Conservation contracts for supplying Farm Animal Genetic Resources (FAnGR) conservation services in Romania

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Abstract

This paper describes a choice experiment (CE) administered to explore farmer preferences for conservation agreements to conserve rare breeds among a sample of 174 respondents in Transylvania (Romania). The study site was chosen due to the prevalence of small-scale and extensive farm systems threatened by a changing policy environment that is increasing the scale and intensity of production units. Agreement attributes included length of conservation contract (5 or 10 years); scheme structure (community or individual managed conservation programme), and scheme support (application assistance or farm advisory support). A monetary attribute that reflects compensation for scheme participation allows the assessment of farmers' willingness to accept (WTA) for different contracts. Results suggest 89% of respondents would be willing to farm with rare breeds; cattle and sheep being the most popular livestock option; 40% of farmers were reportedly farming with endangered breeds. However, only 8% were likely to qualify for funding support under current requirements. WTA estimates reveal minimum annual compensation values of €167 and € 7 per year respectively, for bovine and ovine farmers to consider enrolling in a contract. These values are comparable to Romanian Rural Development Programme (RDP) support offered to farmers keeping rare breeds of € 200 and € 10 per year for bovine and ovine farmers respectively. Our estimates of scheme uptake, calculated with coefficient values derived from the CE, suggest rare breed conservation contracts are considered attractive by Romanian farmers. Analysis suggests meeting farmer preferences for non-monetary contractual factors will increase participation.

1 Introduction

Farm Animal Genetic Resources (FAnGR) diversity underpins resilient agricultural systems and need to be part of any sustainable intensification (SI) strategy to meet rising demand for livestock products (Eisler et al., 2014). However, concentration on elite breeding lines has reduced genetic variation in many commercial breeds whilst marginalising traditional breeds whose value is often poorly understood (Ahtiainen and Pouta, 2011; FAO, 2015).

SI strategies should include investments to maintain genetic variation across a range of breeds (including rare breeds) to ensure adaptive capacity in livestock systems. This is particularly important when considering profound demographic and environmental changes facing the agri-food sector including population growth, land scarcity and climate change (FAO, 2017). Equally important, but less often articulated in decision making, are the cultural and heritage attributes embodied in rare breeds (Gandini and Villa, 2003; Zander et al., 2013). Markets often fail to reflect these values, which can be substantial but difficult to measure. Breed genetic diversity is therefore undersupplied by markets and there is a need to explore policy interventions to counter market failure.

While contractual schemes for rare breed conservation are present in Europe, many are often poorly targeted (Kompan et al., 2014; Bojkovski et al., 2015). Targeting incentives towards small-holder and extensive farm systems may improve scheme efficiency and uptake, given their lower opportunity cost of conservation (Naidoo et al., 2006). This paper explores rare breed conservation contracts in Transylvania (Romania), where the average farm size is only 3.4 ha and the economic efficiency per farm (as measured by standard monetary output of agri-products per holding) is significantly lower than the European Union (EU) average (Popescu et al., 2016).

Traditional farm systems in Transylvania are under pressure from development of more intensive farm systems that are changing the scale and nature of practices (Sutcliffe et al., 2013, 2015). A focus on improved efficiency is at the expense of the supply of public goods, including breed diversity. Some 42% of livestock breeds in Romania are classified as 'at-risk'[1] (Draganescu, 2003). This figure may be an underestimate since population estimates for many Romanian breeds are unknown (FAO, 2018). There is therefore a need to develop targeted policy responses that aid conservation by balancing an intensification agenda with incentives for the supply of other non-market goods and services.

Farm scale drivers of diversity loss are often assumed to relate solely to the lower productivity of traditional livestock breeds (Cicia et al., 2003). While income forgone is a key factor to establish the cost of incentive-based schemes, other factors also motivate farm business decisions, and may be particularly relevant in a semi-subsistence farming context. Such non-financial motives may include tradition, community relations, professional pride and independence (Gasson, 1973; Ilbery, 1983; Burton et al., 2008). It is therefore necessary to identify how such attributes might influence the design of conservation programmes and farmer willingness to supply diversity. Other potential technical and institutional barriers-to-entry (i.e. requirements for breed genealogical records) also warrant exploration in this context.

We used a choice experiment (CE) survey to elicit farmer preferences for supplying (rare breed) conservation under alternative contracts forms. CEs are a stated preference technique where individual preferences for attributes of a good or service are elicited using surveys that mimic hypothetical scenarios – in this case conservation contracts (Louviere et al., 2000). The paper adds to the literature on farmers' willingness to participate in incentive-based schemes (Ducos et al., 2009; Ruto and Garrod, 2009; Broch and Vedel, 2010; Espinosa-Goded et al., 2010; Greiner, 2015;

[1] Corresponding to the United Nations Food and Agricultural Organisation (FAO) definition of an 'at-risk' breed.

Lienhoop and Brouwer, 2015) but focuses on the neglected issue of the cost of conserving FAnGR in small-holder and extensive farm systems.

The paper is structured as follows. Section 2 presents background to the CE design and case study site. Section 3 reports the analysis of choice data. Section 4 provides discussion of the design of rare breed conservation programmes, and Section 5 provides conclusions.

2 Methods

2.1 Case study: Romania

As an EU member state, Romania's agricultural policy is structured and supported in an agreed Rural Development Programme (RDP 2014-2020), which includes a support measure (M10.2, art 28) for rearing endangered livestock breeds under EU Regulation 1305/2013 (MARD, 2014). Uptake for this RDP option is anticipated to be low due to farmer difficulties in meeting EU standards to qualify for subsidy payments (Page, 2015, *personal communication*). Data on uptake rates are not yet available, but previous work has found that 70% of Romanian farmers experienced difficulties meeting EU environmental standards for payments under the Common Agricultural Policy (CAP) (Fischer et al., 2012). It is therefore important to explore whether such barriers persist for farmers in small-scale and extensive systems, as this could reduce participation. Equally important is to measure whether voluntary agri-environmental stewardship (AES) measures, specifically M10.2, match farmer preferences and expectations for scheme design and rewards.

