POST-PRINT VERSION

February 2015

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Paper accepted to be published in
Land Use Policy
Editorial: Elsevier Science ISSN: 0264-8377
http://dx.doi.org/10.1016/j.landusepol.2015.02.009

This research is co-financed by the Spanish Ministry of Economics and Competitiveness (MINECO) and the European Regional Development Fund (ERDF) through the project MERCAGUA (AGL2013-48080-C2-1-R).

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THE DESIGN OF AGRI-ENVIRONMENTAL SCHEMES: FARMERS' PREFERENCES IN SOUTHERN SPAIN

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ABSTRACT

Agri-environmental schemes (AES) play a key role in promoting the production of environmental public goods by European Union agriculture. Although extensive literature has analyzed AES, some important issues remain understudied. This paper performs an ex-ante assessment of AES in permanent cropping, analyzing several issues that have received little attention from researchers, such as ecological focus areas (EFA) and collective participation. For this purpose, a choice experiment was used to assess farmers' preferences toward AES in a case study of olive groves in southern Spain. Results show high heterogeneity among farmers, with different classes being identified, from potential participants to non-participants. As regards EFA, almost half of the farmers would be willing to accept it for low monetary incentives (€8-9/ha per additional 1% of the farmland devoted to EFA) while the rest would do it for moderate-to-high monetary incentives (€41-151/ha per additional 1% of EFA). However, for a high share of EFA (e.g., 5-7%) higher incentives would presumably be required due to the intrinsic spatial restrictions of olive groves. With regard to collective participation, we find that it is unlikely that farmers would participate collectively with the incentive of the up-to-30% EU-wide bonus. These results are relevant for policy-making now when new AES are being designed for the next programming period 2014-2020.

KEYWORDS: Environmental public goods; Agri-environmental Schemes; Olive groves; Collective participation; Ecological focus areas; Choice experiment.

THE DESIGN OF AGRI-ENVIRONMENTAL SCHEMES: FARMERS' PREFERENCES IN SOUTHERN SPAIN

1. Introduction

The provision of public goods by agriculture is a relevant objective shared by most of the agricultural policies of developed countries (OECD, 2008). This objective has gained relevance throughout time because of society's increasing demands for such goods. However, the design of efficient tools oriented to achieve this objective represents a daunting challenge for policy-making. In particular, policy-makers have to take account of the type of joint production (of private and public goods) and farmers' preferences and circumstances to design tools that effectively promote agricultural public goods production without distorting commodity markets (OECD, 2001; Cooper et al., 2009). Yet, analyses are still required to support public decision-making regarding the design of such tools (Hart et al., 2011; OECD, 2013).

Among tools to promote the provision of public goods by agriculture, voluntary incentive-based payments aimed at compensating the farmer for the rent forgone derived from the use of related non-productive agricultural practices are a suitable option (OECD, 2001; Hart et al., 2011; Hodge, 2013). These are no (or little) distorting tools (i.e., part of the Green Box of World Trade Organization Agreement on Agriculture) specifically targeted to the production of agricultural public goods. A paradigmatic case of this type of tools are the agri-environmental schemes (AES) of the European Union's (EU) Common Agricultural Policy (CAP). AES are multiannual and voluntary incentive-based payments to farmers for preserving and enhancing environmental public goods. They usually consist of a per-hectare payment implemented regionally and co-financed by the EU and each of its Member States (Espinosa-Goded et al., 2010; Uthes and Matzdorf, 2013). AES stand out as one of the most significant CAP tools as they have assigned an aggregated expenditure of 22.2 billion euro (that is, 22% of the budget of the European Rural Development Policy 2007-2013, according to ECA, 2011). Thus, the implementation of AES is a good proof of how the objective of encouraging public goods provision has become a key concept for the design of the CAP (EC, 2010a).

Not surprisingly, AES have been the subject of much attention by researchers (Uthes and Matzdorf, 2013). Their work has focused mainly on the barriers to participation in such schemes (Falconer, 2000; Christensen et al., 2011; Broch and Vedel, 2012), and on improving their design (Ruto and Garrod, 2009; Espinosa-Goded et al., 2010). However, more in-depth knowledge is still needed regarding some important issues such as farmers' willingness to accept (WTA) for AES participation in agricultural systems made up of permanent crops, the inclusion of ecological focus areas (EFA) and collective participation in such schemes.

With regard to the first issue, it is worth pointing out that ex-ante analyses of farmers' WTA for AES enrollment in permanent cropping systems are lacking in the literature. While AES in these agricultural systems have been previously studied (Calatrava-Leyva et al., 2007; Duarte et al., 2008; Fleskens and de Graaff, 2010; Franco, 2011), to the authors' knowledge none of these works have focused on the ex-ante assessments of farmers' WTA for AES participation, though this is not the case for herbaceous cropping systems (Christensen et al., 2011; Broch and Vedel, 2012). Ex-ante analyses of farmers' WTA for AES participation in permanent crops are opportune now since new AES are being designed for the next programming period, 2014-2020. This is particularly true for the case of olive groves in southern Spain, considering not only their high socioeconomic relevance, but also the numerous environmental problems that have emerged as a consequence of the expansion and intensification process that olive growing has undergone over the last two decades (Gómez-Limón and Arriaza, 2011). Specifically, these negative environmental impacts are soil erosion, biodiversity loss, overexploitation of water resources, non-point water pollution and deterioration of traditional landscapes (Beaufoy and Pienkowski, 2000; Gómez, 2009). Recent studies highlight that there is great scope for improvement in the production of environmental public goods by olive growing (Carmona-Torres et al., 2014; Villanueva et al., 2014). These studies identify soil conservation practices as one of the most important environmental-friendly practices to be adopted by olive growers, especially the use of cover crops (CC). CC are spontaneous or cultivated plants that grow between tree lines with the main objective of soil protection (Gómez, 2009). Apart from soil conservation, the use of CC has additional positive environmental impacts on soil carbon sequestration (González-Sánchez et al., 2012), biodiversity (Rey, 2011), visual quality of landscapes (Arriaza et al., 2004) and water pollution (Castro et al., 2008). Although there are studies that analyze the adoption of CC (Franco, 2011; Rodríguez-Entrena and Arriaza, 2013), to our best knowledge there are no other studies estimating farmers' WTA for CC within AES.

Apart from the agricultural system, the second issue that has received limited attention in the literature about AES is the promotion of EFA in farmland. EFA is defined in CAP regulations as areas with landscape features, terraces, buffer strips, land lying fallow, afforested areas and agro-forestry areas, or areas with a reduced use of inputs on the farm, such as those covered by catch crops and winter green cover. The presence of EFA generally improves biodiversity, as well as other public goods such as visual quality of landscapes, soil conservation, and so on (Stoate et al., 2009; EC, 2011a). This is the main reason that led to the European Commission (EC, 2011b) proposing a new instrument in the CAP 2014-2020, known as *green payment*, for those farms fulfilling some basic environmental requirements, including dedicating 7% of their farmland to EFA. However, this particular requirement was later relaxed as a result of the political debate and in the final regulation (Regulation 1307/2013, Art. 43-47) the share of EFA was set at 5%, compulsory for arable land only (permanent crops are eligible for this payment without any minimum EFA requisite). Therefore, this research aims at exploring in advance the olive growers' behavior regarding the implementation of EFA in their farmland. This is carried out by means of considering the inclusion of EFA in AES as a possible transitional period on the way to a hypothetical future implementation of EFA as a requisite for being eligible for the green payment in permanent crops.

