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A window into land managers' preferences for new forms of agri-environmental schemes: Evidence from a post-Brexit analysis

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ABSTRACT

Securing the provision of environmental public goods from agriculture is central to addressing the critical challenge of ensuring global food security while halting ecosystem degradation. Agri-environment schemes (AES) are considered to have a key role to play in supporting the transition to more sustainable ways of producing food. Existing evidence suggests that farmers are generally willing to enrol in AES for the delivery of environmental features, but robust policy support requires further exploration of land managers' preferences and how these interplay with contract features to achieve higher environmental targets. We undertook a discrete choice experiment with land managers in post-Brexit UK, with what can be considered a 'benchmark' sample of younger AES-inclined land managers. This provides a window into the future of the UK farming landscape, but also, given the revision of the European Union's Common Agricultural Policy and other international discussions, it also provides insights into land managers' preferences for new contract features more widely. Our results suggest that (such type of) land managers are likely to be receptive to a transition to result-based, collaborative schemes supporting landscape-wide interventions in alignment with net zero agendas. These interventions could be done in exchange for levels of compensation similar to current levels. While this raises promise, our results also emphasize challenges, particularly to attract those less generally AES-prone land managers. Payments levels probably need to remain close to the current ones (not lower), farmers' awareness and support for net-zero agendas need to be reinforced and more interaction between land managers and policy makers will be needed.

1. Introduction

The provision of public goods from agriculture has been of key interest since, at least, the late 1960s (Raffaelli and White, 2013), initially being framed as agricultural multi-functionality (Maier and Shobayashi, 2001; Huang et al., 2015) and more recently as preservation or enhancement of ecosystem services (Schaller et al., 2018). Environmental public goods provision has been a central piece of the development and 'greening' of agricultural policies, such as the European Union's (EU) Common Agricultural Policy (CAP) (Baldock et al., 2010; Viaggi et al., 2021), but also in Australia (e.g., Ansell et al., 2016) and the United States (e.g., Stubbs, August, 2014). More generally, it is seen as a critical way of addressing the fundamental challenge of how to ensure global food security while halting ecosystem degradation, mitigating climate change (Eurostat, 2017) and promoting rural development (European Network for Rural Development, 2015).

The debate on the efficiency and effectiveness of different policies for delivering public goods from agriculture is entrenched with multiple complex issues (Baldock et al., 2010). Discussions range from the roles and responsibilities of land managers, including how farmers can be perceived as environmental stewards rather than strictly food producers (Brodt et al., 2006), to discussions about the most effective and fair mechanisms to financially support such provision of public goods (Cooper et al., 2009) or the role that land managers' awareness plays in the adoption of environmentally friendly farming practices (Okumah et al., 2018, 2021a, 2021b). High expectations have been placed on economic incentives to support effective policy action on environmental public goods from agriculture (Viaggi et al., 2021). Agri-Environment Schemes (AES) have been one of the key tools employed, compensating land managers for providing increased environmental protection

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while ensuring rural economic growth. (Wynne-Jones, 2013). This has been particularly notable in the EU, where around 22.5 % of the total agricultural land was under some type of AES between 2014 and 2022 (although this percentage varies considerably between countries (Hasler et al., 2022)). The inadequacy of such financial incentives has been claimed to be, in part, responsible for insufficient progress on the transition to more sustainable ways of producing food and conserving natural resources (Pe'er et al., 2020). At the heart of some of the reasons given for the insufficient success of AES are the factors that make farmers more or less inclined to adopt the schemes and accept compensation or other forms of payment for conservation or delivery of environmental features (Uthes and Matzdorf, 2013).

There are a number of empirical studies that address these factors by surveying land managers' preferences for enrolling in AES based on the neoclassical economics notion of willingness to accept (WTA) monetary compensation for participation (e.g., Espinosa-Goded et al., 2010; Villanueva et al., 2015; Hasler et al., 2019; Salazar-Ordóñez et al., 2021, Tanaka et al., 2022). Tyllianakis and Martin-Ortega (2021) systematically reviewed such evidence for Europe and found a complex and nuanced picture: farmers appear generally willing to enrol in AES for the delivery of environmental features (e.g. buffer strips, wildflower margins and fallow areas in arable fields) but the current evidence base provides few clues on how best to match that willingness with contract design formats and features that appeal to land managers. A significant leap forward for more robust policy support requires more primary studies and a deeper reflection on how the complexity of farmers' preferences is best captured in the design of policy instruments.

This paper tries to provide further evidence to feed into such reflection by placing the focus on a set of contract features that were identified by Tyllianakis and Martin-Ortega (2021) as important for the delivery of environmental public goods from agriculture. These include: collaboration across neighbouring farmers for landscape-wide delivery of public goods (e.g., McKenzie et al., 2013); payments for environmental outcomes (e.g., Tienhaara et al., 2021; Tanaka et al., 2022); and availability of advice for farmers (e.g., Ducos et al., 2009). We apply a discrete choice experiment (DCE) of land managers' WTA compensation for the delivery of ecosystem services (in our example conceptualised in the form of soil carbon storage), under varying formats of such contract features. This allows us to understand farmers' preferences for those features and to determine the effect that they have on the payment levels that farmers would prefer in order to participate in the schemes (i.e. whether these contract features lower or increase the requested payment levels). We also measure the economic impact that such schemes, if adopted, would have in terms of land managers' welfare.

We use the UK as a case study. Following Brexit, the UK had postulated ambitious changes in its agri-environmental policy, putting public goods delivery at the forefront of public spending (Bateman and Balmford, 2018; Reed et al., 2020). At the time when we designed and implemented this research, the post-Brexit reconfiguration of UK AES was at the heart of the policy and farming community debates, with new proposed schemes being under public consultation (Defra, 2020a). This provided a context of credibility to land managers who were expecting change to the types of AES contracts that will be offered to them in the future and an additional motivation for them to meaningfully engage in our experiment. Still, while the DCE was designed to fit into the policy discussions in the UK, the chosen attributes and their levels are of relevance more widely across Europe as well as Australia and the US, making our findings of broader international relevance.

2. Methodology

We use a well-known environmental economics method, DCE, which is a survey-based stated preference technique that allows determination of the influence of different attributes of a policy or good on individuals' choices (Ruto and Garrod, 2009). By inserting a component of cost or compensation as an attribute into the choice experiment, trade-offs between attributes can be presented in monetary terms, conceptualised in the form of WTA (Villanueva et al., 2015). In this context, WTA is estimated as the marginal rate of substitution between compensation received for costs incurred and income foregone and the characteristics of the AES contract. DCEs have been used over the past ten years or so in the field of AES, with studies focusing on farmers enrolling in voluntary conservation schemes (Ruto and Garrod, 2009; Espinosa-Goded et al., 2010), joining 'greening' schemes under Pillar I (Schulz et al., 2014) and protecting biodiversity (Czajkowski et al., 2019).

In our study, WTA for entering an AES for the delivery of soil carbon storage (estimated in £ per hectare enrolled in the scheme) is examined under varying contract features, including collaboration across neighbouring farm for landscape-wide success of AES, payments by actions or outcomes, and availability of advice. WTA compensation is modelled using a latent class approach (Schaak and Musshoff, 2020) that allows to group respondents in classes with similar preferences, based on individual-specific covariates such as socio-demographic, risk perceptions and behavioural characteristics gathered in the questionnaire.

