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To what extent are farmers willing to adapt to climate change? An assessment of agricultural best management practices adoption

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Abstract

Aim of study: Address farmers' preferences for the adoption of agricultural best management practices in a climate change context and estimate their willingness to accept values for these practices.

Area of study: Region of Murcia (SE Spain).

Material and Methods: The method employed is a discrete choice experiment, whose attributes are the agricultural best management practices for climate change adaptation [regulated deficit irrigation, crop diversification, organic fertilisation, crop residues management, narrowing farmland by 5%, perimeter hedgerows, biological control, enabling eco-tourism activities] and a subsidy to incentivise their adoption. Data were collected for a sample of 250 farmers and analysed by a mixed logit model.

Main results: Narrowing farmland by 5%, biological control and the establishment of perimeter hedgerows were the practices generating the greatest values of disutility, and therefore they displayed higher willingness to accept values, ranging from 320 to 410 €/ha/year. In contrast, organic fertilisation and crop residues management were the practices with lowest levels of disutility, and so demanding lower compensatory payments to engage farmers to adopt, which rounded 110 €/ha/year, respectively. Preference heterogeneity was also assessed, revealing that the likelihood of adopting best management practices was determined by farm characteristics (farm size, crop type and farming system) and farmer factors (educational level).

Research highlights: Farmers are willing to adopt agricultural best management practices for climate change adaption if they are associated to properly designed incentives.

Keywords: agriculture; ecosystem services; Mediterranean; sustainability; willingness to accept.

¿Hasta qué punto están dispuestos los agricultores a adaptarse al cambio climático? Una evaluación de la adopción de buenas prácticas de cultivo

Resumen

Objetivo del estudio: Analizar las preferencias de los agricultores para la adopción de buenas prácticas de cultivo en un contexto de cambio climático y estimar su disposición a aceptar por dichas prácticas.

Área de estudio: Región de Murcia (sureste de España).

Material y métodos: El método empleado es un experimento de elección discreta, cuyos atributos son las buenas prácticas de cultivo para la adaptación al cambio climático [riego deficitario controlado, diversificación de cultivos, fertilización orgánica, incorporación de restos de cultivo, reducción de la superficie de cultivo en un 5%, setos perimetrales, control biológico, permitir la realización de actividades de ecoturismo] y una subvención para incentivar su adopción. Los datos se analizaron mediante un modelo logit mixto a partir de una muestra de 250 agricultores.

Principales resultados: La reducción de la superficie de cultivo en un 5%, el control biológico y el establecimiento de setos perimetrales son las prácticas que presentan valores de disposición a aceptar más elevados, que oscilan entre 320 y 410 €/ha/año. Por el contrario, la fertilización orgánica y la gestión de residuos de cultivos son las prácticas que requieren menores pagos compensatorios para que los agricultores las adopten, cuyos valores rondan los 110 €/ha/año. También se evalúa la heterogeneidad de las preferencias, lo que pone de manifiesto que la probabilidad de adoptar buenas prácticas de cultivo viene determinada por las características de las explotaciones (tamaño de la explotación, tipo de cultivo y sistema de explotación) y los agricultores (nivel educativo).

Aspectos destacados de la investigación: Los agricultores están dispuestos a adoptar buenas prácticas de cultivo para la adaptación al cambio climático si están asociadas a incentivos adecuadamente diseñados.

Palabras clave: agricultura; disposición a aceptar; región mediterránea; servicios ecosistémicos; sostenibilidad.

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Introduction

Climate change will impact on the way agriculture is conceived nowadays (Shahzad et al., 2021). Higher temperatures, droughts and extreme rainfall will impose additional challenges to agricultural production. Alterations in crop development, pest and diseases proliferation and reduction of soil fertility are examples on how climate change may compromise the current suitability of the agricultural sector (Rezaei et al., 2023). This also adds to the eroded agricultural resilience after decades of highly intensive agricultural models, which undermines agroecosystem capability to adapt and mitigate climate change effects (Raven & Wagner, 2021). These effects are distributed unevenly across the territory, with a greater impact in areas where there is a combination of intensification of agricultural land use together with scarcity of water resources (Ingrao et al., 2023). This is exemplified by the semi-arid Mediterranean basin (Zapata-Sierra et al., 2022). As such, new agricultural practices are needed, especially in these water-scarce areas, to address the vulnerability of the agricultural sector in face of climate change impacts.

Agricultural practices are the methods used by farmers to modify the capacity of agroecosystems to provide flows of ecosystem services and disservices, according to the state conditions of agroecosystems (Zabala et al., 2021). Changes in climate conditions will disturb the provision of agroecosystem services and disservices, therefore driving farmers to also modify the agricultural practices they implement (Toromade et al., 2024). To overcome the observed or expected climate change challenges, conventional agricultural practices may be adapted by taking advantage of opportunities revealed by environmental change (*adaptation practices*) or by just mitigating the risks derived from the environmental threats (*mitigation practices*). In this way, agricultural best management practices are agronomic techniques that can help farmers to improve agroecosystem adaptive capacity to the impacts from climate change (Martínez-García et al., 2025).

Agricultural best management practices are, among others, regulated deficit irrigation (Egea et al., 2017), crop diversification (Zabala et al., 2023), biological control (Barratt et al., 2018), organic fertilisation (Wezel et al., 2014), incorporation of organic crop residues into agricultural soil (Rojas et al., 2013), establishment of perimeter hedges in agricultural plots (López-Felices et al., 2022), and leaving the plot partially uncultivated (Sakellariou et al., 2021). Most of these agricultural best management practices are included in recent IPCC (Kerr et al., 2022) and CAP (European Commission, 2022) reports. The practices documented in these reports encompass a range of agricultural techniques, including intercropping, biodiversity enhancement, crop and pasture rotation, organic amendment application, cover cropping, and the minimisation of toxic and synthetic inputs, which have been demonstrated to have positive effects on both human health and the environment. These practices are already being applied in some Mediterranean agricultural areas (Albaladejo-García et al., 2025) and corroborate their role in improving agroecosystem regulation processes and reducing negative impacts on the environment (Rehman et al., 2022). As such, eco-schemes within the new CAP reform for the period 2023-2027 become currently the most emblematic policy for the promotion of agricultural best management practices at a large scale. However, the simplicity in their design seems to make challenging to achieve extended environmental benefits, whilst different adoption rate by farmers from across European regions seems far from ensuring a generalised adoption of good agricultural practices among farmers (Nadeu & Godfroy, 2024).

