# Assessing consumers' preferences for beef and lamb meat linked to wildfire prevention services

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## Abstract

Meat from silvopastoral systems, due to its provision of numerous ecosystem services such as wildfire risk reduction in Mediterranean forests, can address societal growing demands for meat produced with lower environmental impacts. Differentiation of meat from these systems may contribute to their economic sustainability and hence to reverse their decline in the Mediterranean. This study investigated consumer preferences and willingness-to-pay (WTP) for beef and lamb meat from silvopastoral systems associated to the provision of wildfire prevention service and explored two alternative ways of labelling this service. Through a choice experiment survey considering type of pasture, length of grazing period, production distance and price, we gathered data from 1209 meat consumers in two Spanish cities. We considered forest grazing with a target purpose as a level in the type of pasture attribute and it was presented either as grazing to prevent wildfires or grazing to reduce biomass in two alternative versions of the valuation survey. The random parameter logit model revealed the highest preferences and WTP towards nearby production distances, followed by targeted grazing and forest grazing, while the length of grazing period was less relevant. No significant differences in consumers WTP were found between conveying targeted grazing either as fire prevention or biomass reduction. Our findings also suggest that consumers' preferences varied with location, attitudes towards local food and environmental role of grazing and consumption habits.

Knowledge gathered in our work contributes to understand consumers perceptions on the beneficial environmental impacts of meat production.

**Keywords:** Meat labelling, Consumer behaviour, Pasture-based systems, Choice experiment; Silvopastoral systems

## 1. Introduction

Nowadays, meat production in developed countries is based in intensive livestock systems that consume a large amount of cereals and cause notable environmental pressures (Gerber et al., 2015; Rijsberman, 2017), among which their negative impacts on climate change, biodiversity loss, water scarcity and soil degradation stand out (Grossi et al., 2019; Lazzarini et al., 2018) and constitute a significant threat to the sustainability of food systems (Stampa & Zander, 2022).

By contrast, extensive livestock systems based on pastures do not compete for food with humans and are key to the maintenance of semi-natural grasslands and their rich biodiversity (Gerber et al., 2015) and are also associated with diverse cultural and natural heritages (Hartel & Plieninger, 2014). Pasture-based livestock systems are the principal form of management of high natural value (HNV) farmland in Europe (Beaufoy & Cooper, 2008).

Among these HNV systems, silvopastoral systems are an agroforestry land use that combines woody perennials with forage and animal production. Agroforestry in the European Union is practiced at least on an area of 25 million hectares, which is equivalent to 14.2% of the utilized agricultural area (den Herder et al., 2017). Agroforestry systems with livestock cover about 15.1 million hectares corresponding to about 3.5% of the territorial area in the EU (den Herder et al., 2017). These are the dominant type of agroforestry in the EU and their highest concentration is found in Mediterranean regions (den Herder et al., 2017).

Silvopastoral systems, along with the provision of meat products, provide key habitats for biodiversity and a wide array of ecosystem services in a synergic way, such as erosion control, recreational opportunities, or wildfire risk reduction in Mediterranean forests (Kay et al., 2019; Rolo et al., 2021; Lecegui et al., 2022). The latter represents a significant environmental contribution since wildfires cause significant losses in habitats (Doblas-Miranda et al., 2017).

Livestock farming and meat production in silvopastoral systems can appropriately address societal growing demands for meat produced with lower environmental impacts, higher animal welfare standards and better nutrition and health outcomes (Grunert, 2006; Hocquette et al., 2018; Henchion & Zimmermann, 2021). Meat from these systems may contributes to meet environmental policy goals related to sustainable production, biodiversity conservation, and climate change mitigation and adaptation (Mosquera-Losada et al., 2018).

However, the management of these low-input farming systems entails higher labour intensity, potentially becoming financially unprofitable and prone to abandonment (Plieninger et al., 2015). The abandonment of extensive livestock farming and forest management, renders these landscapes vulnerable to biotic and abiotic risks (Anderson & Mammides, 2020) being one of the most prominent ones, the increased vulnerability to wildfires (Cervera et al., 2019).

Rendering these livestock systems viable relates to increasing consumer demand and willingness to pay (WTP) for sustainable livestock products (Stampa & Zander, 2022; Varela et al., 2022) and improving their economic sustainability and hence reverse their decline in the Mediterranean (Flinzberger et al., 2020).

