WHAT DO FARMERS WANT FROM AGRI-ENVIRONMENTAL SCHEME DESIGN? A CHOICE EXPERIMENT APPROACH

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ABSTRACT

Agri-environmental schemes (AES) have had a limited effect on European agriculture due to farmers' reluctance to participate. Information on how farmers react when AES characteristics are modified can be an important input to the design of such policies. This paper investigates farmers' preferences for different design options in a specific AES aimed at encouraging nitrogen fixing crops in marginal dry-land areas in Spain. We use a choice experiment survey conducted in two regions (Aragón and Andalusia). The analysis employs an error component random parameter logit model allowing for preference heterogeneity and correlation amongst the non-Status Quo alternatives. Farmers show a strong preference for maintaining their current management strategies; however significant savings in cost or increased participation can be obtained by modifying some AES attributes.

KEYWORDS: choice experiment, agri-environmental schemes, farmers, Spain, error component random parameter logit model.

JEL classifications: C25, H23, Q12, Q21, Q51

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1. INTRODUCTION

Agri-environmental schemes (AES) are the main policy instrument in the European Union designed to foster improvements in the relationship between agriculture and the environment (European Commission, 2005). A typical AES requires farmers to modify farming practices in exchange for a per-hectare payment. This payment is calculated using a supply-side approach, considering the income forgone or the additional costs associated with scheme requirements. The substantial public expenditure needed to fund these schemes (€6.8 billion in the EU's 2007-2013 budget) has motivated a wide range of research aimed at both evaluating and improving their performance.

The voluntary nature of AES means that farmers' decisions to participate, with appropriate distribution across target areas, is central to achieving policy objectives. While there has been a considerable research interest in identifying the factors that influence participation (e.g. Siebert *et al.*, 2006), most studies are based on actual participation behaviour rather than on contingent behaviour. A drawback of this approach is that farmers' decisions to participate are considered subsequent to the design of the AES. As a result, there is typically insufficient variation in scheme attributes to allow the impact of scheme design on participation to be examined.

To overcome this limitation, this study uses a choice experiment (CE) approach to investigate farmers'*ex-ante* preferences for key elements of AES design, such as the amount of land enrolled, grazing regime, provision of technical advisory services, and payment levels. By including payment as one of the attributes, the public expenditure needed for each new design can be estimated. Modelling farmers' choices allows us to estimate how they would trade-off different levels of these contract attributes against per hectare payments. Knowledge of such trade-offs can inform AES policy design. In addition, this approach allows us to estimate the compensating premiums needed for farmers to participate in specific schemes combining different attributes. This enables an informed assessment of relative budgetary costs.

This paper contributes to literature in two main ways. For AES adoption, this is one of two studies which have considered the role of scheme design on farmers' participation, and hence on reducing implementation costs. Although a few studies have been conducted using CE to evaluate farmer behaviour (e.g. Peterson *et al.*, 2007; Ruto *et al.*, 2008; Roessler *et al.*, 2007; Birol *et al.*, 2006; Scarpa *et al.*, 2003), only one has focused on AES design (Ruto and Garrod, 2009). Ruto and Garrod pool responses from surveys covering a wide range of AES and use a payment attribute defined as a change in the premium level. In contrast, we focus on one scheme and use actual payments, which allows us to estimate willingness to accept (WTA). In addition, we account explicitly for preference heterogeneity and the impact of farmer characteristics on WTA estimates for AES attributes. The analysis employs, simultaneously, the error component approach to account for correlation among the non-Status Quo (SQ) alternatives and the random parameter approach to the attributes (Scarpa *et al.*, 2007).

The paper is structured as follows: a brief description of the choice experiment design and the case study is presented in Section 2. Section 3 presents the econometric specification followed by the results in Section 4. Conclusions are drawn in the final section.

2. CASE STUDY DESCRIPTION

Data was obtained from an in-person survey of three hundred farmers undertaken in two regions in Spain (200 in Aragón and 100 in Andalusia) during June-August 2008. The two regions represent low yield rain fed cereal production and semi-extensive ovine farming systems and were selected partly to facilitate investigation of regional differences in preferences for AES attributes. The AES selected as most suitable to provide the framework for this case study was "*introduction of nitrogen fixing crops in dry land areas*" (NFC). This scheme was proposed in both Aragón and Andalusia Rural Development Programs (RDP) for 2007-2013[2]. The main characteristics of NFC are presented in Table 1. The measure closely resembles the Alternative Crop Measure (ACM) scheme included in the 2000-2006 RDP for Aragón but not in the RDP for Andalusia.

