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Research article

Fighting the pollinators decline in practice – Farmers' willingness to accept an eco-scheme for their conservation in Aragon, Spain

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ABSTRACT

We design an eco-scheme under the framework of the Common Agricultural Policy (CAP) 2023–2027 integrating the two most relevant agricultural practices for pollinator conservation: setting aside conservation land areas and reducing pesticides. Our main objectives are: (i) to measure farmers' willingness to accept the implementation of pollinators-friendly agricultural practices, and (ii) to assess the effect of farmers' environmental concerns and the source of recommendation on said willingness. A choice experiment is used to measure farmers' preference for alternative designs of the eco-scheme in two cropping systems representative of the Aragonese and Mediterranean agriculture: rainfed extensive crops and irrigated/permanent crops.

As we find, Aragonese farmers are willing to uptake agricultural practices for pollinator conservation to certain extent if they are paid to do so. This is especially true for setting aside land for conservation where more demanding practices could be accepted within current Spanish unitary payments (per ha payment). The reduction or elimination of pesticides would require payments far beyond current Spanish unitary payments. Irrigated/permanent crop farmers require larger payments than rainfed crop farmers. Farmers with pro-environmental attitudes selected more environmentally-demanding alternative levels both for sparing agricultural land and reducing pesticides. Finally, the uptake of the eco-scheme could be easier if cooperatives play an active role in its promotion. The hypothetical eco-scheme presented here could be readily implemented within CAP eco-schemes while integrating the objectives of the European Pollinators Initiative, the Biodiversity Strategy 2030 and the Farm to Fork Strategy.

1. Introduction

Agriculture plays a central role in biodiversity conservation (Dudley and Alexander, 2017; Henle et al., 2008). The evolution of agriculture toward more intensive monocultures with increasing use of pesticides and fertilizers to boost food production explains much of the decline of biodiversity (Outhwaite et al., 2022; Raven and Wagner, 2021; Rigal et al., 2023). Transitioning to alternative agricultural practices has the potential to curb that trend (Hart et al., 2017; Sutherland et al., 2021). Despite political efforts to support and enhance a greener agriculture through successive reforms of the Common Agricultural Policy (CAP) (European Commission, 2019, 2016), biodiversity loss in agricultural landscapes remains (European Court of Auditors, 2020; European Environment Agency, 2019; Mancini et al., 2023). This state of affairs has led some to question the ambition of agricultural policies (Mann and Kaiser, 2023). Pollinators, which provide essential ecosystem services to maintain agriculture and ecosystems integrity (Potts et al., 2016), are amongst the most impacted species. Their decline can trigger a cascade effect impacting both general ecological processes and agricultural production (Potts et al., 2016, 2010).

The concern about the continuous and fast decline in pollinators' biodiversity has triggered new conservation regulations at the European level (European Commission, 2018). In Spain, this effort has translated into the Spanish National Strategy of Pollinators (MITECO, 2020). In

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both the European and Spanish cases, the goal has been to integrate pollinators conservation in the framework of the CAP (Spanish Strategy, *action B.1.5.*) and to improve natural and seminatural habitats in agricultural landscapes through voluntary measures and novel eco-schemes (see below) (Spanish Strategy, *action B.1.6.*). As a consequence, political aims manifested in European and Spanish strategies to fight the decline of pollinators have been later translated into public policies that allocate budget to such ends, in particular the eco-schemes of the CAP.

There is increasing literature exploring agricultural practices that simultaneously improve farming environmental sustainability and maintain food production (Pywell et al., 2015; Tamburini et al., 2020). However, the implementation of pro-environmental agricultural practices is still criticized for trading off with a reduction of productivity (Marja et al., 2024) or a modification of business-as-usual practices and, therefore, often encounters the resistance of farmers. Agri-environmental policies tackle these barriers by economically supporting specific practices or outcomes to compensate farmers for the potential loss of productivity (Martin et al., 2014). Not without reason, the budget allocated to those policies has increased in Europe in the last decades (Ait Sidhoum et al., 2023; Kolinjivadi et al., 2023).

The literature has addressed how much society is willing to support farmers for the ecosystem services they supply in high nature value farmlands (Bernués et al., 2019), the relationships between agricultural practices and diverse ecosystem services (Bernués et al., 2022; Rodríguez-Ortega et al., 2018), and the extent to which farmers are inclined to implement pro-environmental practices (Barreiro-Hurle et al., 2023). Farmers have also been shown to care about pollinators, with reducing insecticides, diversifying crops and increasing fallow land being the most common agricultural practices to sustain pollinators (Hevia et al., 2021). Although a few years ago there was almost no literature on farmers' willingness to participate in programmes to conserve pollinators (IPBES, 2016), recent studies have begun to address the topic (Bakker et al., 2021; Weituschat et al., 2023a). However, none of them framed their study based on the current eco-schemes to investigate how this new agri-environmental tool may work in promoting farmers to uptake practices to enhance pollinators.

The new CAP (2023–2027) eco-schemes are tools designed to support farmers in implementing practices that minimize the negative impact of agriculture on the environment and the climate and help them evolve toward more sustainable farming models. This CAP reform followed a long and contested process to simultaneously promote more sustainable agricultural practices while including farmers' claims. In the design process of an eco-scheme, it is central to identify the practices that enhance the delivery of one or several public goods, and a payment mechanism for such practices. In the case of pollination, scientific evidence agrees that the establishment of spaces for biodiversity and the reduction or elimination of pesticides (IPBES, 2016; Sutherland et al., 2021) are appropriate to mitigate agricultural impact on pollinators. However, only Italy explicitly mention pollinators in the spaces for biodiversity eco-scheme (Runge et al., 2022).

For eco-schemes to be an effective and efficient agri-environmental tool, the required practices have to be relevant to farmers and coherent with other public policies (*e.g.*, Farm to Fork Strategy, Biodiversity Strategy for 2030). In this study, we design a pollinators' eco-scheme that integrates objectives from different public policies and assess the farmers' willingness to implement them. Environmental concerns have proven to influence farmers' preferences regarding agri-environmental practices and conservation of endangered species (Choi and Fielding, 2013; Dessart et al., 2019; Mariel and Arata, 2021; Reimer et al., 2012; Vogel, 1996). In addition, studies have shown the importance of social and identity dynamics in the uptake of these kind of practices, *e.g.*, the attention that farmers pay to recommendations from certain actors, like peer-farmers or scientists (Villamayor-Tomas et al., 2021, 2019). Indeed, strengthening stakeholders' relations within the value-chain has been mentioned as a requirement to scaling up sustainable agricultural practices (Weituschat et al., 2023b), to which farmers' trust in the recommendations from different stakeholders may be playing a role. Moreover, the characteristics of the farm and farming management are also relevant to understand farmers' enrollment in agri-environmental schemes (Ma et al., 2012).

This study designs an eco-scheme under the framework of the CAP (2023–2027) integrating the two most relevant agricultural practices for the conservation of pollinators; *i.e.*, establishing conservation areas and reducing the use of pesticides. The specific objectives are: (i) to measure farmers' willingness to accept the implementation of the proposed agricultural practices, and (ii) to assess the effect of farmers' environmental concern and of who suggests adopting the agricultural practices on farmers' willingness to accept the eco-scheme. The results of this study could help to: (i) design a specific eco-scheme for pollinator conservation; (ii) integrate objectives from different public policies (CAP, Farm to Fork and Biodiversity Strategy); (iii) identify characteristics of engaged farmers that could play a role in peer-to-peer learning processes; (iv) improve the understanding of how the specific stakeholder informing farmers to adopt a novel practice can influence the implementation.

