

Surveys

Assessing the total economic value of threatened livestock breeds in Italy: Implications for conservation policy



Kerstin K. Zander^{a,*}, Giovanni Signorello^b, Maria De Salvo^b, Gustavo Gandini^c, Adam G. Drucker^d

^a The Northern Institute, Charles Darwin University, Darwin, NT 0909, Australia

^b Department of Agrifood and Environmental Systems Management, University of Catania, Italy

^c Department VSA, Faculty of Veterinary Medicine, University of Milan, Via Celoria 10, 20133, Milan, Italy

^d Bioversity International, Via dei Tre Denari 472a, 00149 Maccaresse, Rome, Italy

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ABSTRACT

The total economic value (TEV) of two threatened Italian cattle breeds (Modicana and Maremmana) was investigated using a choice experiment survey. Most respondents (85%) support breed conservation, their stated willingness-to-pay easily justifying EU support. The high landscape maintenance, existence and future option values of both breeds (around 80% of their TEVs) suggest that incentives mechanisms are indeed needed in order to allow farmers to capture some of these public good values and hence motivate them to undertake conservation-related activities. The positive direct use values of both breeds (around 20% of their TEVs) imply that niche product markets aimed at enhancing the private good values associated with conservation could also form elements of a conservation and use strategy for these breeds.

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1. Introduction

According to the most recent State of the World's Animal Genetic Resources report Europe is home to 277 local cattle breeds (FAO, 2007a; p. 34), which is about 30% of the world's FAO-registered local cattle breeds. Worldwide 16% of cattle breeds have become extinct (FAO, 2007a) and a further 16% are at risk (critical or endangered). Despite a comprehensive inventory of cattle breeds worldwide the status of 30% of cattle breeds is still unknown. For Europe the situation appears even worse, with 27% of the cattle breeds being at risk and another 9% having an uncertain status (FAO, 2007b).

The loss of and increasing threat to such breeds can largely be attributed to changes in production systems leading to changes in breed use and crossbreeding, as well as changes in consumer preferences associated with changes in socio-economic factors (Rege and Gibson, 2003). In particular, as production systems have evolved into more intensive and commercially-oriented systems high-yielding breeds have become increasingly preferred and largely kept for their production traits. As these high-yielding breeds have increasingly replaced multipurpose traditional breeds, the associated non-direct use values of the latter have also been progressively reduced.¹ These include important non-market and public good values related to their indirect use

(e.g. traditions and culture, landscape maintenance) as well as non-use existence and future option values. The latter value is a type of insurance against unknown future change, such as climate change and disease outbreaks (Rege and Gibson, 2003).

In the presence of the significant non-market and public good values associated with agrobiodiversity, of which animal genetic resources (AnGRs) are one component, positive incentives as called for under the Convention on Biological Diversity's 2011–2020 Strategic Framework (CBD, 2011) are required in order to ensure that socially desirable levels of livestock diversity are maintained. However, as conservation funds are limited understanding the 'true' (i.e. total) economic value of different breeds and their contribution as a public good can be an important tool to support prioritisation and funding allocation (Fadlaoui et al., 2006). Understanding such values can help in the design of incentive mechanisms, including those that are based on the development of new markets to promote breed self-sustainability. Although incentive payment schemes exist under the European Union (EU) Council Regulation (EC) no. 1257/1999, Council Regulation no. 1698/2005 and Commission Regulation (EC) no. 817/2004 (European Union, 1999, 2004) for farmers rearing local traditional breeds at risk, these payments are often inadequate to cover the true financial opportunity costs of local breed farmers (Signorello and Pappalardo, 2003).

A number of studies related to the economic valuation of traditional cattle breeds have been carried out in developing countries where the livelihood functions (e.g. indirect use-values) of such breeds are particularly important. Such studies include, *inter alia*, the Borana (Zander and Drucker, 2008), the Fulani (Jabbar and Diedhiou, 2003) and Zebu breeds

* Corresponding author.

E-mail address: kerstin.zander@cdu.edu.au (K.K. Zander).

¹ Gibson and Pullin (2005) estimated that up to 90% of the value of traditional livestock breeds can be associated with their non-direct use values.

(Ruto et al., 2008; Scarpa et al., 2003). Ouma et al. (2007) and Kassie et al. (2009) have valued particular traits of local cattle breeds for breeding purposes, such as trypanotolerance, fertility and milk yield. Developed country AnGR valuation studies are more limited in number but include two in Italy related to the costs and benefits of conserving the Pentro horse (Cicia et al., 2003) and Valdostana Cattle (Giacomelli et al., 2001). Both studies have employed the contingent valuation method.

The aim of this study was to assess the total economic value (TEV) of two Italian cattle breeds, the Modicana and the Maremmana. The study was carried out within the project 'Towards self-sustainable European regional cattle breeds' (EURECA) which aimed to assess cattle breeds in eight European countries (Hiemstra et al., 2010). Two hypotheses guided our approach. We firstly hypothesise that both breeds have significantly different use and non-use values, implying that different types of conservation intervention may be appropriate. We test this hypothesis by means of a choice experiment (CE), a non-market multi-attribute valuation method which enabled us to estimate the values of the different types of benefits to society associated with the conservation of these breeds. Given that most breed valuation studies using CEs have been carried out in developing countries, it is interesting to reveal how the TEV of local breeds in Europe are made up. The second hypothesis relates to the importance of 'localness' in valuation studies. Considering findings from other valuation studies (e.g. Garrod et al., 2012; Hanley et al., 2003; Pate and Loomis, 1997; Sutherland and Walsh, 1985), we hypothesise that respondents who live closer to where the breeds are kept are willing to pay more for their conservation. To address this hypothesis we administered the CE in locations close to and more distant from where the breeds are kept. Where it can be shown that respondents from the more distant locations reveal a willingness-to-pay (WTP) for the conservation of these breeds, it may be reasonable to extend these conservation values to a wider section of Italian society. A comparative analysis of the TEV components of the two breeds and an understanding of how society's WTP for conservation activities differs between respondents also permit us to elaborate conservation policy recommendations. To support recommendations we also estimate overall conservation costs, including those currently being incurred under the EU Rural Development Plans (RDPs).

The remainder of the paper is structured as follows: the next section (Section 2) provides an outline of the economic framework of the conservation of genetic resources for food and agriculture. Section 3 describes the underlying random utility theory and the applied logit model, followed by the presentation of the results (Section 4). Discussion is undertaken in Section 5 and conclusions are highlighted in Section 6.

