Payments for environmental services with ecological thresholds: farmers' preferences for a sponsorship bonus

Fanny Le Gloux, Carole Ropars-Collet, Alice Issanchou, Pierre Dupraz

Journal of Environmental Planning and Management

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/cjep20

Payments for environmental services with ecological thresholds: farmers' preferences for a sponsorship bonus

Fanny Le Gloux, Carole Ropars-Collet, Alice Issanchou & Pierre Dupraz

Journal of Environmental Planning and Management, 2024
https://doi.org/10.1080/09640568.2024.2303738

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Payments for environmental services with ecological thresholds: farmers' preferences for a sponsorship bonus

Fanny Le Gloux[a]*, Carole Ropars-Collet[b], Alice Issanchou[a] and Pierre Dupraz[a]

[a]*SMART, INRAE, Rennes, France;* [b]*SMART, L'Institut Agro Rennes-Angers, Rennes, France*

(*Received 30 November 2022; final version received 5 January 2024*)

Designing incentives for agri-environmental public good provision with threshold effects calls for payment mechanisms favouring critical mass participation and continuity of commitments at the landscape scale. We conducted a choice experiment to test the acceptability of a bonus in a scheme for improving river water quality in France. We introduce a sponsorship bonus each time the farmer convinces a peer into entering the scheme, which can be combined with a collective result bonus per hectare if the river reaches a higher step on the water quality scale. We consider the involvement of local financers could increase the willingness to pay beyond opportunity costs and income foregone and propose higher levels of payment than agri-environmental schemes. Results suggest a sponsorship bonus on its own is cost-effective. We characterize respondents' heterogeneity and identify three groups based on choice patterns: (i) "pro-environment individualists", (ii) "management change averse" farmers, and (iii) "pro-incentive" farmers.

Keywords: Water quality; choice experiment; collective action; mixed logit model; latent class model

1. Introduction

Payments for environmental services (PES) are initiatives supporting farmers' voluntary interventions contributing to the preservation of ecological functions (Duval *et al.* 2016; Wunder 2015). They emerged in the early 1990s, in response to the growing awareness of the value and shortage of agri-environment-climate public goods. In the European Union (EU), the most widely implemented PES are the agri-environmental measures, now called agri-environment-climate measures (AECM), of the common agricultural policy. Over the past decades, the low environmental additionality, participation rates and cost-effectiveness of AECM have been highlighted in the literature, in particular due to underfunded and poorly designed measures (Zavalloni, Raggi, and Viaggi 2019; Espinosa-Goded, Barreiro-Hurlé, and Dupraz 2013; Dupraz and Pech 2007; Cullen *et al.* 2018; Pe'er *et al.* 2014;

*Corresponding author. Email: legloux.fanny@gmail.com
Fanny Le Gloux's affiliation moved during the peer review process to: Research and Innovation, Directorate-General for Agriculture and Rural Development, European Commission, Brussels, Belgium. The information and views set out in this article are those of the authors and do not necessarily reflect the official opinion of the European Commission.

European Court of Auditors (ECA) 2011; Pe'er *et al.* 2022). Dedicated PES involving other contractual arrangements and financial contributors are also implemented on a smaller scale (Heinz 2008). Examples include schemes funded by water bottlers such as the Nestlé Waters, or by municipalities such as the water authorities of Munich and New York City (Grolleau and McCann 2012; Depres, Grolleau, and Mzoughi 2008).

Designing efficient payment mechanisms for public good provision is a challenge that often involves trade-offs between environmental ambition and wide acceptance by farmers. Conditionality rules must define environmental services with sufficient effort to achieve the environmental objective(s), while remaining attractive to ensure significant participation on enough farmland. When the objective is to improve water quality or biodiversity, high participation and spatial continuity of environmental commitments at the landscape scale are necessary to observe environmental improvements (Dupraz, Latouche, and Turpin 2009; Batáry *et al*. 2015). Developing instruments favouring collaboration among land managers, coordination of actions and high uptake within the same area are promising ways to increase the environmental effectiveness of farmers' environmental services, as well as the cost-effectiveness of the payment. In addition to supporting the passing of ecological thresholds, collective approaches provide other advantages, such as fewer transaction costs for financial contributors, and building of social capital for farmers (Lefebvre *et al*. 2015; Kuhfuss *et al*. 2016; Pretty 2003).

Collective approaches can take different forms of PES contractual arrangements and payment conditionality (Kuhfuss *et al.* 2019; Organisation for Economic Co-operation and Development [OECD] 2013). Some involve a collective payment. In this case, the contracting party receiving the payment and meeting the requirements is a group of farmers, which distributes the amount to participants according to rules defined by the collective. The Netherlands provide a large amount of examples of successful collective AECM, in which participants are local groups of farmers organised in environmental cooperatives (Franks 2011). Cases from other EU countries are scarce. One can cite the collective AECM for preserving the European Hamster habitats in France (Eichhorn *et al.* 2022). Other approaches are based on individual contracting, but the distribution of the payment is conditional on the achievement of a landscape-scale objective (minimum participation or land enrolment, reaching an environmental goal …), or of a collaborative action (coordination of management practices, agglomeration of the plots enrolled …). These conditionality rules can apply to all or part of the payment. In the latter case, the collective component of the contract takes the form of a conditional "reward" or "bonus". An example of such a payment mechanism is the Swiss network bonus (agglomeration bonus) (Krämer and Wätzold 2018).

The literature suggests that farmers are reluctant when collective requirements are conditioning the full payment, but favourable to a reward conditioned to collective action on top of an individual payment (Villanueva, Rodríguez-Entrena, *et al.* 2017; Ben-Othmen and Ostapchuk 2019; Le Coent, Préget, and Thoyer 2017; Villamayor-Tomas, Sagebiel, and Olschewski 2019; Kuhfuss *et al.* 2016). Villanueva *et al.* (2015, Villanueva, Rodríguez-Entrena, *et al.* 2017) show that individual contracting tends to be preferred to collective contracting of a minimum number of farms from the same municipality, especially among older farmers with little experience of participating in cooperatives. Interestingly, Ben-Othmen and Ostapchuk (2019) find the opposite result, with positive preferences for collective contracting, but the threshold number was slightly lower (three farms from the same municipality against five in Villanueva *et al.* [2015]). Both case studies included prior information that farmers would be left free to form a group with whom they trust the most, and that only free-riders would be sanctioned in the case of non-compliance with management requirements. A key factor of collective AECM acceptance is well-defined group governance and monitoring, which is often emphasized by researchers studying successful Dutch case studies of environmental cooperatives (Franks 2011; Uetake 2014; Barghusen *et al*. 2021), or more generally collective management of natural resources (Ostrom 2002; Kerr, Vardhan, and Jindal 2014). Le Coent, Préget, and Thoyer (2017) looked at farmers preferences for biodiversity offsets with the full payment conditioned to a minimum of 20% of participation by farmers from the area. They found that farmers anticipate transaction costs for reaching the participation threshold and prefer contracts without it. Another study measuring preferences for an AECM requiring the coordination of the location of tree planting with neighbouring farms also concluded that farmers were reluctant about the collective approach due to transaction costs and beliefs that other farmers would not be willing to cooperate (Villamayor-Tomas, Sagebiel, and Olschewski 2019). However, they identified a peer effect, with the finding that farmers were more likely to choose an agri-environmental measure recommended by other farmers. A positive effect of social norms at the neighbourhood level on the uptake and cost-effectiveness of conservation measures was also reported by Chen *et al.* (2009). When it comes to collective bonus options, a study by Kuhfuss *et al.* (2016) reveals positive preferences for a conditional bonus if at least 50% of the eligible area is enrolled in the scheme after five years. Another study measured positive preferences for an annual collective bonus if at least 50% of the farmers of the targeted production orientation join the scheme (Blazy *et al*. 2021).

Similar to collective approaches, result-based incentives are emerging as a way to improve the environmental-effectiveness of PES (Pe'er *et al*. 2020; Herzon *et al*. 2018). They introduce conditionality rules such that farmers are paid for offsite environmental outcomes (providing public benefits beyond the farm-gate) or according to an intermediary indicator of an offsite environmental outcome (Russi *et al*. 2016; Chaplin, Mills, and Chiswell 2021; Matzdorf and Lorenz 2010; Burton and Schwarz 2013; Klimek *et al*. 2008). In practice, result-based PES were developed for grassland biodiversity (Klimek *et al*. 2008; Herzon *et al*. 2018; Bartkowski *et al*. 2021), and more marginally for reducing or storing tCO_2eq (Eichhorn *et al*. 2022).

Farmers preferences for result-based incentives have been explored in the literature, both when environmental results condition the reception of the full payment (Niskanen *et al*. 2021; Tanaka, Hanley, and Kuhfuss 2022), or part of it (Salazar-Ordóñez, Rodríguez-Entrena, and Villanueva 2021). The main reported obstacles to the adoption of result-based PES are increased risks for farmers (Zabel and Roe 2009; Massfeller *et al*. 2022). This is confirmed by experimental results, which suggest that farmers tend to prefer contracts with no requirements of result and ask for higher monetary incentives to adopt result-based PES compared with contracts with obligations for means only (Niskanen *et al*. 2021; Tanaka, Hanley, and Kuhfuss 2022). However, a study suggests farmers become indifferent to result-based incentives when they are not binding (result-based bonus) (Salazar-Ordóñez, Rodríguez-Entrena, and Villanueva 2021).

The literature on mixed-payment mechanisms for boosting the environmental effectiveness of PES with threshold effects suggests a promising acceptability, in particular in the form of collective participation bonuses (Kuhfuss *et al*. 2016; Blazy *et al*. 2021), but also individual agglomeration bonuses (Vaissière *et al*. 2018). Further analyses would confirm or nuance the acceptability of these nudges in other contexts, and provide recommendations for designing successful schemes. This present study aims at providing new elements on the acceptability among farmers of a collective component in PES, designed to meet high participation rates and environmental efforts at the landscape scale.

We develop a choice experiment (CE) to measure preferences for a contract targeting the improvement of river water quality in three regions of northwestern France, characterized by the predominance of livestock farming and concerns over too much release of excess nitrogen and phosphorous into water bodies. CE are particularly relevant to elicit preferences for specific contract characteristics that do not yet exist (Louviere, Hensher, and Swait 2000). Two types of bonuses are tested to explore new elements on the design of payment mechanisms: an individual bonus for sponsoring a peer, and a sponsorship bonus combined with a collective environmental result bonus distributed equally to all participants. By definition, AECM payments are limited to profit foregone and additional costs and are socially sub-optimal (Uthes and Matzdorf 2013). They often do not include an incentive component signalling social demand for an optimal level of public good provision, making them socially inefficient (Espinosa-Goded, Barreiro-Hurlé, and Dupraz 2013). In our study, we propose payment levels that are higher than the range of current AECM. By doing so, we consider the possibility for other contributors than public authorities to finance the PES beyond the public policy constraint of income foregone and additional costs.

2. Method

2.1. Discrete choice experiment approach

A CE is a survey-based method to elicit stated preferences of individuals. Respondents are successively asked to choose their preferred option among a small number of hypothetical alternatives, which differ according to several levels of attributes. CE techniques are based on Lancaster's theory that consumption decisions are determined by the utility derived from the attributes of the good being consumed (Lancaster 1966) and the random utility theory decomposing utility into a deterministic part and a random part (McFadden 1974). They are particularly useful to estimate ex-ante the marginal utility of different characteristics of policy design. The application of CE methods has already provided a lot of useful policy recommendations for agri-environmental contract design, for instance regarding farmers preferences for contract length (Ruto and Garrod 2009; Bougherara and Ducos 2006; Christensen *et al*. 2011; Latacz-Lohmann and Breustedt 2019; Ropars-Collet 2022), payment sequences (Bougherara *et al*. 2021) and conditional bonuses (Vaissière *et al*. 2018; Kuhfuss *et al*. 2016).

