributes are different from the contract design attributes as they specifically iterate the purpose for which the farmer will accept the contract prescriptions. The purpose of an AES could be a conservation activity, afforestation, land allocation for environmental activity, chemical reduction, etc., which is what these attributes offer.

#### 3.5.1 Allocation of land to some environmental activity(s)

Attributes like ‘maintenance of soil organic matter,’ ‘protection of soil from water erosion,’ ‘recreational access,’ ‘biodiversity improvements,’ ‘forest co-benefits,’ ‘afforestation,’ etc. are different types of environmental and conservation activities that define the contract motives. Some studies like Broch & Vedel (2012) used the attribute ‘purpose’ specifically to combine different conservation activities into one choice for their CE (biodiversity, water protection, or recreation). Le Coent et al. (2017) also used ‘purpose’ as a separate attribute to highlight farmers’ preferences between different conservation activities. One of the significant inferences from testing this attribute has been that most farmers prefer conservation over compensation (according to the studies by Le Coent et al., 2017; Lienhoop & Brouwer, 2015; Santos et al., 2015; Vedel et al., 2015). Greiner (2016) also used this attribute to understand the significance of different conservation activities; however, he observed that 33% of farmers found the choice insignificant, rather focused on payment values and contract duration.

#### 3.5.2 Ecological focus area

Though 5 out of 34 reviewed studies used this attribute in their CE; however, 4 of these studies use the same set of choice attributes in their CE (Rodríguez-Entrena et al., 2019; Villanueva et al., 2015b, 2015a; Villanueva et al., 2017). According to Villanueva et al. (2017, p6), this attribute was included in the CE to “*explore a hypothetical future implementation of the EFA requisite of the Common Agricultural Policy (CAP) ‘green payment’ in permanent crops such as olive groves*”. Some previous studies have also mentioned EFA in their articles but do not test it in their CEs; like Breustedt et al. (2013) and

Villamayor-Tomas et al. (2019).

Overall, studies using this attribute observed that farmers have a negative preference for EFAs, since agreeing to it would mean dedicating additional areas to ecological functions than stated in the contract. A similar attribute called ‘Naturalization’ used by Rocchi et al. (2017) defines conversion of agricultural areas to pastures, using particular species with a high natural value. However, farmers in their study show the least interest in this attribute.

#### 3.5.3 Reduction of chemicals (%)

This attribute is typically used to study the compensation payments that would be required for a higher reduction in chemicals. Kuhfuss et al. (2015) found that higher chemical reduction can lead farmers to enroll more farm areas in the AES because chemical reduction needs higher investment in equipment that becomes more cost-efficient if used on the whole farm rather than just small areas. Chang et al. (2017) observed that after a point, farmers show high reluctance to further reductions of chemical fertilizer use even when additional payments are offered. Similarly, Kanchanarook & Aslam (2018) also observed that shorter contract lengths and a lower reduction in chemical input together lowered the WTA substantially. 3 out of 4 studies using this attribute reported that chemical reduction negatively impacts farmers’ participation and increases their WTA. Only Rocchi et al. (2017) observed that most of their respondents are interested in reducing nitrates. Chang et al. (2017) suggested that farmers should be incentivized if they agree to an additional reduction of chemical fertilizers.

## 4. DISCUSSIONS

Our study used a systematic review for a reliable and transparent method of reviewing previous AES literature that uses CE to elicit farmers’ preferences to alternative AESs. We set three specific research questions that this review hoped to answer and discuss. We listed out 32 attributes used by studies as shown in Appendix 3 and defined and analyzed in the Results section, which answers our first research question. The most common attribute used by all studies is the payment attribute that can help estimate the monetary value of other attributes. However, AES studies aim to find incentives other than monetary payments for estimating farmers’ WTA (Villamayor-Tomas et al., 2019). The contract purpose is present in all studies, which could include either ‘allocation

of land to environmental activity,' or 'chemical reductions,' or 'changing the land to an ecological focus area.' The purpose of the contract helps in deducting the conservation versus compensation behavior of the farmers. The general contract design is shaped by attributes such as 'duration of contract,' 'area enrolled under contract,' and 'availability of scheme support/additional training,' which are usually the first few attributes in the choice cards of AES studies. Attributes indicating flexibility in overall contract terms and environmental goals have shown to increase farmers' acceptance and participation (like Christensen et al., 2011; Espinosa-Goded et al., 2010; Ruto & Garrod, 2009; etc.); thus, most studies also include a flexibility attribute. The management, technical, and policy prescriptions can also be tested for an effective policy design through a CE. These can include attributes such as 'collective participation,' 'monitoring,' 'farmer recommendation,' etc. They can also be a novel attribute that has not been tested before, like 'risk.'

Upon surveying the common attributes, five main typologies were established under which all the extracted attributes could be classified, which answers our second research question. At least one attribute under each typology must be used in the AES study for an effective outcome and to remove subjectivity bias among researchers designing CE. Our classification includes monetary attributes, general attributes, flexibility attributes, prescription attributes, and purpose attributes, which have been discussed in detail in the Results section.