Agricultural best management practices not only may reduce the vulnerability to climate risks but also could help to shape the provision of agroecosystem services, such as food provision (Zabala et al., 2021), temperature regulation (Albaladejo-García et al., 2020), or landscape enjoyment (Albaladejo-García et al., 2023), and agroecosystem disservices, such as overexploitation of aquifers (Alcon et al., 2022) or soil degradation (Sutton et al., 2016). Therefore, benefits for the adoption of such agricultural practices are twofold. On the one hand, farmers experience a reduction in the probability of suffering losses from climate change impacts (Martínez-García et al., 2025). This evinces a supply side perspective; whose value necessarily refers to the actual value of the expected avoided costs from the negative climate change impacts. On the other hand, society would also experience wellbeing gains from the adoption of such practices: both by increasing the provision of agroecosystem services (e.g. biodiversity, erosion regulation, climate regulation...) and diminishing the provision of disservices (aquifer pollution, irrigation water consumption...), and by avoiding services deterioration and disservices growth. Hence, agricultural best management practices not only provide benefits for farmers, but also for the entire society.

The adoption of agricultural best management practices becomes a significant challenge for farmers. It involves actions, decisions and attitudes that shape farmer's behaviour to cope with such alternative practices (Doran et al, 2020). On the one hand, farmers may be reluctant to adopt alternative agricultural practices because of their low risk tolerance, their resistance to change or their lack of environmental concern (Dessart et al., 2019). On the other hand, farmers may be unwilling to adopt agricultural best management practices if they perceive them as difficult to implement, costly or risky. That is, they feel that they lack control over the process of implementing the practices or perceive that the cost and risk - whether financial or environmental - outweigh the benefits (Luo et al., 2016). From this point on, all these factors need to be addressed to improve farmers' adoption of agricultural practices.

Incentives are economic instruments designed to change individual behaviour (Ling & Xu, 2021). Following Piñeiro et al. (2020) classification, three categories of incentives may be distinguished in the frame of agricultural practices adoption: market- and non-market-based incentives, regulatory proposals and cross-compliance measures. Market-based incentives provide financial benefits to farmers to compensate and/or encourage agricultural practices adoption. They include input compensations, price premiums, subsidies, income transfer, or any other in cash or in-kind incentive that provides a market signal. In contrast, non-market incentives comprehend any type of incentive that does not provide a signal through the market scope. It is such a broad set of incentives that encompass from technical and technological support and training, to the promotion of cooperation mechanisms among farmers. Regulatory proposals are general, and commonly mandatory, rules imposed by public and private entities to enforce farmers to adopt practices. Cross-compliance measures ultimately impose farmers to adopt practices in fulfilment of conditions from obtaining public benefits. Properly designed incentives seek to encourage farmer to adopt alternative agricultural practices.

Public policy may strengthen farmers' adoption rates of agricultural best management practices if properly links behavioural farmer factors and incentives (Dessart et al, 2019). Cognitive factors, which are the nearest to such decision-making process, play a key role in this sense: if incentives are designed to influence on such cognitive factors, the success of public policy is almost ensured. Cognitive factors comprehend individuals' learning, reasoning and understanding capacities, which determine the perceptions about behaviours and their consequences. Particularly, they apply to knowledge, difficultness and perceived benefits and risks. As such, farmers will not be willing to adopt climate change practices if they perceive them as difficult to implement, costly or risky. That is, they feel that they lack control about the implementation process of the practices, or they perceived their cost and risk -either financial or environmental- exceed their benefits. Therefore, incentives need to be designed to address the lack of knowledge and control about alternative agricultural practices or directly provide higher enough benefits for farmers so that risks and costs are offset. In such a context, market incentives arise as feasible options to be applied. For instance, farm subsidies for the adoption of such these agricultural practices (Puntsagdorj et al., 2021). Hence, as stated, it seems easy: subsidies to farmers to encourage the adoption of agricultural practices. However, many questions emerge when such subsidies should be designed and implemented: How much these subsidies: only to compensate overcosts or higher amounts to generate additional financial incentives? Which terms? Fixed quantities regardless the practices? Will actually these practices be adopted by farmers? These are only a brief example of such a complex set of choices for public policy, which just show the needs to develop ex-ante policy evaluations to make public decision effective and efficient.

In such a context, the purpose of this paper is to address farmers' preferences for the adoption of agricultural best management practices in a climate change context, so that the farmers' willingness to accept for such practices is understood. To this end, the semi-arid Mediterranean agriculture has been selected as a case study, as it is one of the most outstanding water-scarce areas that has undergone major agricultural intensification and requires better adaptation to the climate change effects.

This paper contributes to better knowledge of the capability of the agricultural sector to adapt to expected climate change scenarios. By using these results, incentives could be designed in order to maximise the adoption of such practices by the agricultural sector. In addition, the paper broadens the knowledge about farmers preferences for climate change mitigation actions, in such a representative region of the Mediterranean area with intense agriculture.

Material and methods

Case study

The case study of this work is the semi-arid Mediterranean intensified irrigated agroecosystems in the Region of Murcia (SE-Spain). This type of agriculture is characterised by being in semi-arid areas with average temperatures above 18 ºC and average rainfall of less than 350 mm (Alcon et al., 2022). Agricultural development has been mainly based on the use of groundwater and water transfers. This has led to an intensification of land use that has provided not only economic benefits, but also environmental impacts, mainly related to water management, nitrate and pesticide pollution and soil fertility, which will be exacerbated in a climate change context (Pellicer-Martínez & Martínez-Paz, 2018).

Irrigated agroecosystems in the Region of Murcia cover an area of 124,892 ha of agricultural land, which is 42.52% of the total cropland (CREM, 2024). This is a type of intensive agroecosystem whose production is export oriented. The most prominent irrigated crop groupings in terms of area are vegetables (35.03%) followed by citrus fruit trees (27.02%), non-citrus fruit trees (25.39%), vineyards (9.18%) and irrigated olive trees (3.38%). Although some techniques are being developed to optimise water use in these areas (Alcon et al., 2013), only 16.79% of crops are grown under agricultural best management practices (Martínez-García et al., 2025). It is therefore necessary to look for solutions to produce crops in a more sustainable way, without compromising either the farmer's profit or the final cost to the consumer.

Discrete choice experiment

Farmers' preferences for agricultural best management practices were analysed by using a discrete choice experiment (DCE). DCE comprehends a non-market valuation methodology based on the multi-attribute utility theory (Lancaster, 1966) and random utility theory (McFadden, 1974). Accordingly, the value individuals attach to a good or service can be obtained from the value of the attributes that compose it [multi-attribute utility]. However, such value does not follow a straightforward relationship among attributes since it is also determined by unobserved and inner individual characteristics [random utility theory]. When applying, this method also requires individuals to face hypothetical situations where combinations of attributes and their levels are presented to be chosen. This also makes DCE to be a stated preference method, which requires surveys to be developed, and commonly applied in marketing, social behaviour analysis and environmental economics. More details about the notion and application of DCE is available in Champ et al. (2017).