2.2. Model specification

Under the random utility theory, the utility U_{njt} that individual n obtains from choosing alternative j out of J alternatives in the choice set t out of a series of T choice sets, is made of an observed component V_{njt} (deterministic part) and a stochastic error term ε_{njt} (random part).

$$U_{njt} = V_{njt} + \varepsilon_{njt} \tag{1}$$

We assume individual n chooses alternative j if, and only if, that alternative maximises his or her utility amongst all alternatives in choice set t. The probability that farmer n chooses alternative j is:

$$P_{njt} = Prob(V_{njt} + \varepsilon_{njt} > V_{nit} + \varepsilon_{nit}) = Prob(\varepsilon_{njt} - \varepsilon_{nit} > V_{nit} - V_{njt})\ \forall i \neq j \tag{2}$$

The deterministic part of the utility function is typically specified to be linear in parameters. The error terms are assumed to follow the Gumbel Type-1 extreme-value distribution (McFadden 1974), such that a logit model can be applied to estimate the parameters.

Under the conditional logit (CL) model, the β coefficients representing respondents' preferences for the attribute levels X_{njt} are constant across individuals (homogeneous preferences), and the error terms are assumed independent and identically distributed across individuals and alternatives (Equation (3)). This implies that the ratio of choice probabilities for any two alternatives is independent of the attribute levels of a third alternative in the choice set, and is known as the independence of irrelevant alternatives (IIA) assumption.

$$P_{njt} = Prob\left(\varepsilon_{njt} - \varepsilon_{nit} > \beta(X_{nit} - X_{njt})\right) \ \forall i \neq j \tag{3}$$

The Hausman test allows us to check the IIA assumption and validate the CL model specification (Hausman and McFadden 1984). To relax the IIA assumption and account for unobserved taste heterogeneity across farmers or across groups of farmers, the mixed logit (ML) (Equation (4) or latent class (LC) (Equation (5)) models are applied (Greene and Hensher 2003).

$$P_{njt} = Prob\left(\varepsilon_{njt} - \varepsilon_{nit} > \beta_n(X_{nit} - X_{njt})\right) \ \forall i \neq j \tag{4}$$

$$P_{njt|q} = Prob\left(\varepsilon_{njt} - \varepsilon_{nit} > \beta_q(X_{nit} - X_{njt}) \ |class \ q\right) \ \forall i \neq j \tag{5}$$

Both the ML model and the LC model keep the assumption that error terms are independent and identically Gumbel Type-1 distributed, but allow preference parameters to vary. The ML model specifies a continuous distribution of the coefficients such that preferences vary randomly across individuals. The LC model specifies a discrete distribution for the coefficients and relies on the definition of classes of individuals. While preferences are heterogeneous across the different classes, individuals of the same class are assumed to be homogeneous.

A monetary attribute is included (ex: individual payment of a PES contract) in order to evaluate respondents' willingness to accept (WTA) for each specific attribute level. An estimate of the average WTA for each attribute X is obtained from the ratio of the coefficient of the corresponding attribute β_X and the payment coefficient $\beta_{payment}$ (Equation (6)) (Mariel *et al.* 2021). WTA_X is the average annual payment per hectare that a farmer requires to accept a contract for which the level of attribute X is higher by one unit.

$$WTA_X = \frac{-\beta_X}{\beta_{payment}} \tag{6}$$

2.3. Experimental design

A CE was conducted to measure farmers' preferences for a five-year contract for which participants would enroll all their farmland, targeting the improvement of the water quality of rivers in northwestern France. The regions Brittany, Pays de la Loire, and most of the Normandy region are classified as Nitrate Vulnerable Zones under the Nitrates Directive (Ministère de la Transition écologique [MTE] 2023). While the Water Framework Directive targets good chemical and ecological status of European waters by 2027 (European Union [EU] 2000), only 13% of surface waters have a good ecological status in Pays de la Loire, 32% in Brittany and 29% in eastern Normandy (Agence de l'eau Loire-Bretagne 2020a, 2020b; Agence de l'eau Seine-Normandie 2018). Locally, some areas are particularly concerning, such as eastern Brittany

Table 1. Attributes and attribute levels in the choice experiment.

Attribute (acronym)	Description	Levels
Soil cover (*COVER*)	Average agricultural soil coverage throughout the year at the farm level (no bare soil, starting from seeding)	85% 90% 95%
Hedgerows density (*HEDGEROWS*)	Average density of anti-erosion multi-species multilayer hedgerows at the farm level	20m/ha 60m/ha 100m/ha
Payment (*PAYMENT*)	Per-hectare individual annual payment	150€/ha 300€/ha 450€/ha 600€/ha
Bonus ($BONUS_{sponsorship}$, $BONUS_{sponsorship/collective\ result}$)	Bonuses conditioned to a collective action: A fixed individual sponsorship bonus of 450€ the farmer receives each time he convinces a peer into entering the scheme; A collective result bonus of 50€/ha distributed to all participants if the river's status reaches a higher step of the water quality scale	None Sponsorship bonus Sponsorship bonus + collective result bonus

Source: own elaboration.

(Ille-et-Vilaine department) with only 2% of surface waters with good ecological status (Observatoire de l'Environnement en Bretagne [OEB] 2020).

Evidence shows that hedge networks in agricultural landscapes such as bocage, act as buffer zones and erosion barriers preventing runoff in water catchments, in synergy with many other ecological side-benefits (Merot 1999; Caubel-Forget, Grimaldi, and Rouault 2001; Burel and Baudry 1995). Avoiding long periods of bare soil, in particular in winter, also contributes to limiting soil erosion and runoff (Souchère *et al.* 2003).

The contracts proposed in the CE are characterized by (1) management requirements defining the environmental services to be delivered by farmers (maintain a level of hedgerow density and soil cover), (2) a per-hectare payment distributed to farmers individually on an annual basis if they comply with management requirements and (3) a bonus option (Table 1).

The choice of management (*COVER*, *HEDGEROWS*) and individual per-hectare payment (*PAYMENT*) attribute levels was based on evidence from a study undertaken in a similar environmental context in Brittany (Ropars-Collet 2022). In particular, her results show that payments of 400€/ha or less restricts the adoption of PES with ambitious levels of management requirements, because some farmers have a higher WTA that cannot be met with this payment range. In France, the five-year AECM contributing to water quality typically range between 70€ and 350€/ha/year, based on an estimation of average opportunity costs (Ministère de l'Agriculture et de la Souveraineté alimentaire (MASA) 2022). In our CE, we include individual per-hectare payment levels higher than typical AECM, to include the possibility that other contributors than governmental authorities finance all or part of the payment. The degradation of rivers' chemical and ecological quality does not only contribute to biodiversity loss, but also increases the costs of water treatment for securing drinking water quality. Protecting water resources is of interest for many local stakeholders (water catchment bodies, inhabitants, companies, municipalities …). Real-life contractual arrangements for reducing costs of drinking water depollution show that big municipalities such as Munich have been paying farmers up to 280€/ha/year (Depres, Grolleau, and Mzoughi 2008), while the private company Nestlé Waters spent around 230€/ha/year to secure their brand Vittel (Perrot-Maitre 2006). Inhabitants of water catchment areas also exhibit a willingness to pay for achieving good ecological status (40€/household/year estimated in Normandy), derived from the value they attach to multiple local benefits (recreational use, drinking water, flood prevention, landscape …) (Poirier and Fleuret 2015). Their role as PES scheme financers would better capture society's willingness to pay and cover farmers WTA beyond compensation for foregone profits. WTA includes uncertainty and factors that are not necessarily technical barriers, such as transaction costs or social capital (Espinosa-Goded, Barreiro-Hurlé, and Dupraz 2013).

The bonus option levels ($BONUS_{sponsorship}$, $BONUS_{sponsorship/collective\ result}$) were defined together with stakeholders involved in the development of experimental PES in the study area (Bailly *et al*. 2022). A sponsorship bonus, suggested by a group of farmers from the Seiche Valley (Ille-et-Vilaine, Brittany), is introduced and takes the form of an individual reward for convincing a peer farmer from the water catchment area to enter the PES scheme. A farmer would receive a one-time 450€ per new peer sponsored. Each farmer can be sponsored only once. As this type of bonus in PES has never been tested in the literature or in the field, the amount could not be defined from a reference. For the parties financing the PES scheme, offering the sponsorship bonus is an opportunity to increase participation at the water catchment scale while benefiting from the peer effect (communication on the PES, knowledge spillover …). However, sponsoring peers induces new transaction costs for farmers (social commitments, time). Convincing a peer may require high personal involvement over several peer-to-peer meetings, and the proposed amount should, for instance, exceed the compensation farmers receive for attending group meetings in current schemes (132€/farmer for the AECM targeting the protection of the European Hamster in Alsace (Eichhorn *et al*. 2022), or 0.66€/ha for AECM targeting water quality (Ministère de l'Agriculture et de la Souveraineté alimentaire (MASA) 2022). The amount of 450€ was validated as credible by farmers involved in the experimental pilot project. It is in the range of the minimum salary of an agricultural production manager for three days' work in France (Chambre d'Agriculture Meurthe-et-Moselle 2023), and from 2€/ha per sponsored peer for a large farm of 200 ha to 22€/ha per sponsored peer for a small farm of 20 ha. A second level of bonus option introduces an additional reward of 50€/ha, distributed to all participants on an annual basis if a collective environmental result is obtained. The amount of the collective result bonus was defined following the ratios bonus/individual per-hectare annual payment proposed in the literature. Kuhfuss *et al*. (2016) designed a collective bonus of 150€/ha after five years (30€/ha per year) corresponding to 6 to 25% of the total payment the farmer could receive, on average, per year, while Vaissière *et al*. (2018) proposed an individual agglomeration bonus from 9 to 20% of the total payment. Blazy *et al*. (2021) and Salazar-Ordóñez, Rodríguez-Entrena, and Villanueva (2021) propose higher ratios ranging respectively from 23 to 33%, and from 9 to 62% of the total payment amount the farmer could receive, on average, per year. In our CE, we follow Kuhfuss *et al*. (2016) and Vaissière *et al*. (2018) with a collective result bonus corresponding to 8 to 25% of the total annual per hectare payment. The environmental result is a higher step for the river's status on the water quality scale. Water analyses are conducted several times each year by public authorities as part of the Water Framework Directive (Ministère de la Transition écologique [MTE] 2022). This bonus option aims at encouraging collaborative effort to achieve a landscape objective and increase even further the environmental effectiveness of the scheme. Testing the combined introduction of a sponsorship bonus and a collective environmental result bonus is particularly interesting to see whether rewarding a collective environmental result affects the WTA of the bonus option relative to the sponsorship bonus only. The interest of the combined bonuses lies in increasing the incentive for reaching a critical mass of participants, and in particular, where environmental effort contributes the most to water quality (big farms or located in the upstream of the river). Moreover, the positive effect of the sponsorship bonus on participation stops once all farmers from the eligible area have entered the scheme. The result-based collective bonus would maintain the incentive to pursue coordinated effort towards the environmental objective. A fourth level with the collective result bonus without the individual sponsorship bonus was not included in the experimental design to limit the number of choice cards and minimum number of respondents required.

Choice sets include two contract alternatives and the status-quo (option to opt-out and choose none of the contracts). They were designed by combining the different attribute levels (see Figure 1 for an example of choice card). A 100% efficient design of 36 choice sets to be divided into four blocks of nine choice cards was constructed by minimizing the D-error using the MktEx SAS macro after ruling out dominant alternatives. The CE, together with the other sections of the survey presented in the next section, was pre-tested with a small group of farmers, to ensure the understandability, clarity and credibility of the information provided, and that the total duration of the survey is not excessive. Due to time constraints to design and conduct the study, we did not conduct a pilot survey, and assume no priors in the CE.

