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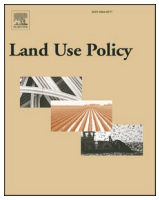

A European perspective on acceptability of innovative agri-environment-climate contract solutions

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ABSTRACT

The agri-environment-climate measures of the European Union Common Agricultural Policy are incentives aiming to reduce negative environmental impacts and increase positive effects generated from agriculture. Several criticisms have been addressed to their efficiency and effectiveness and thus, the design of innovative contract solutions is currently suggested. Among the novel contractual solutions, there are result-based payments, collective implementation of measures, the engagement of private and business actors in value chains, and new forms of land tenure systems coupled with environmental clauses. Little is known about the factors at interplay influencing farmers' decision to uptake such contracts. The present paper investigates the acceptability determinants of the above-mentioned novel contractual solutions concerning a sample of nearly 1900 farmers from 10 European Union countries. The analysis is based on a questionnaire built through a common research framework. We apply ordered logistic regressions: both proportional and partial proportional odds models are used. Farmers' preferences are interpreted by splitting the innovative contractual solutions into 13 individual contractual features which are then modeled in combination with the structural characteristics of the farms and the sociodemographic and behavioral characteristics of the farmers. We estimate farmers' willingness to enroll in result-based, collective, value-chain, and land tenure contracts and highlight the positive and negative factors potentially influencing farmers' acceptability of each type of contract.

1. Introduction

As agriculture simplifies ecosystems' resources and services to optimize food production (Nyström et al., 2019), trade-offs with supporting, regulating, and cultural services (Millennium Ecosystem Assessment (Program), 2005; de Groot et al., 2010) and the supply of agri-environmental climate public goods (AECPGs) arise, being commonly acknowledged nowadays (Foley et al., 2005; Pagliacci and Zavalloni, 2023; Zhang et al., 2007). To date, the supply of services related to biodiversity, water, and amenities from agricultural areas is under threat or in negative trends (Verburg et al., 2006; European Environment Agency, 2021), in particular where historic human-environment interactions have generated distinctive agro-ecological systems (Debolini et al., 2018).

Worldwide, among the most well-known target incentives aiming to reduce negative environmental impacts and increase positive effects

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generated from agriculture, there are the agri-environment-climate measures (AECMs) of the European Union (EU) Common Agricultural Policy (CAP) (Hanley et al., 2012; White and Hanley, 2016). AECMs are voluntary measures defined as a commitment on which there are incentives attached, compensating farmers for the income losses deriving from the adoption of environment-friendly practices. The environmental ambition is also mirrored in the CAP budget earmarked for AECMs with at least 35% of the rural development budget and 25% of the direct payment budget for eco-schemes (Münch et al., 2023). In this context, we must acknowledge the relevance of the EU as a case study. The EU agricultural sector contributed €215.5 billion towards the EU's overall GDP in 2022 (1.4% of the GDP), with the agricultural industry creating an added value of €220.7 billion, and the output value of €537.5 billion (EUROSTAT, 2023). There are around 11 million farms in the EU, with 22 million people working regularly in farming, while up to 44 million jobs are provided by farming and food sectors combined (EUROSTAT, 2017). Agriculture accounts for 8% of the EU exports (being the fourth voice by sectors) and generates up to 25% of the EU's trade surplus (EUROSTAT, 2017). As per the CAP, it regulates a sector that is almost exclusively supported at the European level (unlike the other sectors of the European economy), setting common rules in a single market, addressing market volatility when needed, providing for a common trade policy, and accounting for almost 40% of the EU budget in the 2014–2020 programming period, while it accounts for 31% for the 2021–2027 period (European Parliament, 2023a).[1]

Despite the massive budget allocation and the solid 'history' of AECMs, a range of criticisms is commonly addressed regarding the efficiency of the CAP in terms of environmental achievements (Pe'er et al., 2022). Moreover, specifically regarding the environmental effects of AECMs, concerns include what follows: 1) there are generally no effects observed for biodiversity and other environmental assets (see, e.g., Kleijn et al., 2011; Batáry et al., 2015; Bartolini et al., 2021); 2) the reported benefits are attributed mainly to maintenance effects and not to actual changes (Uthes and Matzdorf, 2013); 3) there is limited longevity of positive effects (European Court of Auditors, 2011; Biffi et al., 2021; Bullock et al., 2021); 4) the impact of direct payments of the CAP Pillar I eventually overrides AECMs objectives (Bateman and Balmford, 2018).

Improving the contractual design of current AECMs on the one hand, but also supporting and complementing the actual instruments on the other (Herzon et al., 2018; Olivieri et al., 2021) is therefore suggested to foster substantial changes in agricultural practices and improve (long-term) environmental efficiency. To overcome the shortcomings of current AECMs, the literature recognizes the following major design features for improving effectiveness, efficiency, acceptance, and longevity:

- A better spatial, environmental, and cost targeting (Herzon et al., 2018; Schomers and Matzdorf, 2013).
- Enhanced flexibility to enable the adaption of contract solutions to different context situations, conditions, and challenges (Waylen and Martin-Ortega, 2018).
- Better compatibility with the farms' business design (Schmitzberger et al., 2005; Wrbka et al., 2008).
- New measures guaranteeing the stability of participation and the support of the farming community (de Snoo et al., 2013).

A contractual design directly linking payments to the measurement of the environmental benefits achieved (Matzdorf et al., 2008), rather than to specific management measures is expected to increase targeting and cost-effectiveness (Bartkowski et al., 2021; Wuepper and Huber, 2022). Such approaches can moreover provide incentives for entrepreneurial capacity and innovation management by serving the need for higher flexibility in management decision-making among farmers (Allen et al., 2014; Herzon et al., 2018) and, consequently, drive down the costs of commitment over time. Ways towards better spatial and environmental targeting, particularly if environmental improvements can only be reached by addressing the landscape level (e.g., habitat fragmentation, water pollution, etc.) are seen as design elements fostering the collective implementation of agri-environmental measures, leading to coordinated interventions across several landholdings, fitting to the ecological habitat scale of the target species and thus, ensuring 'economies of configuration.' The building of social and cultural capital through learning, knowledge, and information exchange is seen as a further benefit of such solutions, also, being regarded as a driver fostering acceptance and the longevity of effects (Burton and Paragahawewa, 2011; Burton and Schwarz, 2013; Burton et al., 2008). Besides the improved design of public AECMs, new forms of land tenure systems coupled with environmental conditionality might represent promising solutions for reaching long-term environmental objectives, guaranteeing cost-efficiency and longevity, e.g., as follow-up solutions to restoration programs or implementing maintenance management in vulnerable regions. Such systems already exist on a relatively large scale, e.g., in Natura2000 sites, as follow-ups to LIFE+ projects, or as compensation area programs (Schöttker and Wätzold, 2018). Last but not least, to overcome the limitations of public funding, but also to consider the increased consumer interest and willingness to pay, and the related capacity of the market to reward AECPGs and services attached to the production of a specific private good (food) (Manyise and Dentoni, 2021), solutions supporting the engagement of private and business actors are moving into focus and are considered as supplementing beneficial approaches in the CAP programming period 2023–2027. Such solutions also reflect intensified efforts of businesses and value chain key players in highlighting their support for AECPGs provision in consideration of consumer demand for environmental credentials (e.g., certified/organic food), but also in including environmental performance and accounting, as well as social scrutiny into their business strategies.

The potential seen in these approaches is reflected within the CAP Strategic Plans Regulation EU 2021/2115, Article 70 (5) (European Parliament, 2015), encouraging EU Member States to stimulate and endorse e.g., collective arrangements and result-based payment schemes as means of motivating farmers or other beneficiaries to deliver substantial advancements in environmental quality on a larger scale or through quantifiable means. Despite their potential advantages, the suggested new proposals of contractual solutions and the novel contractual design features are different from the contracts known and acknowledged by farmers. Hence, it is to be expected that farmers might find difficulties and constraints in terms of acceptance, adoption, and implementation (Bredemeier et al., 2022).

When considering the AECMs, the literature recognizes different sets of factors influencing either positively, or negatively, their acceptance, adoption, and implementation (Brown et al., 2019). Among them, **farms' characteristics** were the most commonly researched factors: 1) being organic farms or implementing the measures on less productive land (Van Herzele et al., 2013; Zinngrebe et al., 2017); 2) the farm size, i.e., being small farms (Aslam et al., 2017; Walder and Kantelhardt, 2018) or large farms (Zimmermann and Britz, 2016); 3) being less profitable farms or non-oriented towards production (Ruto and Garrod, 2009); 4) or being led by professionals and/or full-time managers (Gatto et al., 2019); 5) technical orientation and land use, since the availability of eligible land is a constraint to contract uptake as well as the fixed costs for changing land use to be compliant with the contract (Espinosa-Goded et al., 2013; Pavlis et al., 2016). Then, there are the farmers' **socio-demographic and behavioral characteristics**: 1) the knowledge or experience of peculiar management practices as well as the education level (Lastra-Bravo et al., 2015; Micha et al., 2015); 2) age (Arata and Sckokai, 2016; Bartkowski and Bartke, 2018); 3) gender (Franzén et al., 2016; Špur et al., 2018); 4) the income and the share of income

[1] Note that the CAP is yet the first voice of expenditure of the EU budget, actually equal to 33.2% of the total financial allocation (European Parliament, 2023b).

generated by the agricultural activity (van Vliet et al., 2015); 5) beliefs and values that can be labeled as 'pro-environment attitudes' (Espinosa-Goded et al., 2010; Micha et al., 2015); 6) a distinct openness or societal-identity (de Krom, 2017; Gabel et al., 2018); 7) the dynamic nature of the latter two groups of 'social' factors (Rose et al., 2018); 8) willing to adopt diversification strategies or trying to reduce risk (Lienhoop and Brouwer, 2015). Third, there are factors related to the **design of the contracts**: 1) the amount of payment (Bock et al., 2013; Alló et al., 2015; Kuhfuss et al., 2015; Le Coent et al., 2017); 2) the prior experience(s) about similar instruments (Rose et al., 2018; Brown et al., 2019); 3) the legitimacy of the State in monitoring and auditing (Kovács, 2015; Micha et al., 2015); 4) the technical support and advice offered (Toderi et al., 2017); 5) the complexity of policy or the administrative burden (Brown et al., 2019); 6) the leverage of sanctions (Zinngrebe et al., 2017).

A major limitation emerging from this state-of-the-art is that it focuses mainly on the existing AECMs, disregarding the above-mentioned new proposals of contract solutions and the novel contractual features envisaged by the EU. Another limitation lies in the fact that, to the best of our knowledge, the (few) existing analyses moving forward concerning the existing AECMs are based mainly on literature reviews complemented with experts' interviews (cf. Drechsler et al., 2017; Rose et al., 2018; Vergamini et al., 2020; Brown et al., 2021). In addition, the determinants of acceptability of these new contract solutions for improved AECPGs provision, whether they are public or private, have not been analyzed comparatively, by using a common research framework (i.e., in the context of the same survey and analysis). Indeed, one element of complexity in addressing this topic is that different contract types are described through a set of novel contractual features, each of which contributes differently to the attractiveness of the contract. Hence, farmers' preferences may be interpreted through the preference for the whole contract solution or the individual contract design features. Splitting contracts' descriptions into individual contractual features may help in understanding what aspects contribute to higher or lower acceptability of the overall contract, but, on the other hand, brings the risk of losing sight of their interaction. In addition, farmers' socio-demographic and farms' characteristics must be considered too, accounting for their (combined) effect on acceptability. Finally, it must be stressed the shortage of wide-EU assessment exercises in this regard (Brown et al., 2021).

Moving from these considerations, the general aim of the present work is to investigate the EU farmers' willingness to enroll in the new proposals of contract solutions. The specific objectives are:

- To coherently define four new forms of contract solutions, namely: result-based (RB), collective (C), value chain-based (VC), and land tenure-based (LT) approaches for improved AECPGs provision through agriculture.
- To set up a common research framework to analyze these new proposals, structuring it on a literature and case study review, followed by a multistep, multi-actor approach of refinement and testing that includes stakeholders across Europe.
- To target a pan-European level of analysis. Namely, we apply this framework to a survey including 1866 farmers from 10 EU Member States, adopting a questionnaire (cf. Appendix A) built upon the abovementioned common research framework.[2]
- To consider several determinants of acceptability by building models that include i) the structural characteristics of the farms, ii) the socio-demographic and behavioral characteristics of the farmers, iii) farmers' preferences for a set of contractual design features. In doing this, we start by considering the determinants already analyzed by the literature on AECMs, assuming they also hold for the new proposals of contract solutions (i.e., value chain-based and land tenure-based approaches).
- To treat all these factors as potentially at interplay. Hence, proper attention is given to the mechanisms through which they interact one each other (cf. Brown et al., 2021; Hammes et al., 2016).
- To apply a quantitative method based on ordered logistic regressions, by adopting both proportional odds models and partial proportional ones. The latter model solution represents a methodological advance since it allows targeting non-proportional effects of the different determinants on the willingness to accept (Williams, 2016).