The third issue to receive scarce attention in the literature is collective participation in AES, understood as farmers collectively signing AES contracts. It represents a promising way of reducing public transaction costs (costs of the resources spent by the Administration in providing information about the AES, subscribing contracts, monitoring implementation and making payments) while increasing the environmental effectiveness of policy tools. Specifically, spreading out the collective participation in AES reduces the number of applications to be processed as well as the costs of monitoring, consequently reducing transaction costs incurred by the government (Franks, 2011; Emery and Franks, 2012). Moreover, if the collective participation in AES is implemented in such a way that ensures the proximity of the farms that form the collective, a greater environmental effect would also be expected (Sutherland et al., 2012). Focusing on olive growing agricultural systems, it is worth quoting a recent work carried out by Rocamora-Montiel et al. (2014) who have explored the potential of territorial contracts in mountainous olive production systems in southern Spain as a tool to increase the farmers' profitability by adopting organic farming. This work represents a precedent of the current research since it reflects the interest for collective contracts in permanent cropping systems, in particular in olive growing. Despite the relevance of this topic, to the authors' knowledge, there is no paper that quantitatively analyzes farmers' willingness to participate in AES collectively, neither in olive growing nor in any other agricultural system.

In this paper, we use the choice experiment method to analyze southern Spain's olive growers' preferences toward AES including the above-mentioned innovative issues. The main objectives of this analysis are to support the design of new AES aimed at promoting public goods production by olive growing, and to partially bridge the existing knowledge gaps about the inclusion of CC, EFA and collective participation in AES contracts. Therefore, the results of this analysis may be very useful for policy-making, particularly now when new AES are being designed for the next programming period, 2014-2020. For this purpose, the paper is structured as follows. The next section is devoted to the description of the method and the data gathering used for the empirical analysis. The main results are presented in the third section and discussed in the fourth, where the main policy implications are also outlined. Finally, in the fifth section some conclusions are highlighted.

2. Method

2.1. Choice experiment approach

Choice experiment (CE) is a stated preference valuation technique based on Lancasterian Consumer Theory of utility maximization which postulates that consumption decisions are determined by the utility or value derived from the attributes of the good being consumed (Lancaster, 1966). The econometric basis of the approach lies in the Random Utility Theory (McFadden, 1974)[1]. CE is well suited to measuring the marginal value of the attributes of a good or a policy instrument (Ruto and Garrod, 2009), with the underlying assumption being that farmers' choices among voluntary policy schemes depend on the specific characteristics -attributes- of these schemes (Christensen et al., 2011). In fact, the use of this approach to support policy-making has sharply increased in the last five years, especially in regard to AES design. Noteworthy studies that use CE to analyze AES include Ruto and Garrod (2009), who study EU farmers' preferences toward design attributes of AES; Espinosa-Goded et al. (2010), who analyze the adoption of AES in specific extensive herbaceous agri-systems in Spain; Christensen et al. (2011), who study Danish farmers' willingness to participate in pesticide reduction AES; and Broch and Vedel (2012), who analyze Danish farmers' willingness to participate in afforestation AES. Also, it is worth remarking on the work of

[1] For an extensive explanation of the choice experiment theory and practice, see Hensher et al. (2005).

Schulz et al. (2014), which analyzes German farmers' willingness to accept green payments. All these examples support the choice of CE as the approach taken for this empirical study.

2.2. Case study, attributes and levels

The case study selected for the analysis is olive growing in Andalusia (southern Spain), given that this is the main crop grown in this region (over 1.5 million hectares, 48% of Andalusian farmland) and has great potential for improvement in the production of environmental public goods. According to Villanueva et al. (2014), soil fertility, visual quality of the landscape, biodiversity and mitigation of climate change are the four public goods presenting the highest enhancement potential from a supply point of view. Moreover, all of these public goods are in high demand by European (EC, 2010b) and Andalusian (Salazar-Ordóñez et al., 2013; Rodríguez-Entrena et al., 2014b) societies. Thus, it is reasonable that any AES for olive growing in Andalusia should focus on agronomic practices aimed at increasing the provision of these public goods. For this reason, three of the attributes considered for the implementation of the CE are linked with agricultural management; two of them related to the use of CC and one to EFA.

Regarding CC, Villanueva et al. (2014) find that it possibly represents the most useful agricultural practice in olive growing in terms of enhancing the production of environmental public goods. In any case, the level of production of these public goods derived from the use of CC in this agricultural system depends on the area covered and how farmers manage these CC (Barranco et al., 2008). Accordingly, the area covered by CC and their management are the two related attributes included in the CE. For the attribute *Cover crops area* (CCAR), two levels were set: 25% and 50% of the olive grove area (CCAR-25% and CCAR-50%, respectively) (see Table 1). In both cases CC are supposed to be maintained (at least) from October to mid-March every year. As regards the attribute *Cover crops management* (CCMA), two levels were also set: free (CCMA-Free) and restrictive management (CCMA-Restr). The latter corresponds to the management established in the current AES specifically devoted to olive growing (*Sub-measure 7* or SM7[2]), that basically restricts the use of both tillage and herbicide in CC management, while the former implies no further restrictions than those that are part of cross-compliance.

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[2] SM7 was an AES implemented for olive growing in the Andalusian Rural Development Program 2007-2013, targeted at integrated farming in olive groves located in Natura 2000 areas or watersheds of reservoirs for urban water supply. Participation in this scheme involved the use of CC from November (when the rainy season begins) to mid-March (when the CC start to compete with olive trees for soil water). SM7 payments were linked to the strip width of the CC, €204/ha and €286/ha per year for strips 1.8 and 3.6m wide, respectively. As regards its management, soil tillage was not allowed (except for sowing cultivated CC) and the use of herbicides was restricted to twice every five years (but never twice in a single year).

For the attribute *Ecological focus areas* (EFA), levels were set at 0 and 2% of the olive grove plots covered by EFA (EFA-0% and EFA-2%, respectively). The first level is equivalent to the requirement included in green payment for permanent crops. The second is substantially below the 5% of EFA finally established for arable lands in the new CAP and was decided upon after taking into account both the current lack of these kinds of areas in Andalusian olive groves and the difficulties of increasing the share of EFA in permanent crops (Gómez-Limón and Arriaza, 2011). In any case, it can be assumed that the proposed 2% of EFA could effectively entail environmental improvement by creating new buffer strips, vegetation boundaries and islets or maintaining some olive trees out of production (the latter being equivalent to land lying fallow).

Table 1. Attributes and levels used in the choice set design[µ].

Attribute [Acronym]	*Explanation*	*Levels*
Cover crops area [CCAR]	Percentage of the olive grove area covered by cover crops	25 and 50%
Cover crops management [CCMA]	Farmer's management of the cover crops	Free and restrictive management
Ecological focus areas [EFA]	Percentage of the olive grove plots covered by ecological focus areas	0 and 2%
Collective participation [COLLE]	Participation of a group of farmers (at least 5) with farms located in the same municipality	Individual and collective participation
Monitoring [MONI]	Percentage of farms monitored each year	5 and 20%
Payment [PAYM]	Yearly payment per ha for a 5-year AES contract	€100, 200, 300 and 400/ha per year

[µ] The status quo level considered is the farmer's initial condition for CCAR, CCMA, and EFA, COLLE=Individual, MONI=5%, and zero PAYM.

Source: Own elaboration.

In addition to the above-mentioned agronomic attributes, the CE implemented also includes two policy design attributes: collective participation and level of monitoring. For *Collective participation* (COLLE), the two established levels are straightforward, that is, collective and individual participation. However, a precise definition of the collective participation was needed; for participation to be considered collective, a group of at least five farmers whose farms were located in the same municipality had to sign the same AES contract. The five-farmer threshold was chosen in order to be large enough to require an effort from the farmers to create the group, and small enough to avoid farmers' negative perceptions of large groups. It was explained to farmers that they could freely create the group with those whom they trust the most. Also, it was specified that if a farmer of the collective was monitored and found not to comply with the scheme requirements, in addition to regular sanctions being imposed on that farmer (calculated, as per usual, according to the nature and gravity of the infringement), the other farmers in the collective would be monitored to ensure their compliance with requirements. Regarding the attribute *Monitoring* (MONI), two levels were also set: 5 and 20% (MONI-5% and MONI-20%, respectively). The lower level was set equal to the normal monitoring level of the CAP measures, while the higher was set to make the difference with respect to the lower level more visible to the farmers (in the pre-test, a 10% of monitoring level was used as the higher level but it was observed that it did not make the difference -in farmers' eyes- with respect to the 5%-level).