2.1. Case study

AES have long formed part of the agricultural policy landscape in the UK. While the UK was in the EU, AES fell within Pillar II, with matching funding being required by Member States (Jack, 2009). Since Brexit, schemes with agri-environmental objectives have continued[1] and, at the time of developing this research, it was strongly expected that the new financial assistance regime introduced by the Agriculture Act 2020 (UK Parliament, 2020), would see AES significantly elevated in terms of importance. In England, so-called Environmental Land Management schemes (ELMs) were being conceived as the main vehicle for the delivery of support to farmers, as the earlier direct payment regime (implemented pre-Brexit under both Pillar I and Pillar II) was to be phased out over a seven-year Transition Period by 2028 (Defra, 2020b). Similarly, it was deemed that there was a strong likelihood that AES would feature prominently in the post-Brexit agricultural policy of the devolved administrations in Northern Ireland, Scotland and Wales. For example, it was envisaged that a Sustainable Farming Scheme would be carried into effect in Wales (Welsh Government, 2020).

Initially (and at the time of implementing this research) there was heavy emphasis for the future from the Department of Environment, Food and Rural Affairs (Defra) on 'narrow and deep' AES, under which farmers would be paid for outcomes (Defra, 2018). While further iterations of policy have seen also inclusion within ELMs of the 'broad and shallow' Sustainable Farming Incentive, under which farmers will be paid for actions (Defra, 2021a, 2021b, 2021c, 2021d), and the discontinuation of Local Nature Recovery (Defra, 2022a), the advent of new forms of financial assistance represent a unique opportunity to evaluate options to be made available to land managers and as a result of this to prioritise funding towards interventions that are more likely to deliver public goods.

2.2. Survey design

The questionnaire was developed from late 2019 to early 2020. Attributes and wording were established in consultation with land managers and farmer group representatives to ensure that information was relevant and communicated in an appropriate manner. The initial survey design was informed by a workshop with land managers, stakeholders and farm advisors. Policy makers involved in the design and monitoring of the ELMs schemes (i.e. representatives from the

[1] Total expenditure in England alone amounting to £205 million in 2020 (Defra et al., 2021), although this must be compared with £1823 million expenditure under the Basic Payment Scheme (including Greening)

government agency Defra), were also consulted during the survey development. It should be noted that the aim of this study was not to establish land managers' preferences specifically for the ELMs (which only apply to England), but it was deemed appropriate to align the study of key aspects of the at the time on going policy discussions which revolved importantly around ELMs, hence the value of having the feedback of the government department in charge of developing them. The survey was piloted with 20 farmers and farm facilitators.

The final questionnaire was administered online and consisted of five sections. The first section included information on the topic of the survey and the nature of AES in the UK and the future of such payments in a post-Brexit environment. The second section was aimed at establishing the farming profile of respondents, such as farm type (livestock, arable or mixed), farm size (land size, number of employees) and type and level of activity (land ownership, full-time or part-time activity), as farm characteristics have been proven to be main drivers of adoption of AES (Unay Gailhard et al., 2015). This section also inquired about respondents' past experiences with AES and their types (i.e. involvement with lower-level AES such as the Entry-level Stewardship Scheme or more demanding, higher-level AES such as the High-Level Organic Scheme, Defra, 2020a), as well as the percentage of income AES contributed to respondent's total household income. Previous experience with AES has been documented to increase participation rates in future similar schemes (Herzon and Mikk, 2007; Defrancesco et al., 2008; Espinosa-Goded et al., 2010). In particular, prior experience with AES has been found to increase how quickly farmers enrol in other AES (Wynn et al., 2001), while early adoption of AES also increases enrolment in other AES (Unay Gailhard et al., 2015). Prior experience with pro-environmental farming practices has been found to increase the number of AES applied in the same land parcel (Defrancesco et al., 2008). In England, 20 % of the total agricultural area was under some type of AES in 2020 (Joint Nature Conservation Committee (JNCC), 2020).

The third section of the questionnaire contained the DCE (see detailed description in Section 2.3). This was followed by a series of questions on the risk perceptions of land managers for their future as land managers and with respect to climate change. Risk perceptions of land managers have received systematic attention as determinants of choices (Chaplin et al., 2019), with past studies focusing on risk preferences in terms of farm practices, changes or adoption of new technology and economic risk (Ghadim et al., 2005; Maybery et al., 2005; Flaten et al., 2005; Greiner et al., 2014; Pröbstl-Haider et al., 2016). More recently, risk perceptions linked to climate change and its impacts on farming have also been examined (e.g., Menapace et al., 2015). Some studies report a general disregard by farmers for the phenomenon and its impact (Cook and Ma, 2014) or farmers being confused about its impacts (Barnes et al., 2013). The level of concern about climate change has been reported to have a positive impact on adopting more environmentally-friendly land management practices (e.g., (Quiroga et al., 2015); Le Dang et al., 2014). The final section of the questionnaire included questions on key socio-demographic characteristics such as gender, age, education and total income.

2.3. Discrete choice experiment design

The design of the DCE was informed by the systematic analysis of AES case studies in Europe made by Tyllianakis and Martin-Ortega (2021), and, importantly, by ongoing post-Brexit AES discussions at the time (notably around Defra's layout for the ELMs (Defra, 2020b), which was publicly available for consultation at the time of survey design).

The DCE was framed to the farmers as an option between two schemes (Schemes A and B) or a "No-contract" option. Schemes A and B offered farmers a range of characteristics and requirements land managers needed to comply with in order to receive payment. Each option also included the payment that the land manager would receive for the land enrolled in the scheme. In these schemes, the contract was assumed to run for five years, after which land managers would be able to revisit the conditions of the contract. This five year duration is common in such contracts (e.g. Ruto and Garrod, 2009; Czajkowski, 2019) and in current UK AES such as the English Countryside Stewardship Scheme (Defra, 2020b). If neither scheme suited participants' preferences, they were informed they could choose the no-scheme option which would mean that they would not receive public funding for their farm activity. This is different to how much of the literature has addressed the opt-out option in the past, where studies have included a business-as-usual option with some level of existing subsidy (e.g. Espinosa-Goded et al., 2010; Schaak and Musshoff, 2020). That would have been relevant in an EU CAP framing (where Pillar I guarantees payment for cross-compliance (Daugbjerg and Swinbank, 2016)). In our case, we had to align with Defra's plan to phase out the Basic Payment Scheme (BPS), to make sure that the DCE matched the policy discourse at the time, ensuring its credibility and the policy relevance of the results. This was followed by a "cheap-talk" script informing participants that survey findings would be communicated with the Defra team responsible for designing the ELM scheme. A labelled approach was initially considered but ultimately not used due to concerns which emerged during the consultation phase of the study. At the time of design, Defra was making an explicit effort to move away from what could be considered 'hierarchical' labelling of their schemes which it associated with negative perceptions. Again, this design choice was made to ensure the matching of our study with the policy context and the policy relevance of our results.

Four attributes and a monetary one (compensation payment) were used (see Table 1 for attribute levels and Appendix I for full description and graphical representation used in the survey). The CONTRACT attribute differentiated between payments for carrying out actions that protect the environment and payment for achieving results, tapping into

Table 1
List of attributes, description and coding for the DCE (attributes in bold are used as the base levels in the DCE modelling).