Table 1. Main Characteristics of nitrogen fixing crop agri-environmental scheme

Eligibility
• Non permanent rain fed arable land
Requirements
• Cultivate alfalfa (nitrogen fixing crop) during a period of 5 years • Implementation of a farm management plan • Rotate the crop after five years
Compensation
• 100 Euros per hectare and year
Environmental benefit
• Reduce fire risk due to green cover presence in summer period • Increase nitrogen soil content • Habitat preservation for birds

The choice of attributes and levels for the choice experiment is based on a combination of evidence from the literature and on information from a previous study that investigated factors affecting farmers' adoption of AES in the two case study areas (Barreiro-Hurlé *et al.*, 2008). An attribute related to the area enrolled is included since environmental scientists suggest that habitat should be provided with a minimum surface to assure viability. Therefore a compulsory enrolment of 50% of eligible area attribute level is included in order to identify the potential cost it would entail. Grazing restriction plays a significant role in the study areas as the production of rain-fed cereals is closely linked to extensive ovine production (Gómez de Molina, 2002). Therefore the attribute grazing is allowed to take the level "no restriction" to identify the impact it would have on the sign-up decision. The relevance of fixed costs as a barrier for adoption, as put forward by Ducos *et al.* (2009) is also tested by introducing a fixed payment as part of the contract. The potential advantage of including technical assistance and monitoring in the AES is also evaluated. In order to estimate the WTA payments of the various AES design attributes, a monetary attribute related to payment level was included. The attributes and levels used to describe the AES in the choice experiment are described in Table 2.

[2] At the time of selecting the AES to provide the framework for this case study, the final RDP had not been adopted. In Andalusia the NFC was proposed in the draft available at the time, however the approved RDP excluded it.

Table 2. AES attributes and levels used in the CE design

Attribute	Description	Levels	Coding
SUR	Flexibility over the amount of land to be enrolled in the AES	**Free**	**1**
		50% eligible surface	0
GRAZING	Flexibility over grazing in the land under the AES	Free	1
		Limited *	**0**
TTA	Availability of a compulsory and free of charge technical training and advisory service	**No**	**0**
		Yes	1
FIXED_PREM	Availability of a 1000 € one-off payment per contract independently of the area enrolled payable on the first year.	Yes	1
		No	**0**
PREMIUM	Payment level per ha and year	60 € ha^{-1}	60
		80 € ha^{-1}	80
		100 € ha^{-1}	**100**
		120 € ha^{-1}	120

Levels in bold represent the AES currently available in Aragón RDP.
* Period for which grazing is limited varies for each region in order to take into account the RDP specifications. For Aragón the limitation is from 01-08 to 30-09 and in Andalusia it is all year round.

Considering the number of attributes and levels, a large number of AES profiles (96) can be constructed, resulting in 96^2 combinations for a two-option choice set design. To create a more manageable number of options, the choice sets were restricted using Street and Burgess experimental design (Street and Burgess, 2007), which is based on D-z optimality criterion, obtaining 96 profiles and a D-efficiency of 91.3%[3]. In order to make the number of choice tasks manageable for respondents, the 96 choice sets were blocked into 16 versions of six choice sets in each block. In each choice set, farmers were asked to choose between two alternatives, allowing for a no choice (or Status Quo) option under which the farmer continues with his current practice. Table 3 shows a typical choice set presented to respondents in the survey.

The questionnaire was designed by a research team after a thorough review of previous research, agricultural structure in the area and discussions with groups of farmers and government agency officials responsible for AES implementation. Before launching the main survey, the questionnaire was subjected to a pre-test with 10 farmers in each case study region and adjusted accordingly. The pre-test helped to ensure that respondents understood the questions and that the choice tasks were manageable. Apart from the choice experiment, basic information about the farm and respondent socio-economic and technical characteristics were also collected in the survey. The survey targeted farmers who were currently enrolled in AES (participants) and those who were not (non-participants). In the sampling strategy, however, there was a discretional overrepresentation of AES participants. In particular 27% of farmers in the Aragón sample are currently enrolled in the ACM AES, while the actual adoption rate in the region is 2.8% and in Andalusia 32% of the sample are AES participants while the actual adoption rate is 16.6%[4].