DCE represents an accurate method for understanding farmers' preferences for agricultural practices and valuing their desired financial incentives for their adoption. According to this method, agricultural best management practices are presented as attributes of agri-environmental schemes to be adopted by farmers to deal with climate change effects. Farmers are asked to choose the agri-environmental schemes whose agricultural practices and amount of subsidy better fit their preferences. And therefore, the demand of agricultural best management practices will be revealed, as well as the amount of subsidy from which they are willing to adopt each practice. This method has been widely applied in the agricultural economic literature for addressing farmers' willingness to accept agri-environmental schemes (Villanueva et al., 2015; Schulze et al., 2024), and sustainable farming practices (Salazar-Ordoñez et al., 2021), currently becoming a growing interest in the frame of agricultural practices for climate change adaptation and mitigation (Bro et al., 2019).

Attributes and levels

As stated, attributes refer to the agricultural best management practices to be implemented by irrigation outdoor farmers. The attributes of the DCE were proposed by considering the opinions and experiences gathered in a focus group with agri-environmental stakeholders (agricultural engineers, technicians, economists, and environmentalists) and public administrators (representatives of the agricultural regional administration). They considered the environment-agriculture nexus and its associated issues in the case study area, mainly water management, nitrate and pesticides pollution, and soil fertility, which are expected to be exacerbated in a climate change scenario. But also, they sought to maximise the impact of the agricultural practices in society in terms of ecosystem services. Thus, a set of eight agricultural best management practices were ultimately suggested as attributes. Table 1 shows the attributes and levels of the DCE. Their levels were defined as dichotomous, so that each practice can be considered integrally in the alternative agri-environmental schemes, or not.

Table 1. Attributes and levels of the discrete choice experiment (DCE).

Attributes (CODE)	Definition	Levels	
Regulated deficit irrigation (RDI)	Irrigation strategy based on sensor-controlled irrigation to reduce water inputs during periods when water deficit does not affect production significantly	Yes/No	
Crop diversification (DIVER)	Establishment of intercropping or rotation with legumes or cereals (including green cover)	Yes/No	
Organic fertilisation (ORGAF)	Replacement of mineral fertilisers with organic fertilisers (e.g., compost, humus, green manure)	Yes/No	
Crop residues management (CRESI)	Shredding and incorporation of crop residues into the soil	Yes/No	
Narrowing farmland (NARROW)	Leaving uncultivated 5% of farmland to reduce global farm intensity	Yes/No	
Perimeter hedgerows (HEDGE)	Establishment and maintenance of plot margins with trees, shrubs or vegetation	Yes/No	
Biological control (BIOCON)	Replacement of chemical pesticides with biological pest control (e.g., natural predators, colour traps, pheromones)	Yes/No	
Enabling eco-tourism activities (ECOTOUR)	To allow recreational and environmental education activities on farms (walking paths, observation points, restored waterwheels)	Yes/No	
Subsidy [5 years] (PAYMENT)	Yearly payment per hectare for a 5-year agri-environmental scheme contract	150 300 450 600 750 900	€/ha/year

According to their contribution to the flow of ecosystem services and disservices, the proposed agricultural practices are grouped in three main categories, following their common classification: (1) those associated with provisioning services, (2) those affecting regulating services, and (3) those connected with cultural services. As such, one practice was proposed to impact on provisioning disservices, six practices to focus on regulating services and disservices, and one also to contribute to cultural services. The greatest number of best management practices was proposed into the regulating category given that the largest climate change impacts are also expected on such services and disservices.

Regulated deficit irrigation (RDI) is proposed with the objective to better water management in the case study area and so mitigating a growing water stress in the frame of climate change. This therefore seeks to alleviate agricultural pressure to water resources in semiarid areas, which moves into the mitigation of provisioning disservices when competing water alternative uses are considered (Zabala et al. 2021). RDI applies either to woody crops (Berríos et al., 2023) and horticultural ones (Yang et al., 2022), considering the latter mostly as an efficient irrigation practice rather than a deficit strategy with water shortage periods.

Crop diversification, *organic fertilisation*, *crop residues management* and *narrowing farmland* are practices seeking to enhance soil fertility and mitigate soil degradation from climate change. *Crop diversification*, either from intercropping or rotation with legumes and cereals, increases the multifunctionality of agroecosystems. The presence of several crops in the same plot may have a positive impact on reducing runoff and soil erosion, increasing organic matter and soil biodiversity, which in turn translates into a better soil structure and composition (Marcos-Pérez et al., 2023; Almagro et al., 2023). *Organic fertilisation* goes directly to improve soil composition by increasing organic matter (Hernández et al., 2021). Besides, it enhances the absorption of nutrients by the crops, and so reduces diffuse nitrate pollution to water bodies, comparing to conventional mineral fertilisation. *Crop residues management* by their incorporation into soil improves soil organic matter content while decreasing fertilizer requirements for next crop (Cerdá et al., 2017). Lastly, n*arrowing farmland* by 5% pursues to reduce intensity in the use of natural resources for agricultural management, which in turn would leave space for soil restoration and its consequent increasing fertility.

Both the establishment of *perimeter hedgerows* and *biological control* seek to improve the agricultural contribution to farm biodiversity, among additional benefits (Heath et al., 2017). The establishment or regeneration of vegetation and shrubs strips, if well designed, would provide farmlands a reservoir for crop auxiliary fauna and pollinators. In addition to biodiversity support, *perimeter hedgerows* would also contribute to nutrient retention, soil erosion mitigation, runoff control and carbon abatement, so better increasing the multifunctionality of agriculture in a climate change frame. Climate warning also promotes crop pesticide resistance (Ma et al., 2021), therefore revealing the need to alternative solutions to crop protection. Replacing conventional chemical plan protection products by *biological* pest *control* seek straightforwardly to restore the natural equilibrium of agroecosystems by managing natural pest enemies.

Agroecosystem multifunctionality is also highlighted by its contribution to social engaging and cultural development of the areas where they embed. Thus, an attribute referring to such contribution to cultural ecosystem services has been proposed as a practice in the design. *Enabling eco-tourism activities* does not imply the own development of leisure and recreational activities for farmers in their farmlands, only to provide the environment to develop them (Albaladejo-García & Martínez-Paz, 2025)

The last attribute of the DCE refers to the market incentive. This is intended to change farmers' perceptions about benefits and costs of adopting alternative agricultural practices (cognitive factor), so that their behaviour is persuaded. The market incentive is defined as a financial payment for a five-year contract consisting of an amount ranging 150€ to 900€ per hectare and year, in exchange for adopting of an agri-environmental scheme comprising, at a minimum, one of the best management practices proposed. The range of market incentives was established in accordance with the maximum subsidies that farmers can obtain from rural development programmes in the area. This was agreed with a group of technicians from the regional agricultural administration and agricultural associations.

