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Saving the breeds: German Farmers' preferences for Endangered Dairy Breed conservation programs

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ABSTRACT

Animal genetic diversity is a unique and irreplaceable heritage. Globally, about 20 % of all breeds or livestock populations are considered to be 'at risk' and 9 % are already extinct. On farm, the concentration on elite breeding lines has endangered a number of alternative breeds. In Germany, over half of the entire dairy cattle population belongs to only three dominant breeds. Although several alternative breeds are well known for superior functional characteristics like e.g. a good fertility, an excellent udder health, and their ability to adapt to diverse environments, they are increasingly replaced by Holstein cows due to higher milk performances. To design effective incentive schemes that encourage farmers to maintain desired breeds, it is crucially important to know about their preferences for certain contract components. A discrete choice experiment (DCE) with 160 dairy cattle breeders revealed determinants of farmers' willingness to accept conservation contracts to conserve rare German cattle breeds like Red dual-purpose cattle or Angler cattle. We included attributes like the monitoring of pairing, requirements for the keeping conditions, a collective bonus for an increase in population by five percent and the contract length in our experimental design. A Random Parameter Logit (RPL) model revealed that farmers favor shorter contracts (one or five years), a bonus for a population increase and the requirement of outdoor access. In contrast, farmers rather reject to choose a contract that requires participation in a breeding program and the prohibition of slatted floors. Two distinctive classes of farmers can be identified based on the results of a Latent Class Model (LCM). Organic farmers are generally less likely to join a program and are even more disapproving contracts where the pairing is monitored by the breeding association. However, it seems that program requirements should not be too restrictive on the farm management and rather focus on the compensation of associated income loss.

Keywords: Endangered dairy breeds; choice experiment; conservation contracts

1 Introduction

The sustainability of animal production systems and future food security require access to a wide diversity of animal genetic resources. Due to the rarity of wild relatives and a smaller gene pool, the loss of animal genetic resources may be a more crucial problem than the loss of crop varieties (Rege & Gibson, 2003). In dairy cattle, the Holstein breed dominates production and raises questions about long-term effects of a genetic drift (Notter, 1999). In Germany, 54 % of the 4.3 million heads of dairy cattle belong to German Holstein Friesian breed and 27 % to Fleckvieh and the German Braunvieh (Lindena, Ellßel, & Hansen, 2016). The concentration on elite breeding lines has endangered a number of alternative breeds although some of them are known for

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important superior characteristics as their ability to adapt to environmental or climate conditions. In the long run, those characteristics can be of particular importance when considering agricultural challenges arising from climate change (Tubiello et al., 2008). In Germany, the breeding of endangered dairy cattle often forms part of the agro-environmental programs of the *Länder* (federal states) and are in most cases co-financed by the EU. The European Union announced within the regulation on support for rural development by the European Agricultural Fund that "the conservation of genetic resources in agriculture […] value should be given specific attention". Currently, 14 out of 16 *Länder* offer a conservation program for traditional endangered cattle breeds that differ greatly in the type of breed, amount of compensation paid, and the animal's age from which the financial support starts. Although numerous conservation initiatives are in place, the Federal Ministry of Food and Agriculture claims that there is still considerable need for optimization in many areas (Federal Ministry of Food and Agriculture, 2008).

Our paper therefore aims to assess factors affecting farmers' willingness to participate in Endangered Dairy Breed (EDB) conservation schemes. Second, we estimate farmers' willingness to accept (WTA) for EDB conservation program requirements to elicit information on costs of participation. And third, conclusions are derived on how to design cost-effective EDB conversation programs. Our analysis is based on a Discrete Choice Experiment (DCE) with 160 breeders of endangered dairy cattle breeds in northern Germany. The following Section 2 sets out hypotheses based on a review of the relevant literature. Section 3 describes the methodology and provides details of the survey. In Section 4 results are presented. In Section 5 results are discussed in the light of existing knowledge and further conclusions are drawn for the design of cost-effective EDB conservation programs.