2. Data and methods

2.1. Methodological approach and questionnaire overview

2.1.1. The common research framework

The common research framework was developed on the one hand to identify and test a set of contractual design features potentially influencing farmers' acceptance of the new proposals of contract solutions. On the other hand, the framework was the basis for the development and presentation of example contract solutions suited for directly testing the acceptance of such approaches. The framework was built and refined through a multistep, multi-actor process that involved stakeholders at the EU level (decision-makers, land managers, wider society, etc.) from the case study countries where the survey was carried out (Viaggi et al., 2022).

The development of such a framework started from a comprehensive view of the interplay between factors that influence the performance of contractual solutions, depicted in Fig. 1. These factors were clustered into three interrelated groups: 'Contract design', 'Mechanisms and impact', and 'System features.' Mechanisms may be described by human behavior and governance processes, comprising the questions of preferences and acceptability.

The basic understanding within the framework is that the overall effectiveness of contract solutions for the AECPGs improved provision can be measured through environmental/ecosystem improvements over time and that this effectiveness can be related to contractual design features and their performance. For example, a performance parameter like longevity is driven by aspects such as the length of the contracts, and the stability of participation, but also by aspects related to education/advice/training/information and the related building of social/cultural capital, and/or the support by the farming community. Acceptance relates to compatibility aspects such as the ease of fit within existing farms (Batáry et al., 2015), but also to attitude to risk, environment, and innovation (Herzon et al., 2018). In addition, the perception of the contract solution has a role in influencing acceptance as participants may consider it unnecessary or even morally questionable (Burton and Paragahawewa, 2011). Profitability is one of the most significant aspects that is considered but it is influenced by payment conditions such as control by authority (including sanctions) (Meyer et al., 2015), flexibility in terms of contract length and enrolled land (Mettepenningen et al., 2013) or selection of practices (Ruto and Garrod, 2009). In relation to profitability, equity is a relevant criterion too as it concerns, for example, the access for participants (e.g., being part of a collective), distribution of project outcomes (in particular, payments) among participants, and the fair distribution of benefits, costs, and risks along the value chain (Schomers and Matzdorf, 2013). Feasibility deals with property rights and program costs (transaction and implementation costs), but also with the compatibility with the farming system and styles (de Snoo et al., 2013; Schmitzberger et al., 2005; Wrbka et al., 2008). Further criteria concern targeting and additionality. Enhanced targeting usually improves (cost-)effectiveness and additionality because it optimizes the spatial distribution of the interventions according to environmental or cost/benefit parameters. However, targeting very often affects the flexibility of the contract and increases transaction costs,

[2] Austria, Bulgaria, Finland, France, Germany, Italy, Latvia, Netherlands, Poland, Spain.

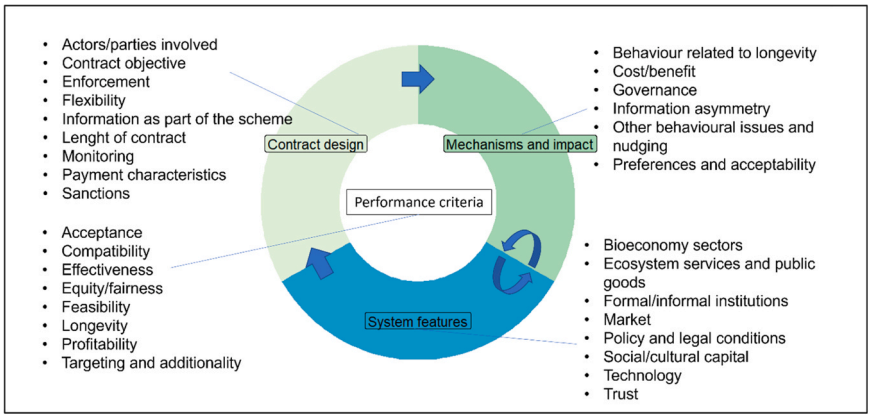

Fig. 1. Common framework for the analysis of new proposals of contract solutions (adapted from Viaggi et al., 2020).

which diminish the adoption of a contract.

Based on this conceptual layout of the framework, the 13 most relevant contractual design features impacting the effectiveness of new contractual solutions have been selected to be tested in our pan-European farmers' survey. Thereby, the selection drew back upon literature (e.g., Raina et al., 2021), but also on the results of a structured collection and assessment of 60 real-life case study examples of successful (new) contract solutions for improved AECPGs provision, which was carried out across Europe in order to shed light on the contractual design of such solutions and to elicit lessons learned on design features leading to effective implementation (cf. Eichhorn et al., 2020a, 2020b). The final features chosen for the survey encompass specific design features characterizing a specific type of contractual solution *per se* (e.g., 'results as parameters for payment' for result-based approaches, 'environmental prescriptions as part of land tenure' for land-tenure approaches, etc.), and general design features (e.g., forms of monitoring and control, contract length, payment setting, etc.), which are common to different types of contracts, but, in their application and/or composition, can contribute or hamper the successful implementation and, consequently, the impact of a contract solution. Also partly based on literature, but mainly on the results of (Eichhorn et al., 2020b, 2020a), descriptions of exemplary contractual solutions have been developed, reflecting typical forms of implementation of result-based and collective private or public incentives schemes, as well as forms of value chain-based and land tenure-based solutions.

2.1.2. Questionnaire development

A questionnaire was developed to test farmers' acceptance of specific design features of new contractual solutions, as well as their willingness to enroll in each solution. The questionnaire (available in Appendix A) comprises two parts. Part I hosts 21 questions about the socioeconomic characteristics of the respondent,[3] features of the farm structure and organization,[4] and several CAP-related aspects.[5] Part II hosts 19 questions about the respondent's preferences towards specific contractual design features of agri-environmental contracts and their acceptability of the four types of new contractual solutions investigated.

In Part II, first, the 13 contractual design features derived from the framework were explained to the respondent in form of the 13 statements (cf. Table 1). Then, the respondent was asked to state how much these design features would increase or decrease his/her willingness to enroll in a general 'agri-environmental contract'. Thereby, the respondent should frame his/her preferences towards the individual characteristics of a contractual solution without already having in mind a specific contract solution or the existing AECMs. Thus, the respondent was not told about the fact that some of the presented features were designed to especially fit with one of the four new proposals investigated here, while others were on purpose independent from a specific contract type. The punctual question asked was *"How much would the following characteristics of agri-environmental contracts increase or decrease your willingness to enrol in an environmental contract or programme?"* (cf. Question 2.2, p.11 of the questionnaire in Appendix A). The possible answers, on a Likert scale, were: 1 = Decreases my willingness considerably, 2 = Somewhat decreases my willingness, 3 = No effect on my willingness, 4 = Somewhat increases my willingness, 5 = Increases my willingness considerably.

Second, Part II of the questionnaire provided the respondent with the descriptions of the four new contractual solutions derived from the common framework (cf. Table 2). These descriptions should ensure that respondents had a common understanding of each contractual solution investigated here. To assess the respondents' acceptability, they were asked about their likeliness to enroll in each contract solution if offered. The punctual question asked was *"How likely is that you would enrol in a* –name of the contract solution– *contract type in the future?"* (cf. Q. 2.6, p.14, Q. 2.10, p.15, Q. 2.14, p.16, and Q. 2.18 p.17 of the questionnaire in Appendix A). The possible answers on a Likert scale were: 1 = Very Unlikely, 2 = Unlikely, 3 = Neutral, 4 = Likely, 5 = Very Likely.

The questionnaire was pre-tested among the group of stakeholders participating in the framework definition, as well as on a collective of Italian farmers provided by the Emilia-Romagna region. Since a sampling procedure was not set up for data collection, here we consider a non-probability sample. The way partners collected the data by using the common questionnaire was a mix of online tools and face-to-face interviews. The questionnaire was mainly advertised by local institutional partners and/or the partners themselves through official social media accounts (cf. table A1 in Appendix A for further details). Timing, non-response rate, respondents' fatigue, etc. were pre-tested (cf. D'Alberto et al., 2022).

2.2. Modelling approach: proportional odds and partial proportional logit models

The respondents' likelihood to enroll (the outcome variable, one per each contractual solution) is analyzed given a set of explanatory variables: 1) the holdings' structural characteristics, 2) the respondents' socio-demographics characteristics and, 3) the perception about the 13 individual contractual design features. We build one model per innovative contractual solution considering ordinal outcome variables

[3] For example, gender, age, education level, role in the agricultural holding, membership in farmers' union or environment-related associations, etc.

[4] E.g., the legal status of the holding, specialization, if producing organic, hectares of utilized agricultural area (UAA), etc.

[5] E.g., direct CAP payments received (and amount, in Euro), Rural Development Program payments received (and amount, in Euro), hectares of UAA under AECMs, etc.

Table 1
The 13 contractual design features with the related statements, complemented by assignment to 'typical' contractual solution (this was not shown to the respondent). RB = result-based; C = collective; VC = value chain-based; LT = land tenure-based.

Contractual design feature	Statement	'Typical' contractual solution
Self-chosen measures	In the contract, you are free to decide about the management practices to achieve the specified environmental result(s)	RB
Better results, higher payment	The payment gets higher, the better your environmental results are	RB
Collective agreement	You can collectively agree on environmental targets and measures at landscape-level together with other farmers	C
Common payment	You and other farmers) receive a common payment. You jointly agree on the distribution of the payment	C
Labelled product	You sell your holding's products labelled as environmentally friendly (e.g., animal welfare products, climate friendly products) when following management measures as prescribed in a processor or retailer contract	VC
Paid by customers	The contract is not paid by public money, instead the compensation that you get for environmentally friendly production is paid by buyers of your products	VC
Reduced land rent	You can lease land with a reduced rent, if you agree to follow environmental management clauses as specified in the lease contract	LT
Self-monitoring	You can do the monitoring of the environmental results yourself (e.g., count specific plants)	RB
Control by authority	The results that you achieve are regularly controlled by the competent authority coming onto your farm, e.g., once per year	
Free training or advice	You are offered free training and advice that enables you to reach the environmental targets	
Sales guarantee	You get a sales guarantee from a processor or retailer in return for implementing environmental measures	VC
Annual compensation	You get environmental compensation payment on an annual basis	
Periodical payment	You get half of the environmental payment at the beginning of, e.g., the five-year contract, and half at the end of it	

Note: Where there is not the reference to a 'typical' contractual solution, this means that the related contractual design feature potentially stands for several novel contractual solutions.

whose categories consist of the lowest up to the highest willingness to enroll stated by the respondents.

Ordinal outcome variables are treated employing the ordered logit model, also called proportional odds (PO) or parallel lines (PL) model (cf. McKelvey and Zavoina, 1975; Mccullagh, 1980; Winship and Mare, 1984). Following the notation of Agresti (2010), let Y be the outcome variable of interest: an ordinal dependent variable of M categories observed for the i-th individual ($i = 1, \ldots, N$). The generalized ordered logit model can be written as

$$P(Y_i > j) = g(X\beta_j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1 + \{\exp(\alpha_j + X_i\beta_j)\}} \quad (1)$$

where $j = 1,\ldots,M-1$. The probabilities that the outcome variable takes on each of the values $1, \ldots, M$ are equal to

Table 2
Descriptions of the four contractual solutions investigated.