The last attribute, *payment* (PAYM), is normally included in this type of analysis to derive willingness to accept (WTA) associated with each attribute considered. The four levels were set according to payments in SM7 (€204-286/ha per year). Two levels (€200/ha and €300/ha) were set in line with these payments, while two further levels (€100/ha and €400/ha) were set as minimum and maximum payments.

Lastly, it is worth commenting on other policy design attributes not considered explicitly in the CE. In this sense, the contract length of the AES was set at five years, with no exit-option available, and the minimum area for participation was set at the area of the largest plot. The first two attributes are typical of AES in Spain, while the last was set to facilitate the answers of the farmers.

2.3. Experimental design and data collection

Considering the number of attributes and levels, a large number of AES profiles (128) can be constructed, resulting in 1924 combinations for a two-option choice set design. To create a more manageable number of options, the methodological approach of fractional factorial design and optimal orthogonal in the differences proposed by Street and Burgess (2007) was used, resulting in 192 profiles and a D-efficiency of 91.3%. To make the number of choice tasks manageable for respondents, the 192 choice sets were divided into 24 blocks of 8 choice sets each, with one farmer answering one block. In each choice set, farmers were asked to choose between two alternatives, in addition to a possible no-choice (Status Quo or SQ) option under which the farmer chooses to continue with his current practice. Appendix A shows an example of a choice set.

A specific questionnaire was designed and tested to implement an *ad hoc* survey, which included five sets of questions: 1) Structural characteristics of the farm (farm size, type of tenancy, rain-fed or irrigated land, slope, age of the grove, olive tree density, subsidies perceived, etc.), 2) Characteristics of the olive grower (gender, age, off-farm economic activities, level of education, agricultural professional training, working time, etc.), 3)

Technology of production, information gathering about agricultural practices (soil management, pest management, pruning, irrigation and harvesting), farm employment, and yield obtained, 4) Choice sets as shown in Appendix A, and 5) Knowledge, attitudes and perceptions toward the implementation of AES in olive growing.

A multi-stage sampling procedure was employed. In the first stage, five agricultural districts[3] in Andalusia were selected as primary sampling units from a total of 52 following a stratified sampling proportional to olive grove area. The sampled districts cover 453,682 ha and account for 31.0% of Andalusian olive groves. In the next stage, 10 villages located in each of the sampled districts were selected as secondary sampling units using a random route procedure. Finally, in each village 6-8 personal interviews were conducted using convenience sampling[4] to select participant olive growers. Finally, 330 properly filled-in questionnaires were obtained. Among them, 35 were considered to be protests[5], reducing the total number of valid interviews to 295 (104 of which related to irrigated farms, which is roughly on par with the share of irrigated farms in Andalusian olive growing according to INE, 2014). The interviews were carried out from October 2013 to January 2014. A cheap talk was used to ensure that farmers understood correctly before answering the questionnaire.

2.4. Model specification: latent class model

To incorporate preference heterogeneity into choice modelling, the Latent Class Model approach (LCM) was used. LCM is a mixed logit model with a discrete distribution of parameters, well suited to the task of considering respondents' preference heterogeneity and revealing its causes (Greene and Hensher, 2003). This approach reveals a considerable richness in the structure of preferences, supporting the hypothesis that there are latent classes, which would otherwise be unobservable (Scarpa and Thiene, 2005). Unlike continuous mixed models (such as Random Parameter Logit Models, RPL), LCM allows the grouping of individuals according to their preferences which is very useful when heterogeneous preferences are analyzed (Hess et al., 2011), especially for extracting policy implications (Hynes et al., 2008). Actually, several studies have recently used LCM to analyze the heterogeneity of farmers' preferences toward agri-environmental policy (Ruto and Garrod,

[3] Campiña Norte and La Loma (province of Jaen), La Sierra and Campiña Alta (province of Cordoba), and Norte (province of Malaga).

[4] The sampling process consisted of looking for olive growers to be interviewed in each village (e.g., in agricultural cooperatives and private olive mills, agricultural public offices, gas stations, fertilizer shops or even at the street).

[5] Those who chose the SQ-option in all the choice sets without considering the alternative AES proposed in each (i.e., did not make trade-offs among alternatives but directly chose the SQ-option) were considered protests. The most commonly cited reason for always choosing the SQ-option was lack of trust in public institutions. This definition of protesters has also been used in previous works (e.g. Christensen et al., 2011).

2009; Schulz et al., 2014, among others). These studies prove the usefulness of the latent classes approach in analyzing such heterogeneity.

As mentioned, latent heterogeneity is analyzed through a model of discrete parameter variation, where it is assumed that individuals are implicitly sorted into a set of *s* classes. However, the specific class of each individual is unknown to the analyst. Therefore, the LCM approach is based on a class membership probability equation, which has a classical logit formulation (assuming that the error components are identically and independently distributed following a Gumbel distribution). Thus, preference heterogeneity is captured by simultaneously assigning individuals to behavioral groups or latent classes while estimating a choice model. Formally, in the LCM, the utility (U) of alternative $j \in$ J to individual n (in a choice situation t) who belongs to a particular class s, can be written as:

$$U_{jnt|s} = \beta_s X_{jnt} + \varepsilon_{jnt} \qquad [1]$$

where X_{jnt} is a vector of attributes associated with alternative j and individual n, β_s is a class specific parameter vector associated with the vector of explanatory choice attributes X_{jn} and ε_{jn} is the unobserved heterogeneity (the scale parameter is normalized to 1 and omitted). Within the class, choice probabilities are assumed to be generated by the multinomial logit model. The probability (P) of an individual n, who makes a sequence of choices (y_1, y_2,… y_T) among a particular set of alternatives J, to belong to class s is given by the following common formulation (Colombo et al., 2009):

$$P_n([y_1, y_2, ...y_T]) = \sum_{s=1}^{S} \left[\frac{\exp(\alpha_s Z_n)}{\sum_{s=1}^{S} \exp(\alpha_s Z_n)} \right] \left[\prod_{t}^{T} \frac{\exp(\beta_s X_{njt})}{\sum_{j=1}^{J} \exp(\beta_s X_{njt})} \right] \quad s = 1, ..., S \qquad [2]$$

where the first expression in brackets is the probability of observing the individual in class s according to a set of individual-specific characteristics (the Z_n variables and their parameters α_s), with the remaining coefficients explained above. In our empirical approach class membership have been estimated based on farmers' preferences only. An overview of the specification of the LCM can be found in Hess et al. (2011).

In the LCM used here, the attributes CCMA and COLLE are treated as dummy coded variables (non-linear effects), CCAR, EFA and MONI as end-point linear variables and PAYM as linear variable.

To choose the optimal number of classes, log-likelihood (LL), minimum Akaike Information Criterion (AIC), and minimum Bayesian Information Criterion (BIC) statistics were used. Table 2 shows the values of these statistics for one-class to five-classes solutions.

As is shown in this table, LL, AIC and BIC statistics experienced a marked improvement (i.e., higher LL, and lower AIC and BIC) in each step of estimation from the one-class solution (LL=-2.107; AIC=1.791; BIC=1.808) to four-class solution (LL=-1569; AIC=1.356; BIC=1.432), simultaneously resulting in a marked increase in the McFadden's pseudo-R^2. For a higher number of classes, there were worse model parsimony and no clear improvement in all the statistics (the five-class solution had negligible improvements for LL, Pseudo-R^2 and AIC, but higher BIC, with respect to the four-class solution). Therefore, we opted for a four-class solution.