[3] The Status Quo (SQ) was not considered in the experimental design. Street and Burgess (2007) conclude that the same experimental design when *"the SQ was not considered"* is optimal when "*the SQ option is adjoined in the choice cards",* albeit with some loss in experimental design efficiency.
[4] This oversampling strategy will be taken into consideration by weighting the final welfare estimates.

Table 3. Example of a choice set (Aragón sample)

	Alternative A	Alternative B	Alternative C
Surface	50 % eligible surface	Free to choose	
Grazing in the enrolled surface	Free	Limited (not allowed between 01/08-30/09)	
Technical Advisory Service compulsory and free of charge	No	Yes	Neither Alt A nor Alt B. I would maintain my current farm management
Fixed Premium of 1000 €	No	Yes	
Premium level (€ ha^{-1} $year^{-1}$)	60	80	

3. ECONOMETRIC SPECIFICATION

Choice experiments are based on Lancaster's theory of consumer choice which postulates that consumption decisions are determined by the utility or value that is derived from the attributes of the particular good being consumed (Lancaster, 1966). The econometric basis of the approach rests on the behavioural framework of random utility theory (McFadden, 1974). Statistical analyses of the responses obtained from CE can be used to derive the marginal values for attributes of a good or policy, in this case AES design attributes. In the model specification, two important issues are simultaneously taken into account: preference heterogeneity and positive correlation among non-Status-Quo alternatives.

Preference heterogeneity has been taken into account in two ways. First, preferences could vary between the two regions. To test for differences between regions, individual multinomial logit models were estimated and subjected to a likelihood ratio test taking into consideration the scale parameter (Swait and Louviere, 1993). Equal attribute and scale parameters can be rejected at the 1% level (χ^2_7=386.7). Therefore two independent models are estimated.

Secondly, we investigate preference heterogeneity within regions (including the effect of farmer characteristics) using a random parameter logit model (RPL). The RPL model overcomes the limitations of a standard multinomial logit model by allowing for random taste variation, unrestricted substitution patterns, and correlation in unobserved factors (Train, 2003). Moreover, heterogeneity can be investigated by interacting individual specific characteristics with attributes or alternative specific constants. In particular we apply an error component random parameter logit (EC_RPL) approach to account for correlation over utilities from different alternatives. The EC_RPL model is a special case of the RPL in which a random error component is used in addition to other random parameters to identify correlation amongst the non-Status Quo alternatives (assumed to be normally distributed). This approach allows us to consider the SQ effect[5] that it is described as "a *systematic inclination of respondents to display a different attitude towards SQ alternatives from those reserved to alternatives involving some change, over and beyond what can be captured by the variation of attributes' levels across alternatives*" (Scarpa *et al*., 2005).

[5] For a recent review of the SQ effect and an application to the analysis of the influence of choice task complexity and attitudes the interested reviewer can refer to Meyerhoff and Liebe (2009).

In our case this issue deserves additional consideration as preference for the non-SQ alternative actually reflects preference for participation in the NFC AES. Since the status quo was defined as "*current farm management*" we have to specify different alternative specific constants (ASC) for AES participants and non-participants. The utility functions can be specified as:

$$\begin{aligned} U_{ALTA} &= \beta'\chi + \eta_{NON-SQ} + \varepsilon \\ U_{ALTB} &= \beta'\chi + \eta_{NON-SQ} + \varepsilon \\ U_{SQ} &= ASC_{SQ\_NOPAR} + ASC_{SQ\_PAR} + \beta'\chi + \gamma_{NOPAR}S + \gamma_{PAR}S + \varepsilon \end{aligned} \quad [1]$$