2. Economic Framework

Narloch et al. (2011), drawing on Swanson (1997) and Drucker and Rodriguez (2009), note that the erosion of agrobiodiversity may be seen in terms of the replacement of the diverse existing pool of local plant and animal genetic resources (PAGR) with a smaller range of specialised improved ones. Local PAGR may be expected to perform better than improved PAGR in marginal production environments which have only slightly been modified by external inputs (Bellon, 2006; Cavatassi et al., 2011). With agricultural intensification, improved PAGR (developed for productive traits under modified environments) become more productive because of their higher responsiveness to external inputs, especially in areas which are favoured in terms of agronomic potential and market access (Bellon, 2006)—see Fig. 1. For AnGRs, such replacement occurs not only by breed substitution but also by crossbreeding, thereby gradually eliminating local breeds in the process of production system changes often associated with the overall development process (Drucker and Rodriguez, 2009).

However, there are a number of reasons which suggest that such replacement is resulting in less than socially desirable levels of PAGR

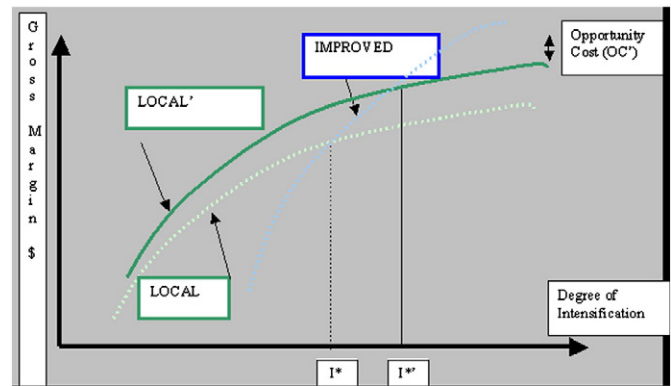


Fig. 1. Local PAGR (LOCAL curve) outperform improved PAGR (IMPROVED curve) up to a given level of production system intensity, I^* —where the term 'intensity' is used in a broad sense and includes, *inter alia*, factors related to access to markets and extension services. According to the market profitability functions represented by the dotted lines, after I^* is reached, farmers face increasing financial incentives to replace the local PAGR with improved ones. Accounting for ignored public good values would lead to an upward shift in the LOCAL PAGR curve (solid line), so that the socially optimal replacement point is in fact be to the right of I^* (at I^{**}) (adapted from Drucker and Rodriguez, 2009).

being maintained, in particular as a result of the fact that significant non-market and/or public good values associated with conservation services have been ignored. At the landscape level, these non-market values relate to the public good role of agrobiodiversity use in, for instance, supporting agroecosystem resilience (e.g. Hajjar et al., 2008), evolutionary processes, gene flow and global option values, as well as maintaining traditions and culture (e.g. Bellon, 2009). Ignored values also include private good characteristics, unrelated to direct use values associated with production outputs but instead associated with the use of agrobiodiversity to minimise farm-level risks related to external shocks, such as climatic events and disease outbreaks (e.g. Di Falco and Chavas, 2009).²

In general, Fig. 1 suggests that farmers will need to be compensated for their financial opportunity costs of continuing to maintain socially desirable levels of local PAGR (also see Krishna et al., 2013). Associated incentive mechanisms to permit the 'capture' of the total economic values arising from the maintenance of local PAGR would have the effect of shifting the dotted curve for local PAGR upwards to the left. Such mechanisms could include support payments such as those under the RDPs, as well as enhancing private values through niche market and value chain development for products and services associated with local PAGR.

Within this conceptual context it becomes apparent that an understanding of non-market and public good values is important from a conservation policy perspective. Accounting for such values within a TEV framework permits us to determine, *inter alia*, whether the benefits of intervention outweigh the costs, and what the appropriate intervention strategies are, including for cases where PAGR conservation priorities have little or no current market development potential. We consequently apply such a framework (Bateman et al., 2004; Pearce and Moran, 1994), classifying such values into use and non-use values. In the context of the multiple values that can be associated with European traditional cattle breeds, it is also possible to identify their relevance to different types of stakeholders and the stakeholder's willingness to pay for the different types of environmental service provided by these local cattle breeds. Direct use values can be linked with livestock production outputs, such as milk and meat production, and are of relevance to farmers and consumers of these products (see Table 1). These values

² Narloch et al. (2011) also go on to identify market failures (e.g. externalisation of environmental impacts) leading to an overestimation of the performance of improved PAGR, as well as important intervention failures (e.g. capital subsidies, support prices) that increase the financial profitability of improved PAGR.

Table 1
Attributes and levels used in the choice experiment.

Attribute ^a	TEV component	Levels	Levels ^b (coding)
Quality of the breed-related special food products	Direct use value (production value)	2	Average (–1), Superior (1)
Maintenance of breed-related rural culture	Non-use value (cultural value)	3	Declining (–1), Stable (0), Improving (1)
Maintenance of breed-related rural landscape	Indirect use value (landscape value)	3	Declining (–1), Stable (0), Improving (1)
Possibility to re-establish the breed should it turn out to be important in the future and no live animals remain	Option value	2	Low (–1), High (1)
Certainty of the continued existence of live animals over the next 50 years	Existence value	3	10% (–1), 50% (0), 90% (1)
One-off contribution to a conservation programme (€)		5	0, 10, 25, 50, 100

^a The variables names as used in the model are in parentheses.

^b Underlined levels indicate the status-quo reference levels.

are generally straightforward to assess because the animals and their products are traded in markets. Indirect use values, such as cultural and landscape maintenance values are likely to be of more relevance to local residents and visitors to the local area. Non-use existence and bequest values, associated with the satisfaction that people have from simply knowing that a breed exists now and for future generations, may be of greater relevance to people from more distant cities who have never seen the cattle but nevertheless assign a value to them. Option values are likely to be of relevance to all of these stakeholders.

Assessing the components of TEV requires the use of stated preference techniques, such as the CE approach. The stated values are expressed by respondent's willingness-to-accept (WTA) compensation for changes in breed status and related ecosystem service provision. WTP and WTA are referred to as welfare estimates and their net sum equals the TEV resulting from the change in the provision of an environmental good, such as that arising from a change in conservation policy.

3. Methods

Two Italian cattle breeds that formed part of the aforementioned EURECA project were selected for this case study: the Maremmana and Modicana breeds. These two breed were chosen to compare and contrast their respective TEVs (hypothesis 1) because of the great differences in their socio-economic and cultural roles. Both breeds are considered to be threatened under EU regulations.³ Although the Maremmana and Modicana cattle populations are not as low as that of other threatened Italian cattle breeds, their current negative population trends are a cause of major concern, threatening opportunities for breed self-sufficiency through sustainable use of the resource (Hiemstra et al., 2010).