Contractual solution	Description
Result-based	In a result-based contract you receive a payment only for the delivery of environmental or climate results. You are free in your decision about the management practices, e.g., how to contribute to water protection, landscape improvement, biodiversity or to sequester carbon. Selected indicators and scoring systems to monitor environmental or climate results are often used, and they will be exactly defined in the contract. You have access to free advice or training when you participate in this contract, and you can voluntarily engage in the monitoring activity.
Collective	You become a member of a group of farmers who applies jointly for compensation in order to implement environmental or climate activities, e.g., water protection, carbon sequestration, biodiversity or landscape improvement. A minimum number of group members (e.g., 5) from your region is required to collaborate in order to get a payment. The group members decide about the implementation and locating the measures, and the distribution of the payment. Within the group, peer farmers and advisors share knowledge and support the achievement of the environmental objectives.
Value chain-based	As a producer, you are part of the value chain (producer, processor, retailer, distributor). You engage in a contract where you commit to deliver environmental or climate benefits connected to the production of selected products, e.g., by carrying out management measures which contribute to water protection, landscape improvement, biodiversity, or carbon sequestration. Often these products get a special label. You are paid for it by the market, mainly through a premium price paid by the processor or retailer.
Land tenure-based	You enter into a land-tenure contract where you commit to give particular attention to environmental aspects beyond legal requirements when producing on the leased land. The landowner accepts a lower lease payment than for comparable land under usual land tenure agreements to compensate your additional efforts. In the contract environmentally friendly management practices on the leased land are prescribed in order to maintain or improve environmental targets, e.g., water protection, landscape and biodiversity improvement or carbon sequestration or alternatively.

$$P(Y_i = 1) = 1 - g(X_i \quad \beta_1)$$
$$P(Y_i = j) = g(X_i\beta_{j-1}) - g(X_i\beta_j), \text{ with } j = 2,\ldots,M-1$$
$$P(Y_i = M) = g(X_i\beta_{M-1}) \quad (2)$$

From this general framework, we can derive special cases: when $M = 2$, for example, the model equals the logistic regression, while, for $M > 2$, it becomes equal to a series of binary logistic regressions which combine the categories of the dependent variable. A special case is represented by the PO/PL model that can be written as

$$P(Y_i > j) = g(X\beta) = \frac{\exp(\alpha_j + X_i\beta)}{1 + \{\exp(\alpha_j + X_i\beta)\}} \quad (3)$$

where $j = 1,\ldots,M-1$. The parallel lines model presents β coefficients that do not vary across the values of j, as it is instead in Eq.1. Hence, this modeling approach requires that only the α coefficients vary across the j values and thus, it implies that the $M-1$ regression lines are parallel. This is the fundamental assumption of the PO/PL model. In other words, such an assumption implies that an individual moves his/her preferences about the object of the question/statement proportionally across the categories depicted by the outcome variable of interest. Hence, we are assuming here that, e.g., the shift in terms of preferability from the category "Very unlikely" to the upper category "Unlikely" is equal to the shift operated by the respondent from "Likely" to "Very Likely" (and vice versa, for all the categories considered).

This modeling approach has been largely applied by several disciplines in different fields (Agresti, 2019), ranging from social sciences

(Fullerton, 2009) to health and medical research (Lall et al., 2002). This is because it can lead to highly interpretable results, also benefiting from computational efficiency (Agresti, 2010). However, its main, widely acknowledged 'cons' lies in the fact that violations of the fundamental assumption frequently occur in practice (see, e.g., Brant, 1990; Clogg and Shihadeh, 1994; Long and Freese, 2014, and the references therein). Violations of the parallel lines assumption lead to biased estimates and mis-interpretable results (Agresti, 2010). Furthermore, recently, such an assumption has been proven to be 'overly restrictive', in addition to the fact that, *de facto*, it is often violated by several applications (Williams, 2016).

A solution for selectively relaxing the assumption without losing the easiness of results interpretability and the computational advantages is offered by the partial proportional logit model (PPO), also called the non-parallel lines model (NPL) (Mccullagh and Nelder, 1989; Peterson and Harrell, 1990). By relaxing the assumption, we have one or more βs differing across the values of j, while some other coefficients can still be equal for all the categories of the ordered outcome variable. For the sake of clarity, let X_1, X_2, X_3 be three explanatory variables. The model in Eq.3 can be re-written as

$$P(Y_i > j) = g(X\beta) = \frac{\exp(\alpha_j + X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_{3j})}{1 + \{\exp(\alpha_j + X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_{3j})\}} \quad (4)$$

where $j = 1, \ldots, M-1$. In the model depicted in Eq.4, the βs for X_1, X_2 are the same for all the values of j, while the coefficient for X_3 can differ. Therefore, the PPO/NPL model allows us to keep the regression lines parallel whenever it is the case and relax such a restrictive assumption when it is violated. In other words, for the explanatory variables that impact proportionally the odds of the ordinal outcome variable, we keep the PO/PL modeling structure, while for the explanatory variables about which the assumption is violated, we relax the 'proportionality of the odds' constraint. Therefore, this means that the effect of an explanatory variable on the odds of the ordinal outcome is not forced to be proportional across the categories of the latter. As a result, we are assuming here that, when considering the explanatory variables X_1, X_2 the shift in terms of preferability from, e.g., the category "Very unlikely" to the upper category "Unlikely" is equal to the shift operated by the respondent from "Likely" to "Very Likely" (and this holds for all the categories considered). However, when considering the explanatory variable X_3, we are allowing the preferability shift from, e.g., the category "Very unlikely" to "Unlikely" to differ from that operated by the respondent in evaluating the "Likely" versus "Very Likely". In other words, in the PPO/NPL model, we admit that the 'magnitude of preferability' in comparing the shift between two categories can be different from that of two other categories, being the shift of preference non-proportional.

For the sake of simplicity, we adopt here a re-parametrization of the model in Eq.4, that is the unconstrained PPO/NPL model proposed by Peterson and Harrell (1990) and further extended by Lall et al. (2002). This re-parametrization hints at the fact that, for each explanatory variable, we have a coefficient β and $M-2$ γ coefficients that indicate a deviation from proportionality. This alternative approach has recently gained momentum due to the developments proposed by Williams (2006) and Yee (2010), and represents a superior alternative to the generalized ordered logit model of Eq.1 (Williams, 2016).

The choice of which modeling approach (PO/PL or PPO/NPL) is the most suitable and robust in estimating the ordinal dependent variable with the explanatory variables at hand should undergo the assessment of the parallel lines assumption, as suggested by Long and Freese (2014) and Williams (2016). To this, we run a Brant test checking both globally and for each independent variable (separately), testing whether any explanatory variable violates the parallel lines assumption or not (Brant, 1990). In addition, following the prescriptions of Buis and Williams (2013), a series of complementary tests[6] are run to further verify whether the model meets the proportional odds assumption or not.

To select the explanatory variables to be included in the model as predictors, 1st) we followed the prescriptions and findings from the literature on the topic; 2nd) we included in the PO/PL model all the potential predictors at hand; 3rd) we checked the model's convergence, discarding the explanatory variables causing the model failure; 4th) we evaluated the log-likelihood of the model, preferring modeling approaches with higher goodness-of-fit measures (Dziak et al., 2019); 5th) checking the results of the Brant test, we decided if a predictor should be included in the PO or PPO final model. Fig. 2 depicts a schematization of the modeling procedure and the method adopted.

2.3. Data

The analysis is based on primary survey data collected in Austria, Bulgaria, Finland, France, Germany, Italy, Latvia, Netherlands, Poland, and Spain during the first semester of 2021. EU farmers were the target population. The survey was based on a common questionnaire prepared in English and then translated into national languages. It was built following the methodological approach presented in Section 2.1. Data collection was implemented mainly online by using Qualtrics[7] and LimeSurvey[8] tools. Please, refer to Table A1 in Appendix A for any further information about the data collection process. Moreover, please refer to D'Alberto et al. (2022) for the details of the survey validation process. Fig. 3 depicts the case study regions (corresponding to EUROSTAT NUTS 2 level[9]) where the survey has been conducted (cf. Table A1 in Appendix A for the list of the NUTS 2 regions surveyed).

3. Results

Table 3 depicts the main descriptive statistics of the sample under analysis (n = 1866 respondents). Male farmers represent the majority of respondents (82%). Almost 59% of the farmers are between 41 and 60 years old, while around 22% of respondents are less than 40 years old. They are, generally, well-educated, single owners (58%), and members of farmers' unions (49%). They are willing to keep the holding activity going in the mid-long run (almost 87% of respondents), being their agricultural activity the main source of the household's income (i.e., over 70% of the total household gross income revenue) for the 51% of the holdings considered. Considering the farms' structure, the sample is made mainly by individual/family holdings, with a very heterogeneous distribution of the hectares of Utilized Agricultural Area (mean UAA: 143 ha; median UAA: 40 ha). 44% of the farms are specialized in arable crops, followed by 24% specialized in livestock, while those specialized in permanent and mixed crops are both around 12%. The mean hectares of UAA under AECMs in the sample is 76 ha (median: 31 ha). 88% of the farms received direct CAP payments, almost 53% of them received RDP payments, with 22% producing organic.

Table A2 in Appendix A shows the results of the statistical tests carried out to check the representativeness of the sample. When available, official statistics about the EU27 farms population (in year 2020) were retrieved from EUROSTAT, and based on these data, we ran both statistical tests of proportion and t-test for the mean. The p-values of variables *gender* and *specialization* (about the "mixed" category) indicate

[6] Namely, likelihood ratio test, score test, Wald test, Wolfe-Gould test.

[7] QualtricsXM Online Survey Software. https://www.qualtrics.com/it/core-xm/piattaforma-di-sondaggi/?rid=langMatch&prevsite=en&newsite=it&geo=IT&geomatch= [accessed September 20th, 2022].

[8] LimeSurvey Software. https://www.limesurvey.org [accessed September 20th, 2022].

[9] For further information about the Nomenclature of territorial units for statistics (NUTS) see https://ec.europa.eu/eurostat/web/nuts/background [accessed November 29th, 2023].

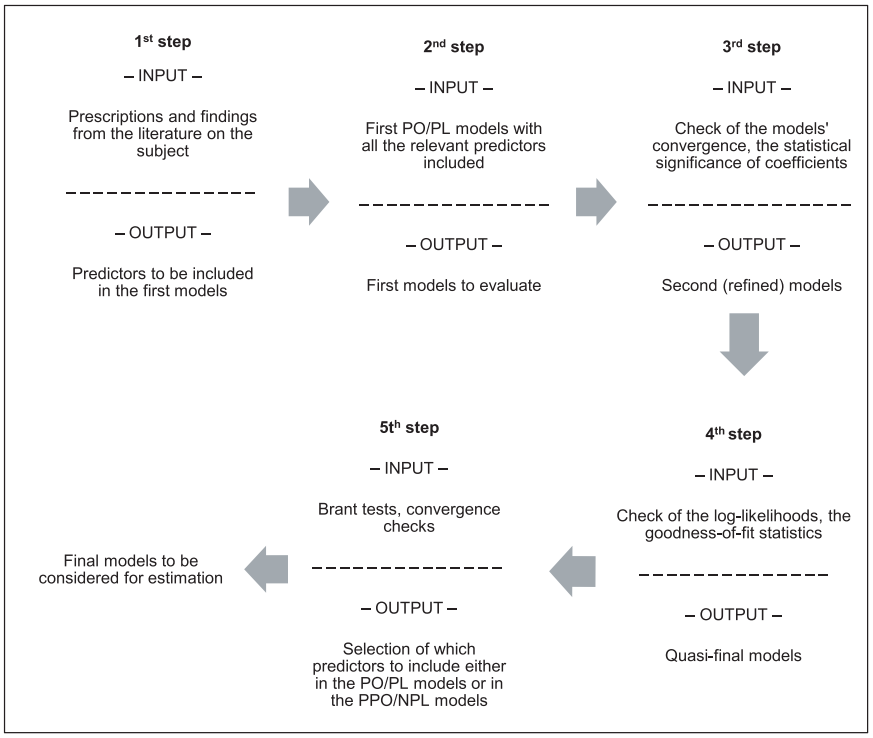

Fig. 2. Steps of the method applied.

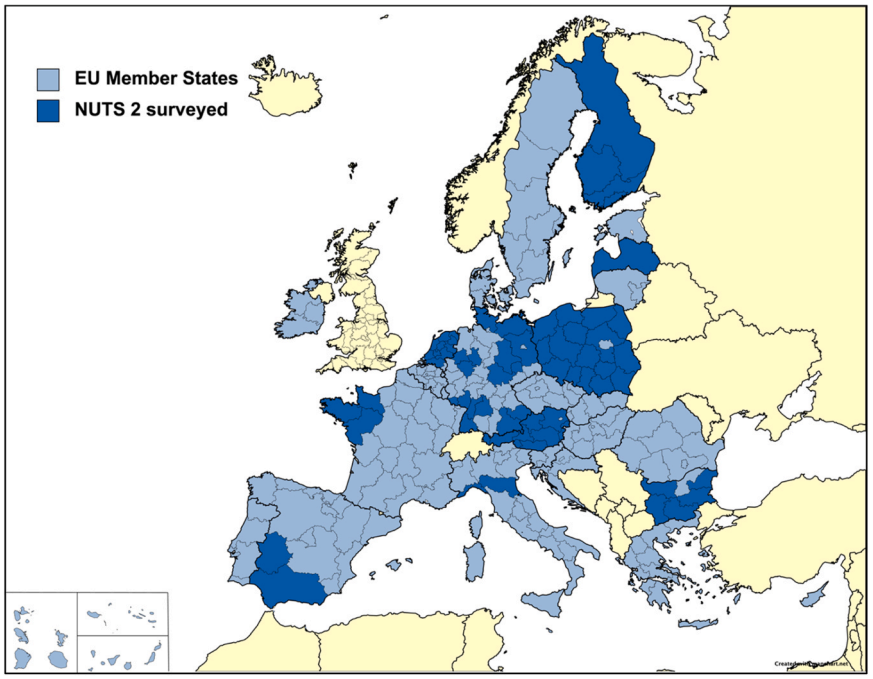

Fig. 3. Case study regions surveyed from the 10 EU countries.

that we must reject the null hypothesis of equality between the sample proportion and the population proportion (at the 5% significance level). For all the other variables, we fail to reject the null hypothesis of equality between the sample's characteristics and those of the population. Hence, limitedly to the available information, we can be discretely confident about the adherence of the sample at hand to the characteristics of the EU27 population of farms.