where ASC_{SQ_NOPAR} and ASC_{SQ_PAR} is the non-random Status Quo alternative specific intercept for non-participants and participants respectively, χ is the vector of AES attributes, $\eta_{NON\text{-}SQ}$ is the error component which identifies correlation amongst the non-Status Quo alternatives and is assumed to be normally distributed, $\eta_{NON\text{-}SQ} \sim N(0, \sigma^2)$. The coefficient vector β, representing individual tastes, is unobserved and varies randomly in the population with density $f(\beta_n|\theta)$, where θ represents the parameters of this distribution, and $\gamma_{NOPAR}S$ and $\gamma_{PAR}S$ capture systematic preference heterogeneity as a function of farmer socioeconomic and farm characteristics (i.e. interaction effects with the ASC_{SQ_NOPAR} and ASC_{SQ_PAR} respectively). The random terms ε are Gumbel-distributed errors that are specified to be the same for all choices made by the same individual (panel structure). This breaks away from the assumption of independence in the error structure across choices made by the same respondent (Scarpa *et al.*, 2005). For panel data, the probability integrand involves a product of logit formulas (Train, 2003). The joint probability of respondent *n* choosing alternative *i* on each of the *T* choice occasions is given by:

$$P(t(n)) = \int_{\beta}\int_{\eta}\prod_{t=1}^{T}\frac{\exp\left(\lambda\left(\beta_n'\chi_{ti} + \eta_{in}\right)\right)}{\sum_{j\subset A_t}\left(\lambda\left(\beta_n'\chi_{ti} + \eta_{jn}\right)\right)} f\left(\beta|\theta\right)d\beta.\varphi\left(0,\sigma^2\right)d\eta_{jn} \quad [2]$$

where, A_t = {ALTA, ALTB, SQ} is the choice set, λ is a scale parameter, $f(\beta|\theta)$ is the density of the attributes random parameters, and $\varphi(.)$ is the normal density of the error component (η_j) which equals zero when j=SQ. Equation [2] cannot be evaluated analytically because the choice probability does not have a closed form. Hence it is approximated using simulation methods, in our case in particular using 1,000 Halton draws. All attributes are assumed to follow a normal distribution, except for the payment level attribute which is assumed to be non-random.

4. RESULTS

The results of the EC_RPL, based on a utility function linear in attributes[6], are presented in Table 4.

All the attribute standard deviations are significant, except for TTA in Andalusia[7], indicating that preferences do indeed vary significantly within the population. The estimated means and standard deviations of the normally distributed coefficients provide information on the proportion of the population that places a positive value on a particular attribute and the proportion that places a negative value. For example, 27.0% of the farmers in Andalusia have a negative preference for the fixed payment attribute (i.e. they dislike the presence of the FIXED_PREM), while in Aragón, 15.5% of the respondents exhibit a negative preference for the attribute related to the flexibility on the surface enrolled.

The ASC_{SQ} is positive and significant for the sub-sample of non-participants in Aragón (ASC_{SQ_NOPAR}) and for both participants and non-participants in Andalusia. As this parameter reflects the probability of not signing up for the proposed AES, this suggests that farmers are reluctant to change their current farm management. However, in Aragón farmers appear to be more willing to change, perhaps because they are already familiar with a variant of the proposed AES. Aversion to changing from the Status Quo is a common finding in choice experiments, consistent with both rational choice theory and observed behaviour (Dhar, 1997). Individuals tend to avoid changes in practice for several reasons (Samuelson and Zeckhauser, 1998): misperceived sunk costs; regret avoidance; desire for consistency. Additionally, loss aversion or asymmetric expectations of costs and benefits has also been put forward as an alternative explanation for this effect (Kahneman *et al.*, 1991). The non-significance of the ASC_{SQ_PAR} in the Aragón sample is consistent with these explanations as there is no major change in practices and farmers already know the costs (and benefits) associated with their participation in such a scheme. The error component specification, $\eta_{NON\text{-}SQ}$, is also significantly different from zero in both models, therefore different correlation pattern exists between the unobservable components of utility of the Status Quo alternative, and those in alternatives involving a change. This is evidence of heterogeneity across respondents in preferences for Alternative A and Alternative B compared to the SQ.

[6] When attributes considered are dummy variables only a linear relationship can be represented. In our case only the payment level attribute is continuous, however non-linearity was rejected using the Wald test ($p < 0.01$).

[7] The standard deviation of the TTA variable in the Andalusia sample was not significantly different from zero, hence the parameter has been assumed as non-random in the final estimation.