2 Literature and hypotheses

The body of literature on valuation of genetic resources appears in diverse applications. Ahtiainen and Pouta (2011) analysed 22 studies on the valuation of plant as well as animal genetic resources in agriculture and they conclude that that future research should address the costs and benefit of maintaining the genetic diversity in Europe. They point out that animal genetic resources have received considerable interest during recent years, but valuation studies from Europe are surprisingly rare. From the data they analyzed, only two studies originated from Europe. One focusing on an endangered horse breed in Italy (Cicia, Dércole, & Marino, 2003) and the other one on general agrobiodiversity characteristics on small Hungarian farms (Birol, Smale, & Gyovai, 2006).

Valuation studies associated with genetic resources of cattle are mainly focusing on specific characteristics of breeds in Africa (Zander & Drucker, 2008; Tano et al., 2003). For example Ouma et al. (2007) found that Kenyan and Ethiopian farmers prefer a good reproductive performance and trypano-tolerance over milk yield as relevant characteristic for cows. Martin-Collado et al. (2014) employed a choice experiment to reveal that the most valuable attributes of a rare Spanish cattle breed are associated with non-use values like maintaining the local culture and values associated with the mere existence of a rare breed.

The literature on how to design effective conservation programs to conserve endangered dairy breeds is scarce and relate mostly to the lower productivity of traditional breeds (Cicia et al., 2003). Bojkovski et al. (2015) compared provided incentives for conservation in 35 European countries and conclude that the current level of financial support does not compensate the loss of income due to lower productivity of traditional breeds. Another cross-country study was carried out by Gandini et al. (2012). They investigated key elements which may affect local breed viability (tendency to increase herd size) from a farmers' perspective and found that collaboration among farmers and the perceived stakeholders' appreciation of the local breed's existence and its products positively influences the breed viability on farm. A study from France by Lauvie et al. (2010) aimed at comparing different approaches (conservation programs and development initiatives) to increase populations of rare breeds and they conclude that development initiatives can help maintain the population size but in some situation induces tensions with conservation. For example in the selection program for the Vosgienne cattle breed, genetic variability is managed through a rotational mating plan involving different

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groups of breeding animals. But at one point in the program, a group of bulls was culled because it was not considered to be profitable.

Studies on valuation of cattle conservation programs in Germany do not exist to date. In the following, our hypothesis on factors affecting farmers' willingness to participate in EDB conservation schemes are derived from current literature on other (mostly environmental conservation) programs. The feasibility of required keeping conditions like the prohibition of slatted floors or access to free-range area or pasture depends on farm-specific resource settings and the cost will vary from farm to farm. We thus hypothesize:

H1: The higher the compensation payment for participating in an EDB conservation program, the more likely the farmer will participate.

H2: The more costly or demanding the required animal keeping conditions, the less likely farmers are willing to participate in an EDB conservation program.

By means of a DCE, Ruto & Garrod (2009) investigated farmers' preferences for the design of Agri-environmental schemes (AES) and showed that longer contract duration requires a higher compensation than a shorter contract period. Christensen et al. (2011) conduct a DCE with 444 Danish farmers to assess their willingness to sign contracts for pesticide-free buffer zones. The results show that farmers prefer contracts with a short contract period and the option to quit the contract from year to year. A positive valuation of a shorter contract length is also in line with results from Bougherara & Ducos (2006) or Broch and Vedel (2012) and leads to the following assumption:

H3: The longer the duration of an EDB conservation contract, the less likely farmers will participate in the program.

Education plays an important role for decision making on farm. The keeping and breeding of endangered cattle breeds requires experience and knowledge about their specific characteristics and needs. A higher education may enhance the capacity for adoption by enabling easier access to information. Hence:

H4: The better educated the farmer is the more likely farmers will participate in an EDB conservation program.