At the beginning of the last century Maremmana cattle herds were a distinguishing feature of the marshy malarial zones of Central Italy. In 1940 there were 150,000 breeding females but by 1983 this had declined to 20,000 (CNR, 1983). Although the breeding female population has been stable at around 5000 head since 2006 it is expected to decline over the coming years because of a reduction of young females reared for replacement (ANABIC, 2011). Today this breed is kept mainly for meat production in the open-pasture systems of the harsh bush habitat of the Mediterranean that it originally evolved in, confined to a limited area of the Lazio and Tuscany regions (Fig. 2). Some of the unique characteristics of the Maremmana include the high quality of its meat and the breed's use in cultural events, for example involving the branding of young cattle by horse-riding cowboys. The breed is also important for maintaining the characteristic Maremma landscape in Tuscany consisting of patchy areas of grasslands and bush fragmented by corrals. The breed, with its long lyre-shaped horns, is synonymous with the cowboys and the Mediterranean bush (Bigi and Zanon, 2008).

The Modicana is the most important local cattle breed of Sicily. The area of origin of the Modicana is the county of Modica, in the province of Ragusa (Mason, 1996; MiPAF, 2005). In 1983 the breed had approximately 170,000 breeding females but by 1994 this figure had declined dramatically to 16,000 (FAO, 2011). In 2008 the population was estimated to be between 2115⁴ and 2567 (MiPAF, 2008), mainly kept for milk production. A particular characteristic associated with the breed is the traditional Caciocavallo and Ragusano cheeses made from its milk. The Modicana breed is not considered to play an important cultural role in its area of occurrence, unlike the Maremmana breed. Kept in semi-extensive farming systems with summer pastures it has, however, great relevance for the landscape and its maintenance (Gandini and Villa, 2003). Being considered threatened in terms of EU regulations, both breeds receive support equivalent to €200 per head per year from the EU under the RDPs of Tuscany, Lazio and Sicily.

3.1. The Choice Experimental Design

In a CE, respondents are presented with a series of choice tasks, known as choice sets, each containing a finite number of options which describe the environmental good or policy outcome in question (Hanley et al., 2001; Hensher et al., 2005). The options vary in their level of attributes and respondents are usually asked to choose their most preferred option. By making this choice respondents trade-off the attributes and the associated costs that come with the chosen option. A key component of the experiment is the definition of attributes used in the choice experimental design. The attributes and levels for this study (Table 1) were determined in consultation with Italian cattle experts and the design was pre-tested before the main survey started. Each attribute represents a component of the TEV so that the sum of the separate attribute values may be used as a proxy for the breed's TEV (see Section 2). As a monetary value, which is required for the calculation of welfare estimates, we selected a one-off donation (in €) to a conservation programme for the cattle breed in question. The use of one-off payment vehicles described as donations are common when evaluating environmental goods and services through respondents' stated preferences (e.g. Kragt and Bennett, 2011; Veríssimo et al., 2009). We opted against the use of an annual contribution, which is also frequently used as a payment vehicle in environmental CEs (e.g. Morse-Jones et al., 2012; Zander, 2013) because respondents then need to think for how long they might keep paying (Zander, 2013). This makes the options in the CE more realistic and the choice tasks cognitively easier to process. To infer potential annual payments for the purpose of cattle breed conservation, we then assumed that the same amount can be collected as donations from the Italian society every year.

³ Taking into account breed population dynamics, the EU uses a threat threshold of 7500 breeding females, which is higher than that of the FAO (European Union, 2004).

⁴ For the sake of simplicity, we use this lower figure for the remainder of the analysis in this paper.



Fig. 2. Distribution of case study breeds in Italy.

We used a generic design and each choice set consisted of three options out of which respondents were asked to name their most preferred. One of the options was always a status-quo (SQ) option, while two others represented different scenarios under a breed conservation programme (Fig. 3). The SQ option did not include a personal cost for respondents and can be interpreted as describing the consequences of decreasing animal numbers. The other two scenarios involved a one-off contribution towards a conservation programme for the breed in question and would result in benefits associated with an increase in animal numbers (or at least not a decline). Given the number of attributes and their levels (Table 1), there would have been too many possibilities ($2^2 * 3^3 * 5^1 = 540$) to use all of them in the survey and hence a CE was designed which only included a fraction of these combinations. An important issue in experimental design is to 'identify efficient designs that can deliver statistically significant roles of attributes for a given sample size'⁵ (Rose and Bliemer, 2008). Given our sample size of 100 respondents per sub-sample and our chosen attributes and levels we obtained a Bayesian efficient design (see Ferrini and Scarpa, 2007; Sándor and Wedel, 2001) containing 12 choice sets using the software Ngene (Institute of Transport and Logistics Studies, 2007). The design was based on prior parameter estimates that we assumed after expert consultation when designing the experiment. While we did not know the exact values of the priors we were quite certain about the expected signs. Using prior parameter estimates leads to more reliable parameter estimates for a given sample size, even if the information on the parameters is scant and the priors misspecified (Bliemer et al., 2009). The 12 sets were blocked into two versions with six sets each. Each respondent was presented with one of the two versions.

⁵ Efficient designs 'pursue the minimum predicted standard errors of the parameter estimates' (Hoyos, 2010). There are different efficiency criteria and our design aimed to minimise the D-error, the most widely used efficiency measure (Street et al., 2005).

3.2. Survey Administration

Adult respondents were interviewed in two locations for each breed: in Ragusa and Catania (Modicana breed) and in Grosseto and Florence (Maremmana breed). Ragusa (adult human population = 61,500; Istat, 2011) and Grosseto (70,000) are towns situated in the area in which the two cattle breeds are respectively kept, and in which we expected respondents to have a fair knowledge of the breed. Catania (240,000) and Florence (319,000), the provincial capitals, are the most populous cities near to the two locations. The interviews were administered in Italian by trained enumerators using a Microsoft Powerpoint presentation on a laptop. Respondents were selected following simple probability sampling. In both Catania and Ragusa (Modicana breed) 104 respondents were interviewed and 100 respondents in both Florence and Grosseto (Maremmana breed).