For the econometric analyses, the individual per-hectare payment attribute (*PAYMENT*) is coded as a continuous variable, and the bonus option levels ($BONUS_{sponsorship}$, $BONUS_{sponsorship/collective\ result}$) as dummy variables. We compare continuous and effects coding for the management attributes (*COVER*, *HEDGEROWS)* to choose the best specification (Mariel *et al*. 2021). We define an alternative specific constant controlling for the status-quo alternative (ASC_{sq}). The attribute levels of the status quo alternative are set at 0 for the individual per-hectare payment and bonus option attributes. For the management attributes, we compare a status quo level fixed at 0 and at the farm current values (individual status quo) to identify the best specification. We conduct the analyses using the Apollo package on R (version 0.2.7). In particular, we use the apollo_searchStart function to test a large range of starting values for the model parameters and keep the best candidate for the estimation (Hess and Palma 2022).

2.4. Survey structure

The CE was included as a section of a pan-EU survey on the acceptability of agri-environmental-climate contract solutions, conducted in France among farmers located in Brittany, Normandy and Pays de La Loire. The sampling procedure was non-random. Following the data protection policy, a preliminary selection of farmers interested in answering the survey was made by intermediaries (farmers union, organisations of milk producers, farmers associations …). We then contacted the voluntary farmers to

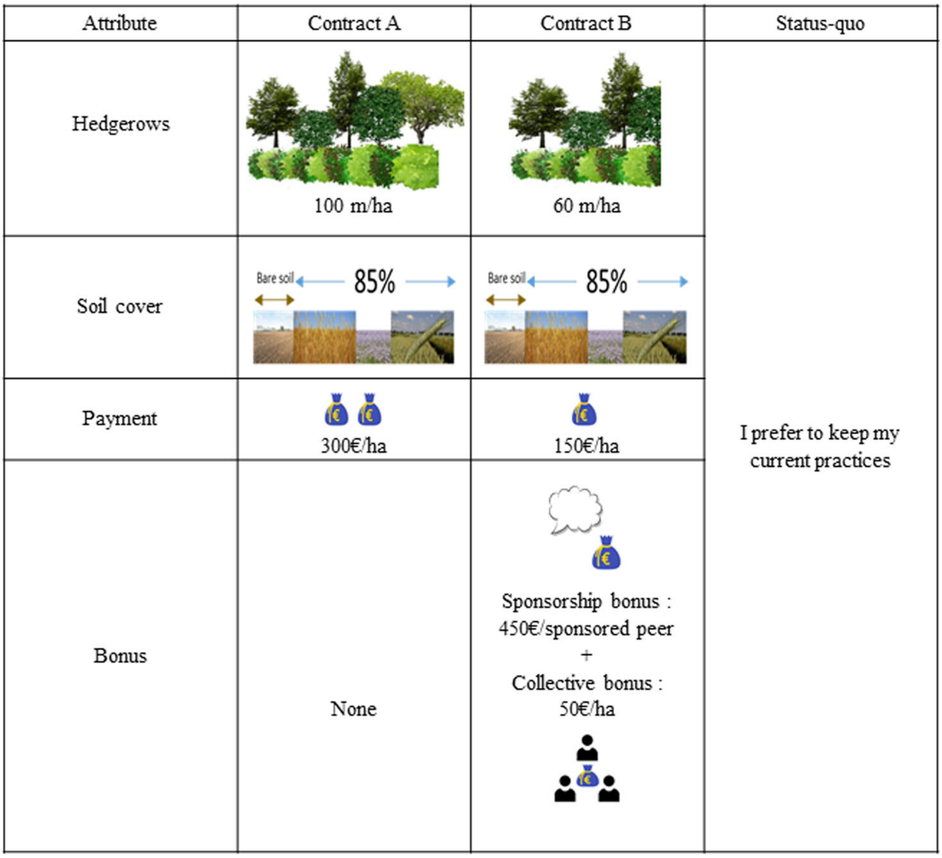
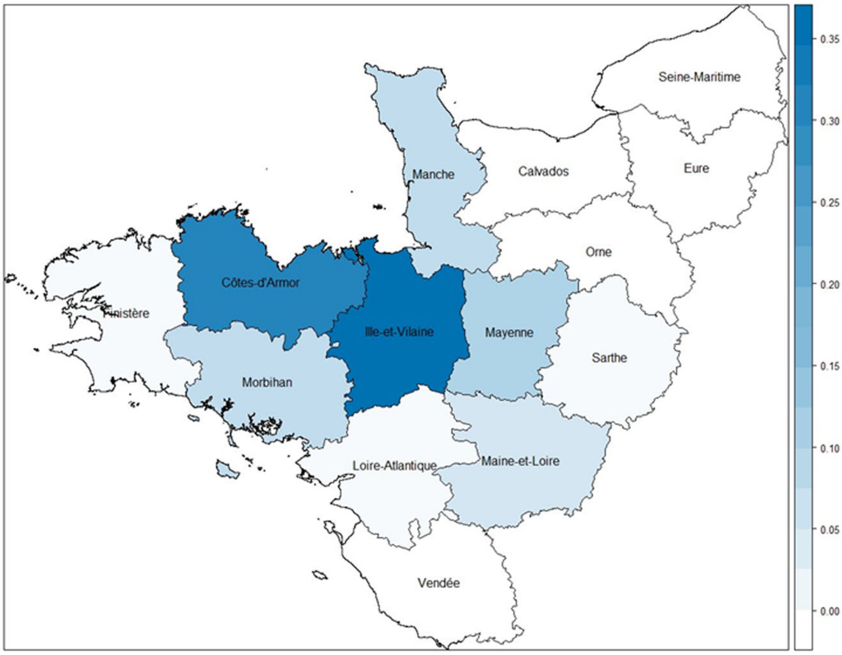


Figure 1. Example of choice set of the choice experiment. Source: own elaboration.

organise face-to-face interviews. The first section of the survey included general information on farmer and farm characteristics, and the second section questions to evaluate the impact of contract characteristics on the willingness to adopt contractual solutions. For instance, farmers were asked to state on a Likert scale how much would the possibility of receiving a common payment to be distributed among participants increase or decrease their willingness to participate. We use this score as an indicator of attitude towards collective approaches (*COLPAY*). In the third section dedicated to the CE, respondents were introduced to the context, objective and rules of the game of the CE, and to the contract parameters (those fixed and those varying from one alternative to another). Preliminary questions were included to help the respondents estimate their current levels of management requirements (individual status-quo). The current soil cover duration was calculated from the stated hectares of permanent grasslands, arable crops, permanent crops and total utilised agricultural area (UAA), as well as the average number of days with bare soil on arable lands and proportion of grass cover on the permanent crop surfaces (bare soil stopping after seeding). The current hedgerow density was calculated from the total UAA and total meters of multispecies multilayer hedgerows currently on the farmland. Farmers were then asked nine times to choose the preferred option among two contract alternatives and the status-quo.



Departments of Brittany: Finistère, Côtes-d'Armor, Ille-et-Vilaine, Morbihan.

Departments of Normandy: Manche, Calvados, Orne, Eure.

Departments of Pays de la Loire: Mayenne, Sarthe, Loire-Atlantique, Maine-et-Loire, Vendée.

Figure 2. Distribution of the sampled farms in the surveyed regions (ratio). Source: own elaboration.

3. Results

3.1. Data

The data that support the findings of this study are available in a public repository (Le Gloux 2022).

The interviews were conducted with 130 farmers between April and July 2021. Among them, 97 farms are located in Brittany, 23 in Pays de la Loire, and 10 in Normandy (Figure 2).

Descriptive statistics for the sample are provided in Table 2. A comparison of the socio-demographics and farm information collected in the first section of the survey with data from the agricultural census and the farm accountancy data network for the surveyed regions shows that our sample presents some biases. This bias can be explained by the non-random sampling procedure respecting the data protection policy, which involved a preliminary selection of volunteers by intermediaries. The average UAA of the sample is 100 ha (median of 85 ha), and half of the respondents are dairy farmers. The sample is representative of the average UAA of farms of medium and large economic size, but over-represents the share of dairy and organic farms, and under-represents farms specialised in field crops (Agreste 2022). While the share of young farmers below 40 years old is representative of the farming population, farmers between 40 and 50 years old are over-represented (Direction régionale de

Table 2. Descriptive statistics for the sample ($N = 130$).

Variable	Acronym	Mean (standard deviations in parentheses)
Utilised agricultural area (ha)	*UAA*	100.3 (64.3)
Share of utilised agricultural area:		
Rented		0.72 (0.28)
Permanent grasslands (4 n.a.)		0.36 (0.32)
Arable land (4 n.a.)		0.62 (0.32)
Share of farms specialised in :		
Dairy		0.51
Beef		0.09
Granivores		0.08
Field crops		0.06
Share of farms:		
Certified organic	*ORGANIC*	0.39
Participating in agri-environmental schemes in 2020		0.41
Share of respondents:		
Female		0.13
Higher education		0.63
Below 50 years old		0.55
Below 40 years old		0.22
Stop managing farm activities in 5 years or less	*SHORTTERM*	0.20
Farming is less than 70% of household gross revenue	*LESS70REV*	0.11
In a farmer organisation		0.62
In an environmental organization	*ENVORGA*	0.17
Impact of the contract characteristic on the willingness to enroll in a contract (Likert scale: 0 = Decreases my willingness considerably, 1 = Somewhat decreases my willingness, 2 = No effect on my willingness, 3 = Somewhat increases my willingness, 4 = Increases my willingness considerably)		
The payment gets higher, the better your environmental results are (1 n.a.)		3.4 (0.9)
You can collectively agree on environmental targets and measures at landscape-level together with other land managers (1 n.a.)		2.7 (1.3)
You and other land managers receive a common payment. You jointly agree on the distribution of the payment.	*COLPAY*	1.7 (1.3)
Current level of management attributes (individual status quo):		
Soil cover (%) (4 n.a.)		94.9 (7.1)
Hedgerows (m/ha) (10 n.a.)		87.8 (73.7)

Note. n.a.: not answered. Source: own elaboration.

l'Alimentation and de l'Agriculture et de la Forêt de Bretagne [DRAAF Bretagne] 2022; Direction régionale de l'Alimentation and de l'Agriculture et de la Forêt de Normandie [DRAAF Normandie] 2022; Direction régionale de l'Alimentation and de l'Agriculture et de la Forêt des Pays de la Loire [DRAAF Pays de la Loire] 2022). The sample is also biased towards highly educated and male farmers.

Regarding the attitude of farmers towards some PES characteristics collected in the second section of the survey, we report those associated with collective or result-based approaches in Table 2. Most of the respondents (89%) have a positive attitude towards higher payments for higher environmental results. Collective approaches are less popular, with 64% of respondents declaring that the possibility to agree collectively at landscape-level would increase their willingness to adopt a contract, and 32% for receiving a common payment to be distributed among participating farmers.

The current levels of anti-erosion multispecies multilayer hedgerow density and soil cover duration estimated for the sample in the third section of the survey dedicated to the CE are particularly high for the surveyed area, with many farms already fulfilling the highest levels of the hypothetical contract requirements. Farmers stated few days of bare soil for their arable land (25 days on average), and 88 m/ha of multispecies multilayer hedgerows on average at the farm level. All types of hedgerows considered (including monospecies or monolayer), the observed average density is 57 m/ha in Normandy, 64 m/ha in Brittany, and 61 m/ha in Pays de la Loire (Delahaye, Guillemois, and Preux 2023).

Among the 130 respondents, five systematically chose the status quo option in the CE. While we cannot exclude the possibility of them being protest respondents (Villanueva, Glenk, *et al*. 2017), we keep their answers in the sample for the following econometric analyses to avoid bias.

3.2. Estimations

As a baseline, we estimate a CL model with attribute levels and the ASC_{sq} as explanatory variables (Equation (3) (Table A1). Three specifications are tested: continuous coding of management attributes (*COVER*, *HEDGEROWS*) with status quo levels fixed at the current farm level stated in the survey (individual status-quo levels) (CL1), continuous coding of management attributes with status quo levels fixed at 0 (CL2), and effects coding of management attributes with status quo levels necessarily fixed at 0 (CL3). They provide similar estimates, in particular for the individual per-hectare payment (*PAYMENT*) and bonus attributes ($BONUS_{sponsorship}$, $BONUS_{sponsorship/collective\ result}$). Effects coding reveals non-linear preferences for hedgerow management requirements. We decided to keep the first specification (CL1) with the best goodness of fit measures (adjusted R^2). By capturing the individual status quo levels of the management requirements, specification CL1 better measures preferences for the ASC_{sq}, while limiting the number of variables in the model.