Experimental design

The experimental design of the DCE requires determining the best combination of attribute levels to maximise its efficiency. A Bayesian D-efficient design was followed to combine attribute levels and conform the different alternatives (Rose & Bliemer, 2009). The priors of such design were obtained from a pre-test survey with sixty answers. Forty-eight different alternatives were ultimately obtained, which were grouped in twenty-four choice-sets. Each alternative represented an agri-environmental scheme composed by, at a minimum, one agricultural best management practice. Consequently, each choice-set was composed by two alternatives and an opt-out option representing the conventional agricultural practices, or current situation (*SQ*), for farmers. Choice-sets were, in turn, grouped among six blocks, each of which were randomly distributed to surveyed farmers. Hence, each farmer should respond to one block, that is, to four different choice-sets, and so each of them faces only four choices. An example of a choice-set is shown in Figure 1 and an example of a block with four choice-sets is presented as Supplementary Material Figure S1.

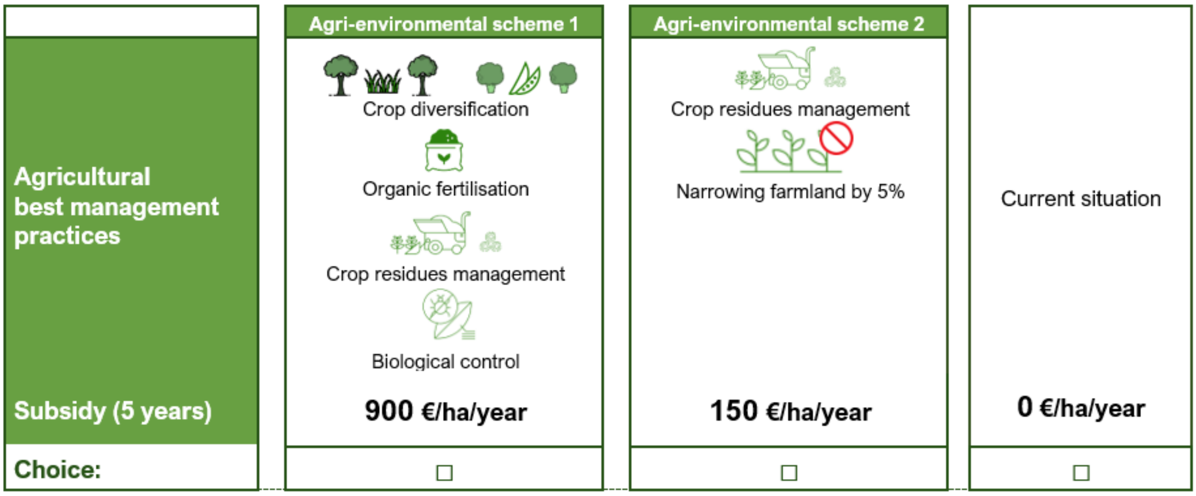

Figure 1. Example of a choice-set.

For the valuation scenario, farmers were asked to join to a public voluntary agri-environmental scheme for five years aiming to adapt their current and conventional practices to a climate change scenario. Such agri-environmental scheme was composed by some of the agricultural best management practices proposed and a subsidy, whose amount will be paid annually and proportional to the farm area enrolled in the scheme. Farmers were therefore shown different alternate agri-environmental schemes, as stated, and they were persuaded to select one of them within each choice-sets. Also, in each choice situation, they were proposed to maintain their current practices, having then the opportunity not to join the scheme (*SQ* alternative). They were previously shown the characteristics of the proposed agricultural best management practices, as well as the expected climate change impacts and the way in which practices mitigate them, so that informed decisions could be made.

Model specification and value measures

Assessment of discrete choices by farmers are analysed by using a mixed logit (MXL) model. This probabilistic model explains farmers' choices among eco-schemes by linking them to the utility they get from their adoption. This utility is explained, in turn, by the agricultural practices (attributes) conforming it and a random error component summarising farmer and farm characteristics (objective and subjective) that determines preferences for such practices but not included in the model. MXL model properly applies the random utility and multi-attribute utility theories whilst allowing for unobserved preference heterogeneity analysis. This model was also selected to assess farmers' preferences given its capability to relax the independence of irrelevant alternatives (IIA) assumption and thereby allowing for unrestricted substitution patterns. The IIA assumption considers that the probability of choosing an alternative is independent of the other alternatives in each choice-sets, which might be not realistic for farmers choices among agri-environmental schemes with different practices to be adopted. The flexibility of MXL models is also revealed by its ability to assume individual-specific marginal utilities of attributes and to model correlation among attributes (Train, 2009; Hensher et al., 2005).

According to MXL model, the utility U_{ij} a farmer *i* obtain from each agri-environmental scheme *j* and the *status-quo* (*SQ*) alternative is expressed as follows:

$$U_{ij} = \sum_{k=1}^{K} \beta_{ik} X_{kj} + \beta_{iPAYMENT} X_{PAYMENTj} + \varepsilon_{ij} \quad (1)$$

$$U_{iSQ} = \beta_{iSQ} ASC_{SQ} + \sum_{s=1}^{S} \beta_s Z_s ASC_{SQ} + \varepsilon_{ij} \quad (2)$$

where and are the individual marginal utility related to each of the k practices and to the subsidy attribute, respectively; represents the k attribute levels in each alternative j, that is, the presence of agricultural practices to which is referred (dummy variable); shows the amount of subsidy within alternative j (continuous variable[1]); is the random error term, identically and independently distributed following a Gumbel distribution; is the alternative-specific constant for the SQ alternative, and so represents the marginal utility for such alternative; and lastly, refers to the farm and farmer factors that have an influence on adopting, or not, alternative best management practices, therefore the coefficients associated to such factors. Coefficients and allows for the

1 It is checked that the marginal utility of money is constant across subsidy levels for farmers, therefore revealing PAYMENT as a continuous variable.

understanding of unobserved heterogeneity by following a normal distribution across farmers' population. captures observed heterogeneity in preferences for the SQ alternative to understand the factors that incidence on the probability of adopting new best management practices by farmers. Therefore, a negative sign for the coefficients is understood as a reluctant to adopt the *k* practice to which is referred to, whilst a positive sign for the coefficient shows the farmers' preferences for remain in their business-as-usual situation. Similarly, positive coefficients referring to covariates with the SQ alternative reveal the factors that directly influence on farmers' desire to stay in their current situation. The MXL model was estimated by using the maximum simulated likelihood estimator with 500 MLHS draws in R software through the Apollo package (Hess & Palma, 2019).

The value farmers attach to each agricultural best management practice is measured by their willingness to accept (WTA), an approximation in monetary terms of the minimum amount required for adopting each practice. This is estimated as the opposite marginal rate of substitution (MRS) between each non-monetary attribute (agricultural practices) and the attribute referring to the subsidy (payment attribute):

$$WTA_{ik} = -MRS^{k}_{iPAYMENT} = -\frac{\frac{\partial U_i}{\partial x_k}}{\frac{\partial U_i}{\partial x_{PAYMENT}}} = -\frac{\beta_{ik}}{\beta_{iPAYMENT}} \quad (3)$$

where and refer to the marginal utility of each *k* agricultural practice and the subsidy, respectively.