Fig. 4 depicts the distribution of the scores for the 13 individual contractual features, i.e., the preference expressed by the respondents for each specific contractual design element. In terms of the set of explanatory variables included in the modeling exercise, the data depicted in the figure refers to the perception of the 13 individual contractual features. In general terms, it emerges that the mostly 'valuated' features are "self-chosen measures", "better results, higher payment", and "annual compensation", while the least desirable feature is "common payment".

We then present the results about the farmers' likelihood to enroll (given the characteristics of our set of explanatory variables) from the

Table 3
Descriptive statistics of the sample.

Explanatory variable	Nr. of observations	Percent	Q1, Q2, **Mean**, Q3‡ (Standard Deviation)
Country	152	8.15%	
Austria			
Bulgaria	95	5.09%	
Finland	408	21.86%	
France	127	6.81%	
Germany	146	7.82%	
Italy	381	20.42%	
Latvia	101	5.41%	
Poland	277	14.84%	
Spain	60	3.22%	
Netherlands	119	6.38%	
Gender	1534	82.21%	
male			
female	332	17.79%	
Age	6	0.32%	
18–20 years			
21–30 years	112	6.01%	
31–40 years	295	15.82%	
41–50 years	506	27.13%	
51–60 years	589	31.58%	
61–70 years	263	14.10%	
71–80 years	80	4.29%	
> 80 years	15	0.80%	
Education level	217	11.63%	
primary			
upper secondary	600	32.15%	
post-secondary	282	15.11%	
Bachelor	334	17.90%	
Master or higher	433	23.20%	
Role in the holding	1078	57.77%	
single owner			
co-owner	595	31.89%	
tenant	144	7.72%	
other	49	2.63%	
Membership	921	49.36%	
farmers' union			
nature conservation, environmental organization	268	14.36%	
none	677	36.28%	
Continue the activity	250	13.40%	
no			
0 -| 10 years	655	35.10%	
> 10 years	961	51.50%	
Total household gross revenue from agricultural activities	227	12.24%	
less than 10%			
10–29%	229	12.35%	
30–49%	195	10.52%	
50–69%	253	13.65%	
70–89%	209	11.27%	
> 89%	741	39.97%	
do not answer	12	0.64%	
Legal status	1495	80.12%	
individual (family) holding			
partnerships	300	16.08%	
other	71	3.80%	
Specialization	821	44.00%	
arable			
horticulture	68	3.64%	
permanent	229	12.27%	
livestock	447	23.95%	
mixed	223	11.95%	
others	78	4.18%	
Utilized Agricultural Area(in hectares)			11, 40, **142.998**, 100 (412.613)
Previous participation in AECMs	968	51.88%	
yes			
Utilized Agricultural Area under AECMs(in hectares)			11, 31, **75.518**, 73 (233.464)
Organic production	415	22.46%	
yes			
Direct CAP payments	1620	88.24%	
yes			
RDP* payments	915	52.65%	
yes			

Note: ‡ Q1, Q2, Q3 stands for 1st quartile, 2nd quartile (median), and 3rd quartile, respectively; * Rural Development Programme.

four models adopted, one for each innovative contract solution.[10] For the sake of brevity, Tables 4–7 depict only the statistically significant odds ratios (with the related p-values in parentheses), i.e., the explanatory variables having a significant influence on willingness to enroll. For the whole tables depicting the coefficients of all the predictors included in the models, please refer to Appendix C (tables C1-C4).

By following the prescriptions of Craemer (2009) and Williams (2016), when the explanatory variables meet the parallel lines assumption, the odds ratio values depicted in the tables (with the related p-values) are the ones of the β coefficients. In other words, when the odds ratios are depicted only with respect to the first category of the ordinal outcome variable (i.e., in the second column of the tables) this means that they are equal for all the other categories of the outcome variable (being the p-values for the Brant test not statistically significant). In contrast, when the odds ratios are depicted (with the related p-values) in all the other columns of the tables (the second column up to the fifth one) they refer to γ coefficients. Hence, in the latter case they refer to the explanatory variables not constrained to meet the parallel lines assumption (being the p-values for the Brant test statistically significant).

3.1. Result-based contractual solution

Table 4 depicts the (statistically significant) odds ratios estimated by the model on the willingness to enroll in result-based contracts. The explanatory variables *membership*, *organic production*, *authority control*, and *periodical payment* violate the parallel lines assumption (i.e., the coefficient for the explanatory variables differ among the categories of the ordered outcome variable), while the other explanatory variables show coefficients that are the same across all the categories of the willingness to enroll in RB contracts.

The predictor *membership* (violating the parallel lines assumption) has only one statistically significant coefficient (one out of eight). Thus, this explanatory variable should make it more likely that the respondent will be in the current (or a lower) category of the response variable when comparing the respondents who are members of nature conservation/environmental organizations with those who are farmers' union members. However, this is true limited to the switch towards the 'Very Unlikely' or 'Unlikely' categories, compared to 'Neutral', 'Likely', and 'Very Likely' ones. This result seems contradictory because it can be expected that farmers who are members of conservation/environmental organizations do value more such a contractual solution than those who are 'just' farmers' union members. Moreover, all the other coefficients of this explanatory variable are not statistically significant. This hints at considering discarding such a predictor from those significantly impacting the willingness to enroll in RB contracts.

For respondents who are willing to keep the activity of the holding for more than 10 years, the odds of being more likely to enroll in RB contracts are 1.7 times greater than those of respondents committed to the activity in the short run. For the holdings specialized in livestock, the

[10] Please, refer to appendix B for the results related to the Brant tests on the parallel lines assumption.

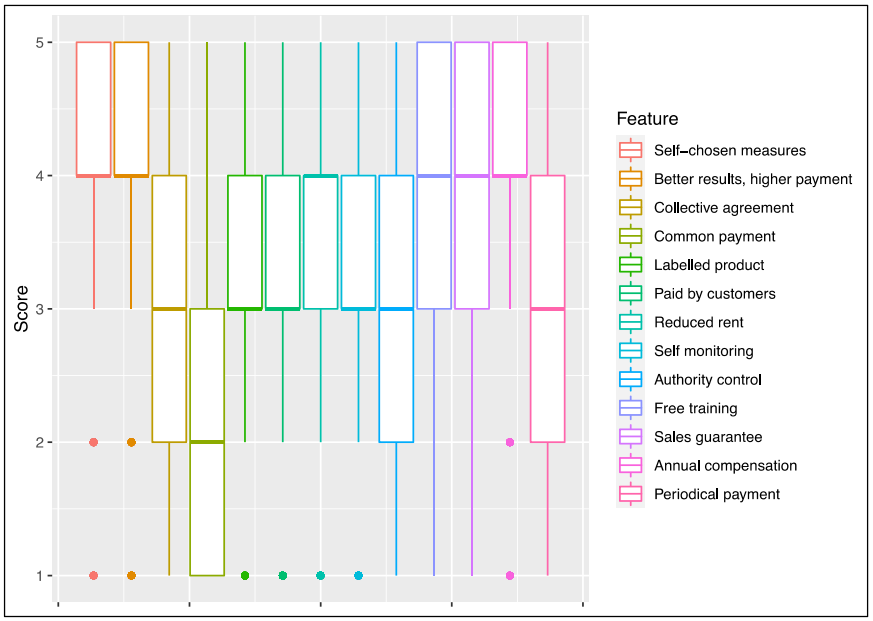

Fig. 4. Scores given to the 13 contract features (1 = Decreases my willingness considerably, 2 = Somewhat decreases my willingness, 3 = No effect on my willingness, 4 = Somewhat increases my willingness, 5 = Increases my willingness considerably).

Table 4
Odds ratios, result-based contractual solution.

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Membership (farmers' union)	0.835 (0.595)	‡ **0.510** (0.030)	1.141 (0.698)	1.570 (0.239)
nature conservation, environmental organization				
none	1.457 (0.168)	-0.418 (0.087)	0.948 (0.843)	0.687 (0.227)
Continue the activity (no)	1.020 (0.894)			
0 -| 10 years				
> 10 years	‡ **1.723** (0.000)			
Specialization (arable)	1.406 (0.181)			
horticulture				
permanent	0.989 (0.943)			
livestock	‡ **1.594** (0.000)			
mixed	1.296 (0.095)			
others	1.320 (0.257)			
Organic production (no)	‡ **0.262** (0.000)	‡ **2.848** (0.000)	‡ **3.515** (0.000)	‡ **4.879** (0.000)
yes				
Direct CAP payments (no)	‡ **0.703** (0.029)			
yes				
Self-chosen measures	‡ **1.139** (0.028)			
Better results, higher payment	‡ **1.301** (0.000)			
Collective agreement	‡ **1.242** (0.042)			
Paid by customers	‡ **1.093** (0.033)			
Self-monitoring	‡ **1.166** (0.003)			
Authority control	‡ **1.316** (0.014)	1.018 (0.855)	1.045 (0.694)	1.243 (0.086)
Periodical payment	‡ **1.303** (0.021)	‡ **0.781** (0.021)	‡ **0.744** (0.010)	‡ **0.615** (0.000)

Note: [§] reference category of the variable in parenthesis; * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; [‡] **in bold**: 0.05 level of statistical significance.

odds of being more likely to enroll in RB contracts are 1.6 times greater than those of the holdings specialized in permanent crops. For the holdings producing organic, compared to non-organic holdings, there is a polarization in the shifts towards the categories of the willingness to enroll. Indeed, when considering the lowest category of the response variable, it is more likely that the respondent will be in the current (or a lower) category (if producing organic) compared to non-organic farms. However, when considering the shifts of preferences towards the upper categories of the willingness to enroll, they are determined in a different proportion by such a predictor. For example, for the organic holdings, the odds of being 'Very Likely' to enroll in RB contracts are 4.9 times greater than those of non-organic holdings. We can interpret this as a greater impulse of the organic holdings in moving toward the upper categories of the willingness to enroll (compared to the non-organic ones) concerning an inverse impulse when considering the lowest category of the willingness to enroll. For those receiving direct CAP payments, the odds of being more likely to enroll in RB contracts are lower than those not receiving them.

Regarding the individual contract features, the odds of being more likely to enroll increase when the respondents assign a higher score to the contractual design features 'better results, higher payments', 'collective agreement', and 'authority control'. For an increase in the scoring of 'self-monitoring', the odds of being more likely to enroll in RB contracts are 1.2 times greater than those of respondents who evaluate

less such contractual feature. For an increase in the scoring of the features 'self-chosen measures' or 'paid by customers', the odds of being more likely to enroll are 1.1 times greater (basically, equal) than those of respondents who evaluate less these two individual contractual features. Hence, these two contractual features are not relevant for the odds change in RB contracts. For an increase in the scoring of the feature 'periodical payment', the odds of being more likely to enroll than being 'Very Unlikely' are 1.3 times greater than those of respondents evaluating less such contractual design feature. Nevertheless, the odds change related to the upper categories of the response variable are negatively affected by an increase in the scoring of such a contract feature. This hints at the fact that farmers valuing more such a contract feature should present a weaker magnitude of shift towards the upper categories of the response variable than those valuing less such a contract feature.

3.2. Collective contractual solution

Table 5 depicts the odds ratios estimated by the model for the collective contracts. The statistically significant predictors that violate the parallel lines assumption (i.e., generating non-proportional effects on the different levels of the ordinal outcome variables) are (all) related to the specific contractual design features: *better results, higher payment*, *common payment*, *authority control*, and *periodical payment*.

For respondents who are members of environmental and/or nature conservation organizations, the odds of being more likely to enroll in collective contracts are 2.1 times greater than those of respondents who are farmers' union members. This is the only variable among the structural or sociodemographic ones impacting the willingness to enroll in C contracts.

Considering the individual contractual design features, for an increase in the scoring of 'collective agreement', the odds of being more likely to enroll in C contracts are 1.3 times greater than those of respondents who evaluate less such contractual feature. For an increase in the scoring of 'reduced rent', the odds of being more likely to enroll are 1.1 times greater (i.e., substantially equal) than those of respondents who evaluate less this contractual design element. For an increase in the scoring of the feature 'annual compensation', the odds of being more likely to enroll are lower than those of respondents evaluating less such contractual design feature. Non-proportional odds are determined by the contractual design features linked to payment, both 'common payment' and 'periodical payment'. The former, for an increase in the scoring, determine that the odds of being more likely to enroll in C contracts are 1.9 times greater than those of respondents who evaluate less this contractual element. However, for the upper categories of the willingness to enroll, the impact on the odds of being more likely to enroll generated by an increase in the scoring is negative. The latter, for an increase in the scoring, determine that the odds of being more likely to enroll in collective contracts are 1.2 times greater than those of respondents who evaluate less the contractual feature (considering the lowest category of the willingness to enroll). Instead, the odds of being in the top category of the willingness to enroll are negatively affected by such a scoring increase.