The Hausman-McFadden test reveals the IIA assumption is violated and there are unobserved preference heterogeneities across respondents, suggesting the need to rely on ML Equation (4) or LC (Equation (5) models to characterise preferences. To disentangle preference heterogeneities, we first apply an ML model with attributes and status-quo coefficients defined as random parameters. We assume a normal distribution for all coefficients beside the individual per-hectare payment (*PAYMENT*). For the latter, we test a fixed and positive lognormal distribution. The fixed distribution has the advantage of facilitating the computation of WTA estimates, but the lognormal distribution accounting for heterogeneity among respondents is often more appropriate and realistic (Mariel *et al*. 2021).

The first ML specification without individual specific variables and a fixed distribution of the payment attribute (*PAYMENT)* (ML1) shows the density of hedgerows

(*HEDGEROWS*) and the level of individual per-hectare payment (*PAYMENT*) significantly affects respondents' choice with the expected signs (negative preferences for *HEDGEROWS* and positive preferences for *PAYMENT*) (Table 3). Preferences for the requirement of soil cover (*COVER*) are not significant, which can be explained by the already high proportion of farmers fulfilling the highest level. Farmers appear indifferent to the bonus options (non-significant preferences for $BONUS_{sponsorship}$, $BONUS_{sponsorship/collective\ result}$). The status-quo was chosen in 16% of the choice situations, and results suggest that farmers tend to prefer choosing a contract rather than the opt-out option (negative preferences for ASC_{sq}). The significance of the standard deviation coefficients shows strong preference heterogeneities for both management attributes *COVER* and *HEDGEROWS*, the status-quo ASC_{sq} and the bonus option offering both the possibility of a sponsorship bonus and a collective environmental result bonus $BONUS_{sponsorship/collective\ result}$. When relaxing the assumption that preferences for the attribute *PAYMENT* are constant across individuals (specification ML2) and including a random component following a positive lognormal distribution, the standard deviation of the preference coefficient is not significant. To limit the number of variables in the model, we decide to keep the payment attribute and sponsorship bonus preference parameters as non-random while adding individual specific variables in the model.

In a third ML specification (ML3), we add interaction terms with individual specific variables collected in the survey. The non-binary covariates are mean-centred. Out of the set of covariates tested, we kept those significantly explaining the heterogeneity of farmers' choices while not diminishing the model's goodness of fit. As expected, farmers who are members of an environmental organisation ($ENVORGA = 1$) and therefore particularly aware of environmental issues, exhibit higher preferences for higher levels of management requirement attributes (Table 3). Moreover, organic farmers ($ORGANIC = 1$) have higher preferences for more ambitious levels of hedgerow density requirements. We can assume organic farms particularly value the multiple ecosystem services delivered by hedgerows (habitats for natural predators of pests, reducing exposure to pesticide spray drift from neighbouring farms …). On the other hand, respondents who plan to stop farming activities in five years or less ($SHORTTERM = 1$) have strong negative preferences for hedgerow requirements, which require long-term engagement for maintaining them. Farms with a larger UAA also tend to prefer lower levels of hedgerow requirements, for which compliance might be particularly costly. Regarding the bonus option, the higher the farmer's score in terms of impact of a common payment on the willingness to adopt a contract (*COLPAY*), the higher his or her preferences for the combined sponsorship and collective result bonuses. This suggests that some farmers have a "pro-collective" behaviour. Finally, respondents for which farming contributes to less than 70% of the household gross revenue ($LESS70REV = 1$) are less likely to choose the status quo option. This is consistent with the findings by Defrancesco *et al*. (2008) that high dependency of the household on agricultural income is a barrier to the adoption of AECM.

To enable more accurate measurement of farmers' WTA for higher requirements of soil cover, we recode the management attributes in specification ML4 so that it defines the level of environmental effort the farmer has to make to meet the contract requirement relative to his or her individual status quo level. $\Delta COVER$ and $\Delta HEDGEROWS$ are defined as the difference between the attribute level required in the PES alternative and the individual status quo of the farmer. $\Delta COVER$

Table 3. Mixed logit estimations with initial coding of management requirement attributes[1,2].

	ML1	ML2	ML3
Attributes			
PAYMENT	0.006*** (0.001)	0.005*** (0.002)	0.006*** (0.001)
COVER	0.017 (0.020)	0.006 (0.034)	0.018 (0.022)
HEDGEROWS	−0.014^{+} (0.007)	−0.008 (0.014)	−0.022*** (0.006)
$BONUS_{sponsorship}$	0.291 (0.182)	0.127 (0.281)	0.364^{+} (0.188)
$BONUS_{sponsorship/collective\ result}$	0.195 (0.257)	0.503 (0.332)	0.193 (0.223)
Alternative-specific constant			
ASC_{sq}	−1.887** (0.654)	−1.527** (0.467)	−1.979*** (0.560)
Interaction[3]			
*COVER*ENVORGA*	–	–	0.063^{+} (0.035)
HEDGEROWS ENVORGA*	–	–	0.022** (0.008)
HEDGEROWS ORGANIC*	–	–	0.037*** (0.009)
*HEDGEROWS*SHORTTERM*	–	–	−0.046*** (0.013)
*HEDGEROWS*UAA*	–	–	−0.002* (0.001)
$BONUS_{sponsorship/collective\ result}$*COLPAY	–	–	0.513*** (0.151)
ASC_{sq}*LESS70REV	–	–	−5.166** (1.651)
Standard deviation of the parameters			
SD.PAYMENT	–	3.882 (16.114)	–
SD.COVER	−0.134*** (0.029)	0.177** (0.065)	0.105*** (0.029)
SD.HEDGEROWS	0.055*** (0.007)	0.085*** (0.017)	−0.045*** (0.005)
$SD.BONUS_{sponsorship}$	0.159 (0.198)	0.563 (0.566)	–
$SD.BONUS_{sponsorship/collective\ result}$	1.346*** (0.288)	2.526*** (0.546)	1.337*** (0.224)
$SD.ASC_{sq}$	−3.624*** (0.627)	1.723*** (0.463)	4.783*** (0.846)
Goodness-of-fit			
Log Likelihood	−739.74	−696.06	−711.99
Pseudo-R^2	0.36	0.40	0.38
AIC	1501.48	1416.13	1457.99
BIC	1556.26	1475.89	1542.65
Observations	1075	1075	1075
Number of farms	120	120	120

Notes. [1] Halton draws are used for ML1 and ML3. As Halton draws are not recommended with more than five random coefficients (Hess and Palma 2022), the estimation of ML2 uses pseudo-Monte Carlo draws.
[2] The reported median and standard deviation of the log-normal distribution are obtained from the estimated parameter ($\beta_{payment}$) and standard deviation ($\sigma_{payment}$) and are respectively $e^{\beta_{payment}}$ and $e^{\left(\beta_{payment}+\frac{\sigma^2_{payment}}{2}\right)}\sqrt{e^{\sigma^2_{payment}}-1}$ (Mariel *et al*. 2021).
[3] Non binary covariates are mean-centered. *indicates an interaction between two variables.
Significance levels: ***robust p value <0.001, **robust p value <0.01, *robust p value $<$ 0.05, $^{+}$robust p value $<$ 0.1. Robust standard errors in parentheses.
ASC_{sq}: alternative-specific constant associated with the status quo alternative.
AIC: Akaike information criterion. BIC: Bayesian information criterion.
Source: own elaboration.

(Δ*HEDGEROWS* respectively) is set at 0 when the individual status quo level exceeds the contract requirement. The management attributes corresponding to choosing the status quo option were also recoded to 0. Recoding *COVER* into Δ*COVER* and *HEDGEROWS* into Δ*HEDGEROWS* slightly improves the model's goodness of fit measures. Δ*COVER* and Δ*HEDGEROWS* significantly affect respondents' choice with the expected signs (negative preferences) (Table 4). Moreover, ML4 reveals significant

Table 4. Mixed logit estimations with recoding of management requirement attributes[1,2].

	ML4	ML5
Attributes		
PAYMENT	0.006*** (0.001)	0.006*** (0.001)
Δ*COVER*	−0.224* (0.110)	−0.155 (0.097)
Δ*HEDGEROWS*	−0.065*** (0.011)	−0.047*** (0.013)
$BONUS_{sponsorship}$	0.329^{+} (0.171)	0.162 (0.193)
$BONUS_{sponsorship/collective\ result}$	0.252 (0.222)	0.080 (0.229)
Alternative-specific constant		
ASC_{sq}	−1.838*** (0.495)	−2.708*** (0.592)
Interaction[3]		
Δ*COVER*LESS70REV*	–	0.386** (0.134)
Δ*HEDGEROWS* ORGANIC*	–	0.072*** (0.021)
Δ*HEDGEROWS*SHORTTERM*	–	−0.113*** (0.033)
Δ*HEDGEROWS*UAA*	–	−0.005*** (0.001)
$BONUS_{sponsorship}$*ENVORGA*	–	1.004** (0.378)
$BONUS_{sponsorship}$*COLPAY*	–	0.213^{+} (0.128)
$BONUS_{sponsorship/collective\ result}$ *ENVORGA*	–	0.996^{+} (0.585)
$BONUS_{sponsorship/collective\ result}$*COLPAY*	–	0.627*** (0.174)
ASC_{sq}*ORGANIC*	–	2.430** (0.868)
Standard deviation of the parameters		
SD. Δ*COVER*	0.425*** (0.097)	0.436*** (0.123)
SD. Δ*HEDGEROWS*	0.112*** (0.026)	−0.120*** (0.019)
$SD.BONUS_{sponsorship}$	0.455* (0.223)	0.564* (0.221)
$SD.BONUS_{sponsorship/collective\ result}$	−1.282*** (0.288)	−1.254*** (0.246)
$SD.ASC_{sq}$	3.516*** (0.555)	3.137*** (0.663)
Goodness-of-fit		
Log Likelihood	−734.04	−704.82
Pseudo-R^2	0.37	0.39
AIC	1490.08	1449.64
BIC	1544.86	1549.24
Observations	1075	1075
Number of farms	120	120

Notes. [1] Halton draws are used.
[2] The reported median and standard deviation of the log-normal distribution are obtained from the estimated parameter ($\beta_{payment}$) and standard deviation ($\sigma_{payment}$) and are respectively $e^{\beta_{payment}}$ and $e^{(\beta_{payment}+\frac{\sigma^2_{payment}}{2})}\sqrt{e^{\sigma^2_{payment}}-1}$ (Mariel *et al.* 2021).
[3] Non binary covariates are mean-centered. *indicates an interaction between two variables.
Significance levels: ***robust p value <0.001, **robust p value <0.01, *robust p value < 0.05, $^{+}$robust p value < 0.1. Robust standard errors in parentheses.
ASC_{sq}: alternative-specific constant associated with the status quo alternative.
AIC: Akaike information criterion. BIC: Bayesian information criterion.
Source: own elaboration.

positive preferences for the sponsorship bonus, as well as a significant heterogeneity of preferences for the sponsorship bonus (significant standard deviation of the parameter).

When recoding the management attributes *COVER* into Δ*COVER* and *HEDGEROWS* into Δ*HEDGEROWS*, the effects of individual characteristics reveal additional information. Membership of an environmental organisation (*ENVORGA* = 1) no longer significantly explains the heterogeneity of preferences for management requirement attributes (Table 4). It suggests that this population, while preferring more

Table 5. Average marginal willingness to accept the payment for environmental services contract design characteristics, estimated from ML5 with the delta method at the mean value of individual characteristics (€/ha/year).