To better design policy scenarios and initiatives, WTA values are aggregated across practices and considered jointly with the value associated to the SQ alternative. This requires considering the compensating surplus (CS), calculated for different policy initiatives according to the following expression (Hanemann, 1984):

$$CS_{im|S} = -\frac{1}{\beta_{iPAYMENT}}\left(U_{im} - U_{iSQ|S}\right) \quad (4)$$

where refers to the compensating surplus for a farmer *i* derived from developing a specific policy initiative *m* where some agricultural best management practices are promoted. As such, is the utility perceived in the current situation by a farmer, accordingly to their *S* farm and individual characteristics, and is the utility obtained from adopting such agricultural practices in the policy initiative *m*.

Data collection and sample description

The DCE was implemented through an in-person survey, supported by a structured questionnaire. The questionnaire was divided into three main parts: (1) the first one describing the farm characteristics (crops, acreage, irrigation system…) and current agricultural practices; (2) the second including the DCE; (3) and the third associated with the farmer's sociodemographic information (sex, age, educational level…).

The target population of the survey was the irrigation outdoor farmers in the case study area, the Region of Murcia (SE, Spain). A pre-test of the survey was developed to verify the suitability and understanding of the DCE design, valuation scenario and questionnaire design. And ultimately, data was collected between May-November 2023 by trained numerators, resulting in a sample of 250 farmers with a balance distribution among blocks -17% on average faced each block-.

Table 2 shows the main variables that describe surveyed farms and farmers. Woody crops, which encompasses both citrus and fruit trees, became the most represented in the sample, followed by horticultural crops, which were grown by almost half and a third of the surveyed farmers, respectively. The average size farm rounded 27 ha, but with great diversity among them, ranging from less than 1 ha to more than 500 ha. Most of the farmers cultivated by using a conventional system, despite environmentally friendly ones -integrated and organic- reveal notorious importance, with 22% of the sampled farmers. Considering regional farming census, sample was representative in terms of farming systems, and crop distribution, but slightly overrepresented regarding farm size.

Table 2. Farm and farmer description.

Farm characteristics	Mean	*Farmer characteristics*	Mean
Crops (%)		Age (years)	49.6
Horticultural	32.0	Sex (% women)	8.4
Woody (citrus + fruit trees)	45.6	Educational level (%)	
Vineyard/Table grape	10.4	Primary school or lower	22.0
Olive trees	6.0	Generalised secondary school	26.4
Others	6.0	Specialised secondary school	26.8
Acreage (ha)	27.4	University	24.8
Farming system (%)			
Conventional	76.8		
Integrated	11.2		
Organic	11.2		
Others	0.8		

Regarding farmers, sample was composed mainly by men with high-middle age, and with secondary-school educational level. This clearly reveals that agricultural sector is highly male dominated, with an increasing representation of older segments. Sample also revealed the global increasing in formation and training for workers, as more than a half of farmers had specialised secondary-school level or higher.

Results

Data collected from DCE together with farm and farmers characteristics gathered in the survey are integrally assessed to understand farmers' adoption of agricultural best management practices and their expected financial incentives. Thus, choice models assessing DCE data are presented in this section, as well as the economic value derived from it.

Estimated choice models

Farmers' choices were modelled by using two different specifications of MXL models. Both models are shown in Table 3.

Table 3. Choice modelling results from discrete choice experiment (DCE).

	MXL model 1: Basic						MXL model 2: Adoption heterogeneity					
	Mean			Standard deviation			Mean			Standard deviation		
Attributes [1]	**Coef.**	[3]	**S.E.**	**Coef.**	[3]	**S.E.**	**Coef.**	[3]	**S.E.**	**Coef.**	[3]	**S.E.**
RDI	-0.804	***	0.287	1.332	***	0.553	-0.763	***	0.236	-1.140	***	0.453
DIVER	-0.768	***	0.312	1.858	***	0.549	-0.781	***	0.261	1.538	***	0.478
ORGAF	-0.433	*	0.303	1.125	**	0.540	-0.337	*	0.234	-0.741	*	0.512
CRESI	-0.424	*	0.299	-1.940	***	0.630	-0.448	**	0.250	-1.819	***	0.446
NARROW	-1.366	***	0.344	-1.527	***	0.441	-1.265	***	0.257	-1.418	***	0.379
HEDGE	-0.993	***	0.365	-1.943	**	0.898	-1.013	***	0.344	1.839	***	0.708
BIOCON	-1.172	***	0.388	2.481	***	0.581	-1.126	***	0.316	2.108	***	0.468
ECOTOUR	-0.795	***	0.289	-0.241		0.609	-0.734	***	0.218	-0.330		0.423
PAYMENT	0.003	***	0.001				0.003	***	0.001			
SQ	-0.933	**	0.455	-3.488	***	0.595	2.750	**	1.284	-2.827	***	0.407
Covariates [2]												
SQ x Acreage							-0.003	*	0.003			
SQ x Woody							-2.598	***	0.721			
SQ x Horticultural							-1.918	***	0.705			
SQ x Conventional							1.224	**	0.624			
SQ x Age							-0.023		0.020			
SQ x Educa2+							-2.723	***	0.621			
Model description												
Log-Likelihood	-896.90						-872.60					
Adjusted-R^2	0.166						0.183					
AIC	1,831.81						1,795.19					

[1] Attributes. RDI: Regulated deficit irrigation. DIVER: Crop diversification. ORGAF: Organic fertilisation. CRESI: Crop residues management. NARROW: Narrowing farmland. HEDGE: Perimeter hedgerows. BIOCON: Biological control. ECOTOUR: Enabling eco-tourism activities. PAYMENT: Subsidy. [2] Covariates refer to farm and farmer characteristics. Acreage: farm size measured in hectares; Woody: farms growing citrus or fruit trees; Horticultural: farms growing horticultural crops; Conventional: farms producing following a conventional farming system; Age: farmer age; Educa2+: farmer with specialised secondary-school education or higher. [3] Statistically significant coefficient at a level of *10%, **5% or ***1%.

Model 1 comprises a basic MXL linear specification considering normal distributions for all the coefficients except for the PAYMENT attribute, whilst Model 2 adds fixed covariates for the SQ alternative. This second model tries to better disentangle the factors that encourage farmers to adopt some agricultural best management practices, regardless the specific ones. Model 2 also better explain farmers' choice for environmental eco-schemes according to the main goodness of fit criteria (Adj-R2, LR test, AIC, BIC). Thus, Model 2 is used for the following in-depth analysis and value measures.

Attribute coefficients for mean associated to the agricultural best management practices showed negative values. This revealed that farmers got disutility from the adoption of such practices, that is, they were unwilling to adopt agricultural best management practices, unless they were properly compensated. The positive sign of the subsidy coefficient revealed the positive utility farmers got when higher payments were received, showing that there was space for trade-offs between practices and subsidies. Thus, disutility for adopting best management practices could be compensated with utility for yearly financial subsidies in such a way that made farmers indifferent to adopt the practices (compensatory payment), or even, could have incentivised them to adopt (incentive payment).