Much of the study site (Figure 1) is situated in the foothills of the Carpathian Mountains and features an undulating topography with low nutritional pastures (Mikulcak et al., 2013). Part of the area (Tarnava Mare) is classified as high nature value (HNV) farmland. Traditional agricultural practices are common in this area, as is the presence of many small scale and semi-subsistence farms

(Page et al., 2011). Mechanised systems are the mainstay for medium to large farms, though are much less common. The site is characterised by high levels of rural poverty, with average household incomes below the national average (Gherghinescu, 2008).

We surveyed livestock keepers across 5 counties (Sibiu, Brasov, Mures, Cluj and Alba). The sampling frame was based on local farmer information held by village mayors, with further random sampling of farms. The survey was administered from June to August (2015).

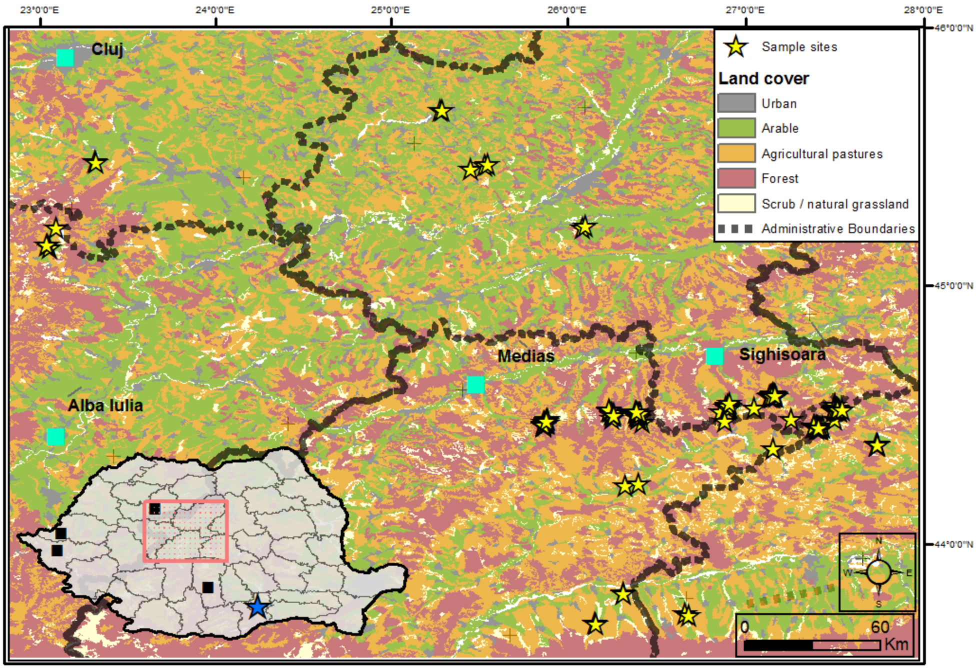

Figure 1: Land cover map of the survey area with inset map of Romania. Sampling locations are shown by yellow stars.

2.2 Questionnaire design and administration

The survey consisted of four sections. The first asked about the farm business including livestock species and breeds, farm size, and traits farmers deem most important when considering choice of breed. In the second, respondents were asked if they receive AES payments and whether they were aware of financial support for rare breeds and ever considered applying for this support. The third part of the questionnaire included the CE. Two CE versions were created - one for ovines and one for bovines. Farmers answered either one or both depending on whether they were keeping ovines, bovines, or both. After the CE tasks were completed, respondents were asked to state their motivations for their choices in the CE, and this information was used to identify genuine choices from protest bids; the latter subsequently being removed from the analysis. Respondents were also asked about their preference concerning scheme remittance (i.e. individual or community payment). The fourth section collected socio-economic information including respondent age, gender, educational attainment and household income.

2.3 Choice experiment design

In CEs, respondents are asked to repeatedly choose from a number of options that differ in their attributes or characteristics following an experimental design. The CE elicited individual preferences using hypothetical contract choice sets requiring farmers to upkeep rare breeds from a list of breeds proposed by the Romanian Government for support under the 2014-2020 RDP measure (see Appendix 2 for list of eligible breeds). Farmers were advised that the breeding of animals must be pedigree to qualify for further subsides on offspring (i.e. non-random mating). Each choice task consisted of two alternative contracts and a ‘none’ option to embody the voluntary nature of the conservation scheme. Attributes and their levels used to describe the conservation contract were determined in a multi-stage process involving literature review, expert consultations and pilot testing.

Each contract option consisted of four attributes (Table 1). The first three attributes described contract length (CL); scheme support (SS); and structure of scheme (SOS). Choice of attributes drew on empirical work suggesting their importance in AES scheme design (Ruto and Garrod, 2009; Christensen et al., 2011; Greiner, 2015). A final monetary attribute (COS) represented an annual payment to farmers (per animal) and took four different levels. The monetary attribute in local currency (Lei per year) was based on a percentage (10%, 30%, 60% and 100%) of the proposed monetary reward outlined in the RDP; the premise being that some farmers may be willing to accept (WTA) a lower reward, depending on contract design. The choice tasks were differentiated based on the livestock species. For bovine (cattle, horses and buffalo) and ovine farmers (sheep and goats) the choice tasks were similar except for the value of the monetary attribute, which reflected the relative support normally given to different species under current RDP conditions.