2. Material and methods

We carried out a choice experiment (CE) to measure farmers' willingness to accept alternative designs of an eco-scheme for pollinators conservation. Choice experiments are a wide used technique for eliciting the preferences of individuals (Hensher et al., 2015) and have been regularly used to disentangle farmers' willingness to participate in agri-environmental programmes, identify most accepted agricultural practices, and estimate the payment (Ma et al., 2012). Discrete choice experiments allow to quantitatively elicit farmers' preferences and willingness to accept through repeated fictional choices and include a diversity of attributes that could be influencing their preferences (Hoyos, 2010; Louviere et al., 2000). In CE, individuals are shown two or more alternatives and have to choose one of them. Each alternative is defined by certain characteristics called attributes (one usually being a monetary attribute), which are determined by their levels (Hensher et al., 2015). Willingness to Accept (WTA) is the minimum necessary payment for an individual to accept implementing a practice, buy a product, or bear a negative externality.

To collect the data, we implemented an in-person survey to agricultural farmers from Aragón (Spain). The cropping systems sampled was divided in two groups according to the current classification in the Spanish CAP 2023–2027 program (PEPAC, 2021): (i) rainfed extensive crops, and (ii) irrigated extensive crops and permanent crops. Therefore, we stratified the sampling to cover a proportional number of farmers based on the total number of farms of these farming systems in the three administrative regions of Aragón (Appendix, Table A.1). These cropping systems are common in the Mediterranean basin, characterized by permanent crops, such as olives, grapes and fruits, fresh vegetables, and cereals, often complemented with extensive livestock, mostly sheep and goats (UNEP, 2020).

2.1. Survey design

The survey contained three sections. First, it included the choice experiment with a brief introductory description preceded by short questions about basic structural data of the farm (surface, main crop, irrigation/rainfed). These questions were instrumental to assign the participants to different sets of choice cards (see Choice experiment design below). The second section gathered the socio-demographic profile of respondents. Since environmental concern has been found to influence farmers uptake of sustainable agricultural practices (Dessart et al., 2019), the third section measured respondents' environmental concern using the New Environmental Paradigm (NEP) scale (Dunlap, 2008; Dunlap and Van Liere, 1978). The NEP is the most widely used scale to measure environmental concern (Dunlap et al., 2000;

Table 1
New environmental paradigm items.

1. We are approaching the limit of people the Earth can sustain. (*Removed in the analysis*)
2. When humans interfere with nature is often produces disastrous consequences.
3. Plants and animals have as much right as humans to exist.
4. The Earth is like a spaceship with only limited room and resources.
5. Humans were created to rule over the rest of nature.
6. The balance of nature is very delicate and easily upset.

Table 2
List of attributes and levels.

Attributes	Description	Levels	
Surface allocated to pollinators' biodiversity (%)	Percentage of farm dedicated to the measure.	Rainfed crop farmers: 7% 10% 12% 15%	Irrigated & permanent crops farmers: 4% 6% 8% 10%
Reduction of pesticides (%)	Percentage of reduction in the use of pesticides.	0% 50% 75% 100%	
Recommendation	Whether the eco-scheme has been recommended over others by a reference stakeholder group.	No particular recommendation Recommended by peer farmers Recommended by farming cooperatives or associations Recommended by public institutions	
Payment (€/ha)	Annual individual payment in € per hectare, in addition to other governmental subsidies.	20€ 80€ 140€ 200€	

Dunlap, 2008). It has been described as influencing farmers' awareness of environmental impacts on agriculture and to promote the formation of personal norms to participate in environmentally friendly actions (Zhang et al., 2020). Such awareness substantially influences farmers' ascription of responsibilities and the intention to implement sustainable agricultural practices (Yang et al., 2024) Respondents were asked to rate their level of agreement or disagreement with the statements of the 6-items NEP scale using a five-point Likert scale with 5 depicting "Completely agree" to 1 depicting "Completely disagree" (Dunlap, 2008) (Table 1). We tested the survey with a small sample of farmers (not included in the final analysis). The Ethics Committee of the Agrifood Research and Technology Centre of Aragón (CITA), Spain, approved the research protocol and questionnaire content (no. CEISH_2023_4). Data anonymity was granted to the participants in the survey, who expressed their formal consent to provide the information contained in the questionnaire.

2.1.1. *Choice experiment design*

The first step in creating a discrete choice design is to decide which attributes and how many levels of each will be included (Meyerhoff et al., 2015). To do so, we reviewed key international literature compiling evidence on agricultural practices that enhance pollinators' biodiversity (IPBES, 2016; Sutherland et al., 2021). We identified an agreement on the evidence that the following practices can improve pollinators' populations in agricultural landscapes: (i) create uncultivated margins around intensive arable or pasture fields, (ii) plant grass buffer strips or margins around arable or pasture fields, (iii) plant wildflower strips or blocks, and (iv) reduce or eliminate the use of herbicides and pesticides. Then, we reviewed the Spanish CAP 2023–2027 program (PEPAC, 2021) to explore how it incorporates the payment of these practices to inform the monetary attribute of our choice experiment. Table 1 includes the description of the attributes and attribute's levels considered in the choice experiment. One attribute accounted for practices related to leaving surface allocated to pollinators' biodiversity and another to reduce or abandon the use of pesticides, the two most relevant practices to avoid agriculture impact on pollinators (IPBES, 2016; Sutherland et al., 2021). A third attribute accounted for the recommendation of the eco-scheme by a reference stakeholder group (peer farmers, cooperatives and public administration). Finally, a monetary attribute is included which allows WTA estimates to be assigned to each of the attribute levels with such estimates representing the payment that respondents would receive under each eco-scheme design. The rationale for the selection of these attributes and their levels is set out in detail below.

Surface allocated to pollinators' biodiversity. The PEPAC includes an eco-scheme for general biodiversity enhancement ("*Agroecology: Spaces for biodiversity in farmland and permanent crops*") that includes the first three practices identified above (i, ii, iii). We built on this existing eco-scheme to design the attribute *Surface allocated to pollinators' biodiversity*. This attribute refers to the percentage of surface allocated to any of the abovementioned practices. To decide the levels of this attribute we differentiated between the two cropping systems studied, since the threshold established in the PEPAC is different for rainfed extensive crops (7% of the surface allocated to the eco-scheme) and for irrigated & permanent crops (4% of the surface allocated to the eco-scheme). These thresholds were taken as the lowest levels in our experiment to test the extent to which farmers may be willing to leave a progressively larger surface and at what (extra) payment. Therefore, we created two different sample groups in our case study with choice cards differing in the levels of this attribute (Table 2).

Reduction of pesticides. Secondly, this attribute was included due to the strong evidence existing on the relation between pesticides and pollinators' biodiversity (IPBES, 2016; Outhwaite et al., 2022; Raven and Wagner, 2021). There is increasing literature on farmers willingness to accept the reduction or abandonment of pesticides (Bakker et al., 2021; Weituschat et al., 2023a), which reinforces its relevance to enhance pollinators' biodiversity and to understand farmers' decisions. Since this practice is not included in the PEPAC biodiversity eco-scheme, we included a first attribute level of zero reduction as a baseline to compare how increasing levels of reduction influence farmers' choices. Attribute levels are based on the 50% reduction objective set by the F2F Strategy, the 100% reduction requirement of organic agriculture (also promoted by F2F Strategy) and an intermediate 75%. Moreover, the inclusion of this attribute together with saving surface to pollinators'