3.3. Questionnaire

The questionnaire consisted of five parts and was tailored for each breed. In the introductory part we provided a short general background on the different uses of the local cattle breeds, the degree of threat faced as a result of their declining numbers and the possibility of supporting a conservation programme. In the second part respondents were asked about their degree of breed knowledge, whether they had ever heard about the breed, seen it or eaten its products. A description of the breed, including pictures, its main characteristics, geographical occurrence and population status was then given to make sure every respondent had sufficient knowledge of the breed to reliably assess it in the choice tasks. The third part contained the choice questions with a detailed description of the attributes. When introducing the payment mechanism we emphasised that respondents should consider that: 1) bringing about good conservation outcomes costs money; 2) the breed is not the only breed that may require support; 3) there are other good causes that the respondents may wish to support; and 4) that respondents had limited income and needed to consider this cost in light of their other expenses. The fourth part included follow-up questions to determine respondents' motivations for their choices and in the last part we asked questions related to household data such as age, education, income, household size and employment status.

3.4. Data Analysis

CEs are based on random utility theory (Luce, 1959; McFadden, 1974) and the characteristics theory of value (Lancaster, 1966). There are different econometric approaches to analyse choice data. The conditional logit (CL) model has often been applied because of its simplicity and closed-form model specification. It has some limitations, however, the main one being strict assumptions made about the error term. This assumption postulates that preferences are supposed to be the same across respondents. In practice this is not a realistic assumption and other more flexible models have been developed. Mixed logit (MXL) models have largely replaced CL models over the last fifteen years for analysing choice data. MXL models are able to account for panel-data, such as those obtained in this study with each respondent answering a series of choice questions, allowing unobserved preference heterogeneity across individuals to be considered (see e.g. Hensher and Greene (2003) for detailed MXL model specifications).

It has recently been argued that it is unclear if this heterogeneity is due to preference (taste) or due to the scale (e.g. Louviere and Meyer, 2008; Louviere et al., 2002). Scale heterogeneity can arise as an artefact of the survey because, for instance, people may have different choice task processing strategies or different degrees of understanding of the choice tasks (e.g. Breffle and Morey, 2000; Christie and Gibbons, 2011; Fiebig et al., 2010). In MXL models scale and preference heterogeneity cannot be separated but the

ability to separate them is important to understand the real preference heterogeneity and allow specific market or consumer groups to be identified. Alternative models such as the scaled multinomial logit (S-MNL) model (Brefle and Morey, 2000), the generalised multinomial logit (G-MNL) model (Fiebig et al., 2010; Keane, 2006) and the WTP-space (WTP-S) model (Train and Weeks, 2005) have been proposed. The last two can model heterogeneity due to both individuals' preferences and to scale (Fiebig et al., 2010). The WTP-S model, as shown by Greene and Hensher (2010), is a special case of the G-MNL model, and has recently seen increasing acceptance when the objective of the CE is to obtain welfare estimates (e.g. Hole and Kolstad, 2012; Scarpa et al., 2008, 2012; Zanolì et al., 2013). Welfare estimates in a WTP-S model can be obtained at the estimation stage and do not need to be derived through simulations and are therefore more stable (Balcombe et al., 2009). Given the above we therefore explored four models for each breed: MXL, S-MNL, G-MNL and WTP-S. In order to account for observed heterogeneity, i.e. investigating why respondents have different preferences (Boxall and Adamowicz, 2002), we included interactions between socio-demographic variables and the attributes as well as between socio-demographic variables and the alternative specific constant for the SQ option.

All categorical attributes were effects coded apart from the numerical attribute 'one-off contribution' which was linear coded (Louviere et al., 2000). We used effects coding rather than dummy coding because effects coded variables are uncorrelated with the grand mean or intercept of the choice model (Hensher et al., 2005; Louviere et al., 2000) and hence allow the calculation of WTP measures for all levels, including the reference levels (Adamowicz et al., 1994; Hensher et al., 2005). The reference level is constrained to be the negative sum of the other levels (Hensher et al., 2005). For attributes with three levels (see Table 1) the reference levels were the ones of the SQ option, i.e. 'Declining maintenance of rural landscape', 'Declining maintenance of rural culture' and '10% certainty of continued existence'.

Welfare estimates from the MXL model results were calculated by using simulation. The simulated distributions were obtained by dividing draws from the distributions of the attribute coefficients by draws from the distributions of the coefficient of the monetary attribute. 10,000 draws were used in these calculations. Because the attributes were effects coded, the estimated WTP estimates have to be multiplied by two (Bech and Gyrd-Hansen, 2005).

4. Results

4.1. Respondents' Characteristics

The gender-ratio of the respondents was roughly equal and respondents were from all age groups, income and educational categories (Table 2). The majority of respondents had heard about the breed in question although there was a big discrepancy between respondents from the two locations assessing the Modicana breed: nearly all (95%) respondents in Ragusa had heard about the breed but only half in Catania. For the Maremmana breed, the high share of respondents having heard about the breed was similar in the two research locations. Fewer people had seen the breeds than heard about them (74% had seen the Modicana breed while this was true for only about half of the respondents for the Maremmana breed). Eighty-eight percent of respondents for the Modicana breed stated that they had eaten its products, while only 67% of respondents had done so for the Maremmana breed. For both breeds, the self-rated score for breed knowledge (on a scale from 1 to 10, with 10 representing perfect knowledge) ranged between 4 and 7 for about 75% of respondents.

4.2. Results of the Choice Experiment

In 27% of the choice sets a respondent chose not to pay (the SQ option) for the Maremmana breed, while this figure was much lower



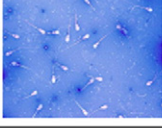


Attribute of the conservation programme		Option 1	Option 2	Status-quo option
Maintenance of breed-related special food products		Yes	No	No
Maintenance of breed-related rural landscape		Stable	Stable	Declining
Possibility to re-establish the breed in case of extinction		High	Low	Low
Certainty of the continued existence of live animals over the next 50 years		50 %	10 %	10 %
One-off contribution to the conservation programme (€uro)		100	10	0

Fig. 3. Example of choice set for the Modicana breed.

Table 2
Respondents' characteristics by research location.