All the proposed agricultural best management practices were considered by farmers, as they all showed significant mean coefficients. However, not all of them were supported in the same way, given that their marginal disutility varied across practices. As such, narrowing farmland by 5%, biological control and the establishment of perimeter hedgerows became the practices generating the greatest values of disutility. They contrasted with organic fertilisation and crop residues management, which were the practices with lowest levels of disutility. This clearly revealed the presence of preference heterogeneity among practices. Therefore, there were practices that would require higher compensatory payments to engage farmers to adopt.

Preference heterogeneity was also verified at individual level. Coefficients for standard deviation showed significant values for the proposed best management practices, except for enabling eco-tourism activities. This revealed that farmers' preferences for each of the best management practices greatly differed among them. The highest standard deviation values were shown for biological control, perimeter hedgerows and crop residues management, revealing major disparities among farmers' willingness to adopt them.

Farmers preferred to continue with their current conventional practices. The positive mean coefficient for the SQ alternative revealed that, on average, farmers got utility from their business-as-usual situation. However, this did not apply for all the farmers equally, as the coefficient for its standard deviation displayed a great and significant value. Preference heterogeneity also arose regarding farmers' perceptions about the SQ situation. As such, covariates concerning farm and farmer characteristics played a relevant role here for disentangle preference heterogeneity of the SQ.

Farm size, crop type and production system determined the likelihood of a farmer to adopt agricultural best management practices. Farmers with larger farms and woody crops (citrus or fruit trees) were more willing to adopt alternative practices. In contrast, those with conventional production systems were prone to stay in their current business-as-usual situation. Regarding farmer factors, only educational level seemed to be an explanatory driver: those with specialised secondary education or higher were more likely to enrol environmental eco-schemes with new agricultural best management practices.

Valuation of agricultural best management practices

Valuation of agricultural best management practices was quantified from farmers preferences through their WTA for such practices. This value represented therefore the trade-off between adopting alternative practices and subsidy amounts, that is, the minimum amount required for farmers to adopt each of the proposed new practices. Following the results of choice models (MXL model 2, Table 3) and by applying Equation 3, Table 4 shows such these average amounts and their respective confidence interval at 90%. On average, WTA for each practice rounded 250 €/ha/year, but with great heterogeneity among practices and farmers.

Table 4. Willingness to accept (WTA) values (€/ha/year).

Attributes [1]	**Mean**	**Confidence interval (90%)**	
RDI	232.07	193.91	270.23
DIVER	241.59	190.80	292.39
ORGAF	105.50	82.64	128.36
CRESI	115.43	54.37	176.50
NARROW	411.43	366.56	456.30
HEDGE	318.85	254.40	383.31
BIOCON	363.11	290.51	435.71
ECOTOUR	248.83	238.02	259.65

[1] Attributes. *RDI*: Regulated deficit irrigation. *DIVER*: Crop diversification. *ORGAF*: Organic fertilisation. *CRESI*: Crop residues management. *NARROW*: Narrowing farmland. *HEDGE*: Perimeter hedgerows. *BIOCON*: Biological control. *ECOTOUR*: Enabling eco-tourism activities. *PAYMENT*: Subsidy.

Narrowing farmland by 5% was the practice which required the highest amount of compensation, ranging from 367 to 456 €/ha/year. The second place was for biological control, whose value referred, on average, to 363 €/ha/year, but revealing the greatest heterogeneity among farmers: such compensation ranged to more than 70 €/ha/year above and below its average. Similarly, the establishment of perimeter hedgerows was demanded to be compensated by an amount of nearly 320 €/ha/year, also with great heterogeneity among farmers.

The second group of practices integrated those whose value rounded the average WTA: regulated deficit irrigation (232 €/ha/year), crop diversification (242 €/ha/year) and enabling eco-tourism farm activities (249 €/ha/year). Actually, value heterogeneity among farmers was also lower than for the practices assessed before. This was particularly relevant for enabling ecotourism activities, revealing therefore a wide consensus among farmers regarding the desired compensating payment.

Lastly, organic fertilisation and crop residues management were the practices with minor mean WTA values, but with great differences between them. As such, organic fertilisation was the practice with the lowest compensatory payment (106 €/ha/year) and narrowed heterogeneity. In contrast, WTA for adopting crop residues management, with a mean value of 115 €/ha/year, ranged from 54 to 177 €/ha/year, showing that not all farmers were willing to adopt such practice in the same degree.

Discussion

This work has analysed farmers' preferences for the adoption of agricultural best management practices, to adapt and mitigate agriculture to the effects of climate change and to achieve a transition towards a more sustainable agriculture. To this end, one of the agricultural regions most vulnerable to climate change was selected for analysis: the semi-arid Mediterranean, with the agriculture of the Region of Murcia (SE Spain) taken as an illustrative case. Based on a survey of farmers' choice experiments, it has been possible to ascertain their WTA for the implementation of a series of agricultural best management practices and to determine the practical implications of their application.

Analysis of the main findings

The main findings indicated that farmers experience a disutility from the adoption of agricultural best management practices unless they receive adequate compensation. Conversely, they experience a positive utility when they receive higher payments. These results are entirely consistent with the existing literature on WTA payment, which indicates that citizens (Beaudet et al., 2022) and farmers (Haile et al., 2019) are more likely to engage with environmental proposals if they are offered a financial incentive.

Narrowing farmland by 5%, biological control and the establishment of perimeter hedgerows were the practices generating the greatest values of disutility, in contrast with organic fertilisation and crop residues management, which are the practices with lowest levels of disutility. Thus, there were practices that would require higher compensatory payments to engage farmers to adopt. The reluctance of farmers to adopt these practices, given their relatively low utility, is a well-documented phenomenon, as evidenced by the studies of Barratt et al. (2018) and Chakir & Thomas (2022).

Values for WTA are in line with the expected changes on farm net margins but not always reflect only the compensatory payment. As such, narrowing farmland become the practice with the greatest required WTA as it represents a reduction in net margin directly proportional to the reduction in farm size. The WTA value stated for this practice (441 € per 5% farmland) is consistent with the average net margins for the selected crops in the case study area, which rounds 8.000 €/ha annually (Alcon et al., 2022). However, this behaviour is not the general pattern for all the assessed practices. The value of financial incentives demanded by farmers could be higher, or lower, than the actual change in net farm margins due to the adoption of these practices. As such, by stating their preferences, farmers may exacerbate, or diminish, their net margin compensation for adopting the practices: in a positive way, reflecting the need to higher payment that actual margin losses, as an incentive payment was or in a negative way, revealing their positive attitude towards such practices so that they are willing to assume part of the cost. Hence, following Albaladejo-García et al. (2025) for the economic assessment of these practices in the case study area, it seems some of these practices are required different financial incentives than net margin changes are expected. For instance, crop residues management and the establishment of perimeter hedgerows are the practices with the lowest changes in farm net margins. However, this is not the same regarding the stated WTA for perimeter hedgerows, which demands one of the most expensive payments. As such, WTA for this practice should be understood as an incentive payment, in place of just a compensatory one, to ensure farmers adopt it. In contrast, for instance, crop diversification becomes the greatest costly for farmers in terms of net margins, but not the same for its demanded payment. This may reveal the positive farmer attitude for adopting such practice.