Attributes	Levels[a]	Variables**
CONTRACT	1. **You carry out actions to protect the environment** 2. You carry out some actions to protect the environment AND you partly achieve results that protect the environment 3. You achieve results that protect the environment	CONTRACT1 CONTRACT2 CONTRACT3
CARBON	1. **The same actions as now. This may lead in net carbon loss in soil** 2. Additional actions to protect soils and achieve carbon balance 3. Further additional actions to increase carbon stored in soil	CARBON1 CARBON2 CARBON3
COLLABORATION	1. **No contractual obligation to collaborate with other nearby land mangers** 2. A contractual obligation to collaborate with other nearby land managers on projects pre-established by the regulator 3. Contractual obligation to collaborate with other nearby land managers on projects pre-established by land managers themselves	COLLAB1 COLLAB2 COLLAB3
ADVICE	1. **No free advice** 2. Free advice provided via demonstration farms 3. Free advice from an independent adviser	ADVICE1 ADVICE2 ADVICE3
COMPENSATION	£50, £100, £250, £350, £500, £700 per hectare of enrolled land per year	COMPENS

[a] Levels in bold broadly represent the current situation (at the time) of payments that farmers receive under the EU's BPS. But note that they were not explicitly linked to BPS in the questionnaire itself to avoid biases. ** All attributes, apart from the payment one, were dummy-coded, with the base levels being coded as 0, assisting with estimating non-linear effects.

the discussion on input and output conditionality (Russi et al., 2016) and payments by outcomes or results (Ruas et al., 2021). The first level (CONTRACT1) refers to land managers receiving payment after committing to actions that can protect the environment, without any monitoring of results. The second level (CONSTRACT2) offers a hybrid approach where land managers would receive payment for a hybrid scheme between committed and result-based actions. CONTRACT3 refers to a land manager receiving payment only after providing evidence of achieving pre-agreed results through monitoring which would take place (generally referred to as "result-based only" (O'Rourke and Finn, 2020)).

The attribute COLLABORATION refers to the obligation for farmers to cooperate in joint actions, similar to Prager (2015) and Westerink et al. (2017). Tyllianakis and Martin-Ortega (2021) suggested that, unless co-operation between several land managers is undertaken, landscape-wide biodiversity and other environmental improvements will not be feasible through AES (Prager, 2015; Franks, 2019). Previous studies (e.g., Villanueva et al., 2015), government initiatives in the UK (e.g., Yorkshire Dales National Park, 2021; Defra, 2020b) and our own consultations during the workshops at the survey development stage, indicate that cooperation between land managers is a contentious topic. Some workshop participants saw cooperation as a means of benefiting from like-minded neighbours that have similar land-use practices and approaches, while others saw this as increasing risk of not achieving the prescribed goals of an AES. These controversies and the scarce evidence on this specific topic noted in Tyllianakis and Martin-Ortega (2021), prompted us to include this attribute. The attribute included three levels: COLLAB1: no collaboration required; COLLAB2: a contractual obligation to collaborate with other nearby land managers on projects pre-established by the regulator and COLLAB3: a contractual obligation to collaborate with other nearby land managers on projects pre-established by land managers themselves; partly following Villanueva et al. (2015).

The environmental feature that the DCE offered payment for was soil carbon storage, captured in the attribute CARBON. Carbon sequestration by soil and permanent biomass as a means to achieve net zero carbon status has been advanced by the UK Government, both in country-level legal targets to achieve net-zero carbon emissions in all sectors by 2050 (e.g., UK Government, 2021a; b) and in the early description of the new ELMs (Defra, 2020b). Following the layout of the ELMs document at the time of designing the survey (Defra, 2020b), the actions land managers would be paid for would result in some increase in the amount of carbon stored in soils, such as (but not limited to) cover crops, conservation tillage and afforestation. The first level assumed the continuation of present activities using the "same actions as now", resulting in net losses of soil carbon (CARBON1). The second level assumed that some actions are taken to stop losses in soil carbon from occurring (CARBON2) "through additional actions" taken and the third level referred to land managers undertaking actions that resulted in increases in net carbon storage in their soil (CARBON3) through "further additional actions". Defined like this, the CARBON attribute remains relatively generic (i.e. it does not correspond to a close set of specific actions). This was done on purpose so that the survey could be of relevance at the national level for all types of farmers, and also places the focus on the outcomes of the actions (soil carbon loss, stop losses and increase storage), while it stills allows for sensitivity to scope in the actions to be undertaken (same actions, additional actions and *further* additional actions). At the time of the writing of this paper (i.e. some eight months after the survey design), the government guidance had been updated indicating that ELMs would aim to support the UK Government's Net-Zero targets, therefore no 'business as usual' options would be available (Defra, 2021a, 2021b, 2021c, 2021d) – we come back to this in the discussion.

The attribute ADVICE referred to free advice being provided in the scheme, and was comprised of three levels: ADVICE1: no free advice offered; ADVICE2: free advice from a demonstrator farmer and ADVICE3: free advice from an independent farm advisor. Such contract features have been investigated in previous studies (e.g. Villamayor-Tomas et al., 2019) and was one of the few that came up as consistently significantly affecting WTA in the review undertaken by Tyllianakis and Martin-Ortega (2021). These were confirmed to be of interest to UK land managers during the development stage of the survey. Specifically, land managers attending our workshops indicated strong preferences for these two types of advice, the first usually accompanied by farm visits and the later focusing on offering one-to-one support during the application and monitoring stages of a scheme.

The levels of the payment attribute (COMPENSATION) were established using the mean WTA estimate from Tyllianakis and Martin-Ortega (2021) of 327 Euros per hectare of land enrolled in the scheme per year as a mean payment value (£277 when translated to local currency and rounded to £250 for measurement purposes), with six different payments per hectare offered to farmers. The range of payments reflected both the minimum payments per hectare under the to-be phased out BPS and maximum Pillar II payments and Defra's Countryside Stewardship payments, to which UK land managers are accustomed (Defra, 2020b).

The pilot survey carried out during the survey development phase was used to support the DCE statistical design, starting with an initial Bayesian efficient statistical design (Ferrini and Scarpa, 2007) with fixed priors in Ngene (ChoiceMetrics, 2012, Version 1.1.1.) which provided a D-error of 0.1728. This was then improved through a soft-launch of the survey (when 10 % of the targeted sample was reached, data collection was paused and the experimental design was examined based on these first responses) and resulted in a final design with a D-error of 0.0846.

Respondents were presented with six different choice situations wherein for each the respondent would choose from two options for AES. An example of a choice situation is presented in Fig. 1.

Respondents that consistently chose the opt-out option in all of six choices were presented with a follow-up question inquiring on the reason in order to differentiate between protest answers and very high takers.[2]

2.4. Respondent recruitment and sampling

As data collection coincided with the Covid-19 pandemic, an online sample of UK farmers was procured via the survey company Qualtrics and participants were recruited from a panel of farmers across the whole of the UK. Qualtrics applies several quality control measures to ensure validity and consistency of responses through incentivising participation while offering compensation only if responses are considered to be of suitable quality. Data collection took place in the winter to ensure higher participation rates at a time when there is often less farm activity. After removing speeders (those taking less than one third of the median survey completion time), protestors and incomplete responses from 196 questionnaires, a final sample of 153 responses was retained for further analysis.