Some initiatives are sprouting in Mediterranean countries aiming to label the meat from silvopastoral systems, highlighting their contribution to wildfire prevention (Ascoli et al., 2023). Examples are found for example in Catalonia (north-eastern Spain) where the Fire Flock label identifies meat and milk from herds grazing in high wildfire risk areas (Nuss-Girona et al., 2022). Similarly, the Mosaico project in Extremadura (western Spain) supported local business proposals that through primary sector activities (agriculture, forestry and extensive grazing) would reduce wildfire risk by actively managing the landscape and granted them with the Mosaico-Wildfire protection label for marketing their products (Pulido et al., 2021). However, very little is known about the perception of consumers with respect to these wildfire-labelled meat and more broadly, towards meat produced in silvopastoral systems. To fill this gap is key for developing successful marketing strategies. Nevertheless, effectively communicating the benefits of meat from these systems involves significant challenges given that most sustainability attributes are credence attributes (i.e. consumers cannot verify these characteristics either prior to consumption or even after consumption), then information has to be provided through labelling claims (Vermeir and Verbeke, 2006). From meat

consumers' perspective, among credence attributes, origin is well known as one of the most relevant, although consumers increasingly show a preference for meat that provide higher standards of animal welfare (García-Torres et al., 2016; M. M. Henchion et al., 2017; Napolitano et al., 2007), such as pasture-based meat (Font i Furnols et al., 2011; Morales et al., 2013). Indeed, pasture-based meat (as this from silvopastoral systems) is often regarded as "natural" and more animal and environmentally friendly (Hocquette et al., 2012; Mezgebo et al., 2017; Stampa et al., 2020b). However, despite this growing appreciation, consumer knowledge on pasture-based products is very low (Stampa et al., 2020), as it is their understanding of sustainability labels (van Bussel et al., 2022). Particularly, the appreciation of consumers of pasture-based meat in relation to environmental benefits such as biodiversity conservation is still an underexplored subject (Stampa et al., 2020; Stampa and Zander, 2022). Additionally, there is a lack of studies assessing the preferences of consumers for meat linked to the provision of wildfire prevention services (Soy-Massoni et al., 2022).

Our study intends to add to the previous knowledge by studying consumers preferences for meat from silvopastoral systems. Differently from previous studies, our work focuses on assessing consumers preferences and WTP for beef and lamb meat from silvopastoral systems associated to the provision of wildfire prevention service, a key environmental contribution of these systems in Mediterranean environments. Furthermore, we explored two alternative ways of labelling this service and conveying the information to the consumers. Wildfires attract the attention of society every year; previous studies show that citizens attach a great importance to wildfire prevention may subordinate their economic preferences in favour of expressive motivations (Holmes et al., 2013; Varela et al., 2014). Therefore, we hypothesized that consumers may be prone to exhibit lexicographic preferences when selecting their preferred choice in a hypothetical experiment where meat is labelled as contributing to wildfire prevention. Thus, we opted for testing two alternative ways of labelling the wildfire prevention service: in version 1of the questionnaire we conveyed the wildfire prevention service, while version 2 we presented the action performed by the grazing animals, i.e. biomass reduction leading to the provision of the wildfire prevention service. Our work contributes to deepen incipient studies on the best way of labelling meat from these systems to highlight their contribution to ecosystem services provision and improve their viability (Flinzberger et al., 2020; Röhrig et al., 2020). Importantly, knowledge

gathered in our work contributes to understand consumers perceptions on the beneficial environmental impacts of meat production and hence may contribute to targeted information campaigns to improve their literacy on the topic (de Araújo et al., 2022).

## 2. Materials and methods

We implemented a discrete choice experiment (DCE) survey to elicit consumers' preferences and WTP for credence attributes of lamb and beef meat, some of which are characteristic of silvopastoral systems.

### 2.1.Attribute selection

The price and three non-monetary attributes were selected after a review of the existing literature in consumer preferences for lamb and beef meat (**Table 1**).

Price to estimate the willingness to pay was presented in six levels established from the price differences observed on representative samples of retail and butcher channels in the study areas at the time of the survey. Lamb chop price ranged from 14€/kg to 24€/kg and beef steak (1ª A commercial category) prices ranged between 14 €/kg and 29 €/kg.

The non-monetary attributes considered were type of pasture, length of grazing period, and distance of production. The former refers to whether the animals graze and the type of resource grazed considering four levels: No grazing, grazing on forage crops and stubble, forest grazing and forest grazing with a target purpose (i.e. targeted grazing). For the latter we considered two alternative versions, each of them presented to half of the sample: version 1 (V1) was presented as forest grazing to prevent wildfires and version 2 (V2) as forest grazing to reduce biomass. Finally, we considered the length of grazing period and the distance of production expressed in kilometers from the place of residence of the respondent (Grebitus et al., 2013).