	Average marginal WTA (€/ha/year)
$\Delta COVER$	18.626 (13.788)
$\Delta HEDGEROWS$	6.447*** (1.427)
$BONUS_{sponsorship}$	−56.846* (27.280)
$BONUS_{sponsorship/collective\ result}$	−46.053 (33.810)
ASC_{sq}	281.165** (90.188)

Note. Robust standard errors in parentheses. Significance levels: ***robust *p* value <0.001, **robust *p* value <0.01, *robust *p* value < 0.05, +robust *p* value < 0.1. Robust standard errors in parentheses. ASCsq: alternative-specific constant associated with the status quo alternative.
Source: own elaboration.

ambitious management requirements than their peers, have similar preferences when it comes to the amount of environmental effort they are willing to make starting from their own individual status quo. It reveals they tend to have higher individual status quo levels than other respondents. Instead, respondents for which farming contributes less than 70% of the household gross revenue ($LESS70REV = 1$) have higher preferences for increasing cover duration from their status quo in comparison with others. This may be explained by their lower opportunity costs from having permanent grasslands compared with households depending more on agricultural income. Apart from *ENVORGA*, the effect of the covariates in explaining the heterogeneity of preferences for increasing the hedgerow density remains similar from the previous coding. A higher score in terms of impact of a common payment on the willingness to adopt a contract (*COLPAY*) and membership in an environmental organisation ($ENVORGA = 1$) significantly increases preferences for both types of bonuses. Finally, when recoding the management attributes, organic farmers ($ORGANIC = 1$) are more likely to choose the status quo option, while the contribution of farming to the household's income no longer significantly explains the heterogeneity of the status quo option uptake.

Farmers' average marginal WTA for the attributes are reported in Table 5. Ceteris paribus, a farmer accepts a contract with, on average, 57€ less individual payment per hectare if there is a sponsorship bonus of 450€/peer. For a farm of 100 ha (average farm size of the sample), this represents a decrease of 5,700€ in individual payment per year. A farmer would need to convince at least 13 new farmers each year to receive the same amount of sponsorship bonuses.

We further characterise preference heterogeneities with choice patterns by estimating an LC model, with the initial coding of management attributes (LC1), and with the recoding (LC2) to compute more realistic WTA estimates. The best model fit was obtained for 3 and 4 classes, as the Bayesian information criterion (BIC) increases substantially starting from 5 classes (Table A2). We decided to keep 3 classes to limit the number of variables in the model and add individual specific variables to explain class membership.

With specification LC1, the first class (52.5% of respondents) describes farmers with positive preferences for both types of bonus options, and with the highest preferences for the individual per-hectare payment (Table 6). Relative to the other classes, the level of financial incentive seems to drive their choice more than technical

Table 6. Latent class estimation with initial coding of management requirement attributes (LC1).

	Class 1	Class 2	Class 3
Attributes			
PAYMENT	0.008*** (0.001)	0.001 (0.001)	0.002* (0.001)
COVER	0.042* (0.019)	0.055* (0.026)	−0.076** (0.024)
HEDGEROWS	0.005 (0.004)	0.024*** (0.006)	−0.038*** (0.008)
$BONUS_{sponsorship}$	0.999*** (0.187)	−0.758^{+} (0.388)	0.143 (0.303)
$BONUS_{sponsorship/collective\ result}$	1.285*** (0.260)	−0.949* (0.386)	−0.363 (0.296)
Alternative-specific constant			
ASC_{sq}	−2.325* (1.173)	−1.547*** (0.448)	0.430 (0.420)
Goodness-of-fit			
Log likelihood		−731.49	
Pseudo-R^2		0.3586	
AIC		1514.98	
BIC		1644.47	
Observations		1075	
Number of farms		120	
Probability of class (unconditional probabilities)	0.5257	0.1616	0.3127
Share of respondents (%)	0.525	0.158	0.317
Class membership function			
Intercept		−1.572** (0.517)	0.194 (0.315)
ORGANIC	–	1.321* (0.632)	−0.993^{+} (0.536)
ENVORGA	–	−0.964 (0.702)	−15.688*** (0.734)
LESS70REV	–	−12.613*** (1.273)	−0.876 (0.717)

Note. Significance levels: *** robust p value <0.001, ** robust p value <0.01, * robust p value <0.05, $^{+}$ robust p value < 0.1. Robust standard errors in parentheses. ASCsq: alternative-specific constant associated with the status quo alternative. AIC: Akaike information criterion. BIC: Bayesian information criterion.
Source: own elaboration.

constraints. Farmers who are members of an environmental organisation (*ENVORGA* = 1), and therefore have experience in working collectively on environmental issues, are more likely to belong to this "pro-incentive" class. The second class (16% of respondents) depicts farms preferring PES contracts with high management requirements and no bonus option. Organic farmers (*ORGANIC* = 1) and farmers for whom the household income is highly dependent on farming (*LESS70REV* = 0) are more likely to be in this "pro-environment individualists" class. The preference parameter for the individual per-hectare payment is not significant, suggesting that the individuals' choice is driven more by the contract design in itself than by the incentive. While this second class describes a small share of the sample, it reveals low acceptability of bonus incentives from a part of the farming population in the surveyed area. The third class of farmers (32% of respondents) exhibits preferences for low management requirements and is not affected by the bonus option. Conventional farmers (*ORGANIC* = 0) and farmers who are not members of an environmental organisation (*ENVORGA* = 0) are more likely to be in this "management change averse" class.

When recoding the management attributes (specification LC2), the effect of membership in an environmental organisation is no longer significant in explaining participation in a specific class. The composition and choice patterns of the classes remain the same as in LC1 (Table 7).

Table 7. Latent class estimation with recoding of management requirement attributes (LC2).

	Class 1	Class 2	Class 3
Attributes			
PAYMENT	0.002^{+} (0.001)	0.009*** (0.001)	0.001 (0.001)
ΔCOVER	−0.213*** (0.051)	−0.011 (0.070)	0.115* (0.058)
ΔHEDGEROWS	−0.063*** (0.011)	−0.011 (0.011)	0.057*** (0.016)
$BONUS_{sponsorship}$	0.270 (0.255)	1.011*** (0.220)	−1.149* (0.564)
$BONUS_{sponsorship/collective\ result}$	−0.206 (0.336)	1.346*** (0.323)	−0.949* (0.467)
Alternative-specific constant			
ASC_{sq}	−0.889^{+} (0.501)	−1.854 (2.370)	0.055 (0.514)
Goodness-of-fit			
Log likelihood		−732.03	
Pseudo-R^2		0.3599	
AIC		1511.95	
BIC		1631.47	
Observations		1075	
Number of farms		120	
Probability of class (unconditional probabilities)	0.3685	0.4876	0.1438
Share of respondents (%)	0.35	0.5	0.15
Class membership function			
Intercept		−0.125 (0.343)	−2.260*** (0.664)
ORGANIC	–	0.894 (0.625)	2.615** (0.953)
LESS70REV	–	1.014 (0.727)	−8.843*** (0.768)

Note. Significance levels: ***robust p value <0.001, **robust p value <0.01, *robust p value <0.05, $^{+}$robust p value < 0.1. Robust standard errors in parentheses. ASCsq: alternative-specific constant associated with the status quo alternative. AIC: Akaike information criterion. BIC: Bayesian information criterion. Source: own elaboration.

Classes' average marginal WTA for the attributes are reported (Table 8). For the pro-incentive behavior class and specification LC2, a farmer accepts a contract with, on average, 113€/ha (120€/ha for specification LC1) less of individual payment per hectare if there is a sponsorship bonus of 450€/peer. For a farm of 92 ha (average farm size of the class), a farmer would need to convince at least 23 (25 for specification LC1) new farmers each year to receive the same amount of sponsorship bonuses. In addition, when associated with the collective result bonus, the WTA decreases more (−35€/ha for specification LC1 and −37€/ha for specification LC2), but less than the collective result bonus amount (50€/ha), revealing a risk premium component.

5. Discussion

On average, in our study, farmers show interest in a sponsorship bonus rewarding their individual effort in convincing new peers to adopt the PES contract. In particular, the estimated average marginal WTA for the sponsorship bonus option confirms the result by Kuhfuss *et al.* (2016) that introducing a bonus option can improve the cost-effectiveness of a PES. However, our respondents are, on average, indifferent between a contract offering no bonus option, and a contract offering both the possibility of

Table 8. Average marginal willingness to accept the payment for environmental services contract design characteristics, estimated from LC2 with the delta method (€/ha/year).

	Class 1	Class 2	Class 3
$\Delta COVER$	105.342$^+$ (56.298)	1.195 (7.809)	−170.727 (319.017)
$\Delta HEDGEROWS$	31.166$^+$ (17.733)	1.242 (1.193)	−84.568 (137.735)
$BONUS_{sponsorship}$	−133.270 (136.522)	−113.069*** (31.054)	1,700.218 (3,164.014)
$BONUS_{sponsorship/collective\ result}$	101.890 (178.969)	−150.491** (45.754)	1,403.678 (2,577.454)
ASC_{sq}	438.773 (444.325)	207.286 (278.927)	−80.761 (687.426)

Note. Robust standard errors in parentheses. Significance levels: ***robust p value <0.001, **robust p value <0.01, *robust p value < 0.05, $^+$robust p value < 0.1. Robust standard errors in parentheses. ASCsq: alternative-specific constant associated with the status quo alternative.
Source: own elaboration.

receiving the sponsorship bonus and a second monetary bonus distributed to all participants conditional on the improvement of the river's water quality. The indifference of farmers towards result-based bonuses confirms the results of Salazar-Ordóñez, Rodríguez-Entrena, and Villanueva (2021). However, in the context of our study, this result is unexpected. As bonuses are not binding, we could have expected indifference towards the collective result bonus to translate into a non-significant difference between preferences for the sponsorship bonus on its own and preferences for the combined sponsorship and collective result bonuses. Our findings suggest a negative effect of the collective result bonus on the acceptability of a bonus option in a PES contract. Several reasons could explain the attitude of respondents towards the collective result bonus. The amount of the collective result bonus (50€/ha/year) may be perceived as too low to represent a significant incentive compared with the rest of the contract payment levels (from 150€/ha/year to 600€/ha/year and 450€/sponsored peer for the sponsorship bonus). While the low financial incentive may explain indifference between a contract offering a collective result bonus and a contract without a bonus option, the fact that we measure lower preferences for contracts with both a sponsorship bonus and a collective result bonus compared with contracts with a sponsorship bonus suggests an opposition to bonuses designed as a collective undertaking. Achieving the environmental objective not only depends on one's own effort but also on the cumulated effort of others and external factors affecting water quality. Farmers might not believe the environmental target can be achieved in their area or within the contract length (5 years) and anticipate that they will not benefit from the bonus regardless of their action to comply with its requirements. They might also be unwilling to collaborate with other farmers on farm management aspects. This hypothesis is further supported by the fact that farmers' general attitude towards collective payments in PES contracts (measured by the variable *COLPAY*) significantly explains the heterogeneity of preferences for the combined bonuses option. This opposition to collective participation/approaches in contractual environmental commitments is confirmed by the literature (Villanueva, Rodríguez-Entrena, *et al*. 2017; Le Coent, Préget, and Thoyer 2017; Villamayor-Tomas, Sagebiel, and Olschewski 2019). Designing the collective bonus requirement based on results may further reduce its acceptability, as negative preferences for result-based requirements are also reported in the literature (Niskanen *et al*. 2021; Tanaka, Hanley, and Kuhfuss 2022).

Results show that there is a significant heterogeneity of farmers' preferences towards the design of bonuses in PES contracts. Membership in an environmental organisation and positive attitudes towards collective payments increase preferences for both bonus options, suggesting that high environmental awareness and a positive attitude towards collective action benefit the acceptability of new types of incentive mechanisms to favour public good provision. Currently, both represent a minority of the surveyed population, and the attractiveness of the bonuses may relate more to the fact that it offers the possibility of receiving more payments. However, in the long term, improving farmers' environmental training on the provision of agri-environment-climate public goods and supporting more initiatives in the agricultural sector to create positive collective experiences may further support the development and uptake of PES with bonus options.