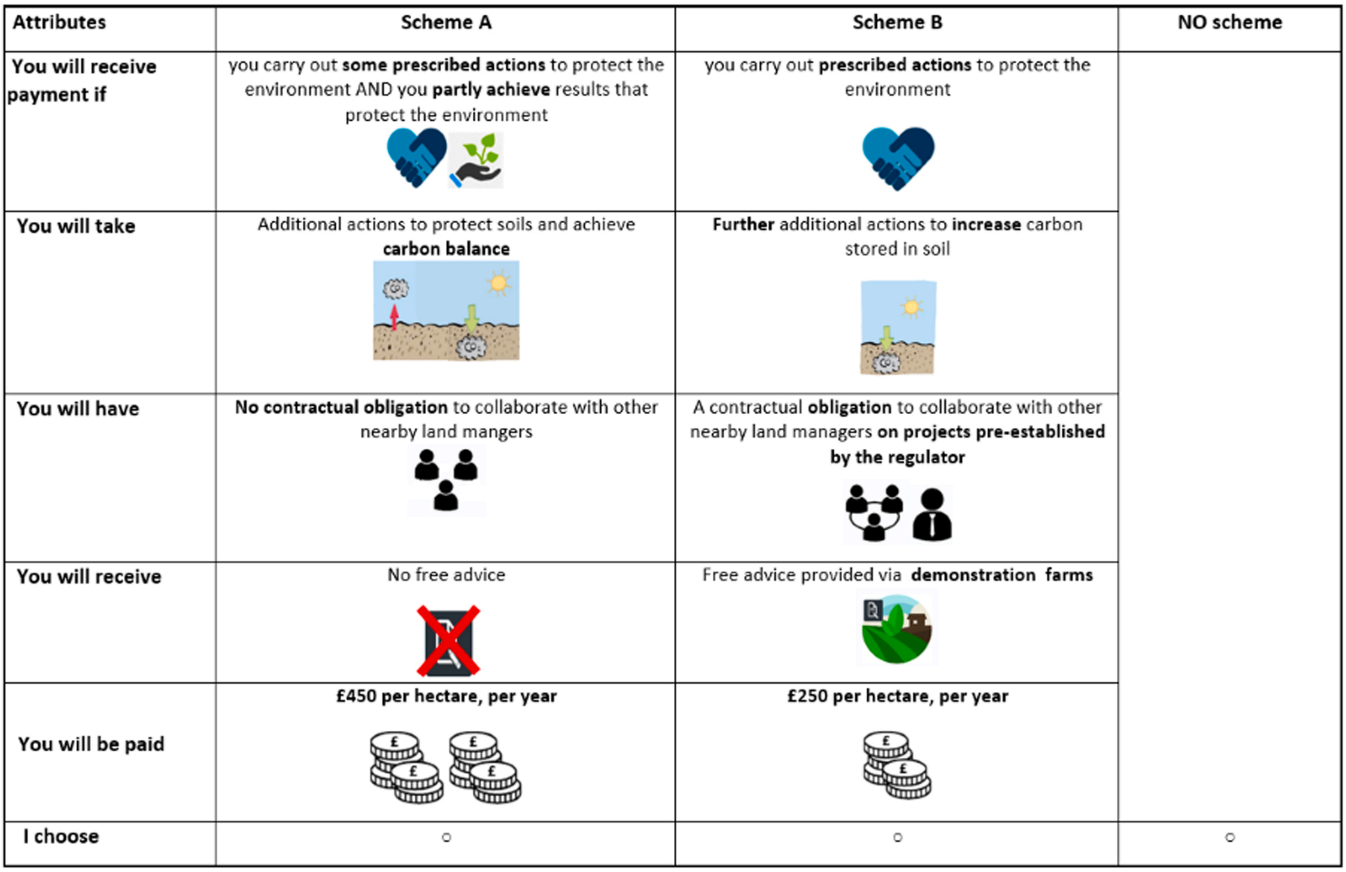
2.5. Modelling approach

The DCE method is based on the Random Utility Theory (RUT, Lancaster, 1966), which in this context assumes that land manager *i*'s stated behaviour is approximated as:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_n' X_{ij} + \varepsilon_{ij} \quad (1)$$

where U_{ij} is the unobserved utility land manager *i* enjoys when enrolling in an AES with alternative *j*. As U_{ij} is unobserved to the researcher, the

[2] Very high takers were identified as: "I did not find the options suitable for my land or current situation", "Enrolling in such schemes would be a bad financial decision for me ". Protest answers were identified as: "I am generally not willing to enrol in agri-environmental schemes", "There is no need for actions to protect the environment in my farm". A fifth option allowed for other reasons, to be recorded a-posteriori.



Attributes	Scheme A	Scheme B	NO scheme
You will receive payment if	you carry out **some prescribed actions** to protect the environment AND you **partly achieve** results that protect the environment	you carry out **prescribed actions** to protect the environment	
You will take	Additional actions to protect soils and achieve **carbon balance**	**Further** additional actions to **increase** carbon stored in soil	
You will have	**No contractual obligation** to collaborate with other nearby land mangers	A contractual **obligation** to collaborate with other nearby land managers **on projects pre-established by the regulator**	
You will receive	No free advice	Free advice provided via **demonstration farms**	
You will be paid	**£450 per hectare, per year**	**£250 per hectare, per year**	
I choose	○	○	○

Fig. 1. Example of choice card.

linear observable utility V_{ij} is estimated instead. V_{ij} is a factor of individual-specific coefficients β_n over a vector of individual-specific characteristics X_{ij}, such as past experience with AES and sociodemographic characteristics. ε_{ij} indicates the error term from unobserved influences on utility and is assumed to follow an *i.i.d.* with a Gumbel, Type I extreme value distribution.

To obtain the factors that affect such WTA compensation, we use a Mixed Logit model (MXL) specification, where the conditional probability of respondent *i* choosing alternative *j* on choice situation t, given knowledge over the parameter β_k is:

$$L_{kij}(\beta_n) = \frac{\exp(\beta'_n X_{ij})}{\sum_{j=1}^{J} \exp(\beta'_n X_{ij})} \tag{2}$$

Denoting y_{njt} as a binary variable taking the value 1 if respondent n chooses alternative j in choice situation t, if the researcher wants to segment respondents in C discrete classes with unique individual-specific coefficients $\beta = (\beta_1, \beta_2, \ldots, \beta_C)$, then the probability of observing their choices is a product of:

$$P_c(\beta_c) = \prod_{t=1}^{T} \prod_{j=1}^{J} \left\{ \frac{\exp(\beta'_n X_{ij})}{\sum_{j=1}^{J} \exp(\beta'_n X_{ij})} \right\}^{y_{njt}} \tag{3}$$

Such a model can be applied to account for unobserved preference heterogeneity, either through a mixed logit or a latent class logit model (LCL) specification with taste parameters segmented and identical within classes, but differing across classes (Hensher, Greene, 2003). Class membership can depend on covariates such as socio-demographic variables, risk perceptions and past experiences variables that have been found in past studies to affect preferences (Schaak and Musshoff, 2020; Grilli et al., 2021). Each class of farmers is assumed to have homogenous characteristics, with probability to belong in class c now being:

$$P_c = \frac{e^{\gamma'_c Z_l}}{\sum_{c=1}^{C} e^{\gamma'_c Z_l}} \tag{4}$$

with *Z* denoting covariates and γ indicating class-specific coefficients.