Table 2. Criteria used for setting the optimal class number*.

Nº of segments/ classes	*Nº of parameters (P)*	*LL*	*McFadden`s Pseudo-R^2*	*AIC*	*BIC*
1	7	-2107.08	0.177	1.791	1.808
2	15	-1781.11	0.311	1.522	1.559
3	23	-1672.93	0.352	1.437	1.493
4	31	-1569.39	0.391	1.356	1.432
5	39	-1556.16	0.395	1.352	1.447

* Sample: 295 individuals (*N*), 2360 choices. M. Pseudo-$R^2=1-(LL/LL_0)$; AIC=$-2(LL-P)$; BIC=$-LL+(P/2)\ln(N)$.
Source: Own elaboration.

2.5. Welfare analysis and AES scenarios

Marginal rates of substitution between non-monetary and monetary attributes were estimated by calculating the ratio of the coefficient of the former to the negative of the coefficient of the latter [$WTA_{NM} = -(\beta_{NM} / \beta_M)$]. These are also called the "implicit prices", representing the WTA for a 1% or 1 unit increase in the quantity of the attribute in question if it is quantitative (e.g., area of EFA), or for a discrete change in the attribute (e.g., from free to restrictive CCMA) if it is qualitative. We apply the Delta method to determine analytically the variance and the standard error of WTA, which is commonly used in CE applications. The mathematical formulation of this method is beyond the scope of the paper, but interested readers may consult Bliemer and Rose (2013) for a full explanation. Additionally, to provide a broader picture of the required payments for different AES scenarios and to estimate the adoption rates in terms of farmers and area, welfare changes were calculated. Thus, individual welfare changes related to hypothetical policy options or scenarios (U_1) that change several attribute levels simultaneously with respect to the status quo (U_0) can be obtained by using the compensating surplus (CS) formula [$CS = -1 / \beta_M \times (U_0 - U_1)$] described by Hanemann (1984). For these estimates we have assumed linearity and separability properties in the utility function.

The five hypothetical AES scenarios used for the analysis are shown in Table 3. They represent different AES alternatives, with different combinations of the attributes of the CE. The two least restrictive scenarios are M_25 and EFA_50. The former is an AES with CCMA-Restr and CCAR-25%, and the latter is an AES with CCAR-50% and EFA-2%. The two most restrictive scenarios are AES_Max and AES_MaxC, which represent AES with all the attributes at their highest levels (CCMA-Restr, CCAR-50%, and EFA-2%) with individual and collective participation, respectively. Finally, there is also an intermediate scenario, EFAM_25, with CCMA-Restr, CCAR-25%, and EFA-2%. In all the scenarios, MONI remains constant and equal to 5%, since it was not significant in the LCM. Finally, we assume that a farmer would participate in a certain AES scenario if the level of payment is equal or higher than the disutility (in absolute terms) experienced by the farmer (i.e. CS) when he/she participates in such AES.

Table 3. AES scenarios considered for the analysis.

Scenario	***CCAR*** *(% of olive tree area)*	***CCMA*** *(1=CCMA-Restr)*	***EFA*** *(% of olive tree area)*	***COLLE*** *(1=collective participation)*	***MONI*** *(% of monitored farms)*
M_25	25	1	0	0	5
EFA_50	50	0	2	0	5
EFAM_25	25	1	2	0	5
AES_Max	50	1	2	0	5
AES_MaxC	50	1	2	1	5

Source: Own elaboration.

3. Results

3.1. Classes of farmers in function of their preferences toward AES

The results of the LCM are presented in Table 4. It can be observed that the model is highly significant and fits well, as shown by the value of pseudo-R^2. The addition of preference heterogeneity across the latent classes yielded a significant improvement in LCM goodness of fit compared to a Conditional Logit Model (CLM) goodness of fit (pseudo-R^2=0.177; LL=-2107.0). As can be observed, four different classes were obtained based on farmers' preferences toward AES. All but one of the attributes are highly significant determinants of choice, and in every case their coefficients have the expected sign. MONI is the attribute that received the least attention from farmers (only significant for farmers included in Class C2), indicating that the level of monitoring played a minor role in their choices.

The differences among the four different classes can be better appreciated by observing Table 5, which shows WTA estimates and their confidence intervals. As can be observed in this table, there is clearly one class that groups potential participants (Class C1), comprising 29.7% of the surveyed farmers with the lowest WTA for the attributes. Beside it, there is another class (Class C2, 14.6% of the farmers) that groups farmers who would only be willing to participate in AES if CCMA-Restr was not required, while also showing moderately high WTA for COLLE. Class C3 (42.1% of the farmers) and especially Class C4 (13.7% of the farmers) group potential non-participants but for different reasons. The former would not be willing to participate in any AES that includes EFA and displays moderately high WTA for the rest of the attributes. The latter would not be willing to participate in any collective AES which includes the use of CC (COLLE and CCAR), while the WTA for CCMA and EFA is also moderately high.

Table 4. Latent Class Model.

Attributes	***C1***		***C2***		***C3***		***C4***	
	Coef.	*s.e.*	*Coef.*	*s.e.*	*Coef.*	*s.e.*	*Coef.*	*s.e.*
CCAR	-0.015 **	0.005	-0.026 ***	0.006	-0.050 ***	0.002	-0.118 ***	0.015
CCMA	-0.163	0.126	-6.104 ***	0.472	-0.811 ***	0.058	-1.120 ***	0.296
EFA	-0.119 *	0.059	-0.059	0.041	-0.559 ***	0.032	-0.260 ***	0.049
COLLE	-0.592 ***	0.130	-0.717 ***	0.214	-1.306 ***	0.072	-5.023 ***	0.747
MONI	-0.009	0.007	-0.041 **	0.015	0.002	0.005	-0.043	0.026
PAYM	0.014 ***	0.001	0.006 ***	0.001	0.004 ***	0.000	0.006 **	0.002
ASCsq	-0.571	0.456	-2.284 ***	0.323	-0.419 ***	0.118	4.095 ***	0.690
Share (%)	29.7%		14.6%		42.1%		13.7%	
LL = -1569.7								
McFadden's Pseudo-R^2 = 0.391								
Number of choices: 2360								

*, **, and *** reflect significance at 5, 1, and 0.1% levels respectively.

Source: Own elaboration.

Table 5. Willingness to accept (WTA) of the attributes (€/ha)[µ].

Attribute	***C1***	***C2***	***C3***	***C4***
CCAR	1.0** (0.3/1.7)	4.1*** (1.8/6.5)	13.5*** (10.6/16.3)	20.4** (8.1/32.7)
CCMA	11.3 (-6.0/28.6)	978.6*** (657.3/1300.0)	220.3*** (169.8/270.8)	193.6* (41.3/345.9)
EFA	8.2* (0.2/16.3)	9.4ns (-4.6/23.5)	151.8*** (120.1/183.6)	44.9** (13.3/76.6)
COLLE	41.2*** (23.3/59.0)	115.0** (33.9/196.1)	354.7*** (277.6/431.7)	868.0** (306.8/1429.3)
MONI	0.6ns (-0.4/1.6)	6.5* (1.4/11.6)	-0.5ns (-3.1/2.1)	7.4ns (-3.3/18.2)

[µ] For CCAR, EFA, and MONI, it is € per 1% of increase in each of them (e.g. 1% of EFA in olive groves area). For CCMA and COLLE, it is € for changing from free to restrictive CCMA and from individual to collective participation respectively.

*, **, and *** reflect significance at 5, 1, and 0.1% levels, respectively, while ns reflects non significance.

Source: Own elaboration.