**Table 1.** Attributes' levels.

| Attribute | Levels | | Variable code |
|---|---|---|---|
| | Lamb | Beef | |
| Price (€/kg) | 14 €/kg | 14 €/kg | PRICE |
| | 16 €/kg | 17 €/kg | |
| | 18 €/kg | 20 €/kg | |
| | 20 €/kg | 23 €/kg | |
| | 22 €/kg | 26 €/kg | |
| | 24 €/kg | 29 €/kg | |
| Type of pasture | No grazing | | * |
| | Grazing on forage crops and stubble | | CROPS |
| | Forest grazing: trees and scrub | | FOREST |
| | Targeted grazing | | |

| | | |
|---|---|---|
| | Version 1 (V1): Forest grazing to prevent wildfire | TARGET_WILDFIRE |
| | Version 2 (V2): Forest grazing to reduce biomass | TARGET_BIOMASS |
| Length of grazing period | Less than half the year outdoors | * |
| | More than half the year outdoors | LGPMORE |
| | All year round outdoors | LGPALL |
| Distance of production | Between 50 and 200 km | D200 |
| | Between 200 and 1,000 km | D1000 |
| | Between 1,000 and 5,000 km | D5000 |
| | More than 5,000 km | * |

* Base level considered for non-monetary attributes in effects coding

## 2.2. Experimental design

Each consumer faced eight choice cards or purchase situations made up of two alternatives plus the non-purchase option (**Fig1** and **Fig2**). The experimental design composed by 24 alternatives distributed into three blocks was optimized employing Ngene software (Choice Metrics, 2021) for D-efficiency, retrieving a D-error of 0.28. A pilot survey was conducted in July 2021 with 70 respondents; the obtained estimates were used as fixed priors and the design was optimized for a multinomial logit model (Rose et al., 2011).

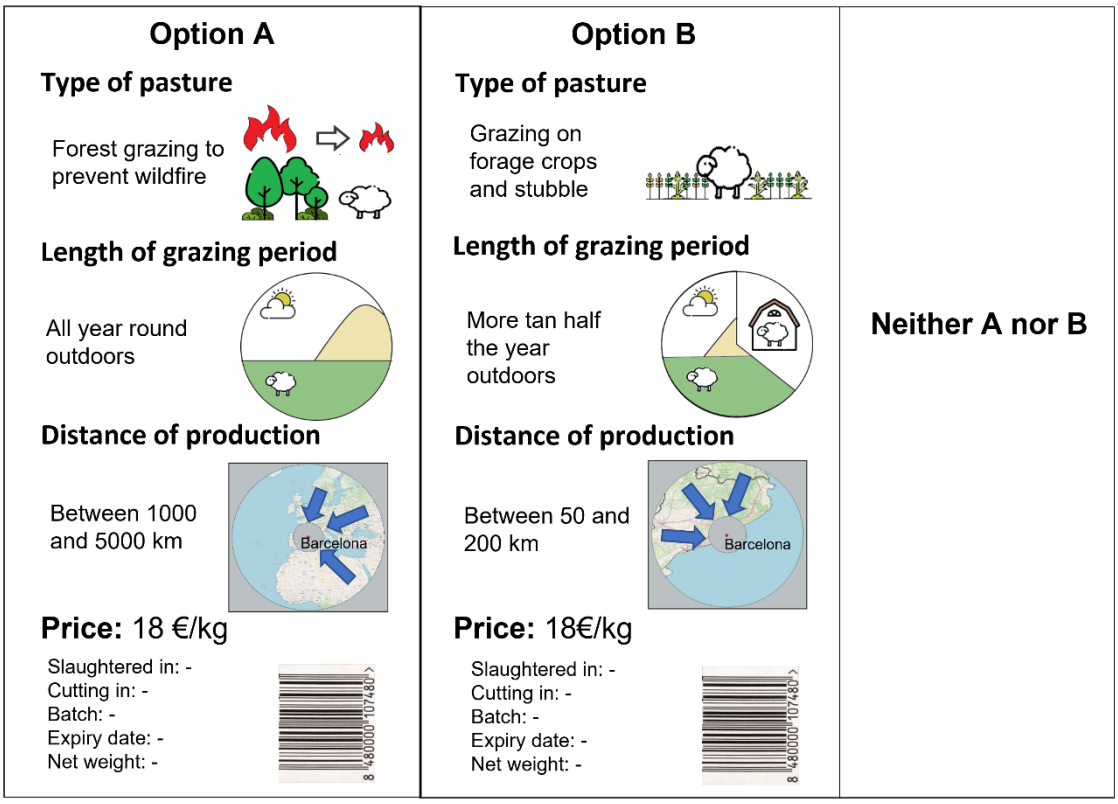


**Fig. 1**. Example of choice cards shown to lamb consumers in Barcelona for version 1 (V1- forest grazing to prevent wildfire).