To estimate marginal WTA, the marginal rate of substitution for each level over the payment coefficient was computed as the ratio of the coefficients of AES characteristics over the payment coefficient derived from Eq.2 (Hanemann, 1984). The Compensating Surplus measure of welfare, measuring the monetary value changes in AES policies was estimated with the Logsum method (Train, 2009). The mixed logit model was estimated with the *mixlogit* command from Hole (2016) while the latent class model was estimated with the *lclogit2* command and post-estimation commands from Yoo (2020) in Stata 15.1.

3. Data

Table 2 presents the summary statistics of the characteristics of our survey respondents. In terms of socio-demographics, our sample is composed of younger, more educated participants than the average for UK land managers. This is to be expected from an online survey (Olsen, 2009; Windle and Rolfe, 2011), but it should be noted that official statistics often report on the registered owner, who tends to be the father of the land managing family, while it is the (younger) offspring who actively manages it and is likely to have responded to our survey, so this may not be an issue in terms of representativeness.

The sample is over-represented for dairy and mixed farms. Farm size, gender distribution, full-time employment in the farm and share of farm ownership (in relation to tenant farmers) is similar to the UK average.

Most participants are currently, or had previously been, enrolled in AES contracts (AES_EXP=84 %) and only 14 % had never taken part in

Table 2
Summary characteristics of survey participants.

	Sample	UK population[a]
Average in years (AGE)	41 (std. dev =8)	59
Average gross farm income in £/year (FARM_INCOME)	£62,535 (std. dev = 23,37)	£51,900
Average hectares (LAND_MANAGED)	181 (std. dev =337)	159.9 (Total Utilised Agricultural Area)
GENDER	Male = 87 %	Male = 85 %
EDUCATION	No formal qualifications = 1 % Secondary school = 8 % Vocational/ professional agricultural education = 20 % College education = 72 %	n.d. Vocational/ professional agricultural education = 17 %** College education = 45 %**
FARM TYPE	Arable = 12 % Dairy = 24 % Lowland livestock = 6 % Upland livestock = 9 % Mixed (arable and livestock) = 31 % Other = 18 %	Arable = 28 % Dairy = 6 % Lowland livestock = 21 % Upland livestock = 33 % Mixed (arable and livestock) = 8 % Other = 5 %
FULL_TIME_FARMER	49 %	41 %
OWNER	80 %	86 %
Past experience with AES**a		
Currently or previously enrolled in AES (AES_EXP)	84 %	–
Currently receiving high payments from AES (>50k per year) (AES_HIGHRECEIPTS)	73 %	
Currently enrolled in AES delivering high environmental standards (AES_ECO)	47 %	
Climate risk perceptions		
Climate change will impact your health and well-being (CLIM_LKLY)	64 %	–
Climate change will impact your farming practices (CLIM_PERS)	50 %	
Climate change' consequences make you worried (CLIM_WORRY)	57 %	

[a] Sources: Agriculture database, Eurostat (2017); Defra (2021a) (2021b) (2021c) (2021d); **UK Government (2016). ***No data on enrolment in AES at the farm level are available, as only land cover and total funding uptake data exist (Joint Nature Conservation Committee (JNCC), 2020).

any AES. From that majority of participants who had experience with AES, again a large proportion (73 %) received high payment levels (£50k per year or above - AES_HIGHRECEIPTS). Forty seven percent had been enrolled in AES that focus on high environmental quality delivery, such as Higher-Level Stewardship (AES_ECO) (with 20 % only involved in AES providing basic environmental benefits, such as the Entry Level Stewardship or Uplands Entry Level Stewardship Schemes).

The above makes our sample a 'benchmark' of land managers with experience, dependency and/or leniency towards AES. Having so far been substantially engaged with AES, they should provide revealing insights into the ways that AES might match land managers preferences (i.e. if certain configurations of AES do not work for this type of farmer, they are not likely to work for those previously not so engaged). Further, being younger and more educated, they also provide a 'window into the future', a forewarning of what land managers preferences might be, moving forward.

Regarding climate change perceptions, over half of our respondents were concerned with climate change and its impact in general, and specifically on the consequences for their land management activities. This level of concern is similar to other UK farmers' surveys (HM Government, 2021; Pröbstl-Haider et al., 2016), which classify this as a moderate level of concern.

4. Results

4.1. Preferences for AES features

The results of a simple multinomial logit (MNL) (considering preferences homogeneous across respondents) and the MXL from Eq.2 are presented in Table 3, which shows the preferences for the attributes of the DCE corresponding to the contract features (CONTRACT, CARBON, COLLAB and ADVICE). COMPENSATION follows a log-normal distribution in the MXL model while the rest of the attributes follow a normal one. An alternative-specific constant accounting for a respondent choosing not to enrol in any scheme was also included (OPT_OUT). The model has a moderate fit in the MNL (22 %) and MXL (pseudo $R^2 = 29$ %) (Greiner, 2015).

Survey respondents showed a strong aversion towards not enrolling in AES, as is evident from the large negative and significant size of the coefficient for the OPT_OUT in both models (indeed less than 2 % of times OPT_OUT was chosen by participants). This is not at all surprising, since the opt-out option explicitly indicated that land managers would not receive public funding for their farm activity (in alignment with the post-Brexit phasing out of BPS). Despite this, we still see a significant positive COMPENSATION in the MXL model,[3] indicating that farmers

Table 3
Results of a multinomial logit (MNL) and mixed logit model (MXL) in preference space.

	Coef.	Std. Err.	Coef.	Std. Err.
Means				
COMPENSATION†	<−0.001	0.001	0.001*	0.001
CONTRACT2	-0.133	0.115	-0.022	0.116
CONTRACT3	-0.124	0.113	-0.013	0.110
CARBON2	0.177	0.111	0.245**	0.116
CARBON3	0.191*	0.111	0.224**	0.112
COLLAB2	-0.182*	0.107	-0.071	0.112
COLLAB3	-0.076	0.112	0.015	0.112
ADVICE2	0.210*	0.113	0.237**	0.114
ADVICE3	0.022	0.117	0.052	0.116
OPT_OUT	-3.804***	0.226	-5.811***	1.233
Standard Deviations				
COMPENSATION	–	–	-0.002***	0.000
CONTRACT1	–	–	0.400	0.304
CONTRACT2	–	–	0.908***	0.244
CONTRACT3	–	–	0.265	0.385
CARBON2	–	–	-0.800***	0.257
CARBON3	–	–	0.581***	0.214
COLLAB2	–	–	-0.522**	0.213
COLLAB3	–	–	0.163	0.438
ADVICE2	–	–	0.716***	0.238
ADVICE3	–	–	-0.583**	0.231
OPT_OUT	–	–	1.729***	0.632
Log-Likelihood	-1363.81		-689.711	
Chi squared	293.14		47.23	
R^2 (Pseudo-R2 for MXL)	0.22		0.29	
AIC	2741.548		1447.883	
BIC	2806.676		1560.379	

† refers to the mean value of the logarithm for the MXL model ***, **, denote statistical significance at the 1 %, 5 % and 10 % level, respectively.