Farmer/farm characteristics of the four classes (see Tables 6 and 7) go a long way to explaining their stated preferences toward AES. **C1** has features typically related to high likelihood of AES uptake. Specifically, its farmers are younger, have a higher level of education, are more likely to be professionally trained, have a more in-depth knowledge of the AES implemented in the region and cross-compliance requisites (knowledge index)[6], perceive the use of CC as economically and environmentally beneficial, and participate more in the former AES SM7. Furthermore, their farms are larger, have a lower single payment per hectare, use less conventional techniques, and harvest fewer ground olives (i.e. olives from the soil surface). Finally it is worth mentioning that this class principally comprises irrigated olive groves, which reportedly make greater use of CC (Rodríguez-Entrena and Arriaza, 2013). Actually, C1 has a higher level of initial compliance with the levels of all agronomic attributes, although only 7.7% of its farmers fully comply with all of them (i.e., make use of CCMA-Restr, CCAR-50% and EFA-2%). All of these features are reported in the literature as being related to higher AES uptake (see Falconer, 2000, Ruto and Garrod, 2009; Hodge and Reader, 2010; and Uthes and Matzdorf, 2013, among others).

The other three classes are generally characterized by features negatively correlated to AES uptake, but with differences among them that explain their different WTA. As regards **C2**, WTA estimates for all attributes are higher than those obtained for C1 but lower than those obtained for the other two classes, with the exception of CCMA. There are several characteristics that confirm this intermediate position with regard to WTA estimates. It is the class with the youngest farmers. Furthermore, their farms are above average with regard to olive groves and total area, they present lower single payment per hectare, make lower use of conventional techniques, there is a lower share of non-trained farmers, and they have the highest percentage of EFA (which explains the low WTA for EFA). Lastly, it is worth noting the majority of C2-farmers have rain-fed olive groves (64.3%), in which CC management usually consists of tilling and, to a lesser extent, applying herbicides. So, they do not normally refuse to use CC but rather refuse to manage it without using tillage, in the belief that tillage helps reduce soil water evaporation during summertime. Thus, it is not surprising that C2-farmers show the highest WTA for implementing CCMA-Restr.

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[6] Knowledge index is obtained using the following discrete variables: knowledge of the requisites of cross compliance regarding both the use of CC in plots with average slope over 10% and the commitment of conserving riparian vegetation (scoring 2, 1 or 0 if the farmer is aware of both requisites, only one or none of them, respectively); and knowledge of options of AES available to the farmer (scoring 1 if the farmer is aware of AES in Andalusia, 2 if he/she is also aware of one AES in olive groves, SM7 or organic olive growing, and 3 if he/she is aware of both SM7 and organic olive growing). Then, the index is computed summing both variables divided by 2 and 3, respectively, in order to obtain a variable ("Knowledge index") ranging from 0 to 1.

With regard to **C3**, preferences of this non-participant class are mainly characterized by high WTA for all attributes, especially EFA. Hence, WTA estimates are higher than those reported for not only C1 but also C2, except for CCMA in the case of the latter. Accordingly, farm/farmer characteristics reflect this non-participant condition, with some characteristics shared with the other non-participant class (C4). C3 is the class with the smallest average olive tree and total area, highest single payment per hectare, smallest share of AES participating farmers, highest share of non-trained farmers, and it ranks second in terms of age and use of conventional farming techniques. With respect to any of these characteristics, however, C3 presents statistically significant differences from C4. In any case, there are other features of C3 that differentiate it from C4, and explain their different preferences toward AES. For example, C3-farmers have a more positive perception of the use of CC, and have a moderately high knowledge index. Moreover, it is the class with the highest share of irrigated olive groves, which is also related to the higher adoption of CC. These differences seem to be behind the non-extreme WTA estimates regarding CCAR and CCMA. Regarding the former, despite the characteristics positively correlated to CC use, it is worth noting that WTA is still high (€13.5 per 1% of CCAR). The main reason behind such a high WTA is that C3-farmers find that high levels of CCAR hinder the harvesting of ground olives. Accordingly, C3 is the class with both the lowest percentage of farmers with CCAR equal to or higher than 50% (CCAR-50%=5.1%) and the highest percentage of olives harvested from the ground. As regards EFA, C3 has the highest WTA, which is to be expected given it is also the class with lowest percentage of EFA (0.68%), consistent with the fact that they are mostly located in Jaen (where an olive monoculture exists).

C4 has the highest WTA regarding COLLE and CCAR, as well as moderately high WTA for CCMA and EFA. Thus, it represents a genuine class of non-participants. This fact can be explained by the extreme figures related with farmer characteristics: highest age and lowest levels of education, knowledge index and appreciation of CC. Moreover, as a non-participant class, it has low olive tree and total area, high single payment per hectare, low level of farming training, and high use of conventional techniques (as does C3).

Table 6. Description of the classes. Average values of numerical variables*.

Type	*Variable*	*C1*	*C2*	*C3*	*C4*	*Total*	*Kruskal-Wallis H*	*p-value*
Farm	Olive tree area (ha)	35.8 [b]	28.3 [ab]	19.5 [a]	22.4 [a]	26.1	8.46	0.037
	Total area (ha)	43.6 [b]	33.1 [ab]	21.1 [a]	23.7 [a]	30.0	9.65	0.022
	Ground harvested / total olive harvested (%)	9.3 [a]	15.6 [ab]	22.3 [b]	13.9 [a]	16.1	18.29	0.000
	CC / olive tree area (%)	32.4 [b]	22.2 [a]	22.0 [a]	21.3 [a]	25.1	10.69	0.014
	EFA / olive tree area (%)	1.71 [b]	1.79 [b]	0.68 [a]	1.50 [ab]	1.28	11.54	0.009
	Single payment (€/ha)	513.6 [a]	536.1 [ab]	640.1 [b]	634.5 [ab]	585.4	10.93	0.012
Farmer	Age (years)	49.3 [ab]	46.5 [a]	50.8 [bc]	54.5 [c]	50.3	11.05	0.011
	Knowledge index[μ] (adim., 0 to 1)	0.49 [b]	0.41 [ab]	0.42 [ab]	0.33 [a]	0.424	10.68	0.014
	Perception of CC as environmentally beneficial (adim., 1-5)	4.40 [b]	4.24 [ab]	4.43 [b]	3.84 [a]	4.30	8.63	0.035
	Perception of CC as economically beneficial (adim., 1-5)	3.78 [c]	2.88 [ab]	3.78 [bc]	2.36 [a]	3.43	37.59	0.000

* Mann-Whitney U was used in pairwise comparisons between classes to show ranking (see superscript letters), at a 5% significance level.
Source: Own elaboration.

Table 7. Description of the classes. Categorical variables (in %)*.

Type	*Variable*	*C1*	*C2*	*C3*	*C4*	*Total %*	*Total Obs.*	*Chi-square* χ^2	*p-value*
Farm	Cordoba	42.9	47.6	38.1	45.5	42.0	124	1.51	0.680
	Jaen	29.7[a]	28.6[ab]	51.7[b]	31.8[ab]	38.6	114	14.23	0.003
	Malaga	27.5[b]	23.8[ab]	10.2[a]	22.7[ab]	19.3	57	11.09	0.011
	Mountain olive groves	26.4	21.4	25.4	27.3	25.4	75	0.48	0.924
	Rain-fed olive groves	33.0[a]	64.3[b]	33.1[a]	45.5[ab]	39.3	104	15.15	0.002
	Irrigated olive groves	40.7[b]	14.3[a]	41.5[b]	27.3[ab]	35.3	116	12.52	0.006
	Use of conventional techniques	56.0	59.5	71.2	72.7	65.1	192	6.91	0.075
	Participation in current AES	26.4[b]	11.9[ab]	11.9[a]	13.6[ab]	16.6	49	9.13	0.028
Farmer	Education level-at least high school	54.0[b]	33.3[ab]	36.8[ab]	27.3[a]	40.0	116	11.39	0.010
	Not trained	42.0[a]	47.6[ab]	65.8[b]	60.5[ab]	55.1	158	12.78	0.005

* Z-test was used to show ranking (see superscript letters), at a 5% significance level.
Source: Own elaboration.