Table 4. EC_RPL estimations for the two case study regions

	Aragón			***Andalusia***		
	Coeff.	*SE*	*p-val*	*Coeff.*	*SE*	*p-val*
Mean values						
ASC_{SQ_NOPAR}	6.453	0.715	0.000	13.851	1.524	0.000
ASC_{SQ_PAR}	N.s.	N.s.	N.s.	11.664	1.373	0.000
SUR	1.212	0.172	0.000	2.465	0.343	0.000
GRAZING	0.675	0.218	0.002	3.002	0.445	0.000
GRAZING*PAR	0.752	0.411	0.067	-1.602	0.908	0.076
TTA	0.656	0.163	0.000	0.482	0.310	0.120
FIXED_PREM	1.852	0.182	0.000	1.587	0.462	0.001
FIXED_PREM*PAR	-0.648	0.349	0.064	N.s.		
PREMIUM	0.049	0.003	0.000	0.077	0.009	0.000
Standard Deviations						
SUR	1.637	0.207	0.000	0.153	0.461	0.001
GRAZING	1.270	0.256	0.000	2.230	0.532	0.000
TTA	0.688	0.283	0.015	N.s.		
FIXED_PREM	1.101	0.250	0.000	2.721	0.465	0.000
η_{non-SQ}	1.840	0.261	0.000	1.423	0.520	0.006
Covariates (socio-economic and technical variables)						
ASC_{SQ_NOPAR} x ELI_SUR	0.010	0.005	0.000	N.s.		
ASC_{SQ_NOPAR} x ASOC	-0.964	0.641	0.098	N.s.		
ASC_{SQ_NOPAR} FARM_ABAN	1.650	0.918	0.072	N.s.		
Log-likelihood (β)	-1318.335			-659.167		
Log-likelihood (β_0)	-946.534			-370.814		
χ^2 (p-value)	743.601 (0.000)			576.707 (0.000)		
Pseudo-R^2	0.282			0.437		
No. of observations	1200			600		

N.s.: Not significant.
ELI_SUR: Eligible surface corresponding to rain-fed non permanent arable land (ha).
ASOC=Farmer is a member of an agricultural association (1 if yes).
FARM_ABAN= The farm will be abandoned due to no succession in the farming activity (1 if yes).

Heterogeneity in preferences across participants and non AES participants is reflected in the significant coefficients for the interactions between attributes and participation (GRAZING*PAR and FIXED_PREM*PAR). In the Aragón sample, farmers who are currently participating in the ACM scheme attach greater value to increased freedom to graze. These farmers are more likely to have livestock and would further benefit from the feed provided by the alfalfa crop[8]. However, participants attach less utility to the Fixed Premium. These farmers have already covered the fixed costs barriers and transaction costs associated with being in a scheme and, understandably, benefit less from the fixed payment. In Andalusia, farmers participating in an AES[9] obtain less utility from the flexibility of grazing period. This could be explained by the fact that among participants, 15% have livestock, while among non-participants this proportion doubles, so that the limitation on grazing has a higher impact on their feed availability.

[8] The null hypothesis of independence between livestock production and participating in the ACM can be rejected (χ^2=30.973: p=0.000).
[9] As mentioned previously, the 2000-2006 RDP for Andalusia did not include a measure similar to the NFC AES and therefore previous participation is considered for any AES in the eligible area.

Additional sources of heterogeneity in preferences were investigated by estimating the effect of socio-economic and technical factors on preferences for the Status Quo[10]. These interaction effects are significant only for the subsample of non-AES participants in Aragón. The results show that farmers who believe that the farm will be abandoned in the future (FARM_ABAN) are more likely to choose the Status Quo in Aragón. This finding is related to the fact that the AES considered implies a significant change in the farm management compared to other AES in Spain, which have low requirements and typically involve maintenance of traditional farming practices. The latter have been found to be preferred mostly by farmers without a successor (Potter and Lobley, 1992). The negative sign associated with belonging to an agricultural trade-union (ASOC) highlights the role that social networks have in encouraging participation; a result in line with the previous research undertaken in the study area (Barreiro-Hurlé *et al*., 2009). Finally, farmers with greater eligible area (ELI_SUR) are less willing to participate, reflecting larger farms' greater specialization in cereal crops[11] and consequent greater foregone revenue from land enrolled in the AES. However, there is still heterogeneity in preferences that we have not been able to identify, as reflected by the significant standard deviations of most attribute parameters.