There are several limits to the generalisation of our findings. High negative preferences for the status quo alternative estimated with ML and LC models suggest our experiment could be subject to hypothetical bias. In hypothetical choice settings, respondents tend to underestimate their WTA, hindering the validity of the results. During the introduction of the rules of the CE in our survey, the farmer was asked to choose as if faced with a real choice situation. To further counter hypothetical bias, we could have added an opt-out reminder on some of the choice cards (Mariel *et al.* 2021).

Due to the sampling procedure, our data also present a selectivity bias. In particular, there is an over-representation of organic farms (39% of the respondents while the actual share is closer to 10%). Since organic farms are more likely to have a "pro-environment individualists" preference pattern, our results likely overestimate negative preferences towards the bonus options. Moreover, the selectivity bias is such that many farmers in the sample have already met the highest levels of management requirements, particularly for the soil cover duration. In particular, most of our farmers are located in a Nitrate Vulnerable Zone and must therefore comply with existing regulations which already involve cover cropping during specific periods of the year. Asking and controlling for individual status-quo levels allowed us to capture part of the bias (Domínguez-Torreiro and Soliño 2011; Barton and Bergland 2010). In this regard, while designed as adapted to the targeted population, the financial incentives proposed in the PES contracts were rather high for the surveyed population. While it is difficult to limit selectivity bias when conducting face-to-face interviews based on the preliminary identification of volunteer respondents by intermediaries, a pilot survey could have given us a sense of the need to adjust attribute and/or payment levels. The research context of the study imposed a tight schedule to design and conduct the interviews, leading to the decision not to include a pilot survey. In addition, while conducting face-to-face interviews presented numerous advantages, such as ensuring the respondents are attentive and fully understand all the questions and stages of the long and complex pan-EU questionnaire, it is also more costly than other survey modes (Mariel *et al.* 2021), and constrained us in having a relatively small sample size. It is a limit to the extrapolation of our findings, in particular when it comes to the characterisation of choice patterns from LC estimations, with the "pro-environment individualists" class corresponding to less than 20 respondents. Further on this specific class, as preferences for the individual per-hectare payment attribute is found not significant, this group of respondents might have taken the opportunity of the survey to express opinions on PES design rather than revealing their willingness to participate.

To ensure sufficient adoption, the introduction of PES with conditional bonuses may require paying farmers beyond opportunity costs. The involvement of private and local stakeholders in financing PES represents an opportunity to capture a higher willingness to pay for water quality. In particular, bonus-mechanisms rewarding a landscape result or high participation could be of particular interest for stakeholders benefiting directly from the improvement of rivers' ecological quality (water bottle companies, water catchment bodies …). Another issue at stake in capturing greater willingness to pay for PES is to consider the other public goods provided in synergy with the implementation of hedgerows and the reduction of bare soil duration, such as carbon storage and the protection of agrobiodiversity. On the one hand, the emergence of carbon and biodiversity offsets together with watershed payments represents an opportunity for farmers to find contributors more easily and valorise the multiple environmental services they provide. Stakeholders from northwestern France seem particularly interested in developing local carbon markets based on the valorisation of a bunch of public goods (Thareau *et al*. 2023). On the other hand, the multiplication of those initiatives could lead to counterproductive effects. Different payment levels for the implementation of the same practices, depending whether a contributor places more value on water quality, carbon storage or biodiversity, raise the issue of fairness. It might provide an additional incentive for farmers to work together in securing a collective supply of environmental services at the landscape level and increase their bargaining power. In areas where experience in collective approaches is low, building institutions facilitating collective action would support this process (Kerr, Vardhan, and Jindal 2014).

6. Concluding remarks

The effectiveness of payment schemes for farmers' environmental services aiming at the delivery of environmental public goods with provision thresholds (biodiversity, water quality) depends on achieving enough farmland enrolment and aggregated environmental effort at the landscape scale. The objective of the present study was to elicit farmers' preferences for a payment mechanism comprising a bonus incentivising farmers to adopt collaborative behavior with other farms from the same area, on top of an individual action-based payment. In comparison to collective requirements conditioning the full payment, the conditional bonus option reduces the risk of receiving no compensation for one's environmental services if the aggregated effort and surfaces are insufficient at the landscape scale. Using a choice experiment approach, we measured preferences for a sponsorship bonus of 450€/sponsored farmer rewarding individual farmers for increasing participation, and a combined bonuses option comprising the sponsorship bonus and a collective result bonus of 50€ per hectare delivered to all participants if an environmental target is met at the landscape level.

Findings suggest that, on average, respondents prefer contracts with a bonus for sponsoring a peer to no bonus, but are less favorable to combined sponsorship/collective result bonuses. Designing bonuses distributed according to an individual effort for attracting more farmers could be a promising way to increase participation and PES cost-effectiveness, while collective bonuses distributed to all might be counterproductive. We characterised respondents' heterogeneity with a latent class model and identified three groups of farmers with a different attitude towards the bonus options: (i) "pro-environment individualists" with negative preferences for both, (ii) farmers who seem indifferent to both, and (iii) "pro-incentive" farmers with positive preferences for both.

Based on this growing evidence of the mixed acceptability of collective payments for environmental services, further research and empirical evidence from practice are needed to assess which contractual arrangements are successful in improving public good provision with threshold effects. Whether the essential collaboration and coordination of farmers in the same area for biodiversity or water quality preservation is more likely to be rapidly achieved on a large scale by generalising contracts for groups of farms or contracts for individual farms including bonus payments for collective action, remains a question to be addressed.

Acknowledgments

The authors would like to thank the students who participated in the data collection and preliminary analyses, as well as the two anonymous referees who greatly contributed to improve the manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research was funded by the Horizon 2020 programme of the European Union (EU) under Grant Agreement No. 817949 (CONSOLE project, https://console-project.eu/).

ORCID

Fanny Le Gloux http://orcid.org/0000-0003-3645-4381
Carole Ropars-Collet http://orcid.org/0000-0003-0672-3763
Alice Issanchou http://orcid.org/0000-0002-8614-0148
Pierre Dupraz http://orcid.org/0000-0001-9910-1482

References

Agence de l'eau Loire-Bretagne. 2020a. "Maine-Loire-Océan, une Situation très Dégradée." Agence de l'eau Loire-Bretagne. Accessed January 4 2023. https://agence.eau-loire-bretagne.fr/home/bassin-loire-bretagne/zoom-sur-la-qualite-des-eaux-en-loire-bretagne-2020.html?dossierCurrentElemente45c63ca-4536-4b29-97c5-1cc2713d5974=044127e5-f646-4213-bda2-0c9f7a100af0

Agence de l'eau Loire-Bretagne. 2020b. "Vilaine et Côtiers Bretons: d'Est en Ouest une Situation Contrastée." Agence de l'eau Loire-Bretagne. Accessed January 4 2023. https://agence.eau-loire-bretagne.fr/home/bassin-loire-bretagne/zoom-sur-la-qualite-des-eaux-en-loire-bretagne-2020.html?dossierCurrentElemente45c63ca-4536-4b29-97c5-1cc2713d5974=d567c88f-8d9b-4a41-93e0-2d66f45d7695

Agence de l'eau Seine-Normandie. 2018. *Qualité des Rivières en Seine-Aval* [The Quality of Rivers in Seine-Aval]. Courbevoie, France: Agence de l'eau SeineNormandie. https://eau-seine-normandie.fr/node/3027

Agreste. 2022. "Data from: Réseau d'information comptable agricole 2018 – 2021 (Régions hors-DOM) - CPS 2013" (dataset). Agreste - Réseau d'information comptable agricole (RICA). Accessed January 2023. https://agreste.agriculture.gouv.fr/agreste-web/disaron/RICA_REGION_SOC2013/detail/

Bailly, Marie-Laure, Sandra Delaunay, Alice Issanchou, Caroline Leroux, Paillard Hélène, and Thareau Bertille. 2022. *Se Lancer Dans Une Démarche de PSE Avec Des Collectifs D'Agriculteurs: Enseignements Méthodologiques du Projet LabPSE [Starting a PES Approach with Farmers' Collectives: Methodological Lessons from the LabPSE Project]*. Rennes, France: Trame. https://trame.org/labspe/

Barghusen, Rena, Claudia Sattler, Lisa Deijl, Carleen Weebers, and Bettina Matzdorf. 2021. "Motivations of Farmers to Participate in Collective Agri-Environmental Schemes: The Case of Dutch Agricultural Collectives." *Ecosystems and People* 17 (1): 539–555. doi:10.1080/26395916.2021.1979098.

Bartkowski, Bartosz, Nils Droste, Mareike Ließ, William Sidemo-Holm, Ulrich Weller, and Mark V. Brady. 2021. "Payments by Modelled Results: A Novel Design for Agri-Environmental Schemes." *Land Use Policy* 102: 105230. doi:10.1016/j.landusepol.2020.105230.

Barton, David N., and Olvar Bergland. 2010. "Valuing Irrigation Water Using a Choice Experiment: An Individual Status Quo Modelling of Farm Specific Water Scarcity." *Environment and Development Economics* 15 (3): 321–340. doi:10.1017/S1355770X10000045.

Batáry, Péter, Lynn V. Dicks, David Kleijn, and William J. Sutherland. 2015. "The Role of Agri-Environment Schemes in Conservation and Environmental Management." *Conservation Biology: The Journal of the Society for Conservation Biology* 29 (4): 1006–1016. doi:10.1111/cobi.12536.

Ben-Othmen, Marie Asma, and Mariia Ostapchuk. 2019. "Farmers' Preferences for Grassland Restoration: Evidence from France." Paper Presented at the 172nd EAAE Seminar 'Agricultural Policy for the Environment or Environmental Policy for Agriculture?, Brussels, Belgium. doi:10.22004/ag.econ.289701.

Blazy, Jean-Marc, Julie Subervie, Jacky Paul, François Causeret, Loïc Guindé, Sarah Moulla, Alban Thomas, and Jorge Sierra. 2021. "Ex-Ante Assessment of the Cost-Effectiveness of Public Policies to Sequester Carbon in Soils." *Ecological Economics* 190: 107213. doi:10.1016/j.ecolecon.2021.107213.

Bougherara, Douadia, and Géraldine Ducos. 2006. "Farmers' Preferences over Conservation Contract Flexibility and Duration : An Estimation of the Effect of Transaction Costs Using Choice Experiment." Paper presented at the 1ère Journée de l'ESNIE, Paris, France, November 23.

Bougherara, Douadia, Margaux Lapierre, Raphaële Préget, and Alexandre Sauquet. 2021. "Do Farmers Prefer Increasing, Decreasing, or Stable Payments in Agri-Environmental Schemes?" *Ecological Economics* 183: 106946. doi:10.1016/j.ecolecon.2021.106946.

Burel, Françoise, and Jacques Baudry. 1995. "Social, Aesthetic and Ecological Aspects of Hedgerows in Rural Landscapes as a Framework for Greenways." *Landscape and Urban Planning* 33 (1-3): 327–340. doi:10.1016/0169-2046(94)02026-C.

Burton, Rob J. F., and Gerald Schwarz. 2013. "Result-Oriented Agri-Environmental Schemes in Europe and Their Potential for Promoting Behavioural Change." *Land Use Policy* 30 (1): 628–641. doi:10.1016/j.landusepol.2012.05.002.

Caubel-Forget, Virginie, Catherine Grimaldi, and François Rouault. 2001. "Contrasted Dynamics of Nitrate and Chloride in Groundwater Submitted to the Influence of a Hedge." *Comptes Rendus de L'Académie Des Sciences - Series IIA - Earth and Planetary Science* 332 (2): 107–113. doi:10.1016/S1251-8050(00)01505-6.