3.2. AES Scenarios

Table 8 shows the results of estimates regarding compensating surpluses for each scenario and each class. Logically, the different preferences among classes hold, with C1 being the class with the lowest compensating surpluses (less than €100/ha) in any of the scenarios, and C4 the class with the highest compensating surpluses on average. C2, on the other hand, shows very high compensating surpluses for scenarios that include CCMA-Restr (all the scenarios considered except EFA_50), and C3 also has high compensating surpluses, especially when more EFA and CC area are required. Assuming estimates of compensating surpluses as the money required to make farmers participate in AES, it is likely that C1-farmers would participate in any of the five scenarios considered in return for relatively low payments; C4-farmers would require an unaffordable high level of payments (above €430/ha) to make them participate in any of the scenarios; while C2-farmers would likely participate in a scenario without CCMA-Restr (e.g., EFA_50, at a payment of €135.7/ha), but not in the other four scenarios; and C3s would only participate in a scenario without EFA and with low CC area (e.g., M_25) for a moderately high payment (€245.9/ha).

Table 8. Mean compensating surpluses for AES scenarios in the 4 classes, in €/ha (standard errors in brackets).

Scenario	*C1*	*C2*	*C3*	*C4*
M_25	13.8^{*} (5.4)	976.2^{***} (163.0)	245.9^{***} (25.7)	437.2^{**} (139.8)
EFA_50	33.0^{***} (9.5)	135.7^{***} (39.7)	615.2^{***} (63.2)	716.6^{**} (222.5)
EFAM_25	23.6^{**} (7.5)	988.8^{***} (167.1)	478.2^{***} (48.2)	499.2^{**} (160.6)
AES_Max	39.1^{***} (10.7)	1065.4^{***} (180.8)	751.7^{***} (75.9)	879.2^{**} (274.6)
AES_MaxC	80.3^{***} (14.2)	1180.4^{***} (205.8)	1106.4^{***} (112.0)	1747.2^{**} (542.7)

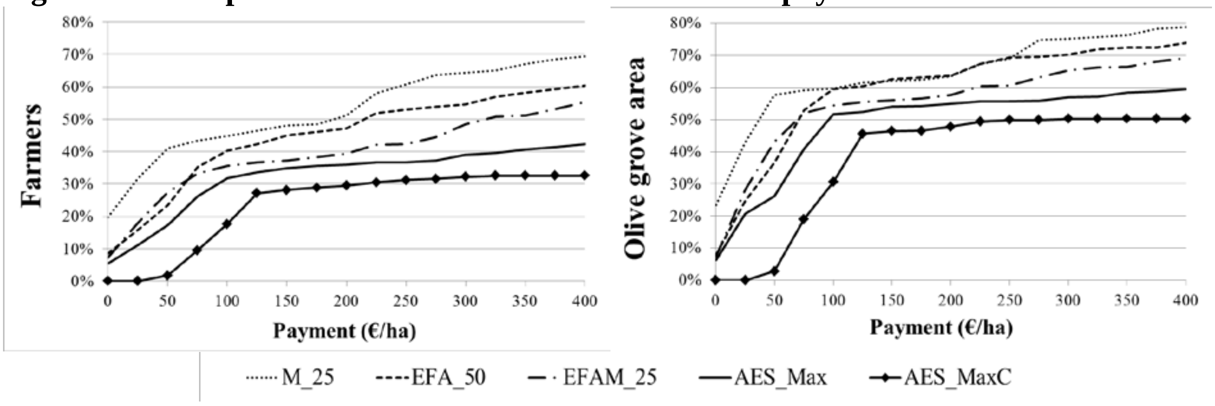
*, **, and *** reflect significance at 5, 1, and 0.1% levels respectively.

Source: Own elaboration.

Figure 1 shows the likelihood of participation in AES both in terms of percentage of farmers and area for the different scenarios considered and different payments. Clearly, the participation rate (in terms of both farmers and area) changes depending on the scenario considered. For example, at the €100/ha-level of payment 18% and 45% of the farmers would be willing to participate in AES_MaxC and M_25, respectively, which corresponds to the minimum and maximum rate obtained for the five scenarios. In terms of area, for the same €100/ha-level of payment the participation rate is higher than in terms of farmers, ranging from 30 to 60% of the area depending on the scenario. This difference between both ranges of percentage is due to C1-farmers, as they are those who first participate in AES at lower payments and own larger farms.

Figure 1 provides interesting information for policy-makers, as it shows the convexity of participation rate curves, allowing the identification of the points of the curve of each scenario where further increases in the payment yield a lower response in terms of participation rates. In the case of farmers' participation rate in the AES_MaxC scenario, that point is reached at approximately €125/ha (which corresponds to a 27% participation rate), which indicates that there would be a smaller response in terms of farmer participation in this AES scenario once this payment threshold is exceeded. Logically, this threshold is different depending on the scenario considered, being €100/ha for EFA_50, EFAM_25 and AES_Max (40, 36 and 32% participation rate, respectively); and €50/ha for M_25 (41% participation rate). In terms of area, the picture changes slightly, with the most cost-efficient payments remaining the same as for farmers (€125/ha and 46% participation rate for AES_MaxC; €100/ha and 52% and 60% for AES_Max and EFA_50; and €50/ha and 60% for M_25) with the exception of one scenario (€75/ha for EFAM_25 and 52% participation rate).

Figure 1. Participation in different scenarios of AES and payments.



Source: Own elaboration.

4. Discussion and policy implications

There is a high heterogeneity among olive growers' regarding their preferences toward AES under current conditions and policy makers must take this into account when designing such schemes. A potential participant class (C1) is clearly identified, comprising 30% of farmers and 41% of area, irrespective of the combination of attributes of the scheme. In order to encourage more farmers to be participants, careful attention would have to be paid to the combination of attributes and the monetary incentive established. For instance, to encourage an additional 15% of farmers (class C2) to participate in AES, a moderately higher monetary incentive would be required and the use of tillage and herbicides in managing CC should not be restricted. Also, for most C3-farmers (representing 42% of the total), higher monetary incentives would be required but with lower levels of stringency in each attribute. Nevertheless, there is a group of farmers (C4) that would not participate in AES whatever the combination of attributes. Apart from payments and requisites, an additional way to encourage farmers' AES uptake could be to improve relevant features such as farmers' training and information about AES and its attributes.

In this section the most relevant points arising from the results are outlined, first those related to each of the attributes separately, and second those linked to the proposed AES scenarios.

4.1. Design and agronomic attributes in AES

As stated previously, the use of CC is the most relevant agricultural practice in terms of enhancing the production of public goods in olive growing. This is why the Regional government has widely encouraged its use. Not surprisingly, then, our survey reveals that this practice is quite widely used nowadays (three quarters of the sampled farmers use CC, being 25% the average area covered). With regard to the **CC area attribute**, we find that 44% of the farmers (C1 and C2) would be willing to use CC at a 50%-level of olive tree area for low-to-medium monetary incentives (€1.0/ha and €4.1/ha per 1% of increase of CCAR, respectively) while the rest (C3 and C4) would not. Yet, reasons behind high WTA differ between the latter two classes. C4-farmers are not willing to use CC because they do not consider it useful. For them, CC are weeds and, as these farmers are the oldest and least educated, it is very difficult to convince them not to remove CC. The case of C3 is more complex. C3-farmers would not be willing to reach a 50% level of CCAR since it would make it more difficult to harvest ground olives, which is important for these farmers. If we assumed that C3-farmers believe that reaching CCAR-50% totally precludes the harvesting of ground olives, net income forgone could be estimated at €183-350/ha (using estimates by Gómez-Limón and Arriaza, 2011), while the WTA of C3-farmers to reach that level would be €378/ha on average. Thus, it seems that C3-farmers' WTA is in line with their perceived net income forgone. Regarding this point, it is worth commenting that the olive oil industry usually pays less for ground olives because of their characteristic dirtiness and worse organoleptic properties. In this sense, there is a market incentive for early harvesting directly from the tree. Hence, from a policy perspective it may be worth training farmers to avoid ground olives harvesting, enabling olive growers to benefit from this quality premium. If this were the case, net income forgone associated with CC (from harvesting of ground olives) would be much lower or even non-existent, reducing WTA for implementing this practice.