Table 1: Attributes and attribute levels used in the CE including relevant coding and a prioir expectations

Contract attributes	**No. of levels**	**Coding**	**Attribute levels**	**Expected sign**
Contract duration	2	Effects	- 5 years + 10 years	-
Scheme support	2	Effects	- Basic assistance to complete the scheme application form + Additional advisory support throughout the scheme (e.g. additional training for animal breeding)	+
Structure of scheme	2	Effects	- Individually managed conservation scheme + Community managed conservation scheme	-
Subsidy	4	Discrete	- Bovines = 90; 270; 530; 890 Lei / year	+
		Discrete	- Ovines = 5; 15; 25; 45 Lei / year	

Choice set design was optimised according to prior information on the distribution of random parameters to improve statistical efficiency - i.e. reduction in sample size needed to achieve statistical significance (Crabbe and Vandebroek, 2011). Prior information concerning the parameter coefficients was estimated from results of the pilot data that was collected *in situ* to ensure the attributes were relevant to participants. A D-efficient experimental design optimised for the random parameter logit (RPL) model was formulated using NGene (Metrics, 2012). The final CE comprised 16 choice sets which were blocked into 4 blocks of four choice tasks each in a bid to reduce the cognitive burden for respondents (Hensher, 2006). Figure 2 shows a typical choice task presented to respondents.

	Option A	Option B	No contract
Contract Length	5 years	10 years	--
Scheme support	Basic application assistance only	Additional advisory support (e.g. extra training)	--
Structure of conservation scheme	Community managed conservation programme	Individually managed conservation programme	--
Subsidy (per animal / per year)	Lei 90	Lei 270	Lei 0

I prefer:	Option A	Option B	Nothing
	❑	❑	❑

Figure 2: A typical choice task shown to respondents

2.4 Econometric specification of choice models

Respondent choices in a CE can be modelled with reference to Lancaster's theory of value (Lancaster, 1966) and Random Utility Theory (McFadden, 1973; Luce, 2005). For a general description see (Holmes et al., 2017). The standard choice mode is the multinomial logit (MNL) model (McFadden, 1973) which assumes the random component of the utility of the alternatives is independent and identically distributed (*i.i.d.*). A key limitation of the MNL is that preferences for attributes of different alternatives are assumed to be homogenous across individuals. The RPL model for choice data analysis is more advanced and takes into account heterogeneity of the parameter values among respondents and relaxes key assumptions that constrain the use of conditional logit models, namely independence of irrelevant alternatives - *iia* (Hensher et al., 2005). Under a RPL specification, the utility a respondent *i* derives from an alternative *j* in each choice situation *t* is given by:

$$U_{ijt} = \beta_i X_{ijt} + \epsilon_{ijt} \quad (1)$$

Where U_{ijt} is a utility maximising individual, X_{ijt} is a vector of observed attributes associated with each contract option (i.e. contract length, scheme support, structure of scheme and price) plus the socio-economic characteristics of respondents, and ε_{ijt} is the random component of the utility that is assumed to have an *iid* value distribution. Conditional on the individual specific parameters β_i and error components ε_i the probability that individual *i* chooses alternative *j* in a particular choice task *n* is represented as:

$$Pr(j|X_{it}, \beta_{it}, \varepsilon_{it}) = \frac{exp(\beta_i X_{ijt} + \varepsilon_i)}{\sum_k^J exp(\beta_i X_{ikt} + \varepsilon_i)} \quad (2)$$

Note, choices for bovine and ovine farmers were modelled separately to explore preference heterogeneity between both groups. The empirical model was estimated using the econometric software NLOGIT 5.0. For a full description of the model specification, see Appendix 3.

3 Results

3.1 Respondent characteristics

A total 174 respondents were surveyed - 116 were bovine farmers and 81 were ovine farmers (note 45 respondents kept both ovines and bovines). The means and standard deviation of multiple individual specific variables is outlined in Table 2. There were later used as interaction terms in the choice model to determine significant covariates that help to explain respondent choice. The mean age of participants was from 40-49 years, with highest education levels of either secondary school or college. Fewer female respondents featured in our sample as more males are employed in agriculture (European Commission, 2012). Average monthly household income was reported to be in the range of €181 to €362; lower than the national average but anticipated at the sample site (Page et al., 2011). The primary income for most farmers was EU subsides, while sale of milk and meat products were generally secondary and tertiary sources, respectively. Some 40% of farmers claimed to be farming with a rare breed from a list of 'at risk' breeds, while 32% were enrolled in AES measures. Only 21% of respondents were aware of RDP support for rare breeds whilst only 8% actually met the EU's criteria to qualify for payments.

Table 2: Summary of individual specific variables (with means) and relevant interpretation

Variable	Interpretation	Mean	Std. Dev	National mean
Gender	1, if male, 0 otherwise	0.83	0.91	49% male[a]
Age	Categorical (1=<20, 2=20-29, 3=30-39, 4=40-49, 5=50-59, 6=60-69, 7=over 70 years)	4.23	1.44	55.7% (25-64 years)[a]
EDU	Categorical (1=secondary, 2=college, 3=degree & professional)	1.58	0.61	85.6% (secondary or college)[a]
Income	Categorical (1=<€45, 2=€45-€90, 3=€91-€181, 4=€181-€362, 5=€362-€678, 6=>€679)	3.8	1.45	€ 566[b]
Size	Categorical (1=1-2 ha, 2=3-6 ha, 3=7-20 ha, 4=>20 ha)	2.59	1.05	3.6 ha[c]
FRB	1, if farming with rare breeds, 0 otherwise	0.4	0.49	-
CON	1, if farmer would consider farming with rare breed in the future, 0 otherwise	0.89	0.32	-
AES	1, if farmer is currently enrolled in an agri-environment scheme (AES), 0 otherwise	0.32	0.47	-
RDP	1, if farmer aware of RDP support for rare breeds, 0 otherwise	0.21	0.41	-
BEN	Categorical (1=if farmer prefers 100% individual cash benefits from a conservation programme, 2=50% cash benefit, 50% community in-kind benefit, 3=100% community in-kind benefit)	1.39	0.71	-
REG	1, if farmer is registering livestock in a genealogic register, 0 otherwise	0.08	0.27	-
Yield	1, if farmer is keeping cross breeds for yield improvement, 0 otherwise	0.47	0.5	-