The findings also illustrated the heterogeneity of preferences for the proposed agricultural best management practices, which reveals large disparities between farmers' willingness to adopt them. It is also important to note that agricultural best management practices were not equally weighted by farmers, who also differ according to their socio-demographic characteristics and the characteristics of their farms. For instance, farmers with larger farms and woody crops (citrus or fruit trees) were more willing to adopt alternative practices. This outcome is corroborated by Czajkowski et al. (2021) on the adoption of agri-environmental schemes by farmers in river valleys.

The results here provided could be used for better design of compensation payments for eco-schemes following the last CAP reform 2023-2027. Applied to the Spanish case study, seven main agricultural practices are proposed as eco-schemes following the carbon farming and agroecology principles, among which crop rotation with improving species, cover crops, pruning residues management and biodiversity islands are highlighted. These are in line with some of best management practices considered in this analysis. However, CAP subsidy amounts slightly differs from the WTA values here obtained. They range from 100 €/ha to 167 €/ha annually in the case of crop rotation -depending on farm size and multiple-years commitment-, 42 €/ha to 187 €/ha annually for covers crops -which depends also on farm size, multiple-years commitment and land slope-, and 39 €/ha annually for biodiversity islands. As such, suggested amounts from best management practices are moderately lower than those currently paid to farmers for such eco-schemes. This may be behind the lower adoption rate of eco-schemes in the case study area, where eco-schemes represented only 43% of CAP direct payments in 2023, and 25% of total farmland. Hence, encouraging adoption rate of agricultural best management practices, and so the success of CAP reform, means increasing subsidy amounts as eco-schemes.

Despite the specificity of the best management practices considered, similar analysis has been developed in the Mediterranean and European area, so that our results could be better discussed and contextualised. Gars et al. (2024), for instance, developed a DCE in Finland, Sweden and the Netherlands to disentangle farmers' preferences for practice-based and result-based schemes, and included as practices, among others, 20 percent reduction in nitrogen fertiliser application, the establishment of buffer strips along ditches and water courses, the establishment of cover crops, which reveals some similarities with our proposal. However, the farmers' WTA for a climate change scenario range from 120 to 230 €/ha/year, depending on the number of practices included, from two to six, respectively. This deeply contrasts with our results, whose WTA values are clearly higher. Nearer to the current case study, Villanueva et al. (2024) also assessed practice-based schemes and determined the WTA for cover strips between olive trees by farmers in Andalucia, which ranges from 112 to 169 €/ha/year depending on the percentage of farmland covered by the strips. These values might be slightly lower than those presented here, given that, in turn, the intensity in adopting the practice proposed by the authors was also lower. Tyllianakis & Martin-Ortega (2021), in addition, made a meta-analysis of WTA values and revealed an average value of 330 €/ha/year, which is in line with our results and provides then a robust support.

Policy initiatives for climate change adaptation

While farmers' preferences for agricultural best management practices have been identified on an individual basis, it would be beneficial to assess the potential for policy initiatives that combine these practices. Table 5 proposes a set of policy initiatives, and their respective CS (Equation 4), as a combination of the agricultural best management practices assessed.

Table 5. Consumer surplus (CS) of policy initiatives for climate change adaptation and mitigation (€/ha/year).

Policy initiative	Attributes [1]	Mean	Confidence interval (90%)	
(1) Agricultural multifunctionality	RDI + DIVER+ ECOTOUR	872.04	754.52	989.56
(2) Soil restoration	ORGAF + CRESI + HEDGE	689.33	559.92	818.74
(3) Enhancing biodiversity	DIVER + HEDGE + BIOCON	1073.10	932.27	1,213.94
(4) Controlled de-intensification	RDI + ORGAF + CRESI + NARROW + BIOCON	1377.08	1,229.45	1,524.71

[1] Attributes. RDI: Regulated deficit irrigation. DIVER: Crop diversification. ORGAF: Organic fertilisation. CRESI: Crop residues management. NARROW: Narrowing farmland. HEDGE: Perimeter hedgerows. BIOCON: Biological control. ECOTOUR: Enabling eco-tourism activities. PAYMENT: Subsidy.

Each of the proposed policy initiatives addresses agricultural challenges that might be exacerbated by climate change impacts. They were selected following the suggestions of agri-environmental stakeholders of the case study area consulted in a focus group. The best management practices and the proposed policy initiatives seek to overcome water management, nitrate and pesticides pollution, and soil fertility in the face of a climate change scenario. Besides, these initiatives are defined to be aligned with the Farm to Fork and Biodiversity 2030 European strategies so that they could contribute to reach their objectives.

First, *agricultural multifunctionality* initiative seeks to comprehensively enhance ecosystem services and mitigate disservices for all ecosystem services categories (Zabala et al., 2021). As such, RDI reduces irrigation water consumption (provisioning disservices), DIVER mitigates runoff and soil erosion (regulating disservices) and improve soil structure and biodiversity (regulating services) (Zhang et al., 2020; Almagro et al., 2023; Marcos-Pérez et al., 2023), whilst ECOTOUR enhances the outdoor physical and experiential interactions with agroecosystems (cultural services).

The second initiative (*soil restoration*) encompasses those related to prevent soil degradation, so embracing ORGAF, CRESI and HEDGE, which expect to improve soil structure, increase soil organic matter and biodiversity (regulating services) (Hernández et al., 2021; Rojas et al., 2013), and reduce soil erosion (regulating disservices) (Puertes et al., 2021). This would address in turn soil fertility, whilst contributing to reduce nutrient losses and fertiliser requirements -by using organic fertilisers and crop residues management- and providing a high-diversity landscape -by the inclusion of perimeter hedges-, in line with Farm to Fork and Biodiversity 2030 strategies.

Thirdly, policy initiatives to enhance farmland biodiversity may include, at least, DIVER, HEDGE and BIOCON practices, so that habitats are restored, and biodiversity is promoted at sub- and top-soil level. This *enhancing biodiversity* initiative focuses on both crop and -auxiliary- fauna diversity with the purpose of overcoming pesticides pollution. In particular, the former is provided by crop diversification practices (DIVER) (Heath et al., 2017) and the latter is determined by the adoption of biological control practices (natural enemies) and the establishment of perimeter hedges which may serve as fauna reservoirs (functional biodiversity) (Kremen, 2020). Hence, this initiative is also expected to positively contribute to reach the objective of 50% reduction in the use and risk of chemical pesticides established by the Farm to Fork commitment.