Regarding **CC management**, most of the farmers would not be willing to manage CC without tilling and/or with restrictions as to the number of herbicide treatments (3 classes, totaling 70.3% of the farmers, show average WTA higher than €190/ha). This is in line with the evidence found in the literature that highlights strong farmer preferences toward flexibility concerning farming requisites included in AES (Espinosa-Goded et al., 2010; Christensen et al., 2011). For the case of olive growing two main reasons are behind these results, namely the existence of resistant species and farmers' beliefs regarding soil water conservation. Regarding the former, many olive growers are worried about the presence of resistant species within CC, and thus they have a negative perception of the reduction of permitted options to manage CC. Regarding the latter, many producers, especially those with traditional plain olive groves (non-steep slope-land and rain-fed conditions), consider tillage a convenient way to reduce soil water evaporation during summertime. As a result, CCMA-Restr appears very stringent to most of the olive growers. If policy-makers wanted a participation rate above 30% they would be justified in not including such a requisite. Alternatively, it would be worth considering it as a requisite only under certain circumstances (e.g., in environmentally-sensitive areas).

With regard to the **ecological focus areas**, we find that there are two classes of farmers (C1 and C2, totaling 44% of the sampled farmers) that would be willing to implement them in exchange for low payments (€8.2/ha and €9.4/ha per additional 1% of the farmland devoted to EFA, respectively), another class for a low-medium payment (C4 with €44.9/ha per additional 1% devoted to EFA) and another for a high payment (C3 with €151.8/ha per additional 1% devoted to EFA). Similar estimates were produced by Schulz et al. (2014), who also distinguished between farmers willing and not willing to implement EFA in their arable land (with average WTA of €8.9/ha and €51.4/ha per additional 1% devoted to EFA, respectively). With regard to C1 and C2-farmers, their WTA are similar to their net income forgone (€8.2-15.7/ha, also using estimates by Gómez-Limón and Arriaza, 2011). However, low willingness to participate in AES shown by C3 and C4-farmers results in much higher WTA, substantially above their net income forgone.

If a share of EFA beyond 2-3% was required the WTA would presumably be higher regardless of the class considered, bearing in mind the general farmers' rejection of the option of complying with EFA by maintaining some olive trees out of production. Such rejection is reflected in two figures obtained from the survey: first, the 97% of sampled olive growers have not any olive tree out of production in their farm; second, only 30% of the sampled olive growers that would be willing to participate in AES would also be willing to use olive trees out of production to comply with the minimum share of EFA. This suggests that those olive growers willing to comply with a minimum of EFA would do it mostly by using buffer strips, vegetation boundaries and islets, being all of these elements limited by the spatial restrictions revealed in olive groves. Therefore, higher levels of EFA (e.g., 5-7%), apart from being very difficult to achieve in the case of Andalusian olive groves, would require very high monetary incentives. This result calls for careful consideration of the specific initial circumstances of the farms, taking into account that some of them could easily comply with EFA requirements -at least for low levels-, while others could barely comply even at the lowest levels. In the case of the latter, it would be necessary to make use of the EFA equivalents allowed in the future CAP if EFA were also enforced in permanent crops.

With regard to **collective participation**, the four classes of farmers reflect different levels of disutility, from low (C1, €41.2/ha) to very high (C4, €868.0/ha) WTA. The qualitative information gathered during the survey suggests that the different WTA estimates are likely due to the different farmers' perception of transaction costs related to collective participation in AES (in line with the evidences found in Rocamora-Montiel et al., 2014) and the different disutility anticipated or expected by farmers related to losing a bit -more- of their freedom of farm management due to such a participation. To be precise in regard to the latter, farmers value differently the fact of being controlled not only by the Administration, as in every AES, but also by farmer-members of the group who, more importantly, are also neighbors of the same village.

Given the wide range of WTA for collective participation in AES, setting the monetary incentive is crucial to promote collective participation in AES. The latest CAP regulations include an up-to-30% bonus to promote such participation. According to the WTA approach, none of the classes would participate in return for this bonus at the cost-efficient payments highlighted for each scenario. For instance, AES_Max presents a cost-efficient payment of €100€/ha; with a bonus of €30/ha none of the classes would be willing to participate in AES_Max collectively. If the reference was included in the AES currently applied (SM7), 30% would represent €61.2-85.8/ha, which would imply that only C1-farmers would participate collectively. Thus, the collective bonus has to be large enough to promote collective participation, although not larger than the gains expected from it. As regards the latter, although expected gains from the reduction of public transaction costs could easily be estimated, those derived from the higher environmental performance are far more difficult to quantify, depending not only on the requisites/practices included in the AES, but also the proximity and configuration of enrolled farmland (Sutherland et al., 2012). Thus, an up-to-30% bonus can be considered too rough an estimation to reflect society's net gains from collective participation. Therefore, it is clear that further research is needed to cover knowledge gaps about costs and -in particular- gains of collective participation.

With respect to the **level of monitoring**, the main outcome here is that farmers are barely aware of it when it comes to choosing whether to participate in AES or not, at least in the presence of other attributes that they perceive as more important. This appears to be counterintuitive and in opposition to the literature on AES uptake. Actually, Broch and Vedel (2012) estimated farmers' WTA of €38/ha per 1% absolute increase in the level of monitoring. Our results indicate different farmer behavior, thus calling for further research to establish to what extent significant disutility to higher levels of monitoring in AES can generally be expected. This further research could be focused on the reasons behind this different behavior. In particular, the informal information collected during the survey suggests that two different reasons could be behind such low WTA, namely the willingness to comply with the requisites (expecting "fair" monitoring) and the adoption of strategic behavior (i.e., not willing to comply, assuming that they will not be fully monitored). Moreover, it could also be explored whether the enforcement of low sanctions in previous AES in olive growing would be another explanation for such a low WTA.

The classes heterogeneity points out to some general **factors influencing AES uptake** which are worth discussing. Among factors related to farm characteristics, the results suggest a positive relationship of farm area and irrigated olive groves with respect to AES uptake. The fact that larger farms are usually more willing to participate in AES has been widely reported in previous works, not only for arable cropping systems (Falconer, 2000; Ruto and Garrod, 2009; Hodge and Reader, 2010, among others) but also for permanent cropping systems such as olive groves (Franco, 2011). As these authors highlight, higher economies of scale and comparatively lower transaction costs are the main reasons behind their greater willingness to participate in AES. In the case of irrigated farms, there appear to be more than one reason behind such a relationship. On the one hand, irrigated olive groves usually require a more qualified management than rainfed ones, thus their farmers are frequently more prone to adopt new technology and have higher training level (Gómez-Limón and Arriaza, 2011). In this regard, literature reports professional training as a positive factor of adoption of innovations by olive growers (Franco and Calatrava-Leyva, 2010; Rodríguez-Entrena and Arriaza, 2013;

Rodríguez-Entrena et al., 2014a). In addition, for the case study there is a more specific reason related to the use of CC as a requisite of AES, namely: as a result of the lower competition for water between irrigated olive trees and CC, farmers are less reluctant to adopt CC (Franco and Calatrava-Leyva, 2010) and, thus, to participate in an AES that includes this practice as a requisite.