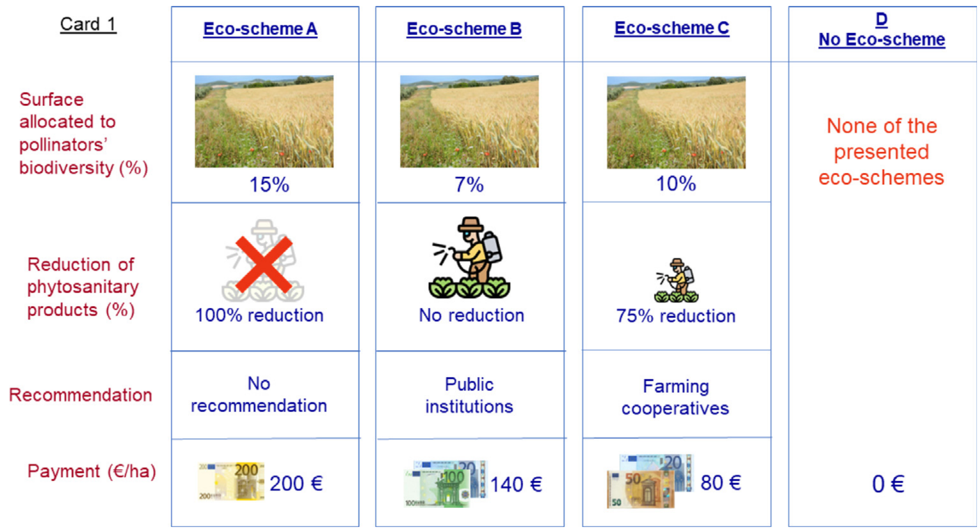

Fig. 1. Example of choice card presented to farmers (translated from Spanish).

biodiversity seek to optimize objectives of different public EU policies to investigate the potential integration.

Recommendation. Thirdly, we included the attribute *Recommendation* to analyze the influence of reference stakeholder groups recommending the adoption of the eco-scheme on farmers' willingness to adopt it. We built on previous studies that found how farmers' uptake of agri-environmental schemes can be influenced by reference stakeholders, in particular peer-farmers and scientists (Villamayor-Tomas et al., 2021, 2019). The selection of attribute levels was based on these studies and modified building on the existing literature on (i) the influence of farmers' membership to a cooperative as being influential in their uptake of agri-environmental schemes (Weituschat et al., 2023a); and (ii) evidence on farmers' mistrust on the public administration, which commonly plays an intermediary role in informing farmers (Martin-Collado et al., 2023) or their reluctance to sign rigid contracts (Christensen et al., 2011).

Payment. Finally, for the attribute *Payment*, we set four levels building from the ranges the PEPAC draw in 2021 for the biodiversity eco-scheme, which originally ranged from 8.5€/ha· year as the minimum payment, 50€/ha· year as the planned payment and 250€/ha· year as the maximum payment (PEPAC, 2021). Considering that neither the minimum nor the maximum payments were realistic and that our eco-scheme was more exigent than that of the current PEPAC, we designed one level of payment below and three levels above the planned (Table 2).

Choice cards were designed using a D-Optimal Design (Street et al., 2005; Street and Burgess, 2007) using *Ngene* software (v.1.2.1), reducing the full factorial 256 (4^4) combinations of the attributes (profiles) to 12, with an 89.3% d-optimality. Considering the two cropping systems studied, there were 12 choice cards for each group, only differing in the levels of the attribute "Surface allocated to pollinators' biodiversity" (Table 2). A total of 12 choice cards is within the margins studied to be manageable by respondents without incurring in fatigue (Bech et al., 2011). The order of the choice cards was randomized and the same for all participants. Fig. 1 shows an example of the choice cards presented to farmers.

2.2. Survey implementation and data analysis

We surveyed face-to-face 248 farmers from Aragón (Spain) between October 2023 and February 2024. Farmers' sample was evenly distributed according to the relative number of farms in each province and cropping system (Appendix, Table A.1). Farmers' characteristics are presented in Table 3.

For the choice experiments, individuals were asked to choose their preferred alternatives from 12 choice cards. Each choice card required respondents to choose among three alternatives with different attribute and payments levels, thereby stating their preferences for the levels of each attribute, with the option to no-choice to avoid forced choices, considering the voluntary nature of eco-schemes. Each survey took around 25 min to be completed.

2.2.1. Econometric framework

We used discrete choice models to estimate utility parameters based on the theoretical framework of Lancaster's consumer theory of utility maximization (Lancaster, 1966) and the random utility theory (McFadden, 1973). In this way, farmer's utility for each alternative is modeled linearly as a function of the attributes and levels associated with each eco-scheme as follows:

$$U_{njt} = \beta_{nj}\, x_{njt} + e_{njt}$$

where n is the farmer that chooses the alternative j in the choice card t, x_{njt} is the attribute level, β_{nj} the corresponding coefficient and e_{njt} the unobservable component of utility treated as a random term. As such, in our study, the utility of each respondent n of choosing alternative j in each choice card t can be specified as follows:

$$U_{njt} = ASC + \beta_1 PAYMENT_{njt} + \beta_2 SURFACE_{njt} + \beta_3 PESTICIDES_{njt} + \beta_4 RECOMMEND_{njt} + e_{njt}$$

where ASC is an alternative-specific constant representing the no choice alternative; $PAYMENT_{njt}$ is a continuous variable represented by the four experimentally designed payment levels; $SURFACE_{njt}$, $PESTICIDES_{njt}$ and $RECOMMEND_{njt}$ are the attributes describing the alternatives, with four levels each.

Different choice models can be formulated based on assumptions made about the distribution of the error term and the functional form of utility (Bazzani et al., 2017). We explored different model specifications, such as the Multinomial logistic model, the Random parameter logit model (RPLM), the RPLM with error component and the RPLM with correlated parameters. From this exploratory analysis, the RPLM with correlated parameter was selected, which has been widely used in the analysis of discrete choice models in environmental economics (Layton and Brown, 2000; Carlsson et al., 2003; Scarpa et al., 2008; Scasný et al., 2017; Waldman et al., 2017; Alberini et al., 2018; Bae and Rishi, 2018; Frontuto et al., 2020; Mariel and Artabe, 2020). The RPLM allows utility coefficients to vary over individuals and accounts for the panel structure of the data where each respondent made several

Table 3
Rainfed crop and irrigated & permanent crop farmers characteristics.

	Rainfed crop farmers (n = 116)					Irrigated & permanent crop farmers (n = 132)				
	Avg	min	max		sd	Avg	min		max	sd
Age (years)	46.7	18	75		12.4	48.5	21		72	11.5
Agricultural area (ha)	185	15.8	609		144	91.1	1.5		590	119
	Male		Female			Male			Female	
Gender (%)	95.7		4.3			91.7			8.3	
Succession (% yes)	53.7					50.0				
Income from agriculture (%)	0%–25%	25%–50%	50–75%		75–100	0%–25%	25–50%		50%–75%	75–100
	5.2	19.8	16.4		58.6	8.3	15.9		9.9	65.9
Education	1	2	3	4	5	1	2	3	4	5
	1.7	14.7	5.2	59.5	19.0	0.8	23.5	14.4	45.5	15.9

Education levels: 1 = no studies; 2 = primary school; 3 = secondary school; 4 = bachelor or professional training; 5 = university or higher.

choices (Train, 2003). We assumed the error terms are independently and identically distributed with a Gumbel (Extreme Value Type I) distribution and we kept the payment coefficient fixed across individuals to ensure that the WTA estimates take the same distribution as the attribute's coefficients (Revelt and Train, 1998; Scarpa et al., 2008). We expected that some attributes may be interdependent for a given individual, thus the correlation structure of β_n was assumed to follow a multivariate normal distribution (De-Magistris et al., 2013; Scarpa and Del Giudice, 2004). We estimated the Random Parameter Logit Model with correlated coefficients using *Nlogit* software (v. 6).