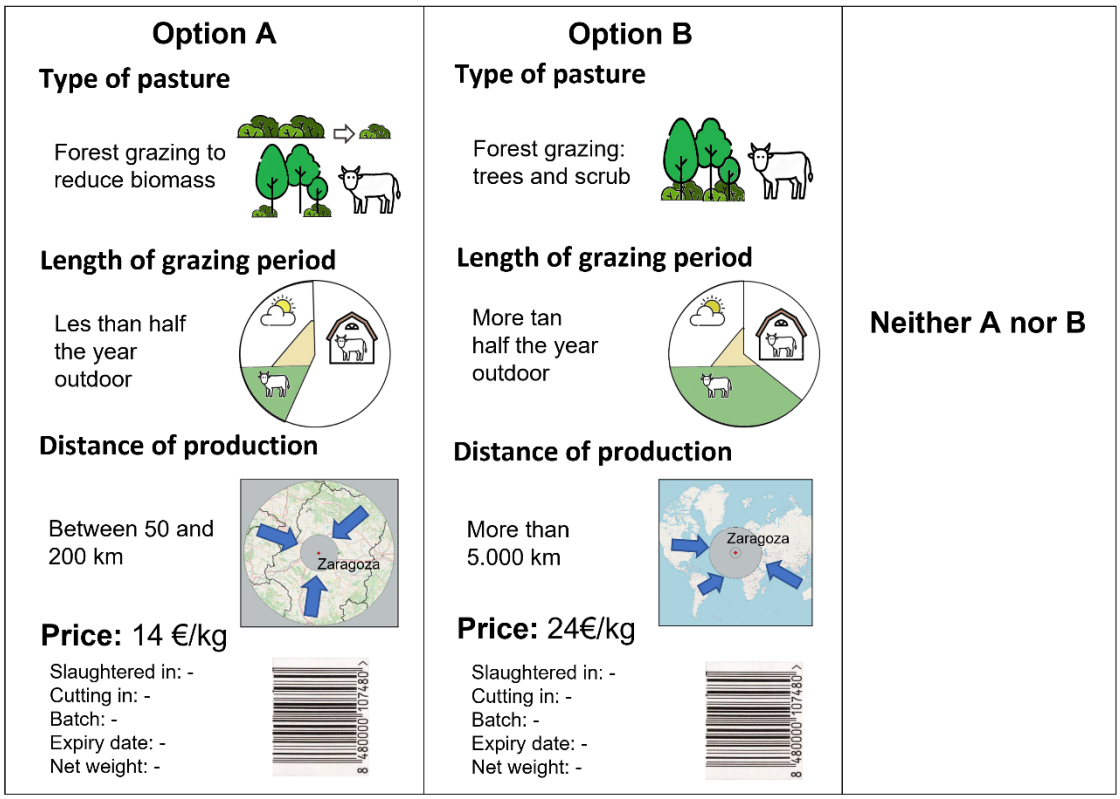


**Fig 2.** Example of choice cards shown to beef consumers in Zaragoza for version 2 (V2- Forest grazing to reduce biomass).

### 2.3.Data collection

Data was collected through an online survey in October and November 2021 in Barcelona and Zaragoza (north-eastern Spain) as part of a larger project on silvopastoralism (Varela et al., 2022). Barcelona is a cosmopolitan city with 1,636,732 inhabitants while Zaragoza is smaller and holds 675,301 inhabitants (INE, 2022). The sample recruited by the online survey company Tickstat (www.tickstat.com) was composed of adults fully or partially responsible for the grocery shopping of lamb and beef in their household. The process fully adhered to the ESOMAR (European Society for Opinion and Market Research) guidelines for ethical online research. This includes assurances that respondents gave informed explicit consent to take part in the survey and had their personal data protected. Indeed, after being informed of the objectives of the survey and how the given information will be used, all respondents gave their informed consent for inclusion of their answers before and after they participated in the study. Respondent details have been collected in an anonymous way with no personally identifiable information and with an option not to answer.

The questionnaire was structured into four sections. i. Meat purchase and consumption habits, ii. Description of beef and lamb production systems and the attributes addressed. This section also contained a series of questions to assess why the attributes were important to consumers using a Likert scale (see **Appendix**). iii. Lifestyle habits and socio-demographics characteristics and iv. The DCE.

## 2.4.Model specification

DCE is grounded on Lancaster's theory of Value (Lancaster, 1966) that assumes consumers gain their utility from the goods they purchase from their attributes and the levels these take, and in the Random Utility Theory (McFadden, 1974). According to the random utility model, individuals (i=1,…, I) will select the alternative (j=1,…,J) providing then with the highest utility. The utility from each alternative is composed of a deterministic part $V_j$, a linear and additive function of n=1,…,N attributes $X_n$ and a stochastic part εj that captures the non-observable variance of elections.

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \sum_n \beta * X_{inj} + \varepsilon_{ij} \qquad (1)$$

Where β represents the parameters of $X_{nj}$ estimated by maximum likelihood simulation using the conditional logit model (Train, 2003).