Chambre d'Agriculture Meurthe-et-Moselle. 2023. "Connaître la Réglementation liée aux Salaires et à la Durée du Travail" Chambre d'Agriculture Meurthe-et-Moselle. Accessed January 4 2023. https://meurthe-et-moselle.chambre-agriculture.fr/gestion-de-lexploitation/emploi/connaitre-la-reglementation-liee-aux-salaires-et-a-la-duree-du-travail/

Chaplin, Stephen P., Jane Mills, and Hannah Chiswell. 2021. "Developing Payment-by-Results Approaches for Agri-Environment Schemes: Experience from an Arable Trial in England." *Land Use Policy* 109: 105698. doi:10.1016/j.landusepol.2021.105698.

Chen, Xiaodong, Frank Lupi, Guangming He, and Jianguo Liu. 2009. "Linking Social Norms to Efficient Conservation Investment in Payments for Ecosystem Services." *Proceedings of the National Academy of Sciences of the United States of America* 106 (28): 11812–11817. doi:10.1073/pnas.0809980106.

Christensen, Tove, Anders Branth Pedersen, Helle Oersted Nielsen, Morten Raun Mørkbak, Berit Hasler, and Sigrid Denver. 2011. "Determinants of Farmers' Willingness to Participate in Subsidy Schemes for Pesticide-Free Buffer Zones: A Choice Experiment Study." *Ecological Economics* 70 (8): 1558–1564. doi:10.1016/j.ecolecon.2011.03.021.

Cullen, Paula, Pierre Dupraz, James Moran, Pat Murphy, Ronan O'Flaherty, Cathal O'Donoghue, Robert O'Shea, and Mary Ryan. 2018. "Agri-Environment Scheme Design: Past Lessons and Future Suggestions." *EuroChoices* 17 (3): 26–30. doi:10.1111/1746-692X.12187.

Defrancesco, Edi., Paola Gatto, Ford Runge, and Samuele Trestini. 2008. "Factors Affecting Farmers' Participation in Agri-Environmental Measures: A Northern Italian Perspective." *Journal of Agricultural Economics* 59 (1): 114–131. doi:10.1111/j.1477-9552.2007.00134.x.

Delahaye, Daniel, Mathilde Guillemois, and Thibaut Preux. 2023. *Les Trajectoires D'Evolution Des Réseaux de Haies: Du Diagnostic Territorial Aux Outils de Simulation [the Evolution Trajectories of Hedge Networks: From Territorial Diagnosis to Simulation Tools].* Flers, France: RESP'HAIES Project. https://afac-agroforesteries.fr/rapport-5/

Depres, Christophe, Gilles Grolleau, and Naoufel Mzoughi. 2008. "Contracting for Environmental Property Rights: The Case of Vittel." *Economica* 75 (299): 412–434. doi:10.1111/j.1468-0335.2007.00620.x.

Direction régionale de l'Alimentation, de l'Agriculture et de la Forêt de Bretagne (DRAAF Bretagne). 2022. Fiche Territoriale Synthétique Recensement Agricole 2020 « Bretagne » [Summary Regional Sheet of the 2020 Agricultural Census 'Brittany']. Rennes, France: DRAAF Bretagne. https://draaf.bretagne.agriculture.gouv.fr/IMG/html/fts_ra2020_bretagne.html#annexes.

Direction régionale de l'Alimentation, de l'Agriculture et de la Forêt de Normandie (DRAAF Normandie). 2022. Fiche Territoriale Synthétique Recensement Agricole 2020 « Normandie » [Summary Regional Sheet of the 2020 Agricultural Census 'Normandy']. Caen, France: DRAAF Normandie. https://draaf.normandie.agriculture.gouv.fr/fiche-territoriale-regionale-recensement-agricole-2020-a2813.html

Direction régionale de l'Alimentation, de l'Agriculture et de la Forêt des Pays de la Loire (DRAAF Pays de la Loire). 2022. Fiche Territoriale Synthétique Recensement Agricole 2020 « Pays de la Loire» [Summary Regional Sheet of the 2020 Agricultural Census 'Pays de la Loire']. Nantes, France: DRAAF Pays de la Loire. https://draaf.pays-de-la-loire.agriculture.gouv.fr/IMG/html/fts_ra2020_pays_de_la_loire_cle0eaedf-1.html#main-d%C5%93uvre-et-devenir-des-exploitations

Domínguez-Torreiro, Marcos, and Mario Soliño. 2011. "Provided and Perceived Status Quo in Choice Experiments: Implications for Valuing the Outputs of Multifunctional Rural Areas." *Ecological Economics* 70 (12): 2523–2531. doi:10.1016/j.ecolecon.2011.08.021.

Dupraz, Pierre, and Michel Pech. 2007. "Effets Des Mesures Agri-Environnementales." *INRA Sciences Sociales* 2: 1–4.

Dupraz, Pierre, Karine Latouche, and Nadine Turpin. 2009. "Threshold Effect and Co-Ordination of Agri-Environmental Efforts." *Journal of Environmental Planning and Management* 52 (5): 613–630. doi:10.1080/09640560902958164.

Duval, Lise, Thomas Binet, Pierre Dupraz, Solenn Leplay, Claire Etrillard, Michel Pech, Elise Deniel, and Marie Laustriat. 2016. *Paiements pour services environnementaux et méthodes d'évaluation économique* [Payments for Environmental Services and Economic Evaluation Methods: Lessons for Agri-Environmental Measures in the Common Agricultural Policy]. Auzeville Tolosane, France: Oréade-Brèche. https://agriculture.gouv.fr/paiements-pour-services-environnementaux-et-methodes-devaluation-economique

Eichhorn, Theresa, Jochen Kantelhardt, Lena Schaller, Fabio Bartollini, Inga Berzina, Tracy Bradfield, and Micaela Cosgrove. 2022. *Deliverable 2.6: Catalogue of Updated Factsheets of European in-Depth Case Studies*. Brussels, Belgium: CONSOLE Project. https://console-project.eu/

Espinosa-Goded, Maria, Jesus Barreiro-Hurlé, and Pierre Dupraz. 2013. "Identifying Additional Barriers in the Adoption of Agri-Environmental Schemes: The Role of Fixed Costs." *Land Use Policy* 31: 526–535. doi:10.1016/j.landusepol.2012.08.016.

European Court of Auditors (ECA). 2011. "*Is Agri-Environment Support Well Designed and Managed?*." *Special Report No 7*. Luxembourg, Luxembourg: Publications Office of the European Union. doi:10.2865/41418.

European Union (EU). 2000. "Directive 2000/60/EC Establishing a Framework for Community Action in the Field of Water Policy." *Official Journal of the European Communities* 327: 1–73.

Franks, Jeremy R. 2011. "The Collective Provision of Environmental Goods: A Discussion of Contractual Issues." *Journal of Environmental Planning and Management* 54 (5): 637–660. doi:10.1080/09640568.2010.526380.

Greene, William H., and David A. Hensher. 2003. "A Latent Class Model for Discrete Choice Analysis: Contrasts with Mixed Logit." *Transportation Research Part B: Methodological* 37 (8): 681–698. doi:10.1016/S0191-2615(02)00046-2.

Grolleau, Gilles, and Laura M. J. McCann. 2012. "Designing Watershed Programs to Pay Farmers for Water Quality Services: Case Studies of Munich and New York City." *Ecological Economics* 76: 87–94. doi:10.1016/j.ecolecon.2012.02.006.

Hausman, Jerry, and Daniel McFadden. 1984. "Specification Tests for the Multinomial Logit Model." *Econometrica* 52 (5): 1219–1240. doi:10.2307/1910997.

Heinz, Ingo. 2008. "Co-Operative Agreements and the EU Water Framework Directive in Conjunction with the Common Agricultural Policy." *Hydrology and Earth System Sciences* 12 (3): 715–726. doi:10.5194/hess-12-715-2008.

Herzon, I., T. Birge, B. Allen, A. Povellato, F. Vanni, K. Hart, G. Radley, et al. 2018. "Time to Look for Evidence: Results-Based Approach to Biodiversity Conservation on Farmland in Europe." *Land Use Policy* 71: 347–354. doi:10.1016/j.landusepol.2017.12.011.

Hess, Stephane, and David Palma. 2022. *Apollo: A Flexible, Powerful and Customisable Freeware Package for Choice Model Estimation and Application. Version 0.2.7: User Manual*. Leeds: University of Leeds.

Kerr, John M., Mamta Vardhan, and Rohit Jindal. 2014. "Incentives, Conditionality and Collective Action in Payment for Environmental Services." *International Journal of the Commons* 8 (2): 595–616. doi:10.18352/ijc.438.

Klimek, Sebastian, Anne Richter Gen. Kemmermann, Horst-Henning Steinmann, Jan Freese, and Johannes Isselstein. 2008. "Rewarding Farmers for Delivering Vascular Plant Diversity in Managed Grasslands: A Transdisciplinary Case-Study Approach." *Biological Conservation* 141 (11): 2888–2897. doi:10.1016/j.biocon.2008.08.025.

Krämer, Jan Eike, and Frank Wätzold. 2018. "The Agglomeration Bonus in Practice: An Exploratory Assessment of the Swiss Network Bonus." *Journal for Nature Conservation* 43: 126–135. doi:10.1016/j.jnc.2018.03.002.

Kuhfuss, Laure, Graham Begg, Sharon Flanigan, Cathy Hawes, and Simone Piras. 2019. "Should Agri-Environmental Schemes Aim at Coordinating Farmers' Pro-Environmental Practices? A Review of the Literature." Paper Presented at the 172nd EAAE Seminar 'Agricultural Policy for the Environment or Environmental Policy for Agriculture?', Brussels, Belgium, May 28-29. doi:10.22004/ag.econ.289774.

Kuhfuss, Laure, Raphaële Préget, Sophie Thoyer, and Nick Hanley. 2016. "Nudging Farmers to Enrol Land into Agri-Environmental Schemes: The Role of a Collective Bonus." *European Review of Agricultural Economics* 43 (4): 609–636. doi:10.1093/erae/jbv031.

Lancaster, Kelvin J. 1966. "A New Approach to Consumer Theory." *Journal of Political Economy* 74 (2): 132–157. doi:10.1086/259131.

Latacz-Lohmann, Uwe, and Gunnar Breustedt. 2019. "Using Choice Experiments to Improve the Design of Agri-Environmental Schemes." *European Review of Agricultural Economics* 46 (3): 495–528. doi:10.1093/erae/jbz020.

Le Coent, Philippe, Raphaële Préget, and Sophie Thoyer. 2017. "Compensating Environmental Losses versus Creating Environmental Gains: Implications for Biodiversity Offsets." *Ecological Economics* 142: 120–129. doi:10.1016/j.ecolecon.2017.06.008.

Le Gloux, Fanny. 2022. "CONSOLE_WP3_Task_3.2_Pan-EU Survey of Farmers and Other Rural" (dataset). *Recherche Data Gouv*. Accessed January 2024. doi:10.57745/RBIG0I.

Lefebvre, Marianne, Maria Espinosa, Sergio Gomez y Paloma, Maria Luisa Paracchini, Annette Piorr, and Ingo Zasada. 2015. "Agricultural Landscapes as Multi-Scale Public Good and the Role of the Common Agricultural Policy." *Journal of Environmental Planning and Management* 58 (12): 2088–2112. doi:10.1080/09640568.2014.891975.

Louviere, Jordan J., David A. Hensher, and Joffre D. Swait. 2000. *Stated Choice Methods: Analysis and Applications*. Cambridge: Cambridge University Press.

Mariel, Petr, David Hoyos, Jürgen Meyerhoff, Mikolaj Czajkowski, Thijs Dekker, Klaus Glenk, J. Bredahl Jacobsen, et al. 2021. *Environmental Valuation with Discrete Choice Experiments: Guidance on Design, Implementation and Data Analysis*. Cham: Springer Nature Switzerland AG. doi:10.1007/978-3-030-62669-3.