	Modicana breed			Maremma breed		
	All	Ragusa	Catania	All	Grosseto	Florence
Number of respondents	208	108	100	200	100	100
Female respondents	52%	53%	51%	50%	50%	49%
Level of education ^a						
Primary school	7%	4%	10%	8%	9%	7%
Secondary school	18%	11%	26%	22%	20%	23%
High school	40%	40%	41%	37%	37%	37%
Diploma or certificate	10%	12%	7%	1%	0%	1%
University	25%	33%	16%	29%	31%	26%
Age category						
18–30	23%	24%	22%	18%	18%	18%
31–45	28%	28%	28%	31%	30%	31%
46–60	22%	20%	24%	24%	24%	23%
61–7530	18%	19%	17%	18%	18%	18%
> 75	9%	8%	9%	10%	10%	10%
Income category (€ per year)						
<6000	1%	1%	2%	4%	4%	3%
6000–14,999	16%	6%	27%	16%	17%	14%
15,000–24,999	34%	24%	45%	24%	25%	22%
25,000–49,999	32%	39%	24%	47%	45%	48%
50,000–69,999	10%	17%	2%	10%	8%	11%
70,000–99,999	5%	10%	0%	1%	0%	2%
> 100,000	1%	3%	0%	1%	1%	0%
Level of breed knowledge ^a (1 = poor; 10 = perfect) ("KNOW")						
1–3	7%	2%	12%	13%	6%	20%
4–7	73%	79%	66%	77%	83%	70%
8–10	20%	19%	21%	10%	11%	9%
Respondents who have heard about breed ("HEARD")	72%	95%	50%	89%	94%	84%
Respondents who have seen breed ("SEEN")	74%	87%	61%	52%	61%	43%
Respondents who have eaten breed-related products ("EATEN")	88%	82%	94%	67%	80%	53%

^a Existence of missing answers means numbers do not sum up to 100%.

Table 3
Choice model results for the Maremma breed (N = 200).

Attributes	MXL			S-MNL			G-MNL			WTP-S		
	Estimate	SE	SD	Estimate	SE	SD	Estimate	SE	SD	Estimate	SE	SD
Superior quality food	1.202***	0.181	0.994***	1.570*	0.860		1.068***	0.153	0.756***	20.90***	2.84	15.05***
Stable maintenance of rural landscape	0.613***	0.188	0.852***	1.028	0.649		0.582***	0.182	0.757***	16.63***	3.84	13.86***
Improved maintenance of rural landscape	1.575***	0.344	0.702***	1.988*	1.085		1.314***	0.311	0.786***	17.58***	6.17	3.24
Stable maintenance of rural culture	0.459**	0.199	0.329*	0.811*	0.480		0.736**	0.203	0.628***	7.12	6.41	14.18***
Improved maintenance of rural culture	0.728**	0.355	0.817***	1.443*	0.799		0.542***	0.322	0.305	12.96***	4.56	4.41
50% certainty of continued existence	-0.591	0.292	1.252***	-0.566	0.660		-0.317	0.275	1.235***	6.65	5.61	10.55**
90% certainty of continued existence	1.616***	0.289	1.080***	1.603*	0.896		1.354***	0.240	0.814***	22.30***	6.91	43.67***
High ability for future use	0.727***	0.179	0.636***	1.140*	0.608		0.720***	0.160	0.511***	12.70***	3.25	8.62***
One-off contribution	-0.080***	0.009	0.080***	-0.076**	0.037		-0.071***	0.007	0.071***			
<i>Non-random parameters</i>												
SQ constant	3.651***	0.490		6.250**	3.027		3.325***	0.416		3.341***	0.409	
FLORENCE * Superior quality food	-0.421**	0.193		-0.596	0.402		0.424**	0.180		-0.366**	0.170	
FLORENCE * Future use	-0.518***	0.184		-0.66	0.455		-0.436***	0.152		-0.492***	0.171	
SEEN * Future use	0.492***	0.172		-0.031	0.127		0.320**	0.154		0.257*	0.148	
KNOW * Improved maintenance of rural culture	0.125**	0.052		0.097*	0.053		0.098**	0.043		0.111**	0.045	
FLORENCE * SQ	-1.024**	0.421		-1.443	0.982		-0.753**	0.363		-1.155***	0.398	
<i>Model fit</i>												
Scale parameter				1.380***	0.320		0.182***	0.051		0.001	0.164	
Sigma				0.837	1.254		0.985***	0.189		0.995***	0.071	
Log likelihood	-900.3			-1014.2			-904.7			-931.4		
R ²	0.31			0.23			0.31			0.29		
AIC	1846.7			2060.5			1857.3			1910.9		
Number of observations	1194 ^a			1194 ^a			1194 ^a			1194 ^a		

SQ = Status-quo; SD = Standard deviation of random parameters; SE = Standard error.

^a Six observations were missing because one respondent did not state the degree of breed knowledge.

*** 1% significance level.

** 5% significance level.

* 10% significance level.

for the Modicana breed (2%). Model results for the Maremma breed are presented in Table 3 and those for the Modicana breed in Table 4. In all models with random parameters, the coefficients for the attributes were given a normal distribution and the coefficient of the cost attribute was assumed to have a constrained triangular distribution. We used 200 Halton draws in the estimates of the models with random parameters. For both breeds, the WTP-S and MXL models outperformed the S-MNL and G-MNL models. The S-MNL models which account for scale heterogeneity only did not fit the data as well as the other three models. This leads us to conclude that there is preference heterogeneity across the sample. For both breeds, the model fit of the MXL model and the WTP-S model differed minimally, a result also found in Hole and Kolstad (2012). For most models, the scale parameter was significant but not very high, indicating that a low level of scale heterogeneity across respondents existed. The scale parameters were much lower in the S-MNL than in the G-MNL models.

The coefficients of the monetary attribute were, as expected *a priori*, significant and negative in all models for both breeds. This implied that respondents preferred to pay less for an option, all else being equal. The coefficients of all other attributes also had the expected signs although not all coefficients were significant. The estimates were fairly consistent across all models in terms of significance and sign although the WTP-S models showed insignificant coefficients whereas they were significant in the MXL models. All else being equal, respondents preferred those levels of the attributes that described improvements due to conservation efforts. For the Modicana breed the attributes 'stable maintenance of rural landscape' and '50% certainty of continued existence' were insignificant across all models, signifying that respondents were indifferent towards these attributes relative to the levels of the SQ option. For both breeds, the standard deviations were significant and large relative to the mean for most random parameters, implying that there was a substantial amount of heterogeneity in the preferences for these attributes, although the reason for this preference variation is unknown.

In order to explain the source of preference heterogeneity across respondents, commonly used demographic parameters such as income,

Table 4
Choice model results for the Modicana breed (N = 200).