We examined the relation between individuals preferred eco-scheme choices (dependent variable) and the levels of the attributes in the alternatives they chose, *i.e.*, *Surface allocated to pollinators' biodiversity*, *Reduction of pesticides*, *Recommendation* and *Payment* (independent variables). The effect of the attributes on choice probability was evidenced by parameter estimates. The sign of a parameter value showed the extent to which the presence of an attribute in each eco-scheme influenced the probability of choosing it. When estimates for the elements of the Cholesky matrix are statistically significant, dependence across utilities can be taken into consideration (Bazzani et al., 2017). Finally, the marginal willingness to accept for an attribute can be estimated as the negative ratio between the coefficient estimated for that attribute and the *Payment* coefficient. We run the model for both samples (rainfed and irrigated & permanent crops).

Additionally, we run the RPLM assuming correlation across coefficients using the environmental concern as covariate to study the role of environmental attitudes in influencing farmers willingness to accept eco-schemes. To include the environmental concern in the econometric model, we use the punctuation of each individual for the validated NEP scale (Dunlap, 2008) by calculating the averaged score of the items as in Barreiro-Hurle et al. (2023). We finally included 5 of the 6 items of the original NEP scale; the first statement of the NEP scale was removed from the analysis due to more than 20% of "Don't know/Don't answer" responses.

The attitudinal dimension was mean centered by subtracting the overall mean from the NEP score of each individual so that the "average" environmental concern had a mean of zero (Bazzani et al., 2017; Van Loo et al., 2015). To incorporate individuals' environmental concern as a possible source of additional heterogeneity in farmers' preferences we introduced an interaction term in the utility function following Bazzani et al. (2017), as follows:

$$\begin{aligned} U_{njt} = {} & ASC + \beta_1 \mathrm{PAYMENT}_{njt} + \beta_2 \mathrm{SURFACE}_{njt} + \beta_3 \mathrm{PESTICIDES}_{njt} \\ & + \beta_4 \mathrm{RECOMMEND}_{njt} + \beta_5 \mathrm{PAYMENT}_{jt} \times \mathrm{NEP}_n + \beta_6 \mathrm{SURFACE}_{jt} \times \mathrm{NEP}_n \\ & + \beta_7 \mathrm{PESTICIDES}_{jt} \times \mathrm{NEP}_n + \beta_8 \mathrm{RECOMMEND}_{jt} \times \mathrm{NEP}_n + e_{nj} \end{aligned}$$

where $\beta 5$, $\beta 6$, $\beta 7$, $\beta 8$ are the coefficients of the interaction terms between the attributes PAYMENT, SURFACE, PESTICIDES, RECOMMEND and the individual NEP score. The non-monetary attribute coefficients $\beta 1$, $\beta 2$, $\beta 3$ and $\beta 4$ are assumed to be random, following a normal distribution. In summary, following Bazzani et al. (2017), the present study employs a RPLM with correlated factors to account for individual variation in preferences. By incorporating interaction terms, the model is able to test whether the environmental concern (NEP scale) can account for the variation in farmers' preferences for the eco-schemes. As noted in Hensher et al. (2015) and Lancaster (1966), the covariate itself does not contribute directly to the utility that an individual derives from an option. Rather, the covariate acts as a proxy for underlying factors that influence preferences. In this way, it helps the model to capture the varying preferences of different groups in the population based on those characteristics.

3. Results

3.1. Farmers willingness to accept eco-schemes

Tables 4 and 5 present the results of the econometric model and Fig. 1 displays the calculation of farmers' willingness to accept for each attribute level, without covariates. We found that all attributes (*Surface allocated to pollinators' biodiversity*, *Reduction of pesticides* and *Recommendation*) were significant to explain farmers' preferences for both rainfed (Table 4) and irrigated & permanent crops (Table 5) samples. The significant values of the standard deviation of all parameters point to the need to consider heterogeneity when assessing farmers' preferences for pollinators' eco-schemes. Moreover, farmers also took the *No-choice* and *Payment* into consideration when choosing for their preferred eco-scheme. The negative sign in the *No-choice* indicates that farmers' utility from choosing any of the presented eco-schemes was higher than not choosing them, that is, they value negatively staying in the *No-choice* situation.

Regarding rainfed crop farms, the *Surface allocated to pollinators' biodiversity* is statistically significant for 12% and 15% levels ($P = 0.001$). This result means that a small increase (from 7% to 10%) in the surface dedicated to pollinators did not affect farmers' preferences, but an increase to 12% and 15% negatively affected farmers willingness to implement the eco-scheme, thus increasing the WTA 30-42€on average (Table 4 and Fig. 2). All levels of restriction in the use of pesticides had a negative effect on farmers' WTA, raising the payment from 35€for a 50% reduction to 170€on average for a full reduction (Table 5 and Fig. 2). The *Recommendation* attribute had a weaker influence than the other attributes of the experiment, albeit farmers were more willing to implement the eco-scheme when advised by the cooperative ($P = 0.01$), decreasing the payment around 8€on average (Table 4 and Fig. 2).

Regarding irrigated & permanent crops farms, only the 6% level of surface dedicated to pollinators' biodiversity was significant. A small increase (from 4% to 6%) in the surface dedicated to pollinators positively affected farmers' WTA the eco-scheme, reducing the payment around 33€on average. However, scenarios with higher surfaces (8% and 10%) did not affect their choice (Table 5 and Fig. 2). All restrictions

Table 4
Rainfed crop farmer sample – Results of the Random Parameter Logit model with correlation estimates.

Parameter	Coefficient	Probability error	Standard deviation	Z-value	|z| >Z*
Random parameters in utility functions					
10% pollinators' surface	0.064	0.277	0.681*	0.23	0.817
12% pollinators' surface	−1.468***	0.273	1.880***	−5.39	0
15% pollinators' surface	−1.066***	0.257	1.645***	−4.15	0
50% phytosanitary reduction	−1.198***	0.297	4.173***	−4.04	0.0001
75% phytosanitary reduction	−2.605***	0.340	4.349***	−7.66	0
100% phytosanitary reduction	−5.454***	0.612	6.623***	−8.91	0
Farmers recommendation	0.205	0.219	0.763***	0.94	0.348
Cooperatives recommendation	0.549*	0.331	1.672***	1.66	0.097
Public institutions recommendation	−0.419	0.281	1.097***	−1.49	0.136
No choice	−1.334**	0.524	4.300***	−2.54	0.011
Non-random parameters in utility functions					
Payment	0.029***	0.002		15.71	0

Notes: ***, **, * = Significance at 1%, 5%, 10% level. Nº respondents = 116. Nº observations = 1392. Log likelihood = −905.72242. Restricted log likelihood = −1929.72175. Significance level = 0.000. McFadden Pseudo R-squared = 0.53. Inf.Cr.AIC = 1943.4. AIC/N = 1.396. BIC = 2289.2. BIC/N = 1.645.

Table 5
Irrigated & permanent crop farmer sample – Results of the Random Parameters Logit Model with correlation estimates.

Parameter	Coefficient	Probability error	Standard deviation	Z-value	|z| >Z*
Random parameters in utility functions					
6% pollinators' surface	0.572**	0.247	0.448*	2.32	0.020
8% pollinators' surface	−0.211	0.229	1.371***	−0.92	0.357
10% pollinators' surface	−0.101	0.262	1.259***	−0.38	0.701
50% phytosanitary reduction	−2.329***	0.418	4.102***	−5.57	0
75% phytosanitary reduction	−3.169***	0.388	3.986***	−8.16	0
100% phytosanitary reduction	−3.723***	0.398	5.970***	−9.36	0
Farmers recommendation	0.140	0.227	1.206***	0.61	0.539
Cooperatives recommendation	0.594**	0.295	1.278***	2.01	0.044
Public institutions recommendation	−0.128	0.266	1.152***	−0.48	0.630
No choice	−1.524***	0.436	6.237***	−3.5	0.001
Non-random parameters in utility functions					
Payment	0.016***	0.001		13.47	0

Notes: ***, **, * = Significance at 1%, 5%, 10% level. Nº respondents = 132. Nº observations = 1584. Log likelihood = −1100.34031. Restricted log likelihood = −2195.89027. Significance level = 0.000. McFadden Pseudo R-squared = 0.50. Inf.Cr.AIC = 2332.7. AIC/N = 1.473. BIC = 2686.9. BIC/N = 1.696.

in the use of pesticides were significant (P = 0.001). This resulted in an increment of payment from 152€(50% reduction) to 330€(full reduction) (Table 5 and Fig. 2). Like the rainfed crop farms, when farming cooperatives advised the eco-scheme farmers were more willing to adopt it, reducing the payment by around 37€(Table 5 and Fig. 2). The recommendations from other stakeholder groups did not influence farmer choices.