It seems to be general consensus that participation in agri-environmental schemes is negatively influenced by a farmer's age (Ruto & Garrod, 2009). Also Gandini et al. (2012) find that with increasing age the likelihood that farmers are planning to increase the herd size of the local breed decreases. Hence:

H5: The older the farmer is the less likely farmers will participate in an EDB conservation program.

Farmers use different marketing channels to sell their products. Direct marketing provides good opportunities to convey positive images of rare dairy breeds to consumers. This leads to:

H6: Farmers who are engaged in direct marketing are more likely to participate in a breed conservation program.

Previous research has found that farmers' attachment to their animals may depend on the species kept and the purpose of keeping the animal (Bock et al., 2007). Economic reasons clearly play a role for running a farm business but equally important are farmer decisions shaped by non-economic motives, such as family tradition, community relations, professional pride and independence (Gasson, 1973; Burton et al., 2008). In a study on farmers' attitudes towards farm animal welfare, Austin et al. (2005) could identify two main dimensions as drivers to enhance animals' wellbeing on farm: a business orientation and a welfare orientation. In the literature on valuation of non-market goods, the concept of non-use values needs to be distinguished from pure economic values. In a meta-analysis, Ahtiainen and Pouta (2011) conclude that that future research on the value of genetic resources in agriculture should not only address the costs and benefit of maintaining genetic diversity, but should also estimate the relative magnitude of use and non-use values of genetic resources. In this context, non-use values are associated with the pure existence of a certain breed without actually using it or represented by a value placed on preserving genetic resources for future generations.

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For genetic resources, use value refers to productive activities, to their use in breeding and further to the future uses of genetic materials such as future breeding and the development of new traits (Gollin & Evenson, 2003; Roosen, Fadlaoui, & Bertaglia, 2005). We therefore asked respondents to state if they keep endangered breeds for idealistic or rather economic reasons to test the hypothesis:

H7: Farmers who keep endangered breeds for idealistic reasons are more likely to participate in a breed conservation program.

Besides the hypothesizes mentioned, we assume also other factors like herd size or the keeping of suckler cows as well as other farm-specific resource settings (keeping cattle on straw or slatted floors) to have an effect on farmers' willingness to participate in a program.

3 Methodology

The empirical analysis is based upon Discrete Choice Experiments with 160 breeders in Germany. The survey was conducted in 2017 using paper-based questionnaires. Thirty-nine shorthorn breeders were interviewed face to face at an auction in Schleswig-Holstein. The majority of farmers were motivated to participate through breeding associations in northern Germany. From 363 breeders of at least one of the rare breeds[1] considered in our study 160 contributed to the data we used for analysis.

Table 1 shows the attributes and levels of conservation programs included in the choice sets. Programme attributes in terms of conservation program requirements for cattle breeders were derived from existing conservation initiatives in Germany and comprise obligatory participation in a program with monitored pairing, access to free-range area or pasture as well as prohibition of slatted floors. As an incentive farmers are compensated with a support measure and a collective bonus for an increase in cattle population by 5% per year.

Table 1 Attributes and levels used for the design of conservation programs

Attributes	Level[2]
Compensation payment	1) 0€/LU/year*;
	2) 150€/LU/year;
	3) 200€/LU/year;
	4) 250€/LU/year
Bonus (population increase by 5 %)	1) 0€/LU/year*;
	2) 40€/LU/year;
	3) 80€/LU/year
Conservation breeding program (pairing)	1) No*
	2) Yes
Keeping conditions	1) No requirements*
	2) Access to free-range area or pasture
	3) Access to free-range area or pasture+ prohibition of slatted floors
Contract duration	1) 0 yrs.*
	2) 1 yrs.
	3) 5 yrs.
	4) 10 yrs.

[1] Originally the survey aimed at collecting data from breeders of red breeds only. Due to a very small population in Germany we decided to broaden our study and included breeders of Shorthorn, German Black Pied, Old Angler Cattle, Angler Cattle, Yellow Cattle and Red Dual Purpose Cattle into our data sample.