The WTA estimates are presented in Table 5. Since all the attributes are normally distributed and the payment level is fixed, the WTA payments are also normally distributed and have been estimated using the Delta method for the subsample of farmers' participants (*Par*) and non-participants (*Non-Par*). The WTA estimate for the whole sample is calculated as a weighted average based on the actual proportions of participants and non-participants in the AES, to avoid the bias of over-representation of participants in the sample. Reported values represent the per hectare premium that farmers require to be willing to participate in a scheme defined by the evaluated attributes. Therefore, the WTA payment for the SUR attribute in the Aragón sample means that if the AES requires enrolment of 50% of the eligible area (as opposed to no fixed requirement), farmers require an extra 24.6 €/ha to participate. Alternatively, farmers would be willing to participate in the NFC AES for a premium reduced by this amount provided that they have flexibility on the amount of land to be enrolled.

[10] A number of covariates were tested in the EC_RPL, however in the final estimations only the covariates that were significant at the 10% level were included. It is worth mentioning that income could not be modelled due to the high item-non-response rate for the variable in the survey.

[11] If we identify the presence of a harvester as an approximation to the cereal specialization, the variable ELI_SUR is correlated with an increase in the cereal specialization (ρ Spearman=0.391, p=0.000).

Table 5. WTA payments in €/ha in the EC_RPL model in the two case studies (standard errors in brackets)

Attribute	*Aragón*			*Andalusia*		
	Part	*Non-Part*	*Average*	*Part*	*Non-Part*	*Average*
SUR	N.a.	N.a.	24.6[a] (3.60)	N.a.	N.a.	31.9[a,b] (4.73)
GRAZING[*]	29.0[#] (6.82)	13.7[#] (4.48)	14.2[b] (4.36)	18.1[#] (10.77)	38.8[#] (5.61)	35.4[b] (5.23)
TTA	N.a.	N.a.	13.3[b] (3.27)	N.a.	N.a.	6.2[c] (3.65)
FIXED_PREM[*]	24.5[#] (6.37)	37.6[#] (3.95)	37.3[c] (3.86)	N.a.	N.a.	20.5[a] (5.75)

Part: farmers participating in AES; **Non-Part:** farmers not participating in AES_s; **Average:** weighted average taking into account actual participation rates; **N.a.:** not applicable as the interaction between participation and the attribute is not significant (see Table 4). All values are significantly different from zero at the 1% level except TTA in Andalusia which is only significant at the 10% level; **[*]:** Values significantly different between regions at the 10% level; **[#]**: Values significantly different between participants and non-participants at the 10% level; **[a,b,c,]:** Different letters denote significant differences between attributes within a region at the 10% level.

Willingness to accept estimates are significantly different between the two regions for GRAZING and FIXED_PREM. There are also significant differences between participants and non-participants in both regions. Within each region most WTA estimates indicate significant heterogeneity amongst those surveyed. There are two important implications of these results. First, farmers are willing to participate with lower compensation payments if measures are accompanied by technical support through advisory services. Compared to the actual AES premium (100 €/ha), this reduction in compensation payments is close to 13% in Aragón and just over 6% in Andalusia. Second, there is a clear trade-off between per hectare payments and fixed per contract payments. Considering that the average enrolled surface for the ACM AES in Aragón is 15.2 ha incorporating the fixed component in premiums would result in an average saving per farm enrolled in the scheme of 567 € per year without taking into account the additional payment made in year zero (the fixed payment). Over the whole duration of the contract and taking into account a 4% discount rate the net total saving is 1.625 €, representing 23% of the total expenditure for the average farm enrolled. In Andalusia, the fixed payment would result in overall savings if farmers enrolled a minimum of 10.5 hectares in the scheme[12].

Preference heterogeneity among regions is not only reflected in significant differences in the WTA estimates, but also in attribute ranking. Grazing limitation is the most limiting factor in Andalusia[13], while the existence of fixed costs not covered by a per hectare compensation payment limits adoption more in Aragón. In order to provide a broader picture of the required premiums for specific AES, we also estimate welfare changes or compensating surplus (CS) related to different policy options using the formula provided by Hanemann (1984):

[12] When the fixed premium is included, public expenditure in year one is increased by 1,000 € and per hectare expenditure could be decreased by 20.5 € ha^{-1}. Therefore to assure a constant expenditure during the five year lifespan of the contract, farmers should enrol at least 10.5 hectares.