A more flexible approach is provided by random parameter logit model (RPL) that allows to integrate preference heterogeneity in the deterministic component of utility. Parameters are then specified as random and characterized by a location (mean) and a scale parameter (variance or spread). The distribution of parameters represents (unobserved) random preference heterogeneity. Complementarily, sources of observed heterogeneity can be incorporated by introducing interaction terms between mean attribute estimates and individuals' socioeconomic or attitudinal characteristics (Hensher et al., 2005).

These two sources of heterogeneity are incorporated by two additional equation terms: $\sigma^n * X_{inj}$ represents the standard deviation of β while the term $\delta_n * z_i * X_{inj}$ reveals the (observed) heterogeneity around the mean parameters where $z_i$ is a set of respondent-specific characteristics.

$$U_{ij} = \alpha_{ij} + \sum_n [\beta * X_{inj} + \sigma^n * X_{inj} + \delta_n * z_i * X_{inj}] + \varepsilon_{ij} \qquad (2)$$

α is an alternative specific constant (ASC) that captures the average of the unobserved effects not captured by the systematic component of the utility (i.e., attribute

parameters) (Hensher et al., 2005). This constant was kept fixed and codded as a dummy variable with value 1 for the non-purchase option and 0 otherwise, i.e. the model was specified with the ASC representing the utility of the no choice option.

Coefficients β follow a multivariate probability density function f(β). If we assume independence over choice-tasks made by the same individual, the joint probability of an individual making a sequence of choices is the product, in our case, of eight probabilities. Each of them represents the probability of choosing an alternative over the choice task and it is a weighted average of the logit formula evaluated at different values of β.

$$P_{ij} = \int \frac{\exp(x_{ij}\beta')}{\sum_{j=1}^{J} \exp(x_{ij}\beta')} f(\beta) d\beta \qquad (3)$$

Since the integral does not have an analytical solution, assumptions have to be made about the distribution of the β parameters across the population and then take a set of draws from the distribution and calculate the logit probability for each of them. The RPL model can be further specified to handle panel data in order to accurately measure interpersonal heterogeneity.

All non-monetary attributes were coded using effects-coding and specified together with the ASC to follow a triangular distribution while the price parameter was modelled following a constrained triangular distribution, to restrict it to be negative. Therefore, the magnitude of the base case level coefficient for the non-monetary attributes was assumed to be equal to the negative sum of the utility weights for the other estimated categories (Louviere et al., 2000)[1]. Initially an RPL model was estimated with no interactions and gradually interactions between attributes and the socioeconomic and attitudinal variables (covariates) of interest were introduced. The covariates included in the final model were dummy coded and considered (see **Appendix** for additional variables considered and tested): i. CITY: the city of residence (1 for Zaragoza and 0 for Barcelona; ii. ENV: answer to the statement "I prefer this type of pasture because it is better for the environment" recoded with value 1 for agreement and 0 otherwise; iii. LOCAL: answer to the statement "I prefer local food" when asked about the importance of meat origin and recoded with value 1 for agreement and 0 otherwise and iv.

[1] An additional column representing the adjusted marginal utility gains from the base level situation for each of the levels of the effects coded attributes has been included in **Tables 2** and **4** to increase the clarity of the interpretation of the results.

HIGHFREQ: denotes the frequency of beef consumption at home per week (1 for at least once and 0 otherwise).

The marginal rate of substitution between price and the attribute in question, i.e., the marginal WTP for a change in the attribute or implicit price for attribute, can be represented as the ratio of the coefficient for any attribute to the negative of the coefficient for the price attribute with all else remaining constant (Louviere et al., 2000):

$$WTP_k = -\frac{\beta_k}{\beta_{price}} \qquad (5)$$

A validity test was conducted to evaluate whether taste parameters are the same up to a scaling constant and hence whether data is allowed to be pooled (Louviere et al., 2000) across Barcelona and Zaragoza subsamples. The full information maximum likelihood procedure proposed by Campbell et al. (2008) was employed to test scale differences between the subsamples. Once having controlled for scale differences, i.e. the peak of the scale parameter ratio $\mu_{Barcelona}/\mu_{Zaragoza}$, the null hypothesis of equal preferences across samples HA: $\beta_{Barcelona}= \beta_{Zaragoza}$ was tested using the likelihood ratio test statistic (Swait and Louviere, 1993; Louviere et al., 2000), which is employed for polling data sets with identically generating processes (Holmes and Boyle, 2001)[2]. Results of this tests indicated that the hypothesis of equality of preferences between the two subsamples could not be rejected at 95% confidence and hence both subsamples were pooled together.

Finally, the non-parametric Complete Combinatorial testing method (Poe et al., 2005) was employed to evaluate whether the observed differences in WTP were statistically significant both between the two versions of the survey and between the different attribute levels in the model.

Models were estimated using NLOGIT6.0 and 500 Halton draws to simulate distributions.