[3] This is not the case for the MNL, for which COMPENSATION is not significant and therefore is not further considered.

still display sensitivity to the contract features (i.e. they are still able to express a trade-off for them). The model also shows significantly positive effects for CARBON (both levels) and ADVICE2. The size of the standard deviations is large for all attributes in the MXL, indicating considerable preference heterogeneity in the responses and justifying the use of the Latent Class Conditional Logit model.

To account for the heterogeneity of preferences indicated in the results of Table 4, a LCL model described in Eq.3 was fitted to the data. A variety of variables was used to determine class membership, accounting for sociodemographic and farm characteristics, as well as past experiences with AES and risk perceptions regarding climate change with respect to farming, informed by the variables in Table 1. The common practice to decide the optimum number of classes is the minimisation of measures of fit such as the Consistent Akaike Criterion (CAIC) and Bayesian Information Criterion (BIC) and compare the results for several classes (Zhou et al., 2018). From the results of Table 4, the CAIC and BIC are lowest in the 2-class solution. Table 4 also shows the differences in the goodness-of-fit measures between the different models.

The maximum likelihood estimation results of the marginal probabilities that each attribute has in a 2-class model are presented in Table 5. The 2-class solution splits the sample into 19 % % in Class 1 % and 81 % in Class 2, with each class having distinct, homogenous preferences and composition for age, employment (full/part-time) and prior experience with AES (see the covariates in the bottom half of Table 5, under 'Membership coefficient').

Class 1 participants were more likely to be full-time, older and without prior experience of AES. Class 1 respondents show a strong aversion towards not enrolling in AES, as is evident from the large negative and significant size of the coefficient for the OPT_OUT. This effect is so large that it overshadows any trade-off for contract features, with COMPENSATION being non-significant. Is to be noted how, in any case, the CARBON attribute is significant at both levels. As expected under RUT, CARBON3 had a lower coefficient than CARBON2, reflecting sensitivity to the increasing demands associated to each level (i.e. no additional actions in the baseline CARBON1, additional actions in CARBON2 and further additional actions in CARBON3). Given the small membership probability in this class, interpretations are undertaken in a cautious manner.[4]

Farmers in Class 2 have the opposite characteristics: they are more likely to work part-time, be younger and to have previous experience with AES. Contrary to the full sample MXL model and Class 1, in Class 2 the OPT_OUT coefficient is positive but not significant. Further, Class 2 has a statistically significant coefficient for COMPENSATION (Table 5). This means that, while Class 2 farmers still displayed a weak desire for opting-out (about 3 % of them chose to opt-out), the effect is less overshadowing allowing us to understand more of their preferences about the design of the AES. Several of the attributes were indeed statistically significant, showing that the contract features they represent affect farmers' willingness to participate in AES. Namely, these features were type of contract (CONTRACT 2: hybrid schemes combining payments by actions and by results and CONTRACT 3:payments by results),

Table 4
Goodness-of-fit measures for different class specifications.

Classes	Log-Likelihood	Parameters	CAIC	BIC
2	-895.841	30	1977.304	1947.304
3	-862.5248	51	2040.606	1989.606
4	-851.3022	72	2148.096	2076.096

Table 5
Marginal probabilities from a Latent Class Conditional Logit model.

Preference space	Latent class conditional logit model			
Choice	Coefficient Class1	St.err	Coefficient Class 2	St.err
COMPENS	<0.001	<0.001	0.003***	0.001
CONTRACT2	-0.105	0.116	1.267**	0.647
CONTRACT3	-0.109	0.117	1.767*	0.999
CARBON2	0.415***	0.123	-1.719***	0.576
CARBON3	0.267**	0.115	-0.701	0.469
COLLAB2	-0.067	0.117	0.663	0.825
COLLAB3	-0.101	0.116	1.648*	0.915
ADVICE2	0.192	0.123	0.462	0.610
ADVICE3	0.130	0.120	-1.100*	0.611
OPT_OUT	-4.286***	0.523	0.381	1.402
	Membership coefficient			
CLIM_LKLY	–	–	ns	ns
CLIM_PERS	–	–	ns	ns
CLIM_WORRY	–	–	ns	ns
HIGH_INC	–	–	ns	ns
HIGH_EDUC	–	–	ns	ns
FARM_YOUNG	–	–	1.600*	0.746
AES_EXP	–	–	2.154*	1.386
AES_HIGHRECEIPTS	–	–	ns	ns
AES_ECO	–	–	ns	ns
FULL_TIME_FARMER	–	–	-1.214*	0.744
OWNER	–	–	ns	ns
CONSTANT	–	–	ns	ns
Class share	19 %		81 %	
McFadden pseudo R-squared	0.38			

***, **, * denote statistical significance at the 1 %, 5 % and 10 % level, respectively, 'ns' denotes non-significant covariates

additional actions to stop the loss of carbon from soils (CARBON2), collaboration with other nearby land managers on projects pre-established by land managers themselves (COLLAB3), and the provision of advice from independent advisors (ADVICE3). The implications of these results in terms of WTA compensation are discussed next.

4.2. *Willingness to accept compensation for AES features*

Table 6 presents the marginal WTA using the Delta Method (Greene, 2003) for each of the contract features,[5] i.e. the amount of money farmers in this class are willing to trade-off to engage in the schemes with the offered features (this is shown with parametric bootstrap estimated confidence intervals). As compensation was only significant in

Table 6
Marginal Willingness to Accept for Class 2 participants, per land manager, per year.

	Marginal WTA, £	St. Error, £	95 % Confidence Intervals, £	
CONTRACT2	-£ 417**	171	-753	-81
CONTRACT3	-£ 582***	235	-1042	-121
CARBON2	£ 566***	168	236	895
CARBON3	£ 231	158	-78	540
COLLAB2	-£ 218	225	-660	223
COLLAB3	-£ 542***	204	-942	-143
ADVICE2	-£ 152	178	-501	197
ADVICE3	£ 362**	178	14	710
OPT_OUT	-£ 125	428	-965	714

***, ** denote statistical significance at the 99 % and 95 % level, respectively

[4] We did not find systematic evidence for attribute non-attendance (ANA) while using an endogenous attribute attendance model. However, because such models are typically difficult to converge, it is possible that ANA might still play a role in explaining status quo results for Class 1.

[5] The small relative size of compensation when compared with the other model parameters and their confidence intervals render some marginal WTA values significant in Table 6 while their model coefficients were not statistically significant and/or had inverted signs in Table 5 (see Dufour, 1997 for a more detailed explanation).

Class 2, only results from this class, which is also the largest, are presented. Interestingly, Table 6 shows that participating in hybrid (combining actions and results, CONTRACT2) and result-based schemes (CONTRACT3) makes Class 2 participants willing to offer a 'discount', by accepting less compensation, with respect to action-based schemes (£417/hectare/year and £582/hectare/year, respectively). Farmers in this class seem to be willing to accept less compensation for schemes in which there is collaboration with other nearby land managers on projects pre-established by land managers themselves (COLLAB3, £542/hectare/year), over programmes that do not require collaboration.

Results also indicate that famers require compensation if the advice is provided by an external advisor, over no advice (ADVICE3 =£362/hectare/year). Additionally, land managers require additional compensation to undertake actions that stop soil carbon loss as a contract feature, of about £ 566/hectare/year (CARBON2) over carrying out the same actions. This compensation seems to "saturate" at this level, i.e. farmers are not really willing to take yet further actions to capture additional carbon into the soil (i.e. CARBON3 not statistically significant). In any case, the compensation levels are similar or close to current levels of carbon related payments (e.g. in the Higher Tier multi-year options under the current Countryside Stewardship, and close to the current payment levels for carbon storing options such as woodland improvement and ecological focus area (Defra, 2020b)).