Attributes	MXL			S-MNL		G-MNL			WTP-S		
	Estimate	SE	SD	Estimate	SE	Estimate	SE	SD	Estimate	SE	SD
Superior quality food	0.547***	0.071	0.449***	0.339***	0.058	0.571***	0.087	0.532***	20.16***	3.19	18.72***
Stable maintenance of rural landscape	0.172	0.158	0.406**	−0.028	0.126	0.149	0.193	0.349	−14.40	9.89	3.80
Improved maintenance of rural landscape	0.760***	0.173	0.241	0.532***	0.138	0.820***	0.223	0.482**	33.66***	12.08	30.20***
50% certainty of continued existence	0.003	0.095	0.059	−0.057	0.075	0.008	0.123	0.123	−3.28	4.22	12.04
90% certainty of continued existence	1.984***	0.324	1.714***	1.111***	0.421	2.013***	0.376	1.771***	16.33*	10.88	21.28**
High ability for future use	0.521***	0.072	0.482***	0.289***	0.058	0.572***	0.089	0.520***	19.94***	2.62	27.33***
One-off contribution	−0.039***	0.005	0.039***	−0.022***	0.006	−0.041***	0.006	0.041***			
<i>Non-random parameters</i>											
SQ constant	−4.016***	0.462		−5.280***	1.784	−4.165***	0.592		−7.320**	2.869	
RAGUSA × Improved maintenance of rural landscape	0.416**	0.170		0.346***	0.118	0.455**	0.194		0.280***	0.097	
<i>Model fit</i>											
Scale parameter				0.574***	0.162	0.148	0.333		1.744***	0.277	
Sigma				0.962*	0.540	1.001***	0.146		0.876	2.097	
Log likelihood	−768.9			−827.7		−764.0			−783.6		
R ²	0.44			0.40		0.44			0.44		
AIC	1567.8			1675.3		1560.0			1599.1		
Number of observations	1248			1248		1248			1248		
Number of respondents	200			200		200			200		

SQ = Status-quo; SD = Standard deviation of random parameters; SE = Standard error.

*** 1% significance level.

** 5% significance level.

* 10% significance level.

education, age and gender were tested but very few had significant impacts on preferences for the attributes or for the choice of the SQ option. The research location (nearby town versus distant city) and some of the attitudinal parameters were found to have the largest impacts. Three of the four models for the Maremmana breed (Table 3) showed that the research location had a significant impact on the preference for two attributes: respondents in Florence (distant city) were less likely to choose an option with 'superior quality food' or 'high ability for future use' than respondents in Grosseto (nearby town). Regarding parameters measuring respondents' degree of breed knowledge and experience only two had significant impact on attribute preferences. Respondents who have seen ('SEEN') the Maremmana breed were more likely to choose an option with 'high ability for future use'. The higher the score respondents assigned themselves for their breed knowledge ('KNOW'), the more likely they were to have chosen an option with 'improved maintenance of rural culture'. Respondents in Florence were furthermore likely to contribute to a breed conservation programme in general, i.e. were less likely to choose the SQ. For the Modicana breed, all models (Table 4) showed that the research location had a significant impact on the preference for the landscape attribute: respondents in Ragusa (nearby town) were more likely to choose options with 'improved maintenance of rural landscape' than respondents in Catania (distant city). No other respondents' attitudinal or demographic characteristics were found to have a significant impact upon either the choice for the attributes or the SQ option in the Modicana CE. The result regarding the research location partly supports our second hypothesis that 'localness' matters for a person's WTP and that respondents who live closer to where the breeds are kept are willing to pay more for certain attributes. However, the fact that respondents in Florence were more likely to contribute to breed conservation in general is inconsistent with this hypothesis.

The scale parameters in the G-MNL and WTP-S models for the Maremmana breed were significant, suggesting the existence of heterogeneity across respondents due to the scale and not due to individuals' preference heterogeneity. The interaction terms were also significant in these two models, giving evidence for both scale and preference heterogeneity. For the Modicana breed, the scale parameter of the G-MNL model was insignificant while the interaction term explaining the preference heterogeneity was significant, implying that heterogeneity is not due to scale. As in the case of the Maremmana

breed the WTP-S model for the Modicana breed showed both significant scale and preference heterogeneity.

For both breeds welfare estimates were derived from the two best fitting models: the MXL model (estimation in preference space) and the WTP-S model (estimation in WTP space). For the Maremmana breed, welfare estimates from both models were fairly consistent, only those of 'Improved maintenance of rural landscape' and '90% certainty of continued existence' were about twice as high as those estimates derived from the WTP-S model (Table 5). This finding is in line with Hole and Kolstad (2012), who reported consistently higher welfare estimates from a MXL model than from a WTP-S model. For the Modicana breed, the estimates derived from the MXL model were also slightly higher than those derived from the WTP-S model. The largest difference was found for a '90% certainty of continued existence' (€104 compared to €16). Only considering the estimates from the WTP-S models, respondents were willing to pay about the same for both breeds for the attributes 'Superior quality food', '90% certainty of continued existence' and 'High ability for future use' while they were willing to pay about twice as much for 'Improved maintenance of rural landscape' of the Modicana breed than of the Maremmana breed.

4.3. The Total Economic Value

The TEV of breed conservation was calculated by the sum of values of the highest levels of the attributes (see Table 1) which were obtained from the WTP-S models. The TEV of a conservation programme was about the same for both breeds (€90 for the Modicana,⁶ €91 for the Maremmana⁷). For the Maremmana breed, all components of the TEV had equal value, with the cultural value and the option value relatively

⁶ The TEV was calculated by: €20 (direct use: superior quality food) + €34 (indirect use: improved maintenance of rural landscape) + €16 (existence value: 90% chance of existence) + €20 (future option value: high ability for future use) = €90.

⁷ The TEV was calculated by: €21 (direct use: superior quality food) + €18 (indirect use: improved maintenance of rural landscape) + €17 (indirect use, improved maintenance of rural culture) + €22 (existence value: 90% chance of existence) + €13 (future option value: high ability for future use) = €91.

Table 5
Welfare estimates (€) for benefits of two threatened Italian cattle breed conservation programmes, derived from two models: mixed logit (MXL) and willingness-to-pay in space (WTP-S) model.

Attributes	Maremmana breed				Modicana breed			
	MXL		WTP-S		MXL		WTP-S	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Superior quality food	32	14–46	21	15–26	28	12–44	20	14–26
Improved maintenance of rural landscape	40	28–52	18	9–24	40	30–48	34	10–57
Stable maintenance of rural landscape	16	2–30	17	5–30	Not significant		Not significant	
Improved maintenance of rural culture	18	4–3	13	4–22	N/A		N/A	
Stable maintenance of rural culture	12	6–18	Not significant		N/A		N/A	
90% certainty of continued existence	40	22–58	22	9–36	104	42–162	16	11–21
50% certainty of continued existence	Not significant		Not significant		Not significant		Not significant	
High ability for future use	18	8–28	13	6–19	28	10–44	20	15–25

lower with shares of 15% of the TEV (Fig. 4). The shares of the direct use value of the TEV were about the same for both breeds (22%–23%) while the share of the existence value was higher for the Maremmana (24%) than for the Modicana breed (18%) and the share of the option value was higher for the Modicana (22%) than the Maremmana breed (15%). The highest share of the TEV of the Modicana breed conservation was assigned to the landscape/recreational value (38%) while the other three values had similar shares of the TEV. For both breeds the sum of the indirect use values was very similar (31% and 34% of the TEVs). The value without direct use was the same for both breeds (€70). Given the similarities in the shares of the TEV components and the same TEV, our first hypothesis that the breeds have significantly different use and non-use values cannot be confirmed.