In considering farmers' characteristics, age, knowledge and perception, as well as the abovementioned farmer's training, appear to be related to AES uptake. The fact that younger farmers are more willing to adopt soil conservation practices (Calatrava-Leyva et al., 2007) and to participate in AES, for both, arable cropping systems (Ruto and Garrod, 2009) and permanent ones (Franco, 2011), has been largely indicated in the specialized literature. With regard to farmer's knowledge, as Franco and Calatrava-Leyva (2010) point out, olive growers who update their technical knowledge are more willing to adopt soil conservation practices. Also, farmer's perception has revealed to be key for adopting soil conservation practices and AES. In our research, it appears that the greater the perception of CC as environmentally and economically beneficial, the higher the AES uptake is. The positive farmers' attitude toward the environmental benefits of using certain practices has been previously remarked as a factor of AES uptake (Ruto and Garrod, 2009). Furthermore, Franco and Calatrava-Leyva (2010) found that those olive growers who more significantly perceived soil erosion as an important problem in their farms were more willing to adopt soil conservation practices. The positive relationship between the perception of CC as economically beneficial and the adoption of environmental-friendly practices is also in line with results obtained by Rodríguez-Entrena et al. (2014a), who highlighted the influence of economic parameters of olive groves (such as, output and profitability) on the adoption of soil conservation practices.

4.2. AES scenarios in olive growing

In the context of the CAP, in olive growing there are only two relevant levels of compensation regarding the production of environmental public goods, one is defined by cross-compliance and the other by AES (the intermediate level fixed by the green payment does not apply for permanent crops). In this sense, the scenarios proposed in the previous section include environmental requirements beyond the former, from moderate to large increase in the environmental performance (represented by M_25 and AES_Max, respectively). They also represent a different policy scope, from a wide targeted area with moderate increase in environmental performance to a limited targeted area with large increase in such performance. For instance, if we assume that the budget for AES in olive growing is to remain the same as for the Andalusian Rural Development Program 2007-2013 (€12.25m/year), and use levels of payment identified as the most cost-efficient, it can be estimated that 245,000 ha (16.3% of the olive grove area of Andalusia) would be enrolled in M_25 for a payment of €50/ha. In contrast, for the same budget, 122,500 ha (8.2%) would be enrolled in AES_Max for a payment of €100/ha. This figure would be even lower if collective participation was required (98,000 ha –6.5%– for AES_MaxC with a payment of €125/ha).

Whatever the policy approach, policy makers must ensure that gains outweigh the costs of AES implementation from a public point of view. For instance, using estimates obtained from Rodríguez-Entrena et al. (2012), Andalusian society's compensating surplus for implementing M_25 would be €103.7/ha, and €204.8/ha for AES_Max[7]. Accordingly, for both AES scenarios, there would be a net benefit from their implementation if payments were established below those figures (assuming zero transaction costs). Then, at the cost-effective payments of €50/ha and €100/ha identified for M_25 and AES_Max, it can be concluded that society would benefit from the implementation of these two AES scenarios. However, the choice between these two scenarios is not straightforward as total net benefits would be very similar (€13.2million and €12.8million respectively, obtained by multiplying net gains by area enrolled). In any case, for a more robust conclusion in this regard, further research would be needed in order to refine benefit estimates (more targeted valuation assessment) and the inclusion of actual transaction costs. If these results were confirmed, an interesting option would be to explore the implementation of two levels of AES simultaneously, similar to the Entry and Higher Level of Stewardship scheme in the UK (Hodge and Reader, 2010).

5. Conclusions

AES are useful policy instruments for enhancing the orientation of CAP to the production of environmental public goods (Hodge, 2013). In spite of the extensive literature generated about such schemes, some important issues remain understudied. Here we have analyzed several issues that have received little or no attention, namely the implementation of AES in permanent crops, EFA and collective participation.

Some valuable conclusions of special interest for agri-environmental policy-making can be drawn from the results. First, a high degree of heterogeneity was found as regards olive

[7] These figures are obtained using the following estimates: €29.7/t CO_2 sequestered; €4.2/t of soil loss prevented; and €0.6/bird·ha (Rodríguez-Entrena et al., 2012). Additionally, to include benefits from higher visual quality of landscape when EFA and CC were presented, ratios between such functions and the other environmental functions were used according to estimates from Arriaza and Gómez-Limón (2011).

growers’ preferences toward AES. In particular, four different classes of olive growers have been distinguished based on their preferences. There are clearly two extreme classes: one comprising potential participants (i.e., members are willing to participate even with stringent requirements) and another comprising non-participants. There are two other intermediate classes that comprise farmers willing to participate but with different combinations of requirements and different WTA.

Second, such heterogeneity is also reflected separately in most of the attributes studied. Hence, we find different intensity of preferences toward each attribute when the comparison is made within classes. For instance, there is clearly one class that rejects EFA, another that rejects restrictive management of CC, and two classes that reject both collective participation and using CC, with intermediate classes for all the attributes. The only exception is the level of monitoring, which received little attention from most of the farmers. This specific result about monitoring calls for further research given the fact that other works report the opposite (i.e., monitoring is a strong determinant of farmers’ preferences toward AES). Moreover, farmer/farm characteristics play a major role as determinants of farmers’ preferences toward AES, suggesting that it may be worth implementing some complementary measures in order to increase participation rates in AES (e.g., specific training programs for farmers).

Third, specific policy implications can also be derived regarding each attribute. With respect to the agronomic attributes (concerning CC and EFA), training, status quo, and flexibility of the requirements are important factors in farmers’ choice as to whether to participate in AES that include such attributes. As regards EFA, almost half of the farmers would be willing to accept it for a low monetary incentive (€8-9/ha per additional 1% of the farmland devoted to EFA) while the rest would do it for a moderate to high monetary incentive (€41-151/ha per additional 1% of EFA). However, for higher shares of EFA (e.g., 5-7%) these estimates would presumably be higher due to the intrinsic spatial restrictions of olive groves and farmers’ rejection to comply with EFA by maintaining some olive trees out of production. With regard to collective participation, the up-to-30% EU-wide bonus set in the EU Regulation should be carefully revised, as the monetary incentive is critical for promoting such participation. For instance, we have found that in general it would be insufficient for most of the olive growers to make them participate collectively.

Finally, as olive growing has only two CAP levels regarding the production of environmental public goods (cross-compliance and AES), it would be interesting in terms of

AES implementation to design two different schemes representing moderate and large increases compared to the provision at the cross-compliance level. This approach would also allow olive growers to choose the alternative that most suits them, thus facilitating their participation in AES. However, whatever the chosen alternative, supply and demand analysis must be run together in order to ensure that positive social welfare gains associated with the implementation of this alternative are to be achieved.

Acknowledgments

We would like to thank the anonymous reviewers for their helpful comments on earlier drafts. This research is co-financed by the Spanish Ministry of Economics and Competitiveness (MINECO) and the European Regional Development Fund (ERDF) through projects MERCAGUA (AGL2013-48080-C2-1-R) and SUSTANOLEA (P10-AGR-5892). It is also co-financed by the Regional Ministry of Innovation and Science (Junta de Andalucia). The first and the last author acknowledge the support provided by Andalusian Institute of Agricultural Research and Training (IFAPA) and the European Social Fund (ESF) within the Operative Program of Andalusia 2007-2013 through pre and postdoctoral training programs, respectively.

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Appendix A. Example of choice set.

Figure A. Example of a choice set.

	Alternative A	Alternative B	Alternative C
Yearly payment	200 €/ha	300 €/ha	Neither Alternative A, nor Alternative B. I would maintain my current farm management
Cover crops area	50% of olive tree area	50% of olive tree area	
Cover crops management	Restrictive mgmt.	Free mgmt.	
Ecological focus areas	0% of EFA in olive tree area	2% of EFA in olive tree area	
Participation	Individual	Colective	
Monitoring	Monitoring at 20%	Monitoring at 5%	
	I choose A ☐	I choose B ☐	I choose C ☐