4.3. AES economic impacts

Here we present the impacts that hypothetical AES may have on Class 2 farmers in economic terms, based on various combinations of contract features and calculated with the *logsum* method (Train, 2009). These economic impacts are estimated as the welfare gains (compensating surplus) that farmers would obtain from enrolling in AES with various combinations of contract features (those statistically significant in Table 5). Specifically, we construct two hypothesised AES (Policy A and B), both involving a shift from no requirement to undertake actions regarding carbon to undertaking actions protecting carbon in the soil (CARBON1 to CARBON2), from no requirement to collaborate with farmers to collaboration with other farmers on goals agreed amongst themselves (COLLAB1 to COLLAB3), and from no advice provided to advice provided by an independent advisor (ADVICE1 to ADVICE3). The two hypothesized AES then differentiate in the type of contract, with Policy A including a shift from action-based schemes to hybrid schemes (CONTRACT1 to CONTRACT2) and Policy B that moves from action-based to result-based schemes (CONTRACT1 to CONTRACT3). Both hypothetical schemes' impact on welfare is examined from the same starting point, the baseline (also including the OPT_OUT levels) from the LCL model estimation.

Results show that achieving policy (a) would result in a welfare increase of around £ 690 per land manager per year, while policy (b) would result in an approximate £ 589 increase per land manager per year. These changes in welfare are clearly very small when compared with the average total farmer income (each policy would impact around 1 % of total farmer income).

5. Discussion

Following Brexit, the UK is experiencing major changes to its AES, including the likely phasing out of all existing direct payments in England (Defra, 2020b). Our results show how, faced with this possibility, land managers display a very strong aversion to being left out of new forms of AES. This "in principle willingness" was also found in other primary studies in similar geographic contexts (Hasler et al., 2019; Broch and Vedel, 2012; Buckley et al., 2012). This would suggest that Defra's ambition to have 70 % of all agricultural land in England enrolled in the Sustainable Farming Incentive component of ELMs by 2028 (end of the Transition Period) might indeed be within reach (Defra, 2020c). This is not to say, however, that such process would be easy, since there is indication that less farmers than previous years appear to understand the Defra's policy direction and the majority believes it will not prove beneficial for their land (Defra, 2022c), which anticipates contestation. Also, it is to be noted there are ongoing discussions which refer to payments levels for the Sustainable Farming Incentive lower than the ones used in our study, which would make it challenging.

While our study does not have a fully representative sample of UK farmers, our benchmark sample of relatively younger, educated land managers with a pre-existing disposition towards AES (Table 2), emphasized by Class 2 characteristics (Table 5), still allows us to understand land managers' preferences for some of the contract features that were tested in this study.

Regarding the type of contract, one could expect land managers to have misgivings regarding hybrid models (i.e. a combination of payment by committed actions and by results) as they might be perceived to be too complicated or burdensome (complexity and administrative burden are well known barriers for AES (Birge et al., 2017)). On the other hand, payments by results carry, by default, a higher risk for land managers as payment is contingent on meeting certain goals while monitoring of results can be problematic (Burton and Schwarz, 2013; Schroeder et al., 2013). Therefore, it could have been expected to see land managers display stronger preferences for AES contracts in which payment is conditional on complying with prescribed actions only, which are also currently more common (e.g., Arnott et al., 2019). It is to be noted, however, that the literature provides divergent evidence on land managers' preferences for results-based schemes. These preferences are dependent on other features of the AES contract, such as contract length, among other (Birge and Herzon, 2019; Niskanen et al., 2021), which this study did not focus on. Indeed, past UK surveys have found conflicting preferences between commitment action-based and results-based schemes (Schroeder et al., 2013). Our results show that some farmers (those in Class 2) appear to prefer result-based schemes over hybrid schemes, when comparing them with action-based schemes. Nevertheless, while offering examples of potential practices in the choice description, our study did not specify other contract characteristics associated with results-based schemes such as monitoring techniques and indicators used to measure results, which might have had some effect on the preferences for non-baseline contract options. More targeted studies dedicated to specific practices could be developed in the future, although they would have to consider smaller spatial contexts or specific farmer groups to ensure relevance. The current proposal for ELMs seems to consider results-based schemes within Local Nature Recovery and Landscape Recovery with Sustainable Farming Incentive agreements to last for only three years and Landscape Recovery schemes projected to last more than 20 years (Defra, 2021a). Such flexibility could possibly allow accommodation of the divergence of preferences and allow appetite for results-based schemes to grow.

Collaboration with other farmers is also subject to debate in the literature. Collaboration has been argued to result in increased environmental benefits (Prager, 2015), but also in decreased participation rates in AES as farmers are unsure about the behaviour of the farmers they are to collaborate with (Villamayor-Tomas et al., 2019, 2021). Westerink et al. (2017) found collaborative governance of AES from groups of farmers and professional organisations to increase the efficiency of spatial coordination of environmental management, resulting in landscape-wide success of AES. During the workshops and in-depth interviews at the survey development stage for this research, participants echoed the same concerns around participation, but claimed that prior collaboration with neighbouring land managers in farmer societies and farmer groups increased their willingness to collaborate. This is reflected in our results from the negative marginal WTA estimates of Class 2 (Table 6), with respondents requiring lower compensation if such options were made available to them (if the goals are pre-agreed between farmers themselves, making achieving goals more feasible), similar to the findings of Villamayor-Tomas et al. (2019). In any case, co-operation with neighbours is highly case-specific as having common goals is crucial and farmers need to be surrounded by similar types of farm. To that end, Burton and Paragahawewa (2011) suggested that creating and maintaining cultural and social capital in farming from the side of policy makers can help AES be more successful in their implementation, while empowering farmers to share experiences with each other (Rodríguez-Entrena and Arriaza, 2013). Further, innovative collaborative arrangements, such as the 'agglomeration payments' proposed by Bell et al., (2016), by which farmers are paid a bonus payment for adoption by neighbouring farms, are worth exploring, since they might help to encourage both compliance as well as spread.

Farm advice as a general contract feature has been found previously in the literature to consistently increase likelihood of participation to AES (Emery and Franks, 2012; Birge and Herzon, 2019; Tyllianakis and Martin-Ortega, 2021). This feature is gaining popularity in AES design both in Europe and in the UK in particular (Morgans et al., 2021). The impact of such free advice being provided by independent farm advisors is, however, unclear in the literature. Hejnowicz et al. (2016), for example, show that in England independent farm advisors have to manage conflicting interests between their clients and organisations involved in AES as well as the inherently complicated nature of contractual agreements, which might explain the high compensation required by our respondents (Table 6). Prager et al. (2016) also noted that farm advisors tend to favour more affluent farmers at the expense of small and younger land managers, while Heffernan et al. (2016) noted that little useful information was shared between UK farmers who were part of two bovine schemes, pointing to potential pitfalls in peer-to-peer advice. Our perhaps surprising results may relate more to the source of the advice (peer-to-peer compared to independent advisers) than the nature of the advice (free in all non-baseline options) which requires further work to disentangle the underlying causes.