Fig. 2 shows the WTA heterogeneity for all the attribute levels in both rainfed and irrigated & and permanent crops samples. Overall, the rainfed sample showed lower levels of heterogeneity (boxes height in Fig. 2). Rainfed farmers showed higher WTA for the surface attribute, while irrigated and permanent crop farmers showed higher WTA for pesticides. The two samples presented similar WTA for the attribute *Recommendation* (Fig. 2).

3.2. Farmers' environmental concerns and WTA eco-schemes

Both samples presented high levels of environmental concerns, with around 50 to 75% of farmers agreeing or completely agreeing with pro-environmental statements and disagreeing with the anti-environmental statement (Fig. 3).

Tables 6 and 7 present the results of the econometric model including NEP as covariate. Fig. 4 shows the farmers' WTA for each attribute level. As above, we found that the attributes *Surface allocated to pollinators' biodiversity* and *Reduction of pesticides* were significant for both rainfed (Table 6) and irrigated & permanent crops (Table 7) samples. However, the attribute *Recommendation* was only significant for irrigated & permanent crops farmers (Table 7). The significant values of the standard deviation of all parameters (Tables 6 and 7) points that heterogeneity needs to be considered to assess farmers' preferences for a pollinators' eco-scheme also when including their degree of environmental concern. As before, farmers took into consideration the *No-choice* scenario and *Payment* attribute when choosing between eco-schemes.

Regarding the interaction between farmers' environmental concerns and attribute levels, we found a significant and positive relationship with the largest level of surface devoted to pollinators (15% in the rainfed sample; 8% and 10% in the irrigated & permanent crops sample). Also, with all levels of *Reduction of pesticides* in both samples, and with the *No-choice* in the irrigated & permanent crops sample (Tables 6 and 7). This positive relation was also present in the *No-choice* scenario, signaling that irrigated & permanent crops farmers with pro-environmental values are more inclined to not selecting any of the presented eco-schemes. There was a negative relationship between NEP and the attribute *Recommendation* from the cooperative in the irrigated & permanent crops sample, indicating that farmers with higher environmental concerns do not trust cooperatives for recommending the eco-scheme.

Concerning the rainfed crop farms sample, the variable of *Surface allocated to pollinators' biodiversity* is significant for 12% and 15% (P = 0.001), increasing the payment 34-47€on average to engage them (Table 6 and Fig. 4). However, the higher degree of environmental concern of the farmers the lower the payment to accept leaving 15% of land to pollinators. As before, the restrictions in the use of pesticides raised the payment from 45€to 190€for 50% to a complete reduction, respectively. Higher pro-environmental concerns decreased the payments. No level was statistically significant for the attribute *Recommendation*.

Concerning the sample of irrigated & permanent crops farms, the 8 and 10% of surface dedicated to pollinators' biodiversity were significant (P = 0.01) (Table 7), increasing the payment an average of 51–57€(Fig. 4). Contrarily, dedicating a 6% of land instead of the

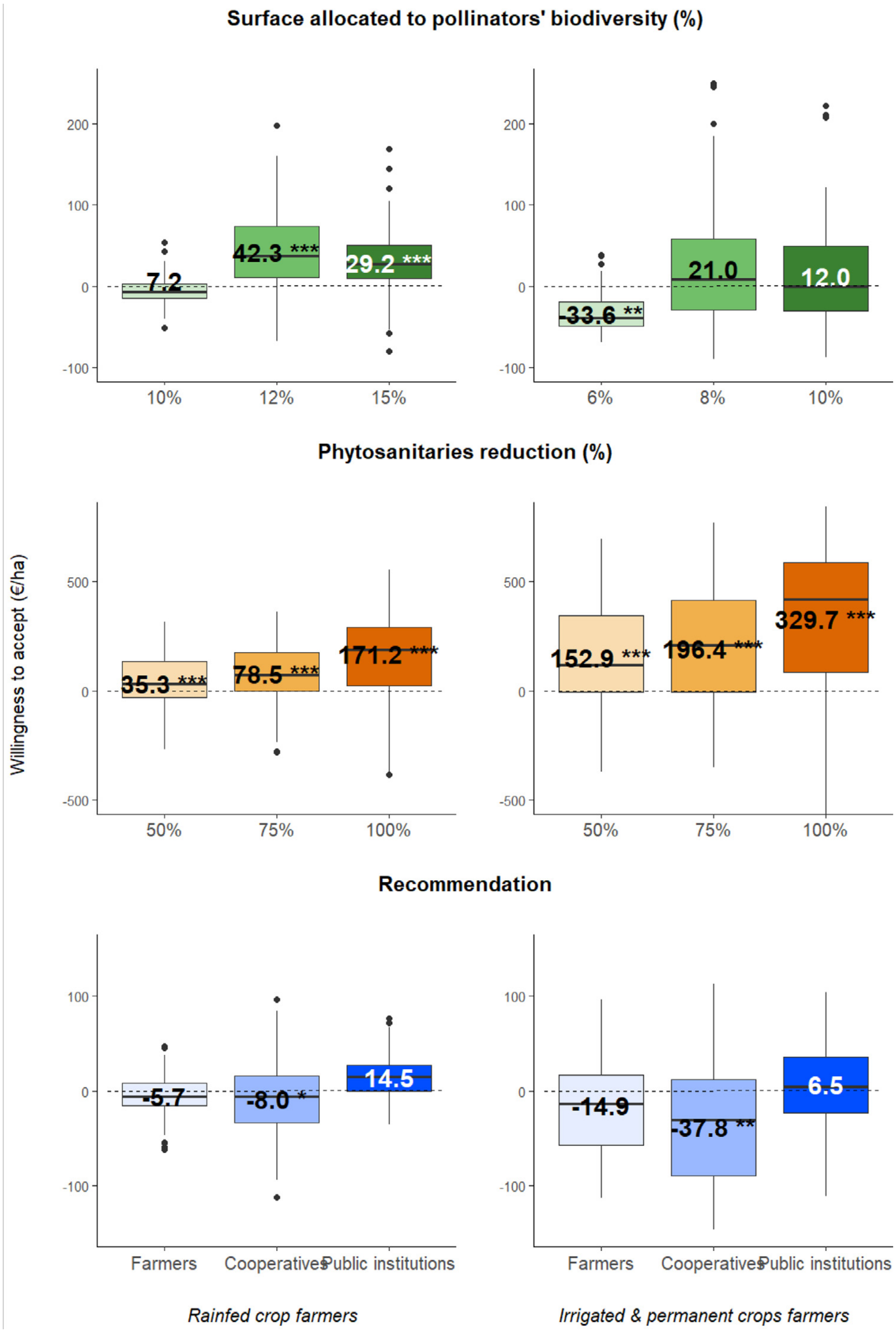

Fig. 2. Farmers' willingness to accept payments for implementing pro-pollination practices. Asterisks refer to the significance in the Random Parameter Logit Models. Boxplots represent the farmers (points), mean (value), median (solid horizontal lines), first and third quartiles (boxes) and dispersion (vertical lines).

current 4% decreased 30€the payment. All restrictions in the use of pesticides are significant (P = 0.01), raising WTA from 191€to 608€for a 50% and 100% reduction, respectively. Peer farmers recommending the eco-scheme reduced an average of 24€the WTA.