References: [a](National Institute of Statistics, 2013) [b](National Institute of Statistics, 2015) [c](Popescu et al., 2016)

3.2 Farm characteristics

To determine how intensification may threaten traditional farming systems and breed diversity, respondents were asked to detail how their farming practices have changed over the preceding 10 years (Figure 3). Increases to dairy cattle herd size were reported by 52% of respondents. Of the 20% of our sample that reported manual hay cutting, 74% reported this to be either stable or increasing; a clear response to EU incentives that reward small-holders for the activity. Mechanical hay cutting was reported to be increasing (67% of respondents) and some 54% of farmers also stated their sheep herd size was increasing.

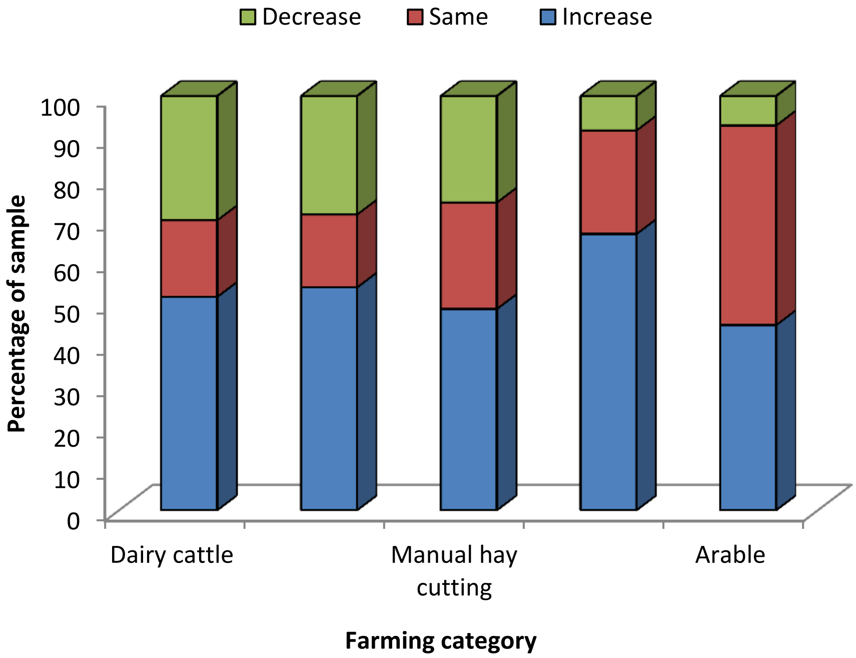

Figure 3: Reported change in farming practices over the last 10 years from respondents.

To investigate whether willingness to participate in a (rare breed) conservation programme was linked to preferences for farm animal species, respondents were asked both livestock species kept and their interest in joining a conservation scheme. Pigs were the most frequently kept farm animal followed by cattle and sheep (Table 3). The highest number of breeds reported was for pigs, while buffalo had the least. The prevalence of breed diversity varied across species. For instance, the main breed kept for each farm species ranged from 83% (Romanian Buffalo) to 37% (Large White pig). Across the sample, 89% of farmers registered interest in joining a rare breed conservation programme, of which cattle (52%) and sheep (39%) were the most popular species. Least popular species were goats (11%); horses (13%) and buffalo (14%). Of interest is the low preference for conserving rare horse breeds given their popularity in the Romanian farming context. This may suggest rare horse breeds do not match farmer preferences for horse breed characteristics and hence are undersupplied.

Table 3: Summary of farm animal and breed characteristics across our sample.

Species	Incidence of farm animal in sample (%)	Total no. breeds reported	Most popular breed (% abundance)*	Farmers stating interest in farming with rare breed (%)
Sheep	61	8	Tsurcana (47%)	39
Goats	24	4	Unknown (56%)	11
Pigs	84	13	Large White (37%)	-
Buffalo	10	3	Romanian Buffalo (83%)	14
Cattle	73	9	Baltata Romanesca (61%)	52
Horses	51	8	Unknown mix (51%)	13

* Percentage abundance was calculated as the number of farm animals in our sample that correspond to a specific breed

Livestock-keepers in different countries prefer different breed attributes. Respondents were asked to rank livestock attributes by importance for breed selection. In Figure 4 radar charts indicate different preferences between rare breed and commercial breed keepers for some attributes. Yield was the most important attribute for both. Adaptability was ranked 2nd for farmers keeping rare breeds, while disease and parasitic resistance was ranked 3rd. For commercial breed keepers, yield was also ranked 2nd and adaptability 3rd. This suggests productive traits are considered most important by both farmer groups, but they differ in perceived importance of non-productive traits. This supports work suggesting rare breed adaptability characteristics play an important role within the livestock sector not matched by commercial breeds (Leroy et al., 2018).