## 3. Results

The sample was formed by a total of 1209 meat consumers, 601 in Zaragoza and 608 in Barcelona. From these, 604 were lamb consumers equally distributed in the two

[2] The test statistic was calculated according to the following expression: $\lambda_A= -2[L\mu\_ - (L_1+ L_2)]$ where $L\mu$ is the maximum log-likelihood for the pooled data model and $L_1$ and $L_2$ are the log-likelihood values for the separated subsamples, respectively.

versions of the questionnaire (302 in V1, forest grazing to prevent wildfire, and V2, forest grazing to reduce biomass) while the remaining were beef consumers (301 in V1 and 304 in V2). The sample characteristics are shown in **Table 2**.

**Table 2.** Summary characteristics of the sampled consumers in Zaragoza, Barcelona and total (%).

| | Zaragoza (n=601) | Barcelona (n=608) | Total (n=1209) |
|---|---|---|---|
| Gender | | | |
| Male | 39.6 | 48.5 | 44.1 |
| Female | 60.4 | 51.3 | 55.8 |
| Other | 0.0 | 0.2 | 0.1 |
| Age (years) | | | |
| Between 18-34 | 14.6 | 13.8 | 14.2 |
| Between 35-54 | 57.0 | 49.1 | 53.1 |
| More than 55 | 28.3 | 37.0 | 32.7 |
| Education | | | |
| Less than primary | 10.6 | 10.5 | 10.6 |
| High School | 26.6 | 24.7 | 25.6 |
| Professional training | 32.4 | 30.4 | 31.4 |
| University degree | 30.3 | 34.4 | 32.3 |
| Household net income (€/month) | | | |
| Less than 1150 | 10.6 | 10.5 | 10.6 |
| Between 1150-2000 | 26.6 | 24.7 | 25.6 |
| Between 2000-2900 | 32.4 | 30.4 | 31.4 |
| More than 2900 | 30.3 | 34.4 | 32.3 |

### 3.1. Consumer preferences for beef and lamb meat attributes

Mean coefficients of attribute levels were highly significant in all four models (**Table 3**). The parameter for the ASC indicated that, on average, consumers preferred a purchase option in all the subsamples. Specifically, the nearest production distance (D200) contributed the most to the utility of lamb meat and beef consumers across the models. The effect of type of pasture levels in the utility function was statistically significant and positive. Targeted grazing was the second attribute in importance determining the utility for beef consumers (V1 and V2). However, for lamb meat, the estimates for targeted grazing were lower than D1000 in V1 and forest grazing in V2.

On average, targeted grazing was more preferred than forest grazing and crops in all the models, except for lamb meat in V2. Forage crops was the least preferred option among type of pasture levels.

The positive and significant estimates for the levels of the attribute length of grazing period showed that on average, consumers preferred all year round outdoors (LGPALL) meat than more than half the year outdoors (LGPMORE) meat across the four models,

297 implying that the utility gained by the consumers increased with the grazing time of
298 animals.

299 Regarding distance of production attribute, the significance and sign of the levels
300 indicated the decrease of the utility as the distance increased.

301 Finally, the significant standard deviation of most parameter distributions indicated
302 heterogenous preferences among consumers. We explored the observable component of
303 heterogeneity in preferences by interacting some of the attributes with attitudinal
304 variables.

**Table ~~23~~.** Parameter estimates for the two versions of beef and lamb choice models.

| | | Lamb | | | | | | Beef | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | V1: Wildfire prevention | | | V2: Biomass reduction | | | V1: Wildfire prevention | | | V2: Biomass reduction | | |
| **Atribute** | **Variable** | **Mean** | **Std. Dev.[a]** | **Adj.[b]** | **Mean** | **Std. Dev.[a]** | **Adj.[b]** | **Mean** | **Std. Dev.[a]** | **Adj.[b]** | **Mean** | **Std. Dev.[a]** | **Adj.[b]** |
| Type of pasture | CROPS | 0.223*** | 0.161 | 1.794 | 0.289*** | 0.402*** | 2.137 | 0.159** | 0.319** | 1.652 | 0.357*** | 0.354** | 1.903 |
| | FOREST | 0.597*** | 0.356** | 2.168 | 0.793*** | 0.698*** | 2.641 | 0.607*** | 0.920*** | 2.1000 | 0.539*** | 0.666*** | 2.085 |
| | TARGET_WILDFIRE | 0.751*** | 0.663*** | 2.322 | - | - | - | 0.727*** | 0.425*** | 2.22 | - | - | - |
| | TARGET_BIOMASS | - | - | - | 0.766*** | 0.429*** | 2.614 | - | - | | 0.650*** | 0.468*** | 2.196 |
| Length of grazing period | LGPMORE | 0.210*** | 0.310*** | 0.764 | 0.232*** | 0.417*** | 0.839 | 0.102* | 0.120 | 0.584 | 0.141*** | 0.097 | 0.709 |
| | LGPALL | 0.344*** | 0.614*** | 0.898 | 0.375*** | 0.491*** | 0.982 | 0.380*** | 0.324*** | 0.862 | 0.427*** | 0.403*** | 0.995 |
| Distance of production | D200 | 1.346*** | 1.079*** | 3.183 | 1.461*** | 1.072*** | 2.922 | 1.047*** | 0.780*** | 2.407 | 0.958*** | 0.845*** | 2.344 |
| | D1000 | 0.850*** | 0.773*** | 2.687 | 0.719*** | 0.650*** | 1.462 | 0.581*** | 0.730*** | 1.941 | 0.616*** | 0.679*** | 2.002 |
| | D5000 | -0.359*** | 0.146 | 1.478 | -0.339*** | 0.122 | 1.461 | -0.268*** | 0.061 | 1.092 | -0.188*** | 0.115 | 1.198 |
| | PRICE | -0.205*** | 0.084*** | | -0.218*** | 0.089*** | | -0.161*** | 0.066*** | | -0.155*** | 0.063*** | |
| | ASC: no choice | -4.878*** | | | -5.131*** | | | -4.082*** | | | -4.205*** | | |
| | Log-likelihood | -1739.043 | | | -1738.792 | | | -1894.887 | | | -1816.273 | | |
| | Akaike Information Criterion | 3514.016 | | | 3512.88 | | | 3825.536 | | | 3667.384 | | |
| | McFadden's pseudo-R2 | 0.336 | | | 0.353 | | | 0.291 | | | 0.313 | | |