Economic factors of farmers' WTA has been well-understood and widely discussed by many studies (like Christensen et al., 2011; Lastra-Bravo et al., 2015; Santos et al., 2016, etc.) which can include the level of compensation, transaction costs, duration, and flexibility of contracts, availability of scheme support, etc. However, equally important cognitive, behavioral, and societal factors have not been discussed enough in AES studies. Farmers' attitudes and values, perceptions about conservation and compensation, and social norms like collective participation can influence farmer participation in an AES (Kuhfuss et al., 2015; Villamayor-Tomas et al., 2019). Many studies have also inferred upon the farmers' dilemma between compensation and conservation. Le Coent et al. (2017) conducted their CE with two types of contracts: compensation and conservation contracts. They reported that farmers preferred to participate in a contract with a biodiversity conservation objective than with a biodiversity compensation objective and exhibit higher WTA for enrolling into the compensation contract. On the contrary, a study by Villamayor-Tomas et al. (2019) showed conservation programs tend to harm farmers' utility and were not preferred by the farm-

ers. Studies have also noted that when the conservation options restrict the land-use options for the farmers, their WTA for conservation measures increases (Aslam et al., 2017; Hope et al., 2008; Pröbstl-Haider et al., 2016). This disparity between what has been tested and what can be tested prompted us to discuss the lesser-used attributes.

Our review also found 12 uniquely used attributes, and we explored their utility for further studies, as per our research question 3. Most of these attributes are prescription attributes, that are specific to the contract area and type and might not be replicable over other AESs. However, some of the attributes can be studied over different contract types and must be explored more. One such novel monetary attribute is 'fine' used by Alló et al. (2015), which could be applied for any law infringement. Even though other studies have also tried to test compliance through economic incentives (Kuhfuss et al., 2015) or monitoring (Broch & Vedel, 2012); however, fine is the only attribute that enforces an economic penalty on non-compliance to the contract, and thus should be tested in more studies. Attributes such as 'coordination' and 'recommendation' are prescription attributes that play on social psychology and behavioral economics to positively influence the choice of farmers to participate in an AES if there is already a high level of participation (Kuhfuss et al., 2015). This indicates that farmers care not only about the economic incentives of the contracts but also of their "reputation" (Villamayor-Tomas et al., 2019), which can be tested through attributes exhibiting neighbor-effect. 'Risk' is another prescription attribute that has only been used in one study (in Star et al., 2019). Though many other AES studies talk about farmers' perceptions of risk and uncertainty as core reasons for non-participation (e.g., Hellerstein et al., 2015; Schilizzi & Latacz-Lohmann, 2016; Whitten et al., 2013; etc.); however it has not been studied in their CEs. Though Star et al. (2019) studied the input and output risks endured by landholders, their study did not consider institutional, production, or market risks that are also critical in designing efficient agri-environmental policies. Another interesting attribute is an 'eco-label' that has been tested in one study (by Chang et al., 2017) that farmers appreciated more than higher compensation amounts. However, such non-monetary incentives are not usually tested in EU studies, but with the rise in local certification schemes, more AESs could have such attributes.

Another variable of interest that hasn't been tested in any study but has shown to lower farmers' WTA and increase participation (Breustedt et al., 2013; Latacz-Lohmann & Breustedt, 2019) which is '*farmers' previous participation in an AES contract.*' However, Wain-

wright et al. (2019) noted that farmers already enrolled in an AES scheme were more likely not to select a contract option. Thus, this is a possible attribute that can be explored through future CE studies.

This study can thus be used as a reference for other AES studies that use literature review for selecting the attributes for their CE from various categories. It also provides a systematic framework for organizing literature that can be applied to newer AES studies. This study can also help shortlist attributes for future CE testing that can evaluate specific aims of CAP post-2020 like penalties to non-compliance (like fine) and alternatives to greening through certification schemes (like eco-label).

## 5. CONCLUSIONS

Our study aimed to highlight the common attributes that are used in a CE for studying farmers' acceptance of choice of agri-environmental contracts using a systematic review of literature while also categorizing the attributes into definitive typologies and glancing at the utility of lesser-used attributes. In conclusion, we found 32 attributes that could fit in five distinct typologies: 7 monetary attributes, 4 general attributes, 6 flexibility attributes, 12 prescription attributes, and 3 purpose attributes. Contract design attributes can impact compensation amounts hugely; e.g., general contract attributes (like smaller area and shorter duration) and flexibility attributes (such as higher flexibility of participation, contract area, contract duration, management, etc.) are highly preferred by the farmers and can lower their WTA and increase their participation. Technical support and scheme assistance are also positively welcomed by the farmers. Overall, the commonly used attributes are an indicator of those contract features that previous studies have tested repeatedly with CEs, and have shown consistent outcomes, e.g., shorter contract duration and the lesser enrolled area is preferred by farmers in most of the studies. However, some attributes also show varied results, e.g., monitoring has been insignificant for farmer acceptance in most of the studies and was found to be negatively related to farmer acceptance in two studies. Moreover, attributes that can directly address some of the emerging issues in EU's CAP reform features, such as result-based contracts (e.g., 'conditional monetary bonus' attribute used by Roussel et al., 2019) and collective contracts (like 'collective participation' and 'communal management' attribute used by Villanueva et al., 2017) have not been tested in many studies. They can be comprehensively analyzed in future AES studies.

We also found attributes that have theoretically been shown to be critical for AES selection but have been overlooked by most of the studies. These are non-monetary incentives, fine, recommendation, risk, coordination with neighbors, etc. The reasons for this exclusion could probably be a lack of literature to support their importance, or maybe these attributes require exhaustive coding in models. Market-based and value-chain attributes such as crop failure, price fluctuations, climate risks, etc. have also not been explored much which can become important under uncertain future scenarios (like climate change, socio-economic change, etc.). Thus, the lesser-used attributes are also an important indicator of farmers' acceptance of a contract and should be studied intensively.

Our review indicates that CEs should take more advantage of the virtual environment they are set to test and should experiment on a broader range of attributes across different areas and contract types. We hope that our systematic review can be used as a repository for choosing choice attributes for future studies and our typologies can be used to make a choice bundle that can fully explain both the farmer perceptions and value of a particular landscape.

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