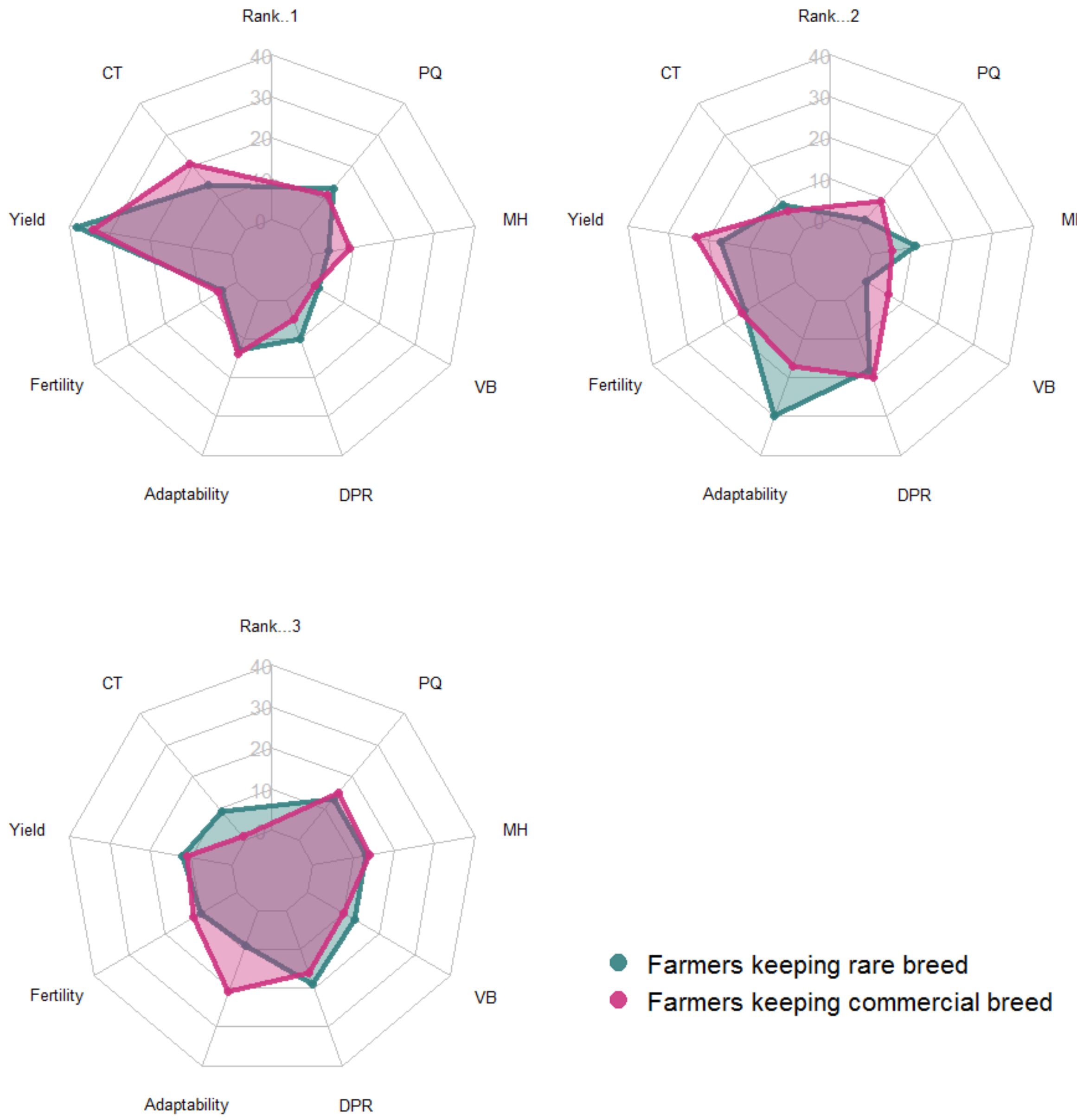

Figure 4: Radar charts showing ranked importance of livestock attributes according to farmer preference. The charts reveal the percentage of farmers who chose each attribute in 1st 2nd and 3rd rank. Note, CT = cultural tradition; DPR = disease and parasitic resistance; VB = veterinary bills; MH = management and handling; PQ = product quality

3.3 Choice Models

The choice models explore the hypothetical contract choices made by respondents that are dependent on information concerning contract attributes and respondent/farm characteristics. The models seek to explain farmers' choices of contract options depending on the values that the attributes take in each contract option. This provides information on the relative importance of each attribute for selecting a contract option and the overall compensation needed by farmers to enrol, which may be heterogeneous across farmers. The model investigates if some of this heterogeneity is systematically associated with farm or farmer characteristics.

Initial results from the MNL are provided in Appendix 3 to provide an overview of the basic model estimation. Results from the more sophisticated RPL model for bovine and ovine farmers are reported separately in Table 4. Both models delivered a good statistical fit (i.e. the model is a good estimator of respondent choice) as indicated by McFadden pseudo R^2 values[2] of 0.33 (bovines) and 0.38 (ovines).

Table 4: RPL model output for estimated marginal utilities for both ovine and bovine models for the CE attributes including interaction terms

Attribute	**Bovines**		**Ovines**	
	Coefficient	SE	Coefficient	SE
Random parameters				
[CL] Contract Length	-0.829***	0.175	-0.984***	0.213
[SS] Scheme Support	0.147	0.230	0.618	0.259
[SOS] Structure of Scheme	-0.554**	0.221	1.499***	0.466
[COS] Subsidy	0.022***	0.003	0.594***	0.108
[N0] Nothing option	1.90***	0.516	2.301***	0.492
Standard deviations of random parameters				
[CL] Contract Length	0.501	0.311	0.652**	0.291
[SS] Scheme Support	1.022***	0.261	0.297	0.495
[SOS] Structure of Scheme	1.689***	0.324	1.223***	0.279
[COS] Subsidy	0.006	0.012	0.018	0.282

[2] Note the McFadden pseudo R^2 can be interpreted very much like a regression R^2 value but the goodness of fit will always be much lower in CE modelling (typically between 0.2 to 0.4).