3.3. Value chain contractual solution

Table 6 depicts the odds ratios estimated by the model on value chain contractual solution's willingness to enroll. The statistically significant predictors *specialization*, *organic production*, *common payment*, *reduced rent*, and *authority control* violate the parallel lines assumption and thus, provide different coefficients (hence, dis-proportional effects on the different levels of the ordinal outcome variable).

For respondents with the highest education levels (BA's and MA's or higher), the odds of being more likely to enroll in VC contracts are, respectively, 1.5 and 1.4 times greater than those of respondents with a lower education level. For those who are not farmers' union members and/or environmental/nature conservation organizations members, the odds of being more likely to enroll in VC contracts are lower than those of respondents who are members. For respondents who are willing to keep the activity of the holding for more than 10 years, the odds of being more likely to enroll in VC contracts are 1.5 times greater than those of respondents committed to the activity in the short run. The impact of specializations on the odds is not straightforward. The results hint at the fact that for horticulture holdings, the odds of being more likely to enroll in VC contracts can be 2.2 times greater than those of arable farms, while for holdings specialized in permanent crops, the odds of being more likely to enroll are lower than those of horticulture farms. For farms receiving direct CAP payments, the odds of being more likely to enroll in VC contracts are 1.5 times greater than those of holdings not receiving such payment, while the RDP payment harms the odds ratios.

For an increase in the scoring of 'self-chosen measures', the odds of being more likely to enroll in VC contracts are lower than those of respondents who evaluate less this contractual feature. A positive impact on the odds of being more likely to enroll in VC contracts are determined by an increase in the scoring of the contractual design features 'labelled product', 'paid by customers' and 'sales guarantee'. An increase in scoring of the feature 'common payment' determines that the odds of being more likely to enroll in VC contracts are 1.2 times greater than those of respondents evaluating such contractual element less, while the same increase has negative impacts on the upper categories of the ordinal outcome variable. For an increase in the scoring of 'reduced rent', the odds of being more likely to enroll are lower than those of respondents evaluating less such contractual design feature.

3.4. Land tenure contractual solution

The odds ratios estimated from the model on the willingness to enroll in land tenure contracts are depicted in Table 7. Only the statistically significant predictor *specialization* violates the parallel lines assumption.

For respondents who are willing to keep (going) the activity of the holding in the short run, the odds of being more likely to enroll in LT

Table 5
Odds ratios, collective contractual solution.

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Membership (farmers' union) nature conservation, environmental organization	‡ **2.079** (0.000)			
none	0.966 (0.749)			
Better results, higher payment	1.054 (0.488)	0.922 (0.255)	1.050 (0.595)	‡ **0.759** (0.031)
Collective agreement	‡ **1.288** (0.000)			
Common payment	‡ **1.874** (0.000)	‡ **0.827** (0.009)	‡ **0.750** (0.001)	‡ **0.751** (0.014)
Reduced rent	‡ **1.143** (0.007)			
Authority control	1.039 (0.558)	1.066 (0.305)	‡ **1.173** (0.038)	‡ **1.645** (0.000)
Annual compensation	‡ **0.883** (0.034)			
Periodical payment	‡ **1.157** (0.001)	0.868 (0.055)	0.900 (0.262)	‡ **0.646** (0.001)

Note: § reference category of the variable in parenthesis; * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ **in bold**: 0.05 level of statistical significance.

Table 6
Odds ratios, value chain contractual solution.

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Education level (primary)	1.268 (0.140)			
upper secondary				
post-secondary	1.053 (0.785)			
Bachelor	‡ **1.488** (0.029)			
Master or higher	‡ **1.434** (0.033)			
Membership (farmers' union)	0.951 (0.732)			
nature conservation, environmental organization				
none	‡ **0.686** (0.001)			
Continue the activity (no)	0.927 (0.607)			
0 -| 10 years				
> 10 years	‡ **1.513** (0.004)			
Specialization (arable)	0.692 (0.472)	‡ **2.234** (0.045)	2.530 (0.070)	1.852 (0.303)
horticulture				
permanent	1.860 (0.124)	0.485 (0.055)	‡ **0.424** (0.039)	‡ **0.388** (0.043)
livestock	0.845 (0.475)	0.848 (0.437)	1.210 (0.435)	1.732 (0.056)
mixed	1.194 (0.589)	0.693 (0.226)	1.054 (0.875)	1.011 (0.978)
others	0.692 (0.354)	1.126 (0.720)	1.128 (0.554)	1.300 (0.637)
Organic production (no)	0.785 (0.292)	‡ **1.828** (0.002)	‡ **1.741** (0.017)	‡ **2.425** (0.001)
yes				
Utilized Agricultural Area(in hectares)	1.000 (0.527)			
Direct CAP payments (no)	‡ **1.499** (0.010)			
yes				
RDP payments (no)	‡ **0.691** (0.000)			
yes				
Self-chosen measures	‡ **0.873** (0.017)			
Common payment	‡ **1.226** (0.040)	0.852 (0.063)	‡ **0.720** (0.001)	‡ **0.683** (0.001)
Labelled product	‡ **1.390** (0.000)			
Paid by customers	‡ **1.445** (0.000)			
Reduced rent	1.159 (0.111)	‡ **0.793** (0.005)	‡ **0.818** (0.036)	‡ **0.785** (0.031)
Authority control	‡ **1.353** (0.001)	0.927 (0.329)	1.038 (0.682)	1.190 (0.110)
Sales guarantee	‡ **1.258** (0.000)			

Note: [§] reference category of the variable in parenthesis; * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ **in bold**: 0.05 level of statistical significance.

Table 7
Odds ratios, land tenure contractual solution.

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Continue the activity (no)	‡ **0.704** (0.017)			
0 -| 10 years				
> 10 years	1.050 (0.727)			
Specialization (arable)	0.782 (0.587)	1.614 (0.223)	1.425 (0.456)	1.040 (0.947)
horticulture				
permanent	‡ **0.601** (0.037)	1.045 (0.852)	0.934 (0.808)	1.236 (0.567)
livestock	0.840 (0.432)	**1.553** (0.027)	1.809 (0.010)	1.324 (0.326)
mixed	0.682 (0.150)	1.363 (0.205)	1.671 (0.069)	1.323 (0.440)
others	‡ **0.404** (0.005)	1.536 (0.147)	1.506 (0.289)	1.533 (0.477)
Reduced rent	‡ **2.235** (0.000)			
Authority control	‡ **1.292** (0.000)			
Sales guarantee	‡ **1.139** (0.024)			
Annual compensation	‡ **0.860** (0.010)			

Note: [§] reference category of the variable in parenthesis; * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ **in bold**: 0.05 level of statistical significance.

contracts are lower than those of respondents who declared to not be committed to keeping on the activity. The holding specialization has a non-proportional effect on the odds. For livestock holdings, the odds of being more likely to enroll in LT contracts could be 1.6 times greater than those of permanent-specialized farms. In addition, permanent and 'others' specializations seem to negatively impact the odds ratios.

Looking at the specific contractual design features, for an increase in the scoring of the 'reduced rent' feature, the odds of being more likely to enroll in LT contracts are 2.2 times greater than those of respondents who evaluate less this contractual feature. For an increase in the scoring of 'authority control', the odds of being more likely to enroll in LT contracts are 1.3 times greater than those of respondents who evaluate less such contractual element. For an increase in the scoring of 'sales guarantee', the odds of being more likely to enroll are 1.1 times greater than those of respondents who valuate less this individual contractual feature (i.e., basically hinting at the same degree of acceptability due to this predictor). For an increase in the scoring of the feature 'annual compensation', the odds of being more likely to enroll are lower than those of respondents evaluating less the contractual design element.

4. Discussion

We now discuss in detail the results concerning each contractual solution, summing it up in Fig. 5.

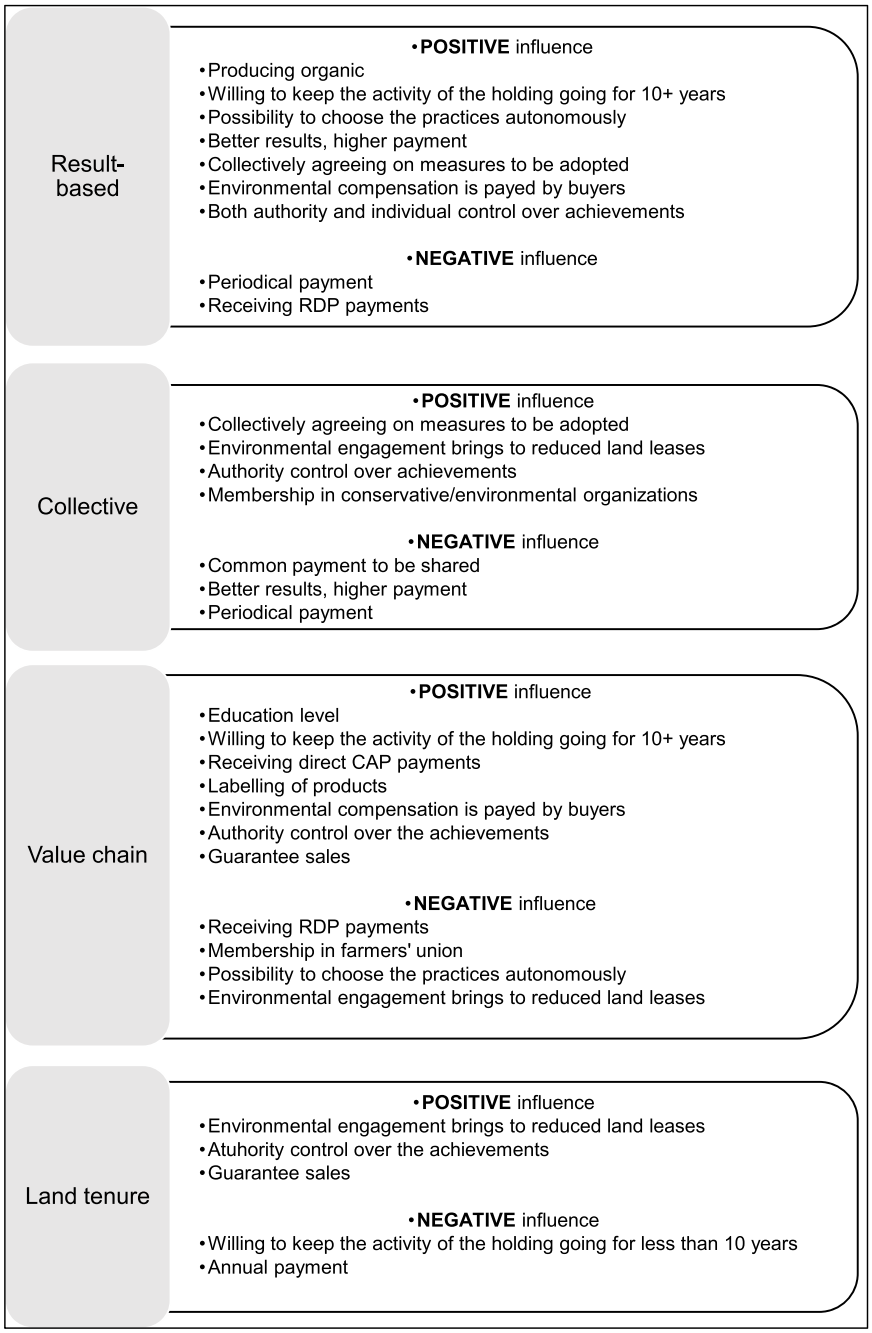

Fig. 5. Summary of the main results.