***, **, * denotes significance at 1%, 5% and 10% level

[a] Standard deviation estimated based on the spread (s) of the triangular distribution estimates as: $s/\sqrt{6}$

[b] Adjusted marginal utility gains from the base level situation for the effects-coded attributes

### 3.2. Exploring observed sources of preference heterogeneity

**Table 4** reports the RPL model with interaction terms to explain consumers´ choices. Results indicated that location, attitudes, and behavioral characteristics of consumers influence their meat preferences. Compared to consumer living in Barcelona, those living in Zaragoza showed a negative estimate for targeted grazing in lamb meat when this was displayed as forest grazing to reduce biomass. Conversely, these consumers that agreed with environmental reasons to select their preferred type of pasture showed a higher preference than the average for targeted grazing when this was displayed as forest grazing to reduce biomass both in lamb and beef samples.

Compared to Barcelona consumers, these in Zaragoza show a negative estimate (disutility) for lamb meat options where animals are all year round grazing outdoors in V1 and V2 models.

Consumers that prioritized local food showed positive and significant preference for the nearest production distance attribute level across the four models. This pattern was also observed for the second nearest production level for all the samples, except for beef V1.

Finally, more frequent consumers of beef steaks at home showed that the nearest production distance level decreased their utility.

**Table 4.** Estimated beef and lamb choice models with interactions.

| | | Lamb | | | | | | Beef | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | V1: Wildfire prevention | | | V2: Biomass reduction | | | V1: Wildfire prevention | | | V2: Biomass reduction | | |
| **Atribute** | **Variable** | **Mean** | **Std. Dev.[a]** | **Adj.[b]** | **Mean** | **Std. Dev.[a]** | **Adj.[b]** | **Mean** | **Std. Dev.[a]** | **Adj.[b]** | **Mean** | **Std. Dev.[a]** | **Adj.[b]** |
| Type of pasture | CROPS | 0.255*** | 0.247 | 1.960 | 0.349*** | 0.26 | 2.213 | 0.189** | 0.441*** | 1.8 | 0.346*** | 0.403** | 1.562 |
| | FOREST | 0.642*** | 0.527*** | 2.347 | 0.889*** | 0.763*** | 2.753 | 0.630*** | 0.977*** | 2.241 | 0.532*** | 0.727*** | 1.748 |
| | TARGET_WILDFIRE | 0.808*** | 0.708*** | 2.513 | - | - | - | 0.792*** | 0.477*** | 2.403 | - | - | - |
| | TARGET_BIOMASS | - | - | - | 0.626*** | 0.4** | 2.49 | - | - | - | 0.338** | 0.518*** | 1.554 |
| Length of grazing period | LGPMORE | 0.224*** | 0.385*** | 1.103 | 0.247*** | 0.5*** | 1.099 | 0.108* | 0.053 | 0.625 | 0.147** | 0.087 | 0.744 |
| | LGPALL | 0.655*** | 0.579*** | 1.534 | 0.605*** | 0.582*** | 1.457 | 0.409*** | 0.493*** | 0.926 | 0.450*** | 0.415*** | 1.047 |
| Distance of production | D200 | 1.038*** | 1.175*** | 2.060 | 1.012*** | 1.071*** | 2.009 | 0.681*** | 0.699*** | 1.705 | 0.824*** | 0.803*** | 1.759 |
| | D1000 | 0.368* | 0.876*** | 1.390 | 0.360** | 0.707*** | 1.357 | 0.632*** | 0.795*** | 1.656 | 0.311** | 0.618*** | 1.246 |
| | D5000 | -0.384*** | 0.344** | 0.638 | -0.375*** | 0.03 | 0.622 | -0.289*** | 0.048 | 0.735 | -0.200*** | 0.195 | 0.735 |
| | PRICE | -0.215*** | 0.088*** | | -0.223*** | 0.091*** | | -0.163*** | 0.066*** | | -0.160*** | 0.065*** | |
| | ASC:no choice | -5.122*** | | | -5.311*** | | | -4.172*** | | | -4.305*** | | |
| | TARGET*CITY | - | | | -0.420*** | | | - | | | - | | |
| | TARGET*ENV | - | | | 0.510*** | | | - | | | 0.374** | | |
| | LGPALL*CITY | -0.555*** | | | -0.317*** | | | - | | | - | | |
| | L200*LOCAL | 0.529** | | | 0.774*** | | | 0.784*** | | | 0.460*** | | |
| | L200*HIGHFREQ | - | | | - | | | -0.357** | | | -0.435*** | | |
| | L1000*LOCAL | 0.682*** | | | 0.6148*** | | | - | | | 0.490*** | | |
| | Log-likelihood | -1714.070 | | | -1697.670 | | | -1875.800 | | | -1798.321 | | |
| | Akaike Information Criterion | 3471.104 | | | 3441.888 | | | 3791.488 | | | 3640.896 | | |
| | McFadden's pseudo-R2 | 0.346 | | | 0.369 | | | 0.298 | | | 0.320 | | |