[N0] Nothing option	1.675***	0.358	1.112***	0.378
Covariates (socio-economic variables)				
COS:AES	-0.981***	0.374		
COS:BEN	0.016***	0.006		
N0:AES	1.681***	0.509		
SOS:BEN			-2.506***	0.565
COS:AES			-0.110*	0.062
COS:BEN			-0.188**	0.077
Model summary				
No of observations	464		324	
Log likelihood	-344.089		-222.246	
Chi squared	331.345		267.409	
Prob > Chi square	0.000		0.000	
McFadden Pseudo R^2	0.325		0.376	

Note: ***; ** indicates significance at 1% and 5% respectively. SE=standard error

The N0 (non-contract option) is positive and significant in both models meaning most farmers have preferences for the status quo option which follows economic theory (Greiner, 2015). This is perhaps because there are some variables, not included in the model, which induce farmers to prefer to not join the offered contract alternatives. The subsidy attribute is positive in both models meaning higher conservation payments increased likelihood of enrolment. Contract length (bovines and ovines) is significant and negative meaning respondents prefer a shorter contract. Scheme support was not significant for both bovine and ovine farmers. Structure of scheme was negative and significant for bovine farmers meaning they prefer individually managed conservation schemes. For ovine farmers structure of scheme is positive and significant, suggesting they prefer community managed conservation programmes.

Significant standard deviations of the normally distributed coefficients indicate there is heterogeneity in farmers' preferences for some attributes. The standard deviations were significant for all attributes accept contract length and subsidy (bovines only) and scheme support and subsidy (ovines only).

Additionally, we also tested for significant relationships between respondent preferences for different contract attributes and various individual specific covariates. The significant covariate interactions for both models are listed in Table 4. For both models, a negative, significant relationship was obtained by interacting farmers currently enrolled in AES schemes (AES) with subsidy (COS) suggesting farmers enrolled in AES measures require less subsidy support. Conversely, farmers not enrolled in AES schemes demanded higher subsidy payments. The N0 interacted with AES was positive and significant suggesting farmers currently enrolled in AES schemes were more likely to select the non-contract option. Education level did not influence likelihood of enrolling into a contract and farmer age did not affect preferences for contract length (both non-significant).

For bovine farmers, interacting respondents wishing to receive community benefits from the scheme (BEN) with COS was significant and positive, indicating farmers looking to receive community based (in-kind) rewards require a higher equivalent subsidy reward. For ovine farmers, interacting BEN with structure of scheme (SOS) is negative and significant meaning farmers preferring individual benefit schemes also prefer individually managed conservation programmes (i.e. consistency in our results). Interacting BEN with COS was also negative and significant suggesting ovine farmers preferring individual payment schemes are WTA lower subsidy premiums.

3.4 Willingness to accept estimates

For WTA estimates (Table 5) the positive value for the N0 of €167 $^{\text{year-1}}$ and €7 $^{\text{year-1}}$ for bovine and ovine farmers, respectively, can be interpreted as the starting value needed for farmer participation in the contractual scheme relative to the baseline contract (Christensen et al., 2011); where baseline refers to a shorter contract length, scheme application support only and an individually managed conservation breeding programme. Changing from a 5 to 10 year contract would cost around €72.8 $^{\text{year-1}}$ and €3.3 $^{\text{year-1}}$ for bovines and ovines respectively. To move from an individual to a community managed conservation scheme would cost an additional €48.6 $^{year-1}$ for bovine farmers while conversely for ovine farmers it would cost an additional €5 $^{year-1}$ to enrol them in an individual scheme.

Table 5: WTA results (€ $^{year-1}$) derived from the RPL model for both ovine and bovine farmers

Attribute	Bovines		Ovines	
	Coefficient	95% confidence interval	Coefficient	95% confidence interval
[CL] Contract Length	-72.8***	-33.1 to -144.7	-3.3***	-1.4 to -7.3
[SS] Scheme Support	12.9	40.7 to -37.6	-0.2	1.4 to -2.3
[SOS] Structure of Scheme	-48.6**	-8.3 to -121.8	5.0***	6.0 to 3.1
[COS] Subsidy	-	-	-	-
[N0] Nothing option	166.9***	198.3 to 109.8	7.0***	67.6 to 5.9

Note, ***; ** indicates significance at 1% and 5% respectively

3.5 Estimating contract participation

Contract participation was estimated according to different payment and contract scenarios to determine how projected uptake by farmers varied according to contract attributes. Coefficient means from the RPL model were used for calculating probabilities under two alternative scenarios; optimal and non-optimal contracts, where optimal refers to contract attributes that meet farmer preferences elicited in the CE while 'non-optimal' contracts do not. For instance, for bovines this would be a 5 year contract that is individually managed. The subsidy premium took consistent values across both scenarios, ranging from 10% to 100% of remuneration offered in the RDP scheme option. This allowed exploration of how scheme uptake might vary with different contract options to gauge the importance of monetary and non-monetary attributes in farmer decision making.

As expected, non-optimal contracts were estimated to receive lower participation relative to optimal contracts (Figure 5). Participation estimates ranged from 4% (€20 $^{year-1}$) to 70% (€200 $^{year-1}$) for bovines and 2% (€1 $^{year-1}$) to 78% (€10 $^{year-1}$) for ovine farmers under the non-optimal scenario.

Conversely, in the optimal scenario participation estimates ranged from 38% (€20 $^{\text{year-1}}$) to 97% (€200 $^{\text{year-1}}$) for bovines and 71% (€1 $^{\text{year-1}}$) to 99% (€10 $^{\text{year-1}}$) for ovine farmers. Recalling that subsidy premiums are comparable across both contract scenarios, our estimates show the difference in participation (between the two contract scenarios) ranges from 27% to 58% for bovine farmers and 22% to 84% for ovine farmers.

We find a non-linear relationship between participation and financial reward, suggesting a one unit change in subsidy does not necessarily equate to a mirrored change in participation (i.e. there are other factors exogenous to our model influencing farmers willingness to participate). Respondents presented with optimal contract designs were much more likely to enrol in a conservation programme even at lower premiums. Ovine farmers were less likely to enrol in a contract that did not match their preferences for non-monetary attributes at lower subsidy premiums (though this was not the case with higher premiums). For both farmers groups (non-optimal contracts) there appears to be a tipping point, before which contract enrolment is relatively static.