Fig. 4 shows the heterogeneity of WTA when including NEP in the models. Overall, the irrigated & and permanent crops farms sample showed higher levels of heterogeneity (boxes height in Fig. 4). Regarding the influence of attributes in WTA, both samples show similar results in the surface dedicated to pollinators, except the 6% level in the irrigated & permanent crop sample, where the WTA was negative. The reduction of pesticides stands out as the costliest practice. Peer farmer recommendation influenced irrigated & and permanent crops' farmers reducing the necessary payment for farmers to implement the practices.

4. Discussion

In this study, we designed and tested an eco-scheme for pollinator conservation that promotes agricultural practices (*i.e.*, saving land for biodiversity and reducing the use of pesticides) that are currently targeted separately in other eco-schemes. Following the state of the art, we included the source of recommendation of the eco-scheme and the environmental concerns of the farmer in the analysis.

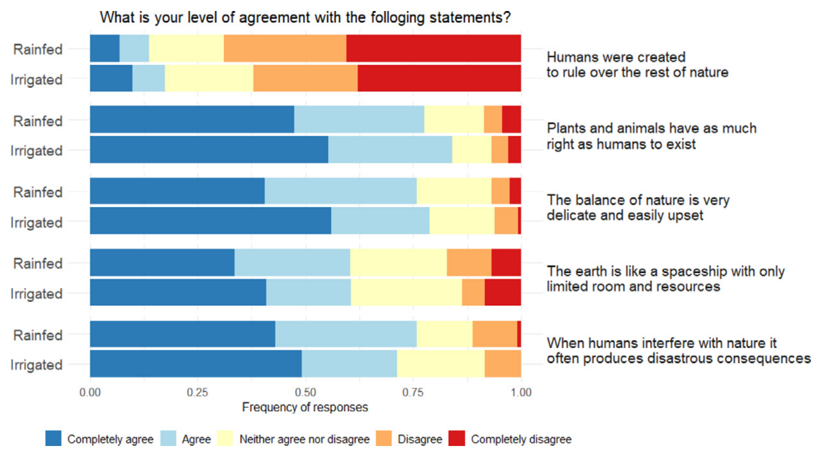

Fig. 3. Farmers' responses to the statements of the New Environmental Paradigm (NEP) scale. Data depicts farmers' responses to 5-point Likert scale statements. N = 248 farmers (116 rainfed and 132 irrigated & permanent crop).

Table 6
Rainfed crop farmer sample – Results of the Random Parameters Logit Model with correlation estimates with New Environmental Paradigm (NEP) scale as covariate.

Parameter	Coefficient	Probability error	Standard deviation	Z-value	|z| >Z*
Random parameters in utility functions					
10% pollinators' surface	−0.356	0.291	0.678**	−1.22	0.222
12% pollinators' surface	−1.868***	0.284	1.891***	−6.57	0
15% pollinators' surface	−1.429***	0.257	1.487***	−5.56	0
50% phytosanitary reduction	−1.424***	0.299	4.288***	−4.75	0
75% phytosanitary reduction	−2.683***	0.346	4.512***	−7.76	0
100% phytosanitary reduction	−5.633***	0.632	6.394***	−8.92	0
Farmers recommendation	0.164	0.243	0.828***	0.67	0.501
Cooperatives recommendation	0.544	0.358	1.558***	1.52	0.129
Public institutions recommendation	−0.194	0.292	1.041***	−0.66	0.506
No choice	−0.875*	0.510	6.747***	−1.72	0.086
Non-random parameters in utility functions					
Payment	0.028***	0.002		16	0
Heterogeneity in mean, Parameter:NEP (only significant interactions shown)					
15% pollinators' surface	0.633**	0.31482		2.01	0.044
50% phytosanitary reduction	0.732*	0.38016		1.93	0.054
75% phytosanitary reduction	1.193***	0.41141		2.9	0.004
100% phytosanitary reduction	1.655***	0.52244		3.17	0.002

Notes: ***, **, * = Significance at 1%, 5%, 10% level. Nº respondents = 116. Nº observations = 1392. Log likelihood = −904.63512. Restricted log likelihood = −1929.72175. Significance level = 0.000. McFadden Pseudo R-squared = 0.53. Inf.Cr.AIC = 1961.3. AIC/N = 1.409. BIC = 2359.4. BIC/N = 1.695.

Table 7
Irrigated & permanent crops sample – Results of the Random Parameters Logit Model with correlation estimates with New Environmental Paradigm (NEP) scale as covariate.

Parameter	Coefficient	Probability error	Standard deviation	Z-value	|z| >Z*
Random parameters in utility functions					
6% pollinators' surface	0.428*	0.234	0.296	1.83	0.067
8% pollinators' surface	−0.918***	0.194	1.348***	−4.73	0
10% pollinators' surface	−0.956***	0.212	1.686***	−4.51	0
50% phytosanitary reduction	−3.563***	0.361	4.476***	−9.88	0
75% phytosanitary reduction	−4.926***	0.425	5.451***	−11.6	0
100% phytosanitary reduction	−9.964***	1.172	9.126***	−8.5	0
Farmers recommendation	0.394*	0.220	0.911***	1.79	0.073
Cooperatives recommendation	0.509	0.334	0.927***	1.53	0.127
Public institutions recommendation	−0.233	0.301	0.971***	−0.77	0.439
No choice	−1.444***	0.369	5.721***	−3.91	0.0001
Non-random parameters in utility functions					
Payment	0.015***	0.001		13.53	0
Heterogeneity in mean, Parameter:NEP (only significant interactions shown)					
8% pollinators' surface	0.653**	0.310		2.11	0.035
10% pollinators' surface	0.875***	0.299		2.93	0.003
50% phytosanitary reduction	1.068***	0.381		2.8	0.005
75% phytosanitary reduction	1.178***	0.412		2.86	0.004
100% phytosanitary reduction	1.599***	0.538		2.97	0.003
Cooperatives recommendation	−0.649**	0.323		−2.01	0.044
No choice	0.986**	0.438		2.25	0.025

Notes: ***, **, * = Significance at 1%, 5%, 10% level. Nº respondents = 132. Nº observations = 1584. Log likelihood = −1100.34031. Restricted log likelihood = −2195.89027. Significance level = 0.000. McFadden Pseudo R-squared = 0.50. Inf.Cr.AIC = 2332.7. AIC/N = 1.473. BIC = 2686.9. BIC/N = 1.696.