[2] *marks the minimum level (Opt-out)

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Besides the choices of EDB conservation contracts, farmers were asked to provide information concerning their farm business and other socio-economic characteristics like age, if succession is secured and education. Moreover we asked for information on current management of EDB on farm and about their motivation to engage in traditional breed conservation.

The *orthoplan* procedure of SPSS was used to generate an orthogonal design, yielding 32 choice sets. We then checked each choice set for utility balance and removed seven choice sets which contained a dominant choice alternative. The experimental design comprising 25 choice sets had a D-efficiency score of 95.7, indicating a satisfying design (Kuhfeld, 2004). Of the 25 choice sets blocks were created and one half of the respondents had to answer six and the other half seven choice sets. In each choice set, respondents were asked to choose among two hypothetical conservation programs and a status quo representing the opt-out, meaning "no contract" is chosen (see Table 2).

Table 2 Example of a choice set for EDB conservation programs

Attributes	**Conservation programme 1**	**Conservation programme 2**	**Opt-out**
Compensation payment	250€/LU/year	250€/LU/year	No contract
Bonus (population increase by 5 %)	40€/LU/year	0€/LU/year	
Conservation breeding program (pairing)	No	Yes	
Keeping conditions	No requirements	Access to free-range area or pasture	
Contract duration	5 yrs	1 yr	
I would choose:	□	□	□

Econometric estimation

Based on McFadden's (1974) Random Utility Theory, an individual n's utility Uobtained from a most preferred alternative j^* consists of a deterministic observable part V_{nj} and a stochastic part ε_{nj} accounting for factors that are unobservable to the analyst[3].

(1) $$U_{nj} = V_{nj} + \varepsilon_{nj}$$

Assuming breeders maximise utility, alternative j^* will be chosen from a set of alternatives J with a certain probability, which can be simulated by means of Maximum Likelihood technique:

(2) $$P_{nj*} = prob\left(V_{nj^*} + \varepsilon_{nj^*} > V_{nj} + \varepsilon_{nj}\right) \forall\, j = J; j^* \neq j$$

The deterministic part V_{nj} can be described as an additive function of conservation program requirements x_{nj} providing different levels of utility. In addition, we assume that the decision makers' personality and the farm resource settings z_n can affect the likelihood of choosing a conservation contract.

(3) $$V_{nj} = \sum_{i=1}^{I} \alpha_i\, x_{nji} + \sum_{m=1}^{M} \beta_{jm} z_{nm}$$

Estimated parameters α and β (summarized under the designation γ_n) provide information on the influence of the conservation contract attributes and personal or farm characteristics on the choice probability. To account for heterogeneity within the population, a Random Parameter Logit (RPL) model was employed which overcomes the limitations of a standard logit model by allowing for random taste variation, unrestricted substitution patterns and correlation in unobserved factors (Train 2003). The utility parameters γ_n vary across the population with density $f(\gamma|\theta)$ where θ are the true parameters of the distribution describing the mean

[3] Following (Train & Weeks, 2005), the stochastic part ε_{nj} is assumed to be extreme value distributed with scale σ_n (normalized to 1).

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and the variance of γ's. The attributes of the conservation contract are included in the model as random parameters, and the personal/farm characteristics interact with constant α_c because they do not vary across alternatives (Hanley et al. 2001). The estimated coefficients do not have a direct interpretation other than in their signs or statistical significance (Burton et al. 2001). We used the coefficients to derive WTA estimates as the negative ratio of the coefficients of the attribute variable of interest x_j and the price variable:

$$WTA\ for\ x_j = -\frac{\alpha_{xj}}{\alpha_{price}} \quad (4)$$

These WTA estimates are calculated at the mean of the sample. In order to account for statistical variability in WTA estimates, confidence intervals of 5 % and 95 % for mean values were computed using the delta method recommended by Hole (2007).