4.1. Result-based contractual solution

The willingness to enroll in RB contracts seems to be positively influenced by the respondents' preference for what follows. 1) The possibility to autonomously choose the practices to be adopted within the contract. This is in line with the results of Burton and Schwarz (2013) and Brown et al. (2019) and hints at the fact that farmers would be able to autonomously manage the practices within the contract if the payment is linked to the achievement of the result. Somehow, they would prefer to be fully 'entitled' and responsible in fulfilling completely and efficiently the contacts' goal(s) and, this way, assuring the payment. 2) The idea that, through the contract, achieving better environmental results will bring higher levels of payment. Hence, even the most profit-oriented farmers will not disregard the provision of environmental and ecosystem services, as stressed by Lienhoop and Brouwer (2015) or, on a more general level, it seems fair enough to be paid for the actual environmental results. 3) The collective agreement on the contract objectives and the practices to be adopted within it. Hence, farmers seem not to disregard the possibility of cooperating within the contract to reach the environmental goals, in line with the findings of Kuhfuss et al. (2015). 4) The option to let the compensation for their environmental commitment be paid by the buyers of the agricultural holding's product(s), as per the findings of Bredemeier et al. (2022). This hints at the fact that farmers would not dislike the acknowledgment of their engagement/efforts concerning the environment and 'take advantage' of such an effort in terms of products' selling. 5) Both the possibility that a recognized authority is entitled to monitor the achievement of the expected contract results (see, e.g., Velten et al., 2018) and the possibility that the farmers themselves will be entitled to monitor the achievements, as it is found instead by Burton and Schwarz, (2013) and Klimek

et al. (2008). These two polarized positions suggest that, if on the one hand the control of the authority can still be envisaged as a guarantee, on the other hand the possibility of carrying out the control of the results' achievement, autonomously, is well-judged by farmers.

A less straightforward influence on the willingness to enroll in RB contracts is shown by the contractual design feature 'periodical payment'. If an increase in the scoring could bring a shift from the lowest level of the willingness to enroll towards the upper one, the other categories of the likelihood of enrolment are negatively influenced in this regard. This could hint at the fact that, whether evaluating such a contractual feature more can boost the increase of the lower levels of the likelihood, valuating such a feature in the space of the highest preferability could not improve the willingness to enroll in RB contracts, but rather affect it negatively. Among the structural and sociodemographic variables, the intention to continue the activity for more than 10 years strongly and positively impacts the willingness to enroll, as well as producing organic. The latter aspect confirms the finding of Brown et al. (2021) and generally suggests a stronger interest in novel contractual solutions for those farmers who are still committed to the activity in the long run. In contrast, agricultural holdings receiving direct CAP payments seem to be less willing to enroll in RB contracts, while being specialized in livestock (compared to permanent, horticulture, and arable farms) could determine a higher willingness to enroll. Membership in nature conservation/environmental organizations could produce a negative impact on the willingness to enroll in RB contracts compared to membership in farmers' unions which can play leverage for legitimization and trust, as stressed by Bredemeier et al. (2022) and Herzon et al. (2018).

4.2. Collective contractual solution

Being allowed to collectively agree on the measures and practices to be adopted in the contract has a positive impact on the willingness to enroll in C contracts, as well as the idea that agreeing to follow environmental management clauses specified in the lease contract can bring land leases at reduced rent. This is in line with the main results of Bredemeier et al. (2022), but in contrast with the findings of Villamayor-Tomas et al. (2019) about "the pessimistic expectations of farmers about collective actions". What probably matters here, in properly disentangling the problem of the "amount of cooperation and collective agreement required" is the lack of a reference to a specific and detailed level of cooperation embedded in the C contractual solution proposed to respondents. This, in turn, would have also potential drawbacks in terms of environmental efficacy and efficiency, as noted by Bareille et al. (2023). The presence of an authority that controls the achievements of the holding can positively impact the likelihood of enrolment (but non-proportionally across the levels of the willingness to enroll). This aspect mirrors what we discussed before in relation to the RB contractual solution, and it is in line with the results of Rose et al. (2018). The idea of a common payment that must be shared among the contractors, when the respondent evaluates such contractual element as very relevant, can negatively influence the willingness to enroll in collective contracts. This suggests that, besides the possibility of appreciating a collective contractual solution, the farmer would prefer a payment to which he/she is fully entitled and that must not be shared with others. Similarly, such a negative trend is shown by the features 'better results, higher payment' and 'periodical payment'. Membership in nature conservation/environmental organizations, in contrast, does impact positively (and strongly) the willingness to enroll in C contracts.

4.3. Value chain contractual solution

The likelihood of enrolment in VC contracts seems to be positively and strongly influenced by high education levels, which is in line with the findings of Brown et al. (2019), as well as by the willingness to keep the activity going in the long run and the fact that the holding receives direct CAP payments. In contrast, RDP payments are supposed to make the willingness to enroll in VC contracts decrease and, similarly, the fact of not being a member of farmers' unions, or environmental organizations. These aspects stress the path towards an increased preferability of such contractual solution for those farmers who already have a knowledge/experience with structured forms of association/organizations. Non-proportional effects are generated by the specialization of the holding. The higher odds of enrolling in VC contracts of horticulture specializations could hint, on the one hand, to the specific structure of these agricultural systems that are used to sale contracts that link more directly production to retailers (more direct e.g., than for cereals producers for instance). On the other hand, horticulture farms are very often high revenue systems that have less interest in agri-environmental incentives and are more interested in market added-value. In addition, in the same line, organic production generates non-proportional effects which positively and strongly influences the willingness to enroll in such a contractual solution. The willingness to enroll is also positively influenced by the respondents' preference for 1) the possibility to sell the holding's product(s) labelled as environment-friendly (cf. Bredemeier et al., 2022); 2) the option to let the compensation for the environmental commitment be paid by the buyers of the agricultural holding's product(s); 3) the possibility that a recognized authority is entitled to monitor the achievement of the environmental results expected by the contract (in line with Toderi et al., 2017); 4) the guarantee of sales from a processor or retailer. Again, these aspects suggest that such a contractual solution could be preferred mostly by those who already have/had relevant experience with the value chain. Farmers who consider being very relevant the possibility of choosing, autonomously, the measures to be adopted within the contract have a lower willingness to enroll in VC contracts, than those who give a higher score to the reduced rent feature. The former point could be a hint in the direction discussed above, with the farmers who are less experienced with the mechanisms of the value chain being less inclined to enroll in a VC contractual solution. If a respondent evaluates with a high score the feature 'common payment', a positive impact on the likelihood of enrolment could be seen concerning the lowest category of the willingness to enroll, while negative impacts would occur in determining the highest level of willingness.

4.4. Land tenure contractual solution

Respondents involved in the holding activity in the short run have a lower willingness to enroll compared to respondents who are not at all interested in keeping the activity going. Hence, here there is a likelihood mechanism that mimics, somehow, what was discussed before about the VC contractual solution, but (surprisingly) referred to the medium term. Also, the specialization of the holding generates non-proportional and asymmetric effects on the likelihood of enrolment. Furthermore, the willingness to enroll in LT contracts is positively and strongly influenced by the respondents' preference for the idea that agreeing to follow environmental management clauses specified in the lease contract can bring land leases at reduced rent (that is, indeed, the contractual design feature that mostly characterize this contractual solution). In addition, the possibility that an authority certifies the achievements of the holding generates an increased willingness to enroll (cf. Toderi et al., 2017), as well as the possibility to arrange some guarantee of sales with a processor or retailer, as per the findings of Bredemeier et al. (2022). Respondents who evaluate the 'annual compensation' feature as being very relevant show a lower likelihood of enrolment.

Therefore, the likelihood of enrolment in the four innovative contractual solutions is influenced by a mix of the holding's structural characteristics, farmers' sociodemographic and behavioral characteristics, and respondents' preferences for individual contractual design features. To sum up, except for the land tenure (LT) contractual solution, being a member of an organization is an important driver of acceptability. This is because of the indirect information on the network of the

farmer. Moreover, organic production is a strong factor of acceptability for value chain (VC) and result-based (RB) contracts' adoption. Both these aspects confirm the "importance of beliefs and values affecting pro-environment attitudes", "societal identity", and "social factors", as per the findings of Espinosa-Goded et al. (2010), de Krom, (2017), Micha et al. (2015), Gabel et al. (2018), Rose et al. (2018). Then, we find an important effect of the continuation of the activity in the long term, except for the collective (C) contractual solution. This suggests that farmers committed to the activity of the holding, in the long run, are generally more motivated towards enrollment in (novel) contractual solutions. A non-significant effect of gender and farm size is found, results that are not in line with the literature (Franzén et al., 2016; Špur et al., 2018). The non-statistically significant effect of *gender* can be due to the lack of representativeness of the sample at hand in terms of this specific aspect. About farm size instead, the conflicting results of the state-of-the-art (see, e.g., Aslam et al., 2017; Walder and Kantelhardt, 2018; vs. Zimmermann and Britz, 2016) hint at not considering such a structural characteristic as pivotal in the adoption of the contractual solutions investigated. Higher levels of education, limited to the value chain contractual solution, could be an important factor in adoption, as per the findings of Lastra-Bravo et al. (2015) and Micha et al. (2015). Generally, the individual contractual design features have a peculiar role in boosting the acceptability of the novel contractual solutions to which they are more linked, i.e., those that they contribute to identifying the most (e.g., 'better results, higher payments' concerning RB contracts; 'paid by customers' for VC contracts). However, they also hint at possibilities of interaction with each other, being potentially combined, as it is, e.g., for the 'collective agreement' about RB contracts. Then, there are individual contractual design features that are largely non-preferred by respondents, as it is, for example, for the 'common payment' contractual element.

5. Conclusions

In this paper, we analyzed the willingness to enroll in four innovative contractual solutions, i.e., result-based, collective, value chain, and land tenure contracts, which are at the edge of the European debate on innovative solutions for the efficient and effective provision of agri-environment-climate public goods.

The main contributions to the state of the art in the subject are the proposal of a coherent research framework built upon both the review of the literature and a multistep approach involving European stakeholders to be used for 1) commonly defining the investigated new forms of contracts and 2) designing a pan-European survey analysis. The farmers' survey on a wide sample provides additional empirical information in a literature largely based on small local samples or expert surveys. In the survey analysis, we consider several determinants of acceptability of such contract types by building models that include i) the structural characteristics of the farms, ii) the sociodemographic and behavioral characteristics of the farmers, iii) farmers' preferences for a set of contractual features/design characteristics.

From the methodological point of view, the analysis carried out lies in the application of the ordered logistic regression method. Both proportional and partial proportional odds models are used, by following the latest advances in the field of ordered outcome variables modelling. When it was the case, in our models we allowed the relaxing of the over-restrictive parallel lines (or proportional odds) assumption, thus, getting robust estimates of the differential effect(s) of several explanatory variables on the willingness to enroll in the four contractual solutions. The use of partially proportional odds represents a methodological advance compared with the current practice in agricultural economics literature and it allows detecting the different magnitude in the shift towards preference levels, instead of assuming they are always proportional (i.e., even when it is not the case).

The investigated innovative contractual solutions are influenced in a different manner and to different extents by the structural characteristics of the agricultural holdings as well as by the socio-demographic characteristics of the farmers. Also, a relevant role in the likelihood of enrolment is played by the individual contractual design features that, in general, define an agri-environmental contract (or programme) and, particularly, can be very specific of one (or more) contractual solutions, up to contributing to the design of *ad hoc* policy instruments. The role played by the several factors investigated differs from contract type to contract type. For example, the result-based contracts are influenced by several individual contractual design features and a mix of sociodemographic and holdings' structural characteristics, while the collective ones are affected by the membership in environmental/nature conservation organizations and those individual contractual features that strictly identify such a contract solution.

In line with our expectations, we found that single contractual design features matter a lot for acceptance. These characteristics are usually related to implementation details, rather than to the contract type, with the notable exception of 'common payment' which seems to be a cleaving characteristic of willingness to enroll in collective contracts.

These findings have relevant policy implications for the future design of the AECMs in the EU, largely driven by the quest for higher efficiency and effectiveness pursued through innovative contractual design. The main insight is that the poor diffusion of innovative contracts cannot be attributed to an extensive and generic reluctance to enroll by farmers, which rather shows a good level of interest. On the other hand, each contract type or specific contract detail may bring trade-offs that need to be properly considered in the design and implementation. That is for instance the case of result-based solutions that, in comparison to the scarce current implementation, resulted as acceptable by farmers. In this context, the idea to involve the farmers in the measurement of the results is one of the aspects that should be considered with attention.

The most relevant one concerns the provision of a 'common payment', the feature less liked by the respondents. As a result, collective contracts should be used only in limited cases where collaboration has a major environmental value added. In this case, collective provision needs to be associated with appropriately higher payments or sufficient support to reduce transaction costs for the farmers.

Careful design is also required by result-based contracts, where large acceptance in principle combines with reluctance towards (some forms of) monitoring. This brings to the need to restrict implementation ambition to solutions with well-accepted and measurable result indicators. On the other hand, the recognition and willingness of farmers to be paid by results is an important leverage to promote this form of payment.

Openness to value chain contracts brings attention to the potential for consumer-based (rather than taxpayer-based) financing of the provision of public goods by agriculture. This is a solution of high policy appealing also in connection with ecological transition concepts and the need to build awareness and commitment by consumers. At the same time, it brings new challenges in the peculiar role of policies for facilitating remuneration of public goods provision through market mechanisms building on willingness to pay of consumers. In this respect, more attention should be given to CAP measures to support public goods-oriented Operational Programs by Producer's Organizations and their coordination with AECMs, as well as connection with private contracting outside the CAP.