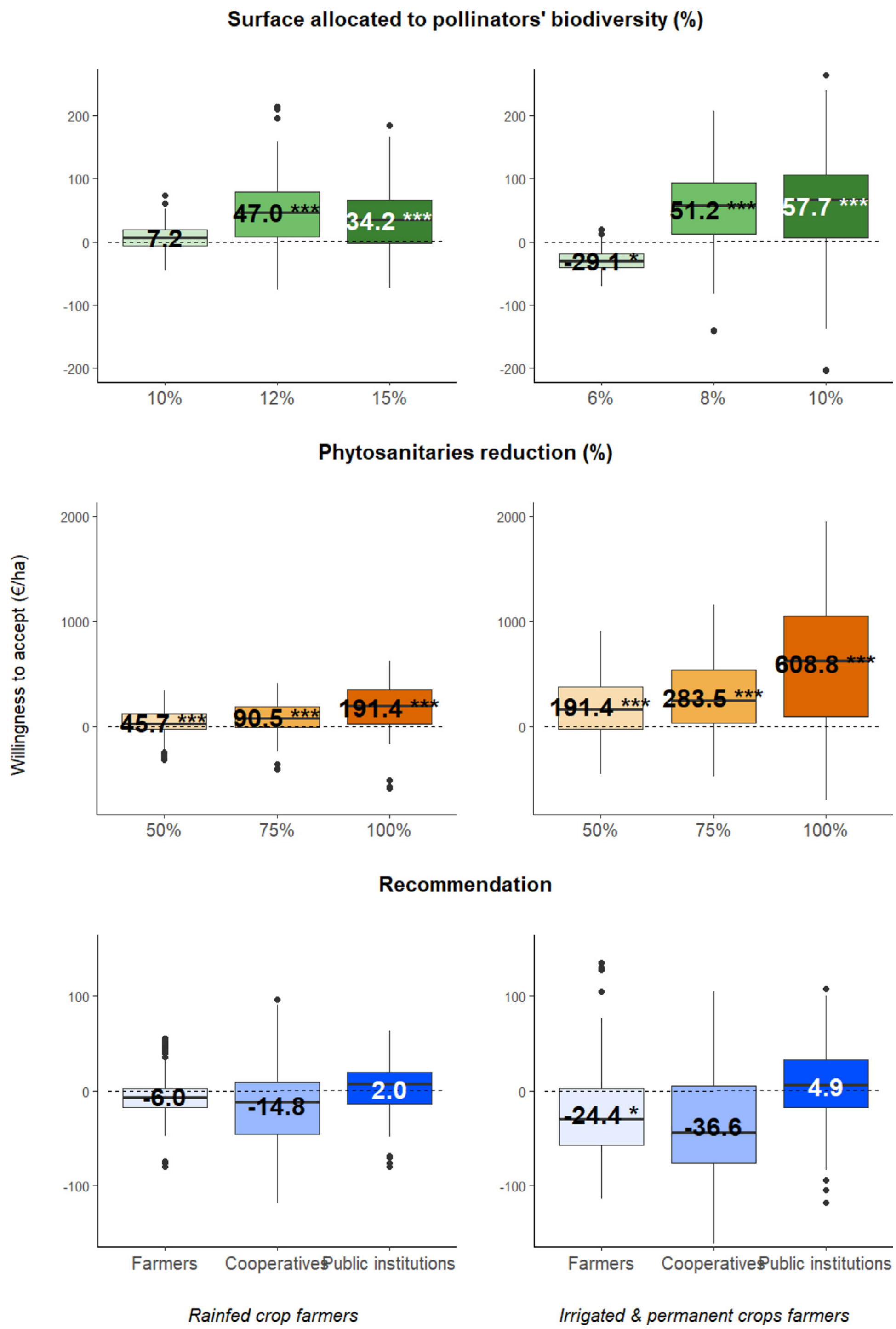

Fig. 4. Farmers' willingness to accept payments for implementing pro-pollination practices with New Environmental Paradigm (NEP) scale as covariate. Asterisks refer to the degree of significance of the attribute level in the Random Parameter Logit Models presented above (Tables 4 and 5). Boxplots represent the farmers (points), mean (value), median (solid horizontal lines), first and third quartiles (boxes) and dispersion (vertical lines). The dashed horizontal line marks the zero.

We first discuss our results in light of previous studies on farmers' WTA agricultural practices and current data about the implementation of the eco-schemes program. Next, we discuss our findings related to the effects of environmental concerns and social dynamics on farmers' willingness to uptake the proposed eco-schemes.

4.1. An eco-scheme to enhance pollinators' conservation

Farmers were willing to uptake agricultural practices to enhance the conservation of pollinators if they are paid for it, as found by other studies measuring farmers' WTA environmental agricultural practices (Weituschat et al., 2023a). The required payment varies both with the specific practice (land spared for pollinators and reduction of pesticides) as well as the farming system (rainfed vs irrigated & permanent crops). In general, our results indicate that pesticides are perceived as key to farm profitability under the current production model, *i.e.* production inputs are a more limiting factor than land itself. Therefore, a policy based on land sparing may be cheaper and more acceptable to farmers than a policy aimed at pesticide reduction. The differences between cropping systems can be related to intrinsic characteristics of each system, such as the productivity gap between rainfed and irrigated crops (Fereres and Soriano, 2007), the level of dependence on pesticides and other inputs, and the integrated technological packages that can hamper management modifications (Pimbert, 2017; Pimentel, 2005; Popp et al., 2013; Wilson and Tisdell, 2001). These results are particularly relevant given the current CAP eco-schemes in Spain also treats those systems separately (PEPAC, 2021).

4.1.1. Agricultural land for pollinators

Rainfed farmers accepted to increase the agricultural land for pollinators from the current 7% (PEPAC, 2021) to 10% without requiring any extra payment. According to informal conversations during surveys, this may be related to the fact that many rainfed crops are cultivated in small plots, being relatively easy to leave marginal or less-productive plots for pollinators. This also means that farmers do not perceive a relevant difference in the economic and management impact of leaving 7% or 10% of land to pollinators. This is promising, as it indicates that the eco-schemes could be more ambitious in terms of land enrolled at no extra cost. Also, although farmers require 30 and 42€/ha/year extra payment to devote 12% and 15% of their agricultural land to conservation, respectively, these figures fall within the budget of the current biodiversity eco-scheme in Spain (PEPAC, 2021).

Irrigated & permanent crop farmers are not sensitive to increases in the surface allocated to pollinators; they are even willing to leave larger surfaces than the current 4% for a lower annual payment. These results are unexpected given the high productivity per area of rainfed crops, but, according to follow-up data on the implementation of eco-schemes in Spain, around 47.000 farmers (both rainfed and irrigated) have adopted more demanding practices than those required by the eco-scheme (https://www.mapa.gob.es/es/pac/pac-2023-2027/seguimiento-y-evaluacion.aspx). Two factors may contribute to explain this. First, many permanent crops are highly dependent on pollinators, so farmers might indeed be just protecting their productivity (Pérez-Méndez et al., 2020). Second, farmers may prefer to reduce their agricultural land (*i.e.*, converting least productive plots) than to change their phytosanitary practices (*i.e.*, in highly productive crops), which could imply larger losses (as we will discuss below).

Overall, farmers' WTA saving agricultural land for pollinators' conservation is similar or lower than the actual payment of the CAP eco-scheme for biodiversity conservation in Spain, which was 46€/ha (https://www.fega.gob.es/es/pepac-2023-2027/ayudas-directas/ecorregimenes/iu-definitivos-2023-ecorregimenes). Therefore, the uptake of the eco-scheme should be relatively easy in terms of agricultural land, which is also in line with the choice of eco-schemes by farmers in Spain, where 88% of the agricultural land was under an eco-scheme in 2024 (https://www.mapa.gob.es/es/prensa/240731solicitudesayudaspac_tcm30-690938.pdf). Additionally, the similar patterns of farmers in our sample and in Spain implementing more demanding practices than those required suggest that our results could be representative of Spanish farmers in terms of their attitudes toward a pollinator eco-scheme.

4.1.2. Reduction of pesticides

The WTA of farmers in rainfed crops to reduce pesticide use by 50% is also within the budget of the current Spanish biodiversity eco-scheme (PEPAC, 2021). Therefore, the proposed eco-scheme could integrate the Farm to Fork goal of a 50% reduction of pesticides to the current environmental demands of the CAP without increasing the necessary budget. However, this is not the case for irrigated & permanent crop farmers, or for greater (75%) or complete elimination of pesticides, which farmers would only accept at massive payments. This is consistent with previous evidence showing that pesticide use can be reduced to certain levels without compromising yields (Sutherland et al., 2021). Our results show that under certain payment levels, risk aversion toward pests (Azadi et al., 2019; Menapace et al., 2013) could be tackled to promote more sustainable agricultural management. However, it should be noted that there is likely to be a gap between farmers' stated willingness to reduce pesticide use and their actual behavior (Vogel, 1996). This gap could be particularly large in Spain, where pesticide use is among the highest in the European Union (EUROSTAT, 2024).