4 Results

4.1 Descriptive statistics

Summary statistics are presented in the appendix. The average age of breeders is 47 years. Almost 90 % run their farm as main occupation and half of all farmers face a secured succession. Nearly 60 % completed a state-certified training in agriculture whereas one fifth holds a university degree or a qualification from a technical college. The average farm size is 63 hectares of arable land, and 58 hectares of pasture land. Twenty percent of the sample are engaged in organic agriculture and market their products directly to consumers. The largest share of farmers keeps Angler cattle (39 %) and Red Dual Purpose (27 %) on farm. Only few farmers breed German Black Pied (11 %), Yellow cattle (9 %) and Shorthorn (7.5 %). Only a minority of farmers keep old Angler cows (4 %), a breed that is traditionally located in northern Germany. One third of breeders keep their animals on straw, whereas half of them keep them on slatted floors. Half of the farmers from our sample already participate in AES or conservation programs. On average farmers are subject to cross compliance controls twice a year and rather neutral towards them. Interestingly the motivation to keep endangered dairy breeds seems to be ambiguous as 40 % are breeding them for economic reasons and other 40 % for idealistic reasons.

4.2 Estimation results

Table 3 shows the estimation results of the RPL model. Forty-seven of the 160 breeders (30 %) always chose a conservation program, whereas 10 (6 %) farmers never chose one of the proposed programmes. The remaining 103 (64%) farmers chose a conservation program selectively. As expected, a higher compensation payment has a positive effect on participation and so has the collective bonus, lending support to **H1**. Interestingly, an annual bonus of 80 Euros for each farmer who contributes to an increase in population by 5% allows lowering the assured compensation payment by 30 Euros p.a. From the requirements on the keeping conditions only the most restrictive one has a negative effect on farmers' participation. An interaction terms between the requirement "access to free-range area or pasture" and farmers who provide access to pasture show a positive sign. Farmers who keep their animals on slatted floors either partly or in the entire barn reject to participate in a program where slatted floors are prohibited. In contrast, farmers who keep their cattle on straw bedding are willing to accept those schemes. This confirms H2, and demonstrates that compliance with certain contractual requirements is closely related to the way animals are kept on farm. Farmers are indifferent to one or five years of contract length but value a contract period of ten years negatively. This result confirms H3 and relates to preferred flexibility of farm business decisions.

Older farmers are *ceteris paribus* less likely to participate in an EDB conservation scheme as they are facing a shorter planning horizon (confirmation of H5). Conversely, the existence of a successor leads to a higher probability of choosing a program. From the sample population of dairy cows, the main part (39 %) belongs to the Angler breed. Compared to other breeds included in our study the Angler breed has a relatively large population and is already under support measures in three *Länder* in Germany. Therefore farmers might not perceive this breed as endangered or already receive financial support. Keeping suckler cows is often related to a negative profit margin due to a lower milk performance. For each additional suckler cow, farmers request an

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additional compensation of around € 1 per year. Farmers who breed the old Angler cattle or Yellow cattle are more likely to accept participation in a conservation scheme. In particular for Yellow cattle, mainly represented in Bavaria, this can be explained by a higher compensation payment for those breeds in the northern states of Germany. Access to free-range area, direct marketing of products from endangered cattle breeds (confirmation of H6) as well as keeping other endangered species (hens, pigs etc.) on farms has a positive effect on the probability to accept a contract. Interestingly, organic farmers, farmers who have either a strong economic motivation or mainly idealistic reasons to keep endangered breeds are less willing to participate in an EDB conservation program. This is a contradicting result that would not be in line with H7.