Lastly, the adaptation of agriculture to a climate change scenario lay also on a de-intensification of current practices, by reducing irrigation water consumption (RDI), changing mineral to organic fertilising (ORGAF), incorporating crop residues into soil (CRESI), replacing conventional pesticides by biological plant protection (BIOCON), and shortening farmland (NARROW). This initiative integrates all the main agri-environmental challenges highlighted by the consulted stakeholders: water management, nitrate and pesticides pollution, and soil fertility. As such, water management is overcome by a RDI strategy (Yang et al., 2022; Berríos et al., 2023), whilst nitrate pollution and soil fertility are expected to be faced by adopting organic fertilisation and crop residues incorporation into soil (Hernández et al., 2021). Pesticides pollution could be tackled by the adoption of a biological control strategy of pest management (BIOCON). *Controlled de-intensification* initiative also contributes to the reduction of chemical pesticides, fertilisers and nutrient losses, committed by the Farm to Fork strategy.

A ranking of the proposed policy initiatives according to the highest amount of compensation required for their implementation reveals that soil restoration would be the primary priority, with an estimated cost of 689 €/ha/year. This is followed by agricultural multifunctionality, with an estimated cost of 872 €/ha/year; enhancing biodiversity, with an estimated cost of 1,073 €/ha/year; and controlled de-intensification, with an estimated cost of 1,377 €/ha/year.

Some of these policies are already being implemented in some areas and have demonstrated favourable outcomes for human wellbeing. For instance, agricultural multifunctionality based on the conjunction of RDI with crop diversification and ecotourism has been evidenced to exert synergistic effects on the provision of regulating and cultural agroecosystem services (Albaladejo-García et al., 2023). It has also been shown that these findings are in line with those values related to intercropping or crop rotation (Alcon et al., 2020; Blasi et al., 2023).

Soil restoration initiatives based on the combination of organic fertilisation, perimeter hedgerows and crop residues management has been demonstrating the role that these agricultural best management practices can play in reducing agroecosystem disservices, for example by regulating soil erosion (Kumarasinghe, 2021) or reducing inputs that lead to polluted groundwater (Zabala et al., 2021).

Habitat enhancement and increased biodiversity of agroecosystems has also been demonstrated with the implementation of diversified cropping (Zhang et al., 2020), biological control (Tomasetto et al., 2017) and perimeter hedgerows (Montgomery et al., 2020), which further enhances the environmental co-benefits of these practices.

The implementation of a strategy of de-intensification of agriculture, which incorporates most of agricultural best management practices, would undoubtedly represent one of the most efficacious methods for reducing agroecosystem disservices and increasing the provision of agroecosystem services (Kremen, 2020). However, and as expected, its implementation completeness increases the total amount of compensation to farmers.

Although this study is structured around the dichotomy of 'either/or' best management practices in agriculture, a combination of policies must be considered to meet the individual preferences of farmers and to ensure the continued maintenance of production levels. Furthermore, it is essential to consider these policies to mitigate the effects of climate change and to provide more agroecosystem services for society. The data on the CS presented in this study serve as a reference point for assessing the practical implications of implementing these scenarios in a climate change context. To gain a deeper understanding of these implications, further research is needed to integrate them with the provision of agroecosystem services and disservices. This could be achieved by conducting additional surveys of farmers on their preferences for enhancing the provision of ecosystem services on their farm.

Factors guiding the adoption and incentives: Practical implications

Understanding farmers' decisions to adopt agricultural best management practices is an essential condition for designing effective incentives. As revealed, farm and farmer characteristics are contributing factors for the adoption of agricultural best management practices. Incorporating this information in the design of policy initiatives is key for boosting adoption rates among farmers. This implies that efforts should be on those clusters of farmers more reluctant to adopt any best management practices: small and conventional farms, mainly growing olive trees or vineyard/table grapes. Also, farmers having a higher educational level are more likely to adopt alternative practices.

Actually, this is not the first time in the literature about practices adoption that farm size, farming system or farmer' educational level are revealed as determining factors for alternative agricultural practices. For instance, Villanueva et al. (2015) also highlighted the importance of higher educational levels for increasing adoption rates and minimising WTA values. They showed that WTA for unformed farmers could be more than 100 €/ha annually compared with those having, at least, secondary-school educational level. In a similar way, McGurk et al. (2020) demonstrated that farmer participation in agri-environmental schemes was positively related to farm size, and Salazar-Ordoñez et al. (2021) also revealed that high-yield farms demanded financial payments more than double than low-yields farmers. With the focus only on water-saving measures, Giannoccaro et al. (2022) illustrated heterogeneity among crops: farmers cultivating tomato and table grapes where less willing to accept such measures.

What inferences can be drawn for guiding prospective policy proposals? To enhance the sustainability of agricultural practices, it is essential that policymakers strike a balance between the stringency of management requirements and the acceptance of such practices by farmers. Factors evincing better adoption of agricultural best management practices should be integrated into agricultural policy making. As such, policy actions generally focus on addressing cognitive behavioural factors for farmers, given its proximity to the decision-making process of adopting new agricultural practices. Improving knowledge and perceived control by training and formation about best management practices could be applied according to our results, given the significance of educational level for adopting practices. But not only this, the results obtained could also be used to shape market incentives for farmers to adopt best management practices. Regressive subsidies according to farm size could be a feasible policy option to address the direct relationship between farm size and willingness to adopt best management practices, and so incentive small farms to engage them. Therefore, higher payments should be directed to small farms, which also expect to better compensate fixed costs of implementing alternative best management practices (Martínez-García et al., 2024). Similarly, these subsidies could also be discriminated according to crop type and farming system, so that higher amounts are expected to non-woody crops and conventional farming systems. Discrimination subsidies seek to better compensate perceived risks and benefits for farmers (Dessart et al., 2019), including their heterogeneity into the design of effective agricultural policy. This provides a benchmark for justifying possible subsidies and payments to the agricultural sector with the aim of maximising social wellbeing in the face of climate change (Weituschat et al., 2023).

Conclusions

Our study offered novel insights into the willingness of farmers to embrace agricultural best management practices in semi-arid Mediterranean regions, characterised by high vulnerability to climate change. The heterogeneity of farmers' preferences informed the selection of the most appropriate agricultural practices and their expected compensatory payments for their adoption. This information can be used to design future and more sustainable policies that are better adapted to farmers' preferences, and therefore potentially more profitable and more widely adopted in the context of climate change. In conclusion, it should be noted that our study focused primarily on farmers' preferences, representing merely the initial phase of a comprehensive cost-benefit analysis of a more intricate policy design. While our study offered empirical evidence and illustrated the utilisation of stated preference methodologies, further research is essential to gain a more comprehensive understanding of farmers' preferences for diverse agricultural best management practices, which may ultimately inform more effective and sustainable land use policies.

Supplementary material (Figure S1): accompanies the paper on SJAR's website.

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