In the case for a full reduction of pesticides, farmers would require a substantial payment (far above current budgets) to uptake the measure, as also found in other European areas (Bakker et al., 2021; Weituschat et al., 2023a). A total elimination of pesticides would not only introduce additional complexities into agricultural management, potentially leading to a reduction in yields or even the loss of the harvest (Nipers et al., 2024), but it would also entail a fundamental shift in the business model toward alternative farming systems such as organic or agroecological production. Mainstream farmers' business models align with the agrobusiness model, characterized by an integrated technological package that includes specific seeding, fertilizing, and plant protection practices (Bernstein, 2016; Horlings and Marsden, 2011; McMichael, 2023, 2009; Pingali, 2012). The interdependence of practices within the package constitutes a strong lock-in that impedes changing one of those practices without changing the others (Magrini et al., 2016). Such interdependence is particularly intense in irrigated & permanent cropping systems, which may explain why we found a stronger resistance in that type of system as compared to rainfed cropping systems.

4.2. Farmers environmental attitudes and sources of eco-schemes recommendation

As expected, the higher the degree of environmental concern of the farmer, the more probable they selected more environmentally-demanding alternative levels in the eco-scheme. This result is consistent with previous studies (Bloom et al., 2021; Hevia et al., 2021; Willock et al., 1999). For instance, Bakker et al. (2021) found that farmers' environmental considerations facilitated their intention to reduce pesticide use. However, we also found that farmers with higher environmental concerns were more prone to not selecting any of the alternative eco-schemes presented. This seems to contradict that these same environmentally concerned farmers tended to choose more sustainable practices, as revealed by the positive relation between a farmer's environmental concern and the selection of more ambitious practices in the RPLM with NEP as covariate, and in line with the references abovementioned. Yet, such no-choice decision may be related to other issues, like farmers' attitudes toward formal contracts (Solazzo et al., 2020).

Additionally, certain pro-environmental segments of the general population are more willing to support farmers for the ecosystem services that these practices provide (Rodríguez-Ortega et al., 2016). This opens an opportunity to further connect farmers and consumers through products based on extrinsic quality attributes, *i.e.*, those that depend on the way food is produced (Bernués et al., 2003). Farmers receive advice about agricultural management from a variety of sources, including peers, cooperatives, public institutions, and other stakeholders. It stands to reason that the higher the trust in a particular source, the more likely farmers are to follow its advice (Rust et al., 2022; Toma et al., 2018). In our case, the positive influence of cooperatives on farmers' acceptance of eco-schemes is understandable given the high trust Spanish farmers place in cooperatives, farming organizations, and other farmers (Martin-Collado et al., 2023). Cooperatives play an important advisory role in Spain. Traditionally associated with agricultural innovation and extension services, such a role has transitioned into a supporting role to farmers in the application to Common Agricultural Policy payments. In this more recent role as intermediaries, cooperatives are known for having a more sophisticated understanding of regulations than other actors (Schomers et al., 2015). Similar results have been found in North Italy, where farmers belonging to a cooperative were more likely to implement sustainable practices (Rossi et al., 2023). Trust in peer farmers only appears in one of the tested models, suggesting that trust on peers is less robust than trust on cooperatives when it concerns the adoption of new pro-environmental practices. Our findings confirm this pattern and shed light on the potential of cooperatives to take a more proactive role as promoters of agri-environmental schemes and sustainability transitions in European rural areas (Dedeurwaerdere et al., 2015). Interestingly, farmers with higher environmental concerns were less likely to implement the eco-scheme if recommended by a cooperative, which confirms the added value that cooperatives target members with lower environmental concerns.

Previous studies have shown that farmers tend not to trust the advice of public institutions (Martin-Collado et al., 2023), that official contracts with public authorities undermine the participation in agri-environmental schemes (Christensen et al., 2011; David et al., 2018), and that the science-policy interface should be reinforced to increase the sustainability of food systems (Caro, 2023). However, in our study the recommendation of public institutions had no significative influence on farmers' acceptance of the pollinators' eco-scheme. This raises concerns about the role that public authorities should have regarding the implementation of the eco-schemes and other public CAP measures. Further research shall clarify whether trust on governmental organizations is conditional on other attributes of the schemes and whether farmer organizations, like cooperatives, should ally with governments and have a stronger role in fostering farmer uptake of pro-environmental practices sponsored by eco-schemes as suggested by other authors (Hasibuan et al., 2023; Sutherland et al., 2013).

5. Conclusions

We designed a payment for ecosystem services for pollinator conservation within the framework of the Common Agricultural Policy. In the Autonomous Region of Aragon, Spain, farmers are willing to adopt agricultural practices to protect pollinators if they are paid for doing so. This is particularly true for the practice of sparing farmland for pollinator conservation, where farmers would accept even more demanding practices within the current Spanish unitary payments.

Regarding the reduction of pesticide use, only a 50% pesticides reduction in rainfed crops was within current Spanish unitary payments. The financial compensation that farmers would require for the complete elimination of pesticides is far beyond the budgetary limits of current eco-schemes. Farmers' preference for a high payment to reduce or eliminate pesticides was more drastic in rainfed & permanent crops than in rainfed crops. The inherent differences between cropping systems (higher productivity and dependence on off-farm inputs of irrigated & permanent crops) make it more challenging for farmers with more intensive production to abandon pesticides.

The higher the farmer pro-environmental attitude (measured through the revised New Environmental Paradigm scale), the more likely they were to select more environmentally-demanding alternative levels (both for sparing agricultural land and reducing pesticides) in the eco-scheme to favor pollinator conservation. Which stakeholder recommended to implement the eco-scheme was significant to understand farmers' willingness to accept. In particular, lower payments were required when a cooperative recommended the eco-scheme. Cooperatives could play an active role as intermediaries in promoting the adoption of more sustainable agricultural practices.

The eco-scheme presented here could be readily implemented within CAP eco-schemes while also considering the objectives of other sectoral policies, such as the European Pollinators Initiative, the Biodiversity Strategy 2030 and the Farm to Fork Strategy.

CRediT authorship contribution statement

Enrique Muñoz-Ulecia: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Pilar Uldemolins:** Writing – review & editing, Software, Formal analysis, Data curation, Conceptualization, Methodology. **Alberto Bernués:** Writing – review & editing, Conceptualization, Supervision. **Tiziana de-Magistris:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Conceptualization. **Sergio Villamayor-Tomás:** Writing – review & editing, Conceptualization. **Daniel Martín-Collado:** Writing – review & editing, Supervision, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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During the preparation of this work, the author(s) used the online AI-based tool DeepL to improve readability and language. Atier using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

Appendix

Data of the current distribution taken from the Department of Agriculture, Livestock and Food of Aragón Autonomous Community.

Data availability

All data is available at http://hdl.handle.net/10532/7154.

Table A.1
Survey representativeness based on current number of farms versus sampled farms. Raw number and (percentage).

Crops	Current distribution			Sampled population		
	Huesca	Teruel	Zaragoza	Huesca	Teruel	Zaragoza
Grains	6838 (20.4%)	4045 (12.1%)	8453 (25.2%)	19,7%	8,4%	29,0%
Permanent	2442 (7.3%)	3329 (9.9%)	7786 (23.2%)	10,1%	5,0%	25,2%
Pastures	271 (0.8%)	230 (0.7%)	168 (0.5%)	0,8%	0,8%	0,8%

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