Table 3 Estimation results from the RPL model

RPL model N = 160 Log-Likelihood: -733.36863 ; Pseudo-R^2: 0.334		Coefficient (SD)	WTA [€/LU/year] (Con. int. 95%)
Attributes of EDB conservation program *x*	Compensation payment	0.015*** (0.003)	-
	Bonus = 40 €/LU/year	-0.069 (0.187)	5 (-19; 29)
	Bonus = 80 €/LU/year	0.453*** (0.152)	-30 (-52; -8)
	Conservation breeding program	-0.1594 (0.255)	11 (-23; 44)
	Access to free-range area or pasture	0.230 (0.255)	-15 (-49; 18)
	INT: Access to free-range area or pasture* Pasture (dummy)	1.322*** (0.295)	-88 (-133; -42)
	Access to free-range area or pasture+ prohibition of slatted floors	-2.475*** (0.418)	165 (93; 235)
	INT: Access to free-range area or pasture+ prohibition of slatted floors* straw (dummy)	1.890*** (0.452)	-126 (-195; -56)
	INT: Access to free-range area or pasture+ prohibition of slatted floors* partly slatted floor (dummy)	-1.340*** (0.446)	89 (25; 153)
	INT: Access to free-range area or pasture+ prohibition of slatted floors*slatted floor (dummy)	-2.110*** (0.613)	140 (51; 230)
	Contract duration = 1 year	0.271 (0.452)	-18 (-77; 41)
	Contract duration = 5 years	0.467 (0.496)	-31 (-98; 35)
	Contract duration = 10 years	-1.627*** (0.495)	108 (43; 173)
Farm structure variables, attitudinal and socio-economic variables *z*	Age	-0.688*** (0.017)	5 (2; 7)
	Successor	1.827*** (0.584)	-121 (-208; -34)
	Agricultural training	0.233 (1.020)	-13 (-146; 119)
	State-certified farm manager	1.278 (0.807)	-85 (-193; 22)
	Technical college or university	0.998 (0.812)	-7 (-112; 99)
	Farm business	0.242 (0.858)	-16 (-127; 95)
	Dairy cows	0.023*** (0.006)	-1.5 (-2.5; -0.6)
	Keeping suckler cows	-0.015*** (0.006)	1 (0.2; 1.7)
	Shorthorn	0.713 (1.266)	-47 (-214; 119)
	German Black Pied	-0.081 (1.390)	5 (-176; 187)
	Old Angler Cattle	7.093*** (2.087)	-472 (-778; -166)
	DGV (Yellow cattle)	3.790** (1.789)	-252 (-500; -4.4)
	Angler	-0.292 (1.561)	19 (-184; 222)
	RDN (Red Dual Purpose Cattle)	-0.090 (1.672)	60 (-157; 276)

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Source: own calculation
Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

Table 4 Estimation results from the RPL Model (continued)

RPL model N = 160 Log-Likelihood: -733.36863 Pseudo-R^2: 0.334		Coefficient (SD)	WTA [€/LU/year] (Con. int. 95%)
Farm structure variables, attitudinal and socio-economic variables ***z***	Access to free-range area	1.303*** (0.504)	-87 (-159; -15)
	Organic farm	-2.884*** (0.728)	192 (77; 306)
	Direct marketing	3.833*** (0.808)	-255 (-384; -126)
	Support measure	-3.667*** (0.849)	244 (118; 369)
	Agricultural environmental schemes (AES)	-0.736 (0.749)	49 (-49; 147)
	Grazing	3.621 (0.809)	-241 (-372; -110)
	Bothering	0.212 (0.455)	-14 (-73; 45)
	Economic reasons	-1.067* (0.643)	71 (-11; 153)
	Idealistic reasons	-1.753*** (0.604)	117 (37; 196)
	Other endangered species	2.631*** (0.760)	-175 (-289; -60)