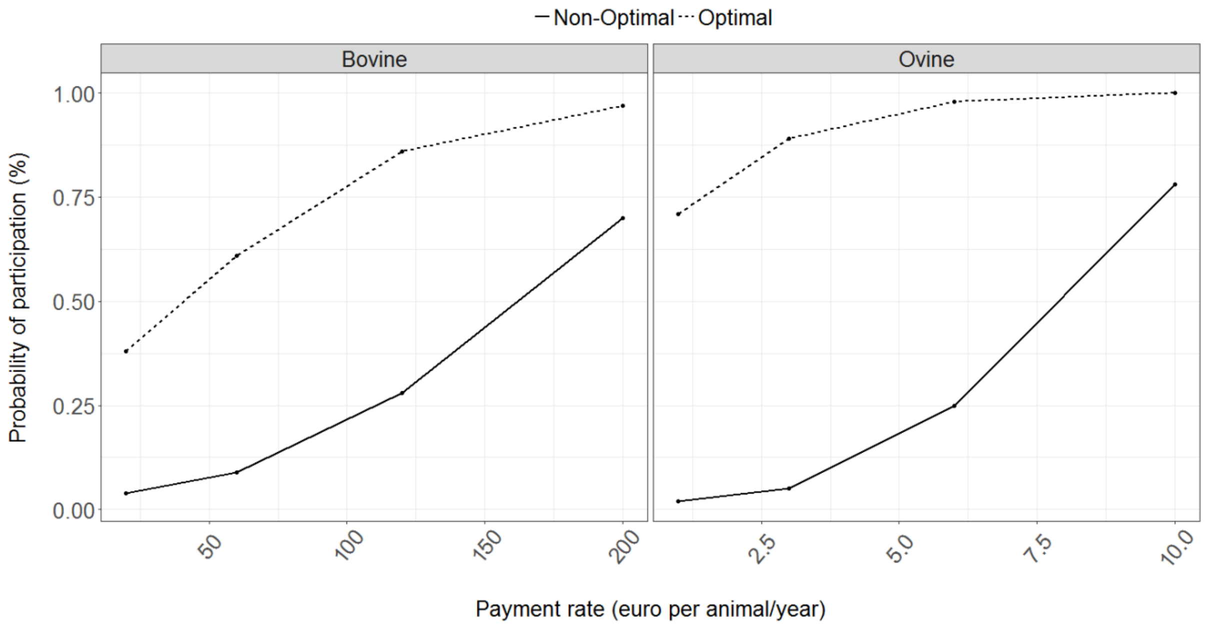

Figure 5: Probability of contract participation according to 'non-optimal' and 'optimal' contract scenarios for different subsidy premiums (bovine and ovine farmers). 'Optimal' refers to contract attributes that meet the preferences of agents.

4 Discussion

4.1 Contract preferences

Results suggest farmers demonstrate a clear willingness to participate in conservation programmes for rare breeds. Participation may be reduced by up to 84% if farmer preferences for non-financial attributes are not taken into consideration Within the model, the N0 may capture the dis-utility of enrolling in a voluntary subsidy scheme that is not linked to contract attributes, but potentially other factors not included in our model (e.g. family tradition or mistrust in authorities). It may also reflect a general reluctance to join a voluntary incentive scheme (Christensen et al., 2011). However, heterogeneity across farmers in our sample (as shown by significant standard deviation of non-random parameters) complicates interpretation of the N0.

Farmers revealed a tendency to value flexibility in contracts as demonstrated through a preference for shorter contract durations, a common finding in similar studies (Christensen et al., 2011; Tesfaye and Brouwer, 2012; Santos et al., 2015). While bovine farmers preferred individually managed conservation programmes ovine farmers preferred community managed schemes. This seems logical in post-communist Romania, which has seen a shift from collective to individual ownership rights across agriculture (Tudor and Alexandri, 2015). On the other hand an enduring communal herd grazing regime among sheep farmers may explain the alternative preference. The significance of the standard deviation for this attribute further complicates interpretation. Although scheme support for a conservation programme was not considered important by both farmer groups similar attributes were significant in other studies (Ruto and Garrod, 2009). For instance, work by Christensen et al. (2011) has shown farmers are able to place a monetary value on being released from certain administrative burdens and that the use of farm advisors for schemes might make farmers willing to accept a lower payment for enrolling in a scheme. In developing countries like Romania, where rural populations are generally less educated than the wider population (FAO, 2001) application support for schemes may in-fact be paramount to securing farmer participation.

A number of covariates help explain heterogeneity in both models. We did not find that farmers keeping rare breeds were WTA less for supplying conservation services, perhaps suggesting other non-monetary motives were driving their decisions regarding the contract options. Both farmer groups enrolled in AES schemes were WTA less compensation for supplying conservation services, thus providing a means for conservation agencies to target least cost service providers. However, farmers enrolled in AES schemes were also more likely not to select a contract option, suggesting overlap with existing contractual schemes may deter farmers from participating. In addition, farmers already enrolled on AES programmes are more likely to harbour pro-environmental attitudes (Heyman and Ariely, 2004) that may improve compliance with contractual schemes.

In both models community (in-kind) based support is associated with higher cost than those preferring cash based payments; implying the use of in-kind rewards will increase overall scheme cost. However, in-kind payments have been shown to be more effective than cash payments in stimulating conservation effort (Gorton et al., 2009) and may provide longer term infrastructure benefits to communities supplying public goods. In addition, Narloch et al. (2017) argue collective payments to community groups may effectively ‘crowd-in’ compliance, thus reducing monitoring costs and improving conservation outcomes. The additional costs of community schemes must therefore be weighed against (potentially) improved social and farm animal diversity outcomes.