[13] However, this could also be due to the fact that the measure in Andalusia restricts grazing all year long while in Aragón only during two months.

$$CS = -\frac{(U_0 - U_1)}{\beta_P} \qquad [3]$$

where β_P is the parameter estimate of the premium, and U_0 and U_1 represent the farmers' utility before and after the change under consideration. For this calculation, we have to assume that utility is linear and separable in attributes.

Welfare changes are evaluated for two extreme scenarios; one which maximises environmental benefits[14]; the other where attribute levels are fixed at those preferred by farmers. Additionally, the current NFC AES design is also included in order to assess whether the foreseen payment will lead to farmer participation in the measure. Attribute levels for the three scenarios are presented in Table 6. As the NFC AES was already in place in Aragón, the Status Quo needs to reflect the initial situation faced by farmers who are already participating in the AES and those who are not. Therefore, two alternative U_0 levels are defined in Table 6.

Table 6. Attribute levels for the baseline and the three policy scenarios used in the calculation of compensating surplus

	"Status Quo"				
Attribute	***Participants in ACM (U_0^1)***	***Non-participants (U_0^2)***	***"Environment" scenario***	***"Farmer" scenario***	***"Current AES"***
SUR	Free	-	50% eligible surface	Free	Free
GRAZING	Limited	-	Limited	Free	Limited
TTA	No	-	Yes	Yes	No
FIXED_PREM	No	-	No	Yes	No

For those farmers already participating in the ACM AES the utility of the current farm management (U_0^1) takes into account the attribute levels which describe the ACM AES , while the second Status Quo option (U_0^2) is used in the case of Andalusia and for farmers not participating in the ACM AES in Aragón. This second Status Quo only takes into account the ASC. Compensating surplus estimates including standard deviations obtained by the Delta method are presented in Table 7[15].

[14] Enrolled area is fixed in order to assure more continuous area enrolled in the NFC AES; grazing is limited in order to favour nitrogen incorporation into soil and avoid fires; free technical assistance is compulsory in order to assure management practices are correctly applied and monitored; and there is no fixed payment allowing for additional funds being available for additional hectares being enrolled or for other programmes being implemented.

[15] Socio-economic and technical characteristics have been included in the utility function for the Status Quo option as mean sample values differentiated for participants and non-participants.

Table 7. Compensating surplus for three future AES (€/ha) scenarios (standard errors in brackets)

	Aragón			Andalusia		
Scenario	***Part***	***Non-Part***	***Average***	***Part***	***Non-Part***	***Average***
"Environment"	11.29 (4.75)	-110.89 (5.30)	-108.10 (5.21)	-144.58 (6.83)	-172.85 (8.49)	-168.16 (7.64)
"Farmer"	66.76 (8.66)	-34.93 (8.25)	-32.08 (8.05)	-74.09 (13.82)	-81.64 (10.21)	-80.39 (9.75)
"Current AES"	-*	-99.60 (5.61)	-	-118.94 (17.66)	-147.21 (7.03)	-142.52 (6.26)

Part: farmers participating in AES; **Non-Part:** farmers not participating in AES; **Average:** weighted average based on actual participation rates; * CS for this group cannot be calculated; however it should be lower than current premium as they are participating in the scheme.

The CS estimates are significantly different between regions and AES scenarios at the 1% level. The results show that CS values for all the policy scenarios are significantly different between participants and non-participants in Aragón while in Andalusia significant differences were only observed for the "*environment"* scenario. For the measure currently included in the Aragón RDP, it can be seen that in Andalusia the average farmer would not enrol with the proposed premium (100 €/ha), while the premium for non-enrolled farmers in Aragón is very similar to the current payment. As far as the evaluated scenarios are concerned, for the Andalusia sample, neither of the scenarios provides a positive CS value, as the preference for non-participation (reflected in the ASC_{SQ}) is not compensated by the proposed attribute levels; agri-environmental payments should be at least €143, €80 and €168 per hectare for the "*current AES"*, "*farmer*" and "*environment*" scenarios respectively. Therefore, only in the "*farmer"* scenario is participation predicted with the current premium payment (100 €/ha). However, as this scenario includes a fixed payment, at least 10 hectares per contract[16] should be enrolled in order to ensure the same expenditure per farmer. An interesting result for Aragón is that for current participants, the "*environment"* and the "*farmer"* scenario would both be accepted without additional compensation, as participants are better-off.