Source: own calculation
Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

To estimate the LCM we included all of the significant farm structure, attitudinal and socio-economic variables from the RPL model into a likelihood function and estimate the model for several segments. Statistical information criteria according to Akaike (AIC) and Bayes (BIC) are applied to identify the optimal number of segments (Boxall and Adamovicz, 2002). As with the adjusted determination coefficients in linear regression models, AIC and BIC "penalise" an excessive formation of classes when there is no marked improvement in model accuracy. In our model the information criteria led to an optimal segmentation into two classes in the dataset. The results of the LCM are presented in Table 5. For Class 1 the WTA estimates reveal that breeders in in this class value a high collective bonus for an increase in population by 5 % that lowers the compensation payment needed by € 37 per livestock unit per year. Farmers in this class strongly reject EDB conservation programs that require access to free-range area or pasture in combination with a prohibition of slatted floors and contracts with a term of ten years. Due to a rather low average probability of choosing an EDB conservation contract of 25 % we labelled this class "Non-adopters". Interestingly, from all the membership variables that shape the classes only organic farming had a significant positive effect on being in Class 1.
For Class 2 we see changes in breeders' preferences for EDB conservation contracts. Similar to Class 1, farmers in Class 2 prefer a collective bonus of € 80 per livestock unit per year and strongly reject contracts that do not allow keeping cows on slatted floors while requiring free-range husbandry. In contrast to farmers from Class 1, they are ready to relinquish an amount of € 185 per livestock unit per year if access to free-range area or pasture is required. Instead of being indifferent towards contract terms of one or five years like farmers in Class 1, they are rather clearly in favor of shorter contract durations. The average probability of choosing an EDB conservation contract for farmers in Class 2 is 44 %. The higher likelihood of accepting an EDB contract is reflected by the label "Adopters".

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Table 5 Estimation results from the Latent Class Model (LCM)

Average membership probability:	Class 1 "Non-adopters" **63 %**	Class 2 "Adopters" **37 %**
Variables	WTA[€/LU/year]	WTA[[€/LU/year]
Bonus = 40€/LU/year	36*	30
Bonus = 80€/LU/year	-37*	-82**
Conservation breeding program	62**	17
Access to free-range area or pasture	-19	-185***
Access to free-range area or pasture + prohibition of slatted floor	67**	444***
Contract duration = 1 year	25	-80**
Contract duration = 5 years	-32	-97**
Contract duration = 10 years	200***	11
Characteristics affecting class membership	Organic farm**	Reference class

Source: own calculation

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

5 Discussion and Conclusion

Three main objectives are targeted with our study. First, we aim to assess factors affecting farmers' willingness to participate in Endangered Dairy Breed (EDB) conservation schemes. Second, we estimate farmers' willingness to accept (WTA) for EDB conservation program requirements to elicit information on costs of participation. And third, we conclude on how to design cost-effective EDB conversation programs. Three out of five contract components show a clear positive impact on farmers' participation in EDB conservation programs. A monetary incentive whether it be a compensation payment per livestock unit per year or a collective bonus seems to be a functioning stimulus. Unlike a compensation payment per farmer, a collective bonus has the potential of changing the social norm concerning endangered breed conservation and might initiate group dynamics towards increasing the whole population of that specific breed (Kuhfuss et al., 2015). Some farmers who are generally more likely to accept a contract take the risk of not achieving the goal of 5 % population growth and receiving no money without demanding a higher compensation payment. From both the RPL model and the LCM result we can conclude that EDB conservation contracts with shorter terms should be offered in order to attract farmers' willingness to join a program. Farmers' preferences for conservation contract flexibility can be confirmed by several studies (Bougherara & Ducos, 2006; Ruto & Garrod, 2009; Christensen et al., 2011; Broch and Vedel, 2012). From the results it becomes clear that requirements on keeping conditions are highly correlated with farmers' willingness to participate in an EDB conservation program. The higher the costs of implementing required measures on farm e.g. bedding cows on straw when slatted floors are prohibited, the more likely farmers reject a contract. In turn, farmers are in favor of contracts that require keeping conditions that are already applied on farm. Another important finding of this study is that breeders of endangered breeds with particular small populations (old Angler cattle and yellow cattle) have a high intrinsic motivation to join an EDB conservation program. Motivational causes like non-use and option values can be of certain relevance for farmers to be engaged in conserving a rare breed (Cicia et al., 2003). Future research should therefore elaborate more on what is behind this intrinsic motivation, an issue that was not sufficiently addressed in this study. To design cost effective EDB conservation programs