Land tenure contracts are the contract type for which it is more difficult to generalize both the design and the perception. Being at the interface with local land regulation, the investigation about this type mainly highlights the need to properly include considerations on land property rights into AECMs design, as well as the potential to attach incentives to (highly locally specific) land contract types.

Besides individual contract types, this work highlights possible interesting opportunities through hybrid contract solutions. For example, result-based contracts with clauses of 'collective agreement' and/or 'paid by customers'; collective contracts with 'reduced rent' clauses; land tenure contracts with prescribed sales guarantees. In

contrast, other combinations are rather dissuasive, e.g., collective contract solutions with payment proportional to environmental results, or value chain contracts combined with 'self-chosen measures.'

A more general policy conclusion may develop from the high relevance shown in this study for managerial aspects and contract design features, as compared to the farm's structural characteristics. This is important as it encourages the use of appropriate participatory approaches in policy design using the flexibility given by the account of multiple policy parameters in building real locally tailored contract solutions.

The main limitation of the work lies in the use of a non-probability sample. Due to COVID-19 restrictions as well as due to budgetary and practical barriers in carrying out a whole-EU farm data collection on a representative sample of farms, the sample at hand accounts for almost 1900 EU farmers, still offering a pan-European perspective which has a relevant value added for the present analysis, since the literature in AECMs and new contracts for the provision of AECPGs shows a shortage of such comprehensive analyses at the EU level. Moreover, the sample of farmers at hand hinted at investigating peculiar national case study regions (cf. Fig. 3) from 10 EU countries. Among these, there are the top five EU countries in terms of total agricultural output among the EU Member States: France (18% of the EU total), Germany (14%), Italy (14%), Spain (12%), Netherlands (7%), followed by Poland (6%) while the other account for 4.2% (EUROSTAT, 2020).

Another limitation is particularly referred to land tenure contracts, since the effort provided here in considering a coherent and common contractual solution for all the locations and jurisdictions present at the EU level, on the one hand, offers an advantage, from the other hand could point at a sort of 'jurisdictional blindness' that underrate local arrangements and traditions in land tenure (as, e.g., can it be the relevant case of Ireland or an ex-EU Member State: the United Kingdom).

Further analysis could approach more directly the interlinks among the different features at stake, as well as consider the present exercise in relation to a representative sample of EU farmers.

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This work does not reflect the view of the EC and in no way anticipates the EC's future policy. The authors are the solely responsible for the content of this manuscript.

CRediT authorship contribution statement

D'Alberto, Riccardo: Conceptualization | Methodology | Software | Formal analysis | Investigation – Data collection design, retrieving, management; Investigation – Data collection (Italy, Emilia-Romagna sample) | Data Curation | Writing – Original Draft; Writing – *Abstract*; Writing – '*Questionnaire development*'; Writing – Section 2.2 '*Modelling approach: proportional odds and partial proportional logit models*'; Writing – Section 2.3 'Data'; Writing – Section 3 '*Results*'; Writing – Section 4 '*Discussion*'; Writing – Section 5 '*Conclusions*'; Writing – *Appendix A*; Writing – *Appendix B*; Writing – *Appendix C*; Writing – Review and Editing | Visualization.

Targetti, Stefano: Writing – Section 1 '*Introduction*'; Writing – Section 5 '*Conclusions*'; Writing – Review and Editing (Section 1 '*Introduction*'; Section 2.1 '*Methodological approach and questionnaire overview*'; Section 5 '*Conclusions*').

Schaller, Lena: Investigation – Data collection (Austria) | Writing – Section 1 '*Introduction*'; Writing – '*The common research framework*'; Writing – Review and Editing (Section 1 '*Introduction*'; Section 2.1 '*Methodological approach and questionnaire overview*').

Bartolini, Fabio: Investigation – Data collection (Italy, Liguria sample) | Writing – Section 1 '*Introduction*'.

Eichhorn, Theresa: Investigation – Data collection (Austria) | Writing – '*The common research framework*'; Writing – Section 3 '*Results*'.

Haltia, Emmi: Investigation – Data collection (Finland).

Harmanny, Kina: Investigation – Data collection (Netherlands).

Le Gloux, Fanny: Investigation – Data collection (France) | Writing –Section 2.3 '*Data*'.

Nikolov, Dimitre: Investigation – Data collection (Bulgaria).

Runge, Tania: Investigation – Data collection (Germany) | Writing – Section 4 '*Discussion*'; Writing – Review and Editing (Section 1 '*Introduction*').

Vergamini, Daniele: Investigation – Data collection (Italy, Liguria sample) | Writing – Section 1 '*Introduction*'.

Viaggi, Davide: Writing – Section 5 '*Conclusions*'; Writing – Review and Editing (Section 5 '*Conclusions*') | Project administration | Funding acquisition.

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.

Data availability

Data will be made available on request.

Appendix A

[Questionnaire to be attached here].

Table A1
Main information about the data collection process.

EU Member State	NUTS 2 region surveyed	Project partner	Nr. of respondents contacted	Nr. of questionnaires collected	Nr. of completed answers	Questionnaire way (tool)[1]	Survey advertised / promoted by[2]	Timing
Austria	Burgenland, Lower Austria, Vienna, Carinthia, Styria, Upper Austria, Salzburg, Tyrol, Vorarlberg	Universitaet Fuer Bodenkultur Wien	*NA*	152	152	online by LimeSurvey	Market research institute "market.at"	Mar-May 2021

(*continued on next page*)

Table A1 (*continued*)

EU Member State	NUTS 2 region surveyed	Project partner	Nr. of respondents contacted	Nr. of questionnaires collected	Nr. of completed answers	Questionnaire way (tool)[1]	Survey advertised / promoted by[2]	Timing
Bulgaria	Severozapaden, Severoiztočen, Jugoiztočen, Jugozapaden, Juzen Centralen	Institute of Agricultural Economics	*NA*	96	96	online andby phone		Dec 2020 - Feb 2021
Finland	West Finland, Helsinki-Uusimaa, Sourth Finland, North & East Finland	Luonnonvarakeskus	4974	408	408	online		Apr-May 2021
France	Lower Normandy, Pays de la Loire, Brittany	Association Trame; Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement	≈160	130	130	face-to-face	Confederation Paysanne (farmers union); Brittany Regional Federation of Organic Farming (FRAB); several organizations of milk producers (CIVAM, CEBR, OLPGO); GEDA35 and CETA35	May-Jun 2021
Germany	Schleswig-Holstein, Sachsen-Anhalt, Saarland, Thüringen, Münster, Detmold, Arnsberg, Rheinhessen-Pfalz, Leipzig, Stuttgart, Karlsruhe, Freiburg, Oberbayern, Niederbayern, Brandeburg, Mecklenburg-Vorpommern	Thünen Institute	≈700	146	146	online by LimeSurvey		Feb-Apr 2021
Italy	Emilia-Romagna	Alma Mater Studiorum – Università di Bologna; Regione Emilia-Romagna	*NA* (Emilia-Romagna Region website); ≈6000 e-mailed by Emilia-Romagna Region	559	305	online by Qualtrics	Emilia-Romagna Region both via its official website and e-mails	May-Jul 2021
Italy	Liguria	Università di Pisa	≈300	110	94	face-to-face directly compiling Qualtrics	Entity which has subcontracted the survey, and which offers administrative and technical services to farmers	Jun-Sept 2021
Latvia	Latvia	Zemnieku Saeima	≈900	101	101	online		Mar-May 2021
Netherlands	Groningen, Friesland, Drenthe, Overijssel, Gelderland, Flevoland, Utrecht, North Holland, South Holland, Zeeland, North Brabant, Limburg	Stichting VU	≈15,000	201	160	online by Qualtrics		Apr-Jul 2021
Poland	Malopolskie, Slaskie, Wielkopolskie, Zachodniopomorskie, Lubuskie, Opolskie, Kujawsko-Pomorskie, Warminsko-Mazurskie, Pomorskie, Lodzkie, Podkarpackie, Podlaskie, Mazowiecki regionalny	Szkola Glowna Gospodarstwa Wiejskiego	450	279	279	online by LimeSurvey		Mar-Jul 2021
Spain	Extremadura, Andalusia	EVENOR Tech sl; Asociacion Agraria Jovenes Agricultores de Sevilla; Universidad Politecnica de Madrid	*NA*	60	60	face-to-face		Mar-Sept 2021

Note: [1] where not explicitly indicated, the used online tool has been set up directly by the partner institution; [2] where not explicitly indicated, the survey promotion/ advertisement has been conducted directly by the partner institution (e.g., by means of social media, internal e-mail repositories, etc.).

Table A2
Statistical tests on sample representativeness.

Explanatory variable	Sample	Population proportion*	One-sample test of proportion
	Proportion(Std. Err.)[95% Con. Int.][§]		p-value
Gender	0.822	0.851	‡ **0.000**
male	(0.009)		
	[0.805, 0.839]		
female	0.178	0.149	‡ **0.001**
	(0.009)		
	[0.161, 0.195]		
Age			
Education level			
Role in the holding			
Membership			
Continue the activity			
Total household gross revenue from agricultural activities			
Legal status			
Specialization	0.440	0.459	0.099
arable	(0.011)		
	[0.417, 0.463]		
horticulture	0.036	0.031	0.175
	(0.004)		
	[0.028, 0.045]		
permanent	0.123	0.221	0.971
	(0.008)		
	[0.108, 0.138]		
livestock	0.239	0.259	0.055
	(0.010)		
	[0.220, 0.259]		
mixed	0.119	0.150	‡ **0.000**
	(0.008)		
	[0.105, 0.134]		
others			
Previous participation in AECMs			
Organic production			
Direct CAP payments			
RDP payments			

	Sample	Population mean*	One-sample t-test for the mean
	Mean(Std. Err.)[95% Con. Int.][§]		p-value
Utilized Agricultural Area(in hectares)	142.998	131	0.209
	(9.552)		
	[124.264, 161.731]		
Utilized Agricultural Area under AECMs(in hectares)			

Note: * Official data about farms population are referred to EU27 (year 2020) and are retrieved here: https://ec.europa.eu/eurostat/databrowser/explore/all/agric?lang=en&subtheme=agr&display=list&sort=category [accessed November 25th, 2023]. [§] Std. Err.: standard error; Con. Int.: confidence interval. ‡ **in bold**: 0.05 level of statistical significance. Grey rows indicate information for which the EUROSTAT official statistics were not available (or the retrievable statistics could not be aligned to the structure of the variables used in our analyses).

Appendix B

Table B1 depicts the Chi-squared and the related p-values resulting from the Brant test on the parallel lines assumption, referred to each explanatory variable included in the model (statistically significant coefficients indicate that the null hypothesis of the Proportional Odds/Parallel Lines model must be rejected and, thus, a PPO/NPL model should be adopted). In addition, for each model related to the contractual solutions under analysis, Table B1 depicts the results of the tests validating the parallel lines assumption for the whole model (see Williams, 2006, and the references therein).

Table B1
Chi-squared values of the Brant test (and the other tests) on the parallel lines' assumption.