4.4. Potential Policy Implications for Conservation Investment

Significant non-market values associated with the provision of public goods services (e.g. traditions and culture, landscape maintenance, existence and future option values) may be associated with the maintenance of traditional livestock breeds. Given that farmers may not be able to afford to maintain such breeds for the generation of such public goods for wider society, the development of incentive mechanisms to allow farmers to capture some of those public good values may be justified, as called for by the CBD 2011–2020 Strategic Framework. For both breeds these public good values were indeed significant, with about 80% of the TEV (see Fig. 4) that the Italian public placed on such breeds (totalling approximately €1.1 m for the Modicana⁸ and €1.4 for the Maremmana⁹ on an annualised basis, using a 5% discount rate) being unrelated to their direct use values. Thus the loss of these breeds (even where total meat/milk production remains unchanged by using an alternative breed) nevertheless can imply the loss of significant public good values.

Based on current support levels, the implied total disbursement costs were €423,000 (€200 × 2115 females) per year for the Modicana and €1.16 m (€200 × 5800 females) per year for the Maremmana.¹⁰ While these sums are large, especially if incurred over long time scales (the payment scheme for the Modicana started in 1998 and that for the Maremmana in 1996), they were economically justified relative to society's WTP (with support costs reaching only 26% to 72% of the stated

public good benefits¹¹). Current EU costs were equivalent to just €1.71 per person p.a. in Catania and Ragusa (€423,000/301,000 people), and €2.98 per person p.a. in Florence and Grosseto (€1.16 m/388,700 people).

5. Discussion

Respondents place the same TEV on both breeds (€90/€91) and also on certain TEV components such as the direct use value (€20/€21) and indirect use values (€70/€66). For the Maremmana breed, the highest values are placed on the production/direct use (€21) and existence (€22) values, while indirect use (landscape €17) and option (€13) values are less important. The fact that the indirect use value is very similar across both breeds, although the Modicana breed is not associated with cultural values, suggests that respondents may compensate for the lack of a cultural value by assigning higher value to its landscape value (which can also be construed as a form of cultural value). The importance placed on the existence value is neither affected by the respondents' level of knowledge and experience with the breeds, nor by the distance to the area where the breeds occur. This means that it might be reasonable to expect that respondents from the cities who possibly have never seen the breeds and never will in the future would be willing to support a conservation programme for the benefit of knowing that the breeds continue to exist in 50 years.

Respondents in Ragusa (nearby town) are more likely to choose options with 'improved maintenance of rural landscape' for the Modicana breed than respondents in Catania (distant city), confirming similar findings by other environmental valuation studies (e.g. Garrod et al., 2012; Pate and Loomis, 1997; Sutherland and Walsh, 1985). For the Maremmana breed 'localness' has a positive impact on the direct use value and the option value while, for the general willingness to support a conservation programme, this nearby town vs. distant city dichotomy is reversed. Hence we cannot fully support our hypothesis that respondents who lived close to the breeds are willing to contribute more to their conservation than respondents from distant cities but the findings do suggest that AnGR conservation values may in some cases be held by wider sections of Italian society.

The current EU support payments might underestimate both the true costs of supporting a breed population close to the risk threshold (i.e. support being paid for 7500 females rather than the 2115–5800 animals currently supported), as well as the true farmer-level opportunity costs. According to RDP's own calculations, the opportunity cost of maintaining the Modicana (as opposed to a mainstream breed) is €425 and for the Maremmana €376 (Regione Lazio, 2011; Regione Sicilia, 2010; Regione Toscana, 2011). Under their respective RDPs, however, a

⁸ Modicana annualised non-direct use values = €70 × 301,000 people × 0.05 discount rate.

⁹ Maremmana annualised non-direct use values = €70 × 388,700 people × 0.05 discount rate.

¹⁰ These are lower-bound estimates of the operational costs of the RDP support programmes as not only the breeding females receive support. But as breeding females constitute the vast majority of the total herd size this estimate may be expected to provide a reasonable approximation of the total costs.

¹¹ Even if support were to be provided to a risk threshold goal of 7500 animals the total costs of €1.5 m (i.e. 7500 × €200) would still be broadly similar to the benefits identified through the stated WTP.

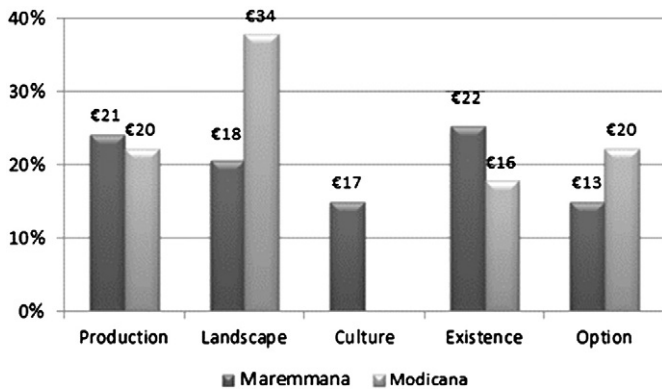


Fig. 4. Distribution of TEV components for case study breeds.

support payment of only €200 per livestock head is paid. The difference between these payments and farmer-level opportunity costs suggest that in order for such support to be capable of raising the breed populations above the risk threshold or at least ensuring that the components of its TEV (i.e. quality food products, landscape and cultural maintenance, existence and option values) continue to be supplied it must be assumed that a large proportion of the remaining opportunity costs will be covered by the non-market values that farmers hold for these breeds. These may include insurance functions as well as strong cultural or 'hobby' farmer preferences.

Should further research reveal that such non-market farmer preferences combined with current RDP support levels are in fact insufficient to provide adequate incentives to raise breed numbers above the official threat threshold (which seems likely given the currently low breed numbers despite well over a decade of RDP support) it will be necessary to consider ways how to increase the return farmers can obtain from maintaining these breeds. In this context a number of factors are worth noting.