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Appendix

Table 5 Descriptive statistics

N = 160

Variable	Mean (SD)	Explanation
Age	47 (0.99)	Farmer's age
Successor	46% (50%)	Dummy: 1= Yes, succession is secured
Succession is not secured	27% (43%)	Dummy: 1= No, succession is not secured yet
Farm business	87% (34%)	Dummy: 1= Yes, farm business is the main occupation
Agricultural training	9% (29%)	Dummy: 1= Farmer has completed an agricultural training
State-certified farm manager	57% (50%)	Dummy: 1= Farmer has completed a state-certified training in agriculture
Technical college or university	21% (41%)	Dummy: 1= Farmer has a degree from s ttechnical college or university
Non-agricultural vocational training or study program	11% (32%)	Dummy: 1= Farmer has completed a non-agricultural vocational training or study program
Farm acreage	63 (53)	Hectares of arable land on farm
Pasture land	58 (126)	Hectares of pasture land on farm
Dairy cows	84 (45)	Number of dairy cows on farm
Keeping suckler cows	29 (30)	Number of suckler cows on farm
Cattle fattening	47 (62)	Number of cattle on farm
Endangered cattle breeds	99% (8%)	Dummy: 1= Yes, endangered cattle breeds are kept on the farm
	84 (85)	Number of livestock units on farm
Specific breeds		"Which breeds do you keep on your farm?"
	7.5% (26%)	Dummy: 1= Shorthorn
	11% (31%)	Dummy: 1= German Black Pied
	3.7% (19%)	Dummy: 1= Old Angler Cattle
	8.7% (28%)	Dummy: 1= DGV (Yellow cattle)
	39% (49%)	Dummy: 1= Angler
	27% (44%)	Dummy: 1= RDN (Red Dual Purpose Cattle)
Straw	31% (46%)	Dummy: 1= Animals are kept on straw
Partly slatted floor	41% (49%)	Dummy: 1= Animals are kept on partly slatted floor
Slatted floor	11% (31%)	Dummy: 1= Animals are kept on slatted floors
Access to outdoor or pasture	183 (47)	Number of days per year
Organic farm	21% (41%)	Dummy: 1= Organic farm
Direct marketing	19% (40%)	Dummy: 1= Direct marketing
Participation in conservation program	20% (40%)	Dummy: 1= Farmer receives already financial support for rare cattle breeds
Agricultural environmental schemes (AES)	30% (46%)	Dummy: 1= Participation in AES
Grazing	27% (44%)	Dummy: 1= Cattle is grazing on conservation area
Cross-compliance or other controls	2 (1.4)	Number of controls during the last 5 years

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Table 6 Descriptive statistics (continued)

Variable	Mean (SD)	Explanation
Bothering	3.2 (1.4) 1+2: 33% 4+5: 50%	"Do you feel bothered by those controls?" Likert scale: 1= yes; 2= rather yes; 3= neutral; 4: rather no; 5= no
Idealistic vs economic	3.0 (1.1) 1+2: 37.5% 4+5: 40%	"Are you keeping endangered cows for idealistic or economic reasons?" Likert scale: 1= Economic reasons; 2= rather economic reasons; 3= neutral; 4: rather idealistic reasons; 5= Idealistic reasons
Other endangered species	14% (34%)	"Are you keeping other endangered species than cattle breeds on your farm?" Dummy: 1= Yes
Other financial support	20% (40%)	"Do you receive other financial support for keeping endangered cattle breeds on your farm?" Dummy: 1= Yes

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