Massfeller, Anna, Manuela Meraner, Silke Hüttel, and Reinhard Uehleke. 2022. “Farmers’ Acceptance of Results-Based Agri-Environmental Schemes: A German Perspective.” *Land Use Policy* 120: 106281. doi:10.1016/j.landusepol.2022.106281.
Matzdorf, Bettina, and Jana Lorenz. 2010. “How Cost-Effective Are Result-Oriented Agri-Environmental Measures? An Empirical Analysis in Germany.” *Land Use Policy* 27 (2): 535–544. doi:10.1016/j.landusepol.2009.07.011.
McFadden, Daniel. 1974. “The Measurement of Urban Travel Demand.” *Journal of Public Economics* 3 (4): 303–328. doi:10.1016/0047-2727(74)90003-6.
Merot, Philippe. 1999. “The Influence of Hedgerow Systems on the Hydrology of Agricultural Catchments in a Temperate Climate.” *Agronomie* 19 (8): 655–669. doi:10.1051/agro:19990801.
Ministère de l’Agriculture et de la Souveraineté alimentaire (MASA). 2022. *Plan Stratégique National de la PAC 2023-2027: Annexes et appendices* [National Strategic Plan for the CAP 2023-2027 - Appendices]. Paris, France: MASA. https://agriculture.gouv.fr/pac-2023-2027-le-plan-strategique-national
Ministère de la Transition écologique (MTE). 2022. “Arrêté du 26 Avril 2022 Modifiant L’Arrêté du 25 Janvier 2010 Établissant le Programme de Surveillance de L’Etat Des Eaux en Application de L’Article R. 212-22 du Code de L’Environnement.” *Journal Officiel de La République Française* 0109: 44–136. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000045780020.
Ministère de la Transition écologique (MTE). 2023. “Arrêté du 30 Janvier 2023 Modifiant L’Arrêté du 19 Décembre 2011 Relatif au Programme D’Actions National à Mettre en Oeuvre Dans Les Zones Vulnérables Afin de Réduire la Pollution Des Eaux Par Les Nitrates D’Origine Agricole.” *Journal Officiel de La République Française* 0034: 157–193. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000047106562.
Niskanen, Olli, Annika Tienhaara, Emmi Haltia, and Eija Pouta. 2021. “Farmers’ Heterogeneous Preferences towards Results-Based Environmental Policies.” *Land Use Policy* 102: 105227. doi:10.1016/j.landusepol.2020.105227.
Observatoire de l’Environnement en Bretagne (OEB). 2020. “Synthèse de l’Etat des Masses d’Eau Cours d’Eau en Bretagne depuis 2006.” OEB. Accessed January 4 2023. https://bretagne-environnement.fr/etat-masses-eau-bretagne-datavisualisation.
Organisation for Economic Co-operation and Development (OECD). 2013. “Relationship between Collective Action and Agri-Environmental Public Goods.” In *Providing Agri-Environmental Public Goods through Collective Action*. Paris, France: OECD Publishing. doi:10.1787/9789264197213-en.
Ostrom, Elinor. 2002. “Common-Pool Resources and Institutions: Toward a Revised Theory.” In *Vol. 2 of Handbook of Agricultural Economics*, edited by Bruce L. Gardner and Gordon C. Rausser, 1315–1339. Amsterdam: Elsevier. doi:10.1016/S1574-0072(02)10006-5.
Pe’er, G., L. V. Dicks, P. Visconti, R. Arlettaz, A. Báldi, T. G. Benton, S. Collins, et al. 2014. “EU Agricultural Reform Fails on Biodiversity.” *Science (New York, N.Y.)* 344 (6188): 1090–1092. doi:10.1126/science.1253425.
Pe’er, Guy., Aletta Bonn, Helge Bruelheide, Petra Dieker, Nico Eisenhauer, Peter H. Feindt, Gregor Hagedorn, et al. 2020. “Action Needed for the EU Common Agricultural Policy to Address Sustainability Challenges.” *People and Nature (Hoboken, N.J.)* 2 (2): 305–316. doi:10.1002/pan3.10080.
Pe’er, Guy., John A. Finn, Mario Díaz, Maren Birkenstock, Sebastian Lakner, Norbert Röder, Yanka Kazakova, et al. 2022. “How Can the European Common Agricultural Policy Help Halt Biodiversity Loss? Recommendations by over 300 Experts.” *Conservation Letters* 15 (6): 1–12. doi:10.1111/conl.12901.
Perrot-Maitre, Danièle. 2006. *The Vittel Payments for Ecosystem Services: A “Perfect” PES Case?* London, UK: International Institute for Environment and Development. https://www.iied.org/g00388.
Poirier, Julie, and Aurore Fleuret. 2015. “Combien Les Résidents Sont-Ils Disposés à Payer Pour Des Améliorations de la Qualité de L’Eau? Une Application Simultanée de la Méthode D’Expériences Des Choix à Quatre Sites Récréatifs D’un Bassin Hydrographique.” *Économie and Prévision* 206 (1): 157–182. doi:10.3917/ecop.206.0157.
Pretty, Jules. 2003. “Social Capital and the Collective Management of Resources.” *Science (New York, N.Y.)* 302 (5652): 1912–1914. doi:10.1126/science.1090847.

Ropars-Collet, Carole. 2022. “Evaluation Economique de L’Offre et de la Demande de Services Environnementaux Sur le Lac au Duc.” Paper Presented at the 16èmes Journées de Recherches En Sciences Sociales INRAE-SFER-CIRAD, Clermont-Ferrand, France, December 15–16.

Russi, Daniela, Hélène Margue, Rainer Oppermann, and Clunie Keenleyside. 2016. “Result-Based Agri-Environment Measures: Market-Based Instruments, Incentives or Rewards? The Case of Baden-Württemberg.” *Land Use Policy* 54: 69–77. doi:10.1016/j.landusepol.2016.01.012.

Ruto, Eric, and Guy Garrod. 2009. “Investigating Farmers’ Preferences for the Design of Agri-Environment Schemes: A Choice Experiment Approach.” *Journal of Environmental Planning and Management* 52 (5): 631–647. doi:10.1080/09640560902958172.

Salazar-Ordóñez, Melania, Macario Rodríguez-Entrena, and Anastasio J. Villanueva. 2021. “Exploring the Commodification of Biodiversity Using Olive Oil Producers’ Willingness to Accept.” *Land Use Policy* 107: 104348. doi:10.1016/j.landusepol.2019.104348.

Souchère, Véronique, Christine King, Nicolas Dubreuil, Véronique Lecomte-Morel, Yves Le Bissonnais, and Martine Chalat. 2003. “Grassland and Crop Trends: Role of the European Union Common Agricultural Policy and Consequences for Runoff and Soil Erosion.” *Environmental Science and Policy* 6 (1): 7–16. doi:10.1016/S1462-9011(02)00121-1.

Tanaka, Katsuya, Nicholas Hanley, and Laure Kuhfuss. 2022. “Farmers’ Preferences toward an Outcome-Based Payment for Ecosystem Service Scheme in Japan.” *Journal of Agricultural Economics* 73 (3): 720–738. doi:10.1111/1477-9552.12478.

Thareau, Bertille, Abdoul Nasser Seyni, Thomas Coisnon, and Pierre Dupraz. 2023. “Designing Carbon Markets Connecting Farmers and Companies: Stakeholders Claiming Territorial - Based Devices to Promote Synergies between Diverse Environmental Challenges.” *Review of Agricultural, Food and Environmental Studies* 104 (2): 167–191. doi:10.1007/s41130-023-00194-6.

Uetake, Tetsuya. 2014. “Agri-Environmental Management through Collective Action.” *EuroChoices* 13 (3): 29–34. doi:10.1111/1746-692X.12072.

Uthes, Sandra, and Bettina Matzdorf. 2013. “Studies on Agri-Environmental Measures: A Survey of the Literature.” *Environmental Management* 51 (1): 251–266. doi:10.1007/s00267-012-9959-6.

Vaissière, Anne Charlotte, Léa Tardieu, Fabien Quétier, and Sébastien Roussel. 2018. “Preferences for Biodiversity Offset Contracts on Arable Land: A Choice Experiment Study with Farmers.” *European Review of Agricultural Economics* 45 (4): 553–582. doi:10.1093/erae/jby006.

Villamayor-Tomas, Sergio, Julian Sagebiel, and Roland Olschewski. 2019. “Bringing the Neighbors in: A Choice Experiment on the Influence of Coordination and Social Norms on Farmers’ Willingness to Accept Agro-Environmental Schemes across Europe.” *Land Use Policy* 84: 200–215. doi:10.1016/j.landusepol.2019.03.006.

Villanueva, A. J., M. Rodríguez-Entrena, M. Arriaza, and J. A. Gómez-Limón. 2017. “Heterogeneity of Farmers’ Preferences towards Agri-Environmental Schemes across Different Agricultural Subsystems.” *Journal of Environmental Planning and Management* 60 (4): 684–707. doi:10.1080/09640568.2016.1168289.

Villanueva, Anastasio J., José A. Gómez-Limón, Manuel Arriaza, and Macario Rodríguez-Entrena. 2015. “The Design of Agri-Environmental Schemes: Farmers’ Preferences in Southern Spain.” *Land Use Policy* 46: 142–154. doi:10.1016/j.landusepol.2015.02.009.

Villanueva, Anastasio J., Klaus Glenk, and Macario Rodríguez-Entrena. 2017. “Protest Responses and Willingness to Accept: Ecosystem Services Providers’ Preferences towards Incentive-Based Schemes.” *Journal of Agricultural Economics* 68 (3): 801–821. doi:10.1111/1477-9552.12211.

Wunder, Sven. 2015. “Revisiting the Concept of Payments for Environmental Services.” *Ecological Economics* 117: 234–243. doi:10.1016/j.ecolecon.2014.08.016.

Zabel, Astrid, and Brian Roe. 2009. “Optimal Design of Pro-Conservation Incentives.” *Ecological Economics* 69 (1): 126–134. doi:10.1016/j.ecolecon.2009.08.001.

Zavalloni, Matteo, Meri Raggi, and Davide Viaggi. 2019. “Agri-Environmental Policies and Public Goods: An Assessment of Coalition Incentives and Minimum Participation Rules.” *Environmental and Resource Economics* 72 (4): 1023–1040. doi:10.1007/s10640-018-0237-9.

Appendix

Table A1. Conditional logit estimations.

Specification	CL1	CL2	CL3
Attributes			
PAYMENT	0.004*** (0.000)	0.004*** (0.000)	0.004*** (0.000)
COVER	−0.024 (0.023)	0.020+ (0.012)	
COVER – 90%			0.064 (0.064)
COVER – 95%			0.072 (0.070)
HEDGEROWS	−0.004 (0.003)	−0.004+ (0.002)	
HEDGEROWS – 60 m/ha			0.127+ (0.065)
HEDGEROWS – 100 m/ha			−0.230* (0.104)
$BONUS_{sponsorship}$	0.402** (0.124)	0.381*** (0.113)	0.393*** (0.117)
$BONUS_{sponsorship/collective\ result}$	0.266+ (0.134)	0.248* (0.123)	0.265* (0.124)
Alternative-specific constant			
ASC_{sq}	0.941*** (0.254)	2.286* (1.139)	0.720*** (0.189)
Goodness-of-fit			
Log Likelihood	−990.63	−1078.90	−1076.53
Adjusted-R^2	0.16	0.15	0.15
AIC	1993.27	2169.79	2169.06
BIC	2023.15	2200.15	2209.55
Observations	1075	1165	1165
Number of farms	120	130	130

Note. Significance levels: ***robust p value <0.001, **robust p value <0.01, *robust p value < 0.05, +robust p value < 0.1. Robust standard errors in parentheses. ASCsq: alternative-specific constant associated with the status quo alternative. AIC: Akaike information criterion. BIC: Bayesian information criterion.
Source: own elaboration.

Table A2. Selection of Latent class model.

Number of classes	2	3	4	5
Log Likelihood	−842.25	−746.27	−692.42	−709.94
AIC	1710.51	1532.53	1503.18	1487.87
BIC	1775.25	1632.14	1637.64	1657.19
Pseudo-R^2	0.2758	0.3512	0.3636	0.3701
Average probability to belong to the attributed class	0.9753	0.9634	0.9560	0.9516

Note. AIC: Akaike information criterion. BIC: Bayesian information criterion.
Source: own elaboration.