Explanatory variable[§]	Result-based	Collective	Value chain	Land tenure
Gender (male)	3.10 (0.376)	1.90 (0.593)	1.68 (0.642)	3.78 (0.286)
female				
Education level (primary)	4.06 (0.255)	0.86 (0.835)	5.09 (0.165)	1.22 (0.749)
upper secondary				
post-secondary	4.04 (0.257)	4.94 (0.176)	1.45 (0.649)	0.68 (0.878)
Bachelor	2.07 (0.558)	0.31 (0.959)	2.66 (0.448)	0.27 (0.966)
Master or higher	0.17 (0.982)	2.38 (0.497)	3.82 (0.282)	0.15 (0.985)
Membership (farmers' union)	‡ **24.49** (0.000)	4.46 (0.216)	1.85 (0.605)	2.82 (0.421)
nature conservation, environmental organization				
none	‡ **11.54** (0.009)	2.93 (0.403)	4.60 (0.235)	6.15 (0.053)
Continue the activity (no)	0.46 (0.927)	7.04 (0.071)	1.10 (0.777)	2.12 (0.548)
0 -| 10 years				

(*continued on next page*)

Table B1 (*continued*)

Explanatory variable[§]	Result-based	Collective	Value chain	Land tenure
> 10 years	1.57 (0.666)	2.64 (0.450)	4.46 (0.215)	2.03 (0.565)
Specialization (arable)	2.47 (0.480)	0.39 (0.942)	2.19 (0.534)	2.64 (0.451)
horticulture				
permanent	3.44 (0.328)	5.22 (0.156)	5.86 (0.119)	0.85 (0.836)
livestock	1.93 (0.587)	6.78 (0.079)	‡ **9.59** (0.022)	‡ **8.51** (0.037)
mixed	3.59 (0.309)	3.64 (0.303)	6.98 (0.073)	5.44 (0.142)
others	6.84 (0.077)	2.52 (0.471)	0.38 (0.944)	3.83 (0.281)
Organic production (no)	‡ **26.57** (0.000)	2.19 (0.534)	‡ **7.95** (0.047)	7.31 (0.063)
yes				
Utilized Agricultural Area(in hectares)	1.90 (0.593)	0.17 (0.982)	1.40 (0.706)	2.35 (0.503)
Direct CAP payments (no)	3.05 (0.384)	5.53 (0.137)	3.84 (0.279)	5.50 (0.139)
yes				
RDP payments (no)	5.20 (0.158)	5.17 (0.160)	5.48 (0.140)	2.28 (0.517)
yes				
Self-chosen measures	1.10 (0.776)	2.68 (0.444)	1.69 (0.639)	4.68 (0.197)
Better results, higher payment	7.60 (0.060)	‡ **10.67** (0.014)	2.69 (0.442)	2.71 (0.438)
Collective agreement	2.84 (0.417)	5.75 (0.124)	3.24 (0.357)	3.60 (0.308)
Common payment	‡ **8.61** (0.035)	‡ **11.58** (0.009)	‡ **13.33** (0.004)	1.00 (0.801)
Labelled product	2.62 (0.453)	1.00 (0.802)	2.13 (0.547)	1.62 (0.656)
Paid by customers	0.85 (0.838)	6.60 (0.086)	4.89 (0.180)	2.61 (0.456)
Reduced rent	3.21 (0.360)	4.04 (0.257)	‡ **9.69** (0.021)	1.64 (0.650)
Self-monitoring	4.03 (0.258)	0.72 (0.869)	2.01 (0.569)	0.42 (0.935)
Authority control	‡ **9.20** (0.027)	‡ **13.31** (0.004)	‡ **10.22** (0.017)	2.18 (0.537)
Free training	2.08 (0.556)	2.80 (0.424)	2.98 (0.394)	1.63 (0.653)
Sales guarantee	4.87 (0.182)	3.11 (0.375)	5.86 (0.119)	2.14 (0.299)
Annual compensation	5.41 (0.144)	3.05 (0.383)	2.24 (0.524)	2.37 (0.500)
Periodical payment	‡ **10.97** (0.012)	‡ **8.04** (0.045)	3.46 (0.440)	‡ **11.53** (0.009)
Test (whole model)				
Brant	‡ **187.9** (0.000)	‡ **174.9** (0.000)	‡ **168.9** (0.000)	110.0 (0.195)
Wolfe Gould	‡ **186.8** (0.000)	‡ **163.6** (0.000)	‡ **152.1** (0.000)	104.5 (0.110)
Score	‡ **204.7** (0.000)	‡ **190.0** (0.000)	‡ **167.1** (0.000)	110.8 (0.100)
Likelihood ratio	‡ **193.7** (0.000)	‡ **184.2** (0.000)	‡ **161.2** (0.000)	111.7 (0.090)
Wald	‡ **213.3** (0.000)	‡ **198.7** (0.000)	‡ **173.3** (0.000)	115.6 (0.056)

Note: [§] reference category of the variable in parenthesis; p-values in parentheses; ‡ **in bold**: 0.05 level of statistical significance.

Appendix C

The following tables are the extended version of Tables 4–7 presented in the manuscript. In the following ones however, not only the statistically significant predictors are depicted, but all the predictors that are included in the models.

Table C1
Model coefficients, result-based contractual solution.

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Gender (male)	-0.026 (0.833)			
female				
Education level (primary)	-0.182 (0.258)			
upper secondary				
post-secondary	-0.356 (0.061)			
Bachelor	-0.281 (0.119)			
Master or higher	0.236 (0.168)			
Membership (farmers' union)	-0.180 (0.595)	‡ **-0.674** (0.030)	0.132 (0.698)	0.451 (0.239)
nature conservation, environmental organization				
none	0.376 (0.168)	-0.418 (0.087)	-0.534 (0.843)	-0.375 (0.227)
Continue the activity (no)	0.020 (0.894)			
0 -| 10 years				
> 10 years	‡ **0.544** (0.000)			
Specialization (arable)	0.341 (0.181)			
horticulture				
permanent	-0.011 (0.943)			
livestock	‡ **0.466** (0.000)			
mixed	0.259 (0.095)			
others	0.278 (0.257)			
Organic production (no)	‡ **-1.340** (0.000)	‡ **1.047** (0.000)	‡ **1.257** (0.000)	‡ **1.585** (0.000)
yes				
Utilized Agricultural Area(in hectares)	-0.000 (0.888)			
Direct CAP payments (no)	‡ **-0.353** (0.029)			
yes				
RDP payments (no)	0.150 (0.144)			
yes				

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Table C1 (*continued*)

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Self-chosen measures	‡ **0.130** (0.028)			
Better results, higher payment	‡ **0.263** (0.000)			
Collective agreement	‡ **0.217** (0.042)			
Common payment	-0.006 (0.911)	0.040 (0.664)	-0.086 (0.405)	-0.197 (0.095)
Labelled product	0.067 (0.211)			
Paid by customers	‡ **0.089** (0.033)			
Reduced rent	0.056 (0.260)			
Self-monitoring	‡ **0.154** (0.003)			
Authority control	‡ **0.275** (0.014)	0.018 (0.855)	0.044 (0.694)	0.217 (0.086)
Free training	0.008 (0.884)			
Sales guarantee	0.011 (0.844)			
Annual compensation	0.073 (0.222)			
Periodical payment	‡ **0.264** (0.021)	‡ **-0.248** (0.021)	‡ **-0.296** (0.010)	‡ **-0.486** (0.000)

Note: [§] reference category of the variable in parenthesis; * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ **in bold**: 0.05 level of statistical significance.

Table C2
Model coefficients, collective contractual solution.

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Gender (male)	-0.085 (0.479)			
female				
Education level (primary)	-0.057 (0.719)			
upper secondary				
post-secondary	-0.245 (0.192)			
Bachelor	-0.184 (0.302)			
Master or higher	0.074 (0.657)			
Membership (farmers' union)	‡ **0.732** (0.000)			
nature conservation, environmental organization				
none	-0.035 (0.749)			
Continue the activity (no)	-0.031 (0.835)			
0 -| 10 years				
> 10 years	0.128 (0.366)			
Specialization (arable)	-0.450 (0.073)			
horticulture				
permanent	-0.148 (0.329)			
livestock	0.111 (0.363)			
mixed	-0.057 (0.703)			
others	-0.227 (0.339)			
Organic production (no)	0.120 (0.294)			
yes				
Utilized Agricultural Area(in hectares)	-0.000 (0.076)			
Direct CAP payments (no)	-0.106 (0.491)			
yes				
RDP payments (no)	0.003 (0.976)			
yes				
Self-chosen measures	-0.049 (0.389)			
Better results, higher payment	0.052 (0.488)	-0.081 (0.255)	0.049 (0.595)	‡ **-0.276** (0.031)
Collective agreement	‡ **0.253** (0.000)			
Common payment	‡ **0.628** (0.000)	‡ **-0.190** (0.009)	‡ **0.288** (0.001)	‡ **-0.287** (0.014)
Labelled product	0.065 (0.221)			
Paid by customers	0.036 (0.388)			
Reduced rent	‡ **0.133** (0.007)			
Self-monitoring	0.071 (0.163)			
Authority control	0.039 (0.558)	0.064 (0.305)	‡ **0.160** (0.038)	‡ **0.498** (0.000)
Free training	0.123 (0.111)			
Sales guarantee	0.018 (0.747)			
Annual compensation	‡ **-0.125** (0.034)			
Periodical payment	‡ **0.145** (0.001)	-0.141 (0.055)	-0.105 (0.262)	‡ **-0.437** (0.001)

Note: [§] reference category of the variable in parenthesis; * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ **in bold**: 0.05 level of statistical significance.

Table C3
Model coefficients, value chain contractual solution.

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Gender (male)	0.031 (0.799)			
female				

(*continued on next page*)

Table C3 (*continued*)

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Education level (primary)	0.237 (0.140)			
upper secondary				
post-secondary	0.052 (0.785)			
Bachelor	‡ **0.397** (0.029)			
Master or higher	‡ **0.361** (0.033)			
Membership (farmers' union)	-0.050 (0.732)			
nature conservation, environmental organization				
none	‡ **-0.377** (0.001)			
Continue the activity (no)	-0.076 (0.607)			
0 -| 10 years				
> 10 years	‡ **0.414** (0.004)			
Specialization (arable)	-0.368 (0.472)	‡ **0.804** (0.045)	0.928 (0.070)	0.616 (0.303)
horticulture				
permanent	0.620 (0.124)	-0.724 (0.055)	‡ **-0.859** (0.039)	‡ **-0.947** (0.043)
livestock	-0.169 (0.475)	-0.164 (0.437)	0.190 (0.435)	0.549 (0.056)
mixed	0.177 (0.589)	-0.366 (0.226)	0.053 (0.875)	0.011 (0.978)
others	-0.367 (0.354)	-0.118 (0.720)	0.245 (0.554)	0.263 (0.637)
Organic production (no)	-0.242 (0.292)	‡ **0.603** (0.002)	‡ **0.554** (0.017)	‡ **0.886** (0.001)
yes				
Utilized Agricultural Area(in hectares)	0.000 (0.527)			
Direct CAP payments (no)	‡ **0.405** (0.010)			
yes				
RDP payments (no)	‡ **-0.369** (0.000)			
yes				
Self-chosen measures	‡ **-0.136** (0.017)			
Better results, higher payment	0.000 (0.995)			
Collective agreement	0.064 (0.203)			
Common payment	‡ **0.203** (0.040)	-0.160 (0.063)	‡ **-0.329** (0.001)	‡ **-0.381** (0.001)
Labelled product	‡ **0.329** (0.000)			
Paid by customers	‡ **0.368** (0.000)			
Reduced rent	0.147 (0.111)	‡ **-0.232** (0.005)	‡ **-0.201** (0.036)	‡ **-0.242** (0.031)
Self-monitoring	-0.025 (0.632)			
Authority control	‡ **0.302** (0.001)	-0.076 (0.329)	0.038 (0.682)	0.174 (0.110)
Free training	0.063 (0.279)			
Sales guarantee	‡ **0.229** (0.000)			
Annual compensation	0.039 (0.513)			
Periodical payment	0.040 (0.365)			

Note: [§] reference category of the variable in parenthesis; * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ **in bold**: 0.05 level of statistical significance.

Table C4
Model coefficients, land tenure contractual solution.

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Gender (male)	-0.128 (0.284)			
female				
Education level (primary)	-0.118 (0.452)			
upper secondary				
post-secondary	-0.288 (0.126)			
Bachelor	-0.168 (0.346)			
Master or higher	0.125 (0.456)			
Membership (farmers' union)	0.024 (0.868)			
nature conservation, environmental organization				
none	0.044 (0.691)			
Continue the activity (no)	‡ **-0.351** (0.017)			
0 -| 10 years				
> 10 years	0.049 (0.727)			
Specialization (arable)	-0.246 (0.587)	0.479 (0.223)	0.354 (0.456)	0.039 (0.947)
horticulture				
permanent	‡ **-0.509** (0.037)	0.044 (0.852)	-0.069 (0.808)	0.212 (0.567)
livestock	-0.175 (0.432)	**0.440** (0.027)	0.593 (0.010)	0.281 (0.326)
mixed	-0.382 (0.150)	0.310 (0.205)	0.513 (0.069)	0.280 (0.440)
others	‡ **-0.907** (0.005)	0.429 (0.147)	0.409 (0.289)	0.427 (0.477)
Organic production (no)	0.167 (0.884)			
yes				
Utilized Agricultural Area(in hectares)	0.000 (0.203)			
Direct CAP payments (no)	0.095 (0.535)			
yes				
RDP payments (no)	-0.106 (0.295)			
yes				
Self-chosen measures	-0.061 (0.285)			
Better results, higher payment	-0.103 (0.060)			

(*continued on next page*)

Table C4 (*continued*)

Explanatory variable[§]	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Collective agreement	0.063 (0.211)			
Common payment	0.022 (0.653)			
Labelled product	0.043 (0.415)			
Paid by customers	0.011 (0.791)			
Reduced rent	[‡] **0.804** (0.000)			
Self-monitoring	0.015 (0.765)			
Authority control	[‡] **0.256** (0.000)			
Free training	0.070 (0.226)			
Sales guarantee	[‡] **0.130** (0.024)			
Annual compensation	[‡] **-0.150** (0.010)			
Periodical payment	0.008 (0.909)	0.039 (0.550)	-0.059 (0.440)	-0.153 (0.110)

Note: [§] reference category of the variable in parenthesis; * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; [‡] **in bold**: 0.05 level of statistical significance.

Appendix D. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2024.107120.

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