According to our survey results, Class 2 land managers are willing to take further action to stop carbon losses from their soil (CARBON2), in exchange for higher compensation levels (Table 6). Such compensation seems to saturate at this level, i.e. land managers on this class are not really willing to take *further* actions to capture additional carbon into the soil, although this could be explored in further research (for example, if there would be different answers for more environmentally aware farmers). This reluctance to adopt measures increasing carbon storage is aligned with findings from Aslam et al. (2017), who found UK farmers reluctant to make drastic changes in grassland extensification schemes. Farmers might be concerned with the scale of the activities that might be required, for example, large-scale tree-planting would have the potential to change not just the landscape but also their role as "farmers". Additionally, previous UK studies among farmers report a lack of connection between adoption of pro-environmental land management practices and concern with climate change (Barnes et al., 2013). In our study, perceptions and attitudes towards climate change did not have any significant effect on preferences. Therefore, there is a need to co-develop carbon strategies with farmers to support novel contract development (COWI, Ecologic Institute and IEEP, 2021). Promoting experiential learning to increase farmers' awareness and promote pro-environmental practices should also assist in this (Okumah et al., 2021b). Non-monetary incentives given to farmers, such as organic labelling (Wuepper et al., 2017) may also be useful in reducing payment levels.

On the economic effects of new (hypothesized) forms of AES with the contract features tested in this study, our results show on average negligible welfare gains in relation to farmers' income (Tables 7, 1 % of Class 2 farmers' average income). It is not possible to compare this with other findings in the literature since these welfare gains tend not to be reported. In the policy context, these welfare figures would be aligned with a policy agenda of sustaining activity based on compensation of income foregone.

It is important to take into consideration when interpreting the above results that they relate to issues currently subject to intense debate in the UK (Gravey, 2019), and therefore that WTA estimates are to be taken with caution outside of this context. Land managers, and particularly the ones of the type reflected in our sample (and specially Class 2), are aware of such debates and might have responded in anticipation of what is expected to happen. The government is promoting payments by results (Defra, 2022b), and farm collaboration to attain landscape wide improvements within ELM schemes (Defra, 2021d). The Net-Zero carbon agenda for agricultural policy is also quite pronounced (Defra, 2021a). Faced with the uncertainty that the phasing out of the BPS brings, land managers might have anticipated that these contract features are likely to secure them payment and responded to our survey accordingly. Indeed, for example, the government guidance has since been updated to indicate that ELMs would aim to support the UK Government's Net-Zero therefore no 'business as usual' options would be available (Defra, 2021a).

Table 7
Land manager welfare gains (Class 2 land managers).

	Welfare gain per land manager, per year (st. dev in parentheses)
Policy A: Action-based schemes to *Hybrid schemes*	£688 (433)
Policy B: Action-based to *Result-based schemes*	£589 (431)

Our study was designed to be of relevance nation-wide, which required the description of the DCE attributes in a sufficiently generic way to be suitable to all types of farmers across the country (notably with respect to the carbon and contract attributes in relation to the type of measures involved in them). This generality would have undoubtedly increased the unexplained preference heterogeneity in our models. Targeted studies for specific types of farmers with higher levels of specificity regarding the measures involved in the AES would be of interest for future research. Similarly, future studies could also test a labelled approach to the DCE, which again might serve to further explore the preference heterogeneity that we found.

6. Conclusions

Securing the provision of environmental public goods from agriculture is central to addressing the fundamental challenge of ensuring global food security while halting ecosystem degradation. AES are considered to have a key role to play, but they seem to have not been entirely successful in supporting the transition to more sustainable ways of producing food. Existing evidence suggests that farmers are generally willing to enrol in AES for the delivery of environmental features, but robust policy support requires more exploration of land managers' preferences and how these interplay with contract features that are more susceptible to achieving higher environmental targets. This paper provides further evidence through a discrete choice experiment survey of land managers in the UK, eliciting their preferences for a series of contract features relevant to the discussion of environmental public goods.

Our benchmark sample of younger AES-inclined land managers provides a window into the future of the UK farming landscape, but also, given the revision of the EU's CAP and discussions elsewhere, our research also provides a window into land managers' preferences for new features within future AES more widely. While the change to new agri-environmental contracts is likely to be less abrupt than what is being brought by Brexit (where the possibility of no public subsidising of agriculture leads to strong aversion to opting out from AES), there are widespread discussions into transitioning to results-based, collaborative schemes supporting landscape-wide interventions, in alignment with net zero agendas, as the ones tested here. Whether out of *resignation* for what is expected to happen *anyway,* or out of genuine endorsement, our results show promise that this type of land manager is likely to be receptive to such contract features, in exchange for levels of compensation not far-off current ones.

While this raises promise, our results also emphasize the challenges associated to a transition to schemes with such features, particularly to attract those less generally AES-prone land managers. Payments levels probably need to remain close to current levels (not lower), farmers' awareness and support for net-zero agendas need to be reinforced and more interaction between land managers and policy makers will be needed. Further research with larger samples and targeted studies focusing on specific carbon mitigation practices tailored to different types of farmers could advance knowledge and help provide more targeted recommendations. Further in-depth qualitative studies uncovering the complex processes regarding land managers collaboration and the role of advice provision would also be welcome.

Data availability

The authors do not have permission to share data.

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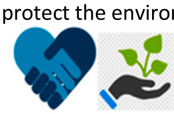
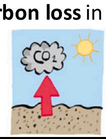
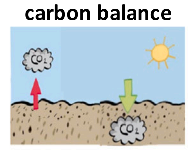
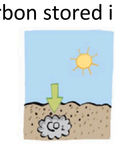
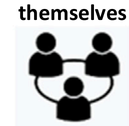
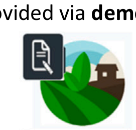
Appendix I. List of attributes, levels and associated images used in the Choice Experiment

Attributes	Your options		
You will receive payment if	You carry out **actions** to protect the environment 	you carry out **some** actions to protect the environment AND you **partly** achieve results that protect the environment 	You **achieve results** that protect the environment 
You will take	The same actions as now. This may lead in **net carbon loss** in soil 	Additional actions to protect soils and achieve **carbon balance** 	**Further** additional actions to **increase** carbon stored in soil 
You will have	**No contractual obligation** to collaborate with other nearby land mangers 	A contractual **obligation** to collaborate with other nearby land managers **on projects pre-established by the regulator** 	A contractual **obligation** to collaborate with other nearby land managers **on projects pre-established by land managers themselves** 
You will receive	No free advice 	Free advice provided via **demonstration farms** 	Free advice from an **independent adviser** 

Appendix II. Class membership model parameters (Class 1 being the reference class. Class 1 coefficients have the opposite sign from Class 2 as in all latent class models)

	Class 1	*Class 2*
CLIM_LKLY	–	-1.207
CLIM_PERS	–	-0.551
CLIM_WORRY	–	1.084
HIGH_INC	–	-0.661
HIGH_EDUC	–	-0.647
FARM_YOUNG	–	1.597
AES_EXP	–	2.146
AES_HIGHRECEIPTS	–	-0.992

(*continued on next page*)

(*continued*)

	Class 1	Class 2
AES_ECO	–	-0.136
FULL_TIME_FARMER	–	1.210
OWNER	–	-0.664
CONSTANT	–	-1.784

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