5. CONCLUSIONS

The main objective of this study was to investigate the role that Agri-Environmental Scheme (AES) design characteristics have on farmers' participation. A choice experiment was conducted in two Spanish regions to investigate farmers' preferences for several important elements of the design of an AES requiring cultivation of rain-fed nitrogen fixing crops. This measure can be considered an example of an AES promoting extensification and the study areas represent low-input low-output agricultural systems. Design attributes considered included increasing flexibility for grazing limitations, requirement for a minimum enrolled area, compulsory technical assistance and monitoring and the implementation of a fixed payment per contract.

[16] Without taking into account the discount rate, in the *"farmer"* scenario expenditure per farmer corresponds to: 80.4 €/ha*5 years*number of ha +1000 €/contract and in the current AES scheme equals to: 100 €/ha*number of ha *5 years. Therefore the number of ha enrolled that equals both expenditures is 10.2 ha.

Results show that farmers are willing to participate for lower compensation in programmes that allow the maintenance of agricultural activity (i.e. grazing in enrolled surface) and do not impose stringent restrictions on farm management (i.e. enrolment of at least 50% of eligible land). However, if policy makers consider that these attributes need to be compulsory to achieve the desired environmental benefits, then higher payments could be offered to induce farmers to participate. In our case, substantial savings can be obtained by including a fixed component per contract in the AES premium. This is confirmed both in the region where the measure is already in place, where savings could be as high as 23% and in the region where the measure is not in place, where savings would be realised by using the fixed payment as long as farmers enrol at least 10.5 hectares per contract. Provision of compulsory technical assistance and monitoring can also be used to reduce the premiums necessary to secure participation. This design feature would provide a three-way benefit as it lowers the cost, increases the probability of delivering the environmental benefits and includes an element of scheme monitoring to ensure adherence to prescribed farming practices.

Significant differences in results are observed between regions and amongst farmers. Although there is no difference in the direction of preferences between regions, the preference ranking of attributes does differ. While a shift to the preferred AES design features will lead to savings in both regions, region specific measures are needed to maximise savings. These results imply that a regional approach to AES design is appropriate both from the perspective of potential savings that can be made and cost-effectiveness. Preference heterogeneity across regions may be due to several factors (e.g. farm and farmer characteristics, institutional setting, environmental attitudes). Our results suggest that spatial heterogeneity may be linked to previous participation in a similar scheme (e.g. in Aragón a similar AES has been in place since 2001). Of course, several factors underlie differences in preference across regions and this may be an interesting subject for further research. Heterogeneity among farmers within a region is mainly attributed to previous experience with AES, which reduces the reluctance to participate in any given programme and the compensation required. Additionally, our results show that participation is also influenced by farm and farmer specific characteristics.

Our findings have important implications for the design of AES aimed at delivering environmental benefits in marginal dry-land areas through the introduction of nitrogen fixing crops in the crop rotation. The main recommendation is that, as long as the main environmental objectives are met, relaxing the grazing restriction could lead to significant increase in farmer up-take at lower budgetary costs since farmers would be willing to participate for less compensation. Moreover, including a fixed component in the compensation premium could reduce overall contract costs. In general, it can be argued that more flexibility in AES management prescriptions is needed to encourage greater farmer participation. In this sense approaches such as those used in the UK where farmers can choose the most suitable combination of practices to achieve specified levels of environmental benefits (Hodge and Reader, 2007) are expected to be more cost-effective. Potential savings can be up to 70% in some of the AES policy scenarios evaluated.

Our results suggest new avenues for research. A key issue is to identify which farmers show negative preferences for specific attributes, which would allow better targeting of design features among different groups of farmers. Moreover, our results should be corroborated with other measures, since factors affecting actual participation have been found to vary with the type of measure (Barreiro-Hurlé *et al*., 2008). An area for further research would be to compare WTA payments with costs and benefits of the proposed changes in AES design. For example, if the additional premium required by farmers to enrol a fixed amount of land in a particular AES (e.g. 50% of the eligible surface) is lower than the environmental gain derived from the potential increase in the amount of land enrolled in AES, then this requirement would lead to net social gains.

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