First of all, strategies for funding the outstanding opportunity costs of farmers could be identified based on the relative values of the individual components of TEV of each breed. The combined existence and future option values of both breeds account for slightly more than 50% of their TEVs, suggesting that conservation support should be continued as farmers are not compensated by the market to maintain these public good values. The direct use values, which account for 20% of the TEV of both breeds, suggest that niche product market development may be a viable option for providing at least co-funding for the continued maintenance of the breed. One way to increase financial support for farmers are price premiums associated with the breeds' special food products. If farmers are able to derive higher returns through niche product market development (e.g. e-commerce and cooperatives) resulting in private good enhancement then they will be less likely to abandon these breeds. Based on the positive attitude towards the attribute 'superior quality food', consumers might well accept premium prices if some of the product cost is advertised (environmental labelling) as being dedicated to supporting the breeds' conservation (Aguilar and Cai, 2010; Rappole et al., 2003). The Maremmana breed's premium food products are valued most by residents in the area where the breed is kept, suggesting that respondents from the distant city may not be fully aware of these products or if they are they may not have had the chance to taste them. To be effective, marketing strategies for the special products must extend beyond the rural areas where the breed's products are well known. However, given that 80% of respondents stated that they have indeed eaten special breed-related products of the respective breeds (Table 2) the marketing of premium products would potentially be a promising element in any strategy for financing breed conservation. Labelling the breed-related products to highlight that a proportion of the price is used to support the breed's conservation could potentially

allow producers to charge such a premium price. In fact, premium products, cheese for the Modicana breed and meat for the Maremmana breed, are already increasingly being sold. The average price of Ragusano cheese is approximately €15 per pound and Caciocavall cheese €10 per pound (both produced from Modicana milk). Over the last 2–3 years Maremmana breeders have been building a quite profitable niche market for the breed's meat (direct farm sales, formation of cooperatives to facilitate economies of scale in meat sales, etc.). Maremmana beef is sold both on-farm and in some gourmet shops for approximately €8 per pound. The cultural value of the Maremmana (15% of TEV) also suggests that such a strategy could be combined with a complementary agritourism development funding strategy. The breed is traditionally kept close to the sea and close to historical sites of great interest to tourists (Tuscany, Lazio). Funds could be invested to help farmers to maintain/restore cultural aspects related to traditional farming practices (e.g. restoring traditional corrals, holding fairs, etc.) and to attract tourists to farms. Such an approach would, however, need to be implemented in a way that is not perceived by key stakeholders as reducing the breed to a 'zoo' animal. Both breeds also have potential to generate income from agritourism: for the Maremmana breeds through a combination of its landscape and cultural values; for the Modicana breed through its landscape value which is almost twice that of the Maremmana breed. However, the landscape value of the Modicana breed is highest for those living in the area so its potential to attract tourists is not as high as it appears since appreciative local residents will not generate tourist income. The findings of the breeds' TEV could also have implications for the analysis of potentially differentiated conservation interventions appropriate for other threatened Italian breeds. Of Italy's 14 other threatened livestock breeds, a rough categorisation suggests that seven of these breeds have a niche product associated with them, nine of these breeds may be associated with important cultural values and seven contribute to landscape maintenance¹² (Bigi and Zanon, 2008).

Secondly, as respondents in more distant cities are willing to support conservation activities, it may be justified to apply the stated WTP figures to a larger human population, thereby justifying higher RDP support. However, the extent to which such broader support could be counted upon may be limited by the fact that other regions will have their own threatened breeds to which they may assign higher conservation priorities.

Thirdly, if it can be demonstrated that public good provision can still be maintained with lower animal populations (e.g. by accounting for farmer numbers and their spatial distribution rather than just overall numbers), then risk thresholds could be established at levels lower than the current rate. For example at half the current rate (3750 females, which is still well above the FAO risk level), maximum RDP support could be paid (€400) while the overall programme would still remain broadly within the stated TEV estimates. Obviously more research regarding the link between animal population sizes, farmer numbers, spatial distribution and other factors vis-à-vis public good provision would however be needed¹³ before such 'higher support' and/or 'reduced risk threshold' approaches could be adopted. Such research would also need to consider the fact that under the current support programme (amongst other conditions) the RDPs state that farmers receiving support payments must also commit to ensuring that over a five year period there is a 20% increase in herd size. Although we were unable to obtain data to assess herd dynamics and whether such individual herd size increases are in fact occurring, this requirement is clearly capable of impacting the link between total breed population and public good provision by influencing the

¹² A single breed may be associated with more than one value category

¹³ As in other areas of agrobiodiversity research, establishing the link between defined threat thresholds and the supply of public good ecosystem services continues to require further research.

underlying configuration of individual herd sizes, farmer numbers and their spatial distribution. Insofar as some configurations may be more efficient at generating specific levels or types of public goods (e.g. maintenance of landscapes or cultural aspects), then for any given total breed population size there is also a 'changed configuration' approach that requires consideration.

6. Conclusions

This study reports results from a CE that sought to explore the conservation benefits associated with two Italian traditional cattle breeds. While many studies related to the conservation of AnGRs have in the past investigated traits of traditional livestock breeds in order to justify their conservation, our approach deliberately focuses on all components of the TEV of the breeds' conservation. While measuring TEV permits an assessment of whether any conservation costs incurred may be justified or not, an understanding of the relative values of the different TEV components provides insight into the viability of the development of alternative conservation and use strategies.

Findings indicate that current support levels, although large, are economically justified as they are below stated WTP for the provision of the public good services (cultural and landscape maintenance, existence and option values) associated with the maintenance of each of the breeds (between €1.1 m and €1.4 m per year). These public good values constitute a significant proportion of the overall TEV for both breeds (80% f TEV) and thereby justifying conservation and use interventions.

The fact that respondents assign a positive value to the high quality of the breed-related food products (the direct use value), although only 20% of the TEV of both breeds, suggests that niche product market development may be a viable option for providing co-funding for the continued maintenance of the breeds. The cultural value of the Maremmana and the high landscape maintenance value of the Modicana also suggest that such a strategy could be combined with agritourism development. However, the combined existence and option values of both breeds (slightly more than 50% of TEV) also suggest that current and increased RDP support levels may continue to constitute their main conservation funding strategy given the dispersed and inter-generational nature of the beneficiaries for the public good services.

Achieving breed population numbers close to the risk threshold of 7500 breeding females, even at existing levels of support, would however raise overall support costs to a level similar to the stated WTP of the adult population in our survey areas. Under such circumstances and given the estimated shortfall in current support levels covering farmer opportunity costs, improved understanding of the relationship between actual breed numbers, their spatial distribution (which is also related to farm numbers and size) and the provision of the public good services would be extremely useful. Similarly, improved understanding of the non-market values that the actual breed farmers associate with the breed would also be useful in order to understand differences between the RDP estimated financial opportunity costs and the true (i.e. economic) opportunity costs of the farmers. Both of these topics should be the focus of future research aimed at making such agrobiodiversity conservation incentive mechanisms more effective.

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