4.2 Contract participation

Contract participation estimates reveal a trade-off between non-monetary attributes and financial incentives. For instance, if RDP subsidies paid € 120/ animal $^{\text{year-1}}$ and € 6/ animal $^{\text{year-1}}$ for bovine and ovine farmers in an ‘optimal’ contract scenario then uptake rates could be as high as 86% and 98%, respectively. This contrasts with enrolment of just 28% and 25% for identical price premiums but with ‘non-optimal’ contracts for bovine and ovine farmers, respectively. The higher uptake rates associated with ovine farmers in optimal contracts may reflect that performance differences between rare and commercial breeds are larger for bovines than ovines, though this supposition requires further evidence.

These participation estimates are still well above actual participation rates of 15% for an AES scheme in Northern Italy (Defrancesco et al., 2008). Empirical work by Wossink and van Wenum, (2003) suggests participation of up to 60% might be achieved in a hypothetical Dutch field margin programme, suggesting the scheme proposed here is indeed considered attractive by farmers. However, while strategies were employed to prevent hypothetical bias (e.g. cheap talk statement) it nonetheless must be considered that the high participation rates found in our work may be exaggerated by such bias (i.e. the hypothetical nature of a CE may induce respondents to overstate their desire to enrol in a contract option). That said, farmers in our sample were generally poorer than the national average which may be an underlying factor driving an increased desire to participate.

Contrary to expectations, farm size, education level and age did not have a significant effect on participation. These findings confirm conflicting results found in the literature concerning the influence of education (Dupraz et al., 2002; Defrancesco et al., 2008; Greiner, 2015), age (Wossink and van Wenum, 2003) and farm size (Christensen et al., 2011; Adams et al., 2014) on participation in contractual conservation schemes. The hypothesis that farmers keeping rare breeds would be more likely to participate in a conservation scheme was not supported. This may be because a high number of farmers were keen to participate in the scheme, irrespective of whether they were currently farming with a rare breed. Although few studies have directly assessed farmer willingness to participate in rare breed conservation programmes, work by Pattison et al. (2007) suggests that farmers keeping rare breed pigs in Mexico were willing to participate in a community conservation breeding programme even without financial incentives.

4.3 Barriers to uptake

Some have been critical of RDP approaches to rural policy (Shortall, 2008; Milcu et al., 2014). This study suggests there are clear barriers to entry for smallholder farmers wishing to participate in some RDP options. This is apparent where RDP eligibility requires a minimum parcel size of 0.3 ha to be entered into agreements and a cumulative field size of 1 ha or more (Mikulcak et al., 2013). The average farm size in our sample was 3-6 ha and discussion by Page et al. (2011) stresses this is a major obstacle for small-scale farmers in Eastern Europe wishing to enrol land into incentive schemes (Gorton et al., 2009). Herd or flock-book registration of livestock is a requirement to qualify for RDP support for rearing local livestock breeds in danger of extinction (MARD, 2014) yet only 8% of farmers in our sample reported having animals registered in this way revealing a major barrier-to-uptake. Implementing alternative mechanisms, or proxies, to identify the genetic merit of farm animals has been identified as an important consideration by Pattison et al. (2007) and novel approaches developed by Bhatia et al. (2010) may serve as a way to surpass such barriers through phenotypic identification of breeds.

EU rural development policy needs be more clearly communicated. In our sample, only 21% of farmers were aware of RDP funding support for farmers rearing endangered breeds. Surveys by Mikulcak et al. (2013) suggest funding measures are often poorly communicated to small-scale farmers and local mayors in Transylvania, emphasising the importance of using local communication channels. In Transylvania, Fundatia ADEPT (a local conservation NGO) are meeting this need by helping small scale farmers through workshops on the CAP and RDP measures; developing milk collection points in local villages and facilitating cooperative bids for farm applications to AES options where, individually, farmers would be ineligible to apply (Fundatia ADEPT, 2014). These factors have culminated in better support for small-scale farm incomes in Transylvania while maintaining the high levels of public goods that arise from these production systems.

5 Conclusion

Farm intensification is a trend across Romania and Central and Eastern Europe (Henle et al., 2008; Popescu et al., 2016) threatening breed diversity. Sustaining this diversity makes an important contribution to the delivery of SI objectives given the high option value that arises from breed diversity, through greater adaptive capacity (Hoffmann et al., 2014). This adaptability, in addition to breed cultural heritage, is considered important by farmers in Transylvania, particularly those keeping rare breeds.

This analysis supports the findings of other work (e.g. Greiner, 2015; Permadi et al., 2018) that suggest contract length and the structure of schemes, in addition to monetary rewards, are important determinants of participation rates in conservation programmes. But we also acknowledge that the monetary values farmers place on accepting specific contractual schemes are case specific (Christensen et al., 2011). As a consequence, the robustness of these results needs to be addressed in further work exploring cost-effectiveness of FAnGR conservation programmes in similar contexts. Moreover, this work has not explored how farmer WTA a contract might vary depending on breed options as part of the scheme. Indeed, work by Zander and Drucker, (2008) suggests farmer do possess heterogeneous preferences for breed attributes and breeds themselves. Exploring the importance of alternative breed and attribute combinations in contracts appears warranted and may further affect farmer willingness to participate in schemes and their WTA a conservation contract.

We found that the average bovine farmer (in Transylvania) needs to be paid €122 per annum per animal extra in order to enrol in a 10 year community managed conservation contract. For ovines, an additional price incentive of €8.3 would be required for farmers to enrol in a 10 year individually managed conservation contract. A key question is whether the conservation and genetic diversity benefit of a longer contract that either includes a collectively or individually managed conservation breeding scheme will exceed the additional costs.

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