***, **, * denotes significance at 1%, 5% and 10% level

[a] Standard deviation estimated based on the spread (s) of the triangular distribution estimates as: $s/\sqrt{6}$

[b] Adjusted marginal utility gains from the base level situation for the effects-coded attributes.

CITY: the city of residence (1 for Zaragoza and 0 for Barcelona)

ENV: answer to the statement "I prefer this type of pasture because it is better for the environment" recoded with value 1 for agreement and 0 otherwise

LOCAL: answer to the statement "I prefer local food" when asked about the importance of meat origin and recoded with value 1 for agreement and 0 otherwise

HIGHFREQ: denotes the frequency of beef consumption at home per week (1 for at least once and 0 otherwise).

### 3.3. Willingness to pay estimates

WTP estimates revealed rather similar patterns across the four models (**Table 5**). The highest WTP was obtained for the nearest production distance, with an average value of 15.51€/kg (V1) and 15.13 €/kg (V2) for lamb, and 14.92 €/kg (V1) and 15.12€/kg (V2) for beef.

Targeted grazing obtained the second highest WTP estimates in both versions of beef and in V2 for lamb meat. Furthermore, targeted grazing attained slightly higher values than forest grazing, although the combinatorial Poe test conducted did not retrieve significant differences in WTP between targeted grazing and forest grazing in any of the four models. In contrast, these differences were significant (p-value 0.000) between forage crops and the other two levels of this attribute in the four models.

When comparing the two versions of the survey presenting targeted grazing either as biomass reduction or as wildfire prevention, consumer WTP estimates revealed slightly higher values for the former, although these differences were not statistically significant according to the combinatorial Poe test performed.

The length of grazing period was the attribute that obtained the lowest WTP estimates, showing higher values for all year-round outdoor grazing across the four models.

**Table 5.** Willingness to pay (WTP) results and 95% confidence intervals following Krinsky and Robb (1986). Poe test of differences between versions was based on 1,000 replications.

| | Lamb | | | Beef | | |
|---|---|---|---|---|---|---|
| **ATRIBUTES** | **V1: Wildfire prevention Mean (C.I. 95%)** | **V2: Biomass reduction Mean (C.I. 95%)** | **Poe test (p-value)** | **V1: Wildfire prevention Mean (C.I. 95%)** | **V2: Biomass reduction Mean (C.I. 95%)** | **Poe test (p-value)** |
| CROPS | 8.74*** (6.72 - 10.76) | 9.80*** (7.77 - 11.83) | 0.259 | 10.24*** (7.73 - 12.75) | 12.28*** (9.58 - 14.99) | 0.162 |
| FOREST | 10.56*** (8.52 - 12.61) | 12.11*** (9.99 - 14.23) | 0.208 | 13.01*** (10.25 - 15.78) | 13.46*** (10.68 - 16.24) | 0.437 |
| TARGET_WILDFIRE | 11.31*** (9.08 - 13.55) | - | 0.356 | 13.76*** (11.12 - 16.40) | - | 0.443 |
| TARGET_BIOMASS | - | 11.99*** (9.88 - 14.09) | | - | 14.17*** (11.41 - 16.93) | |
| LGPMORE | 3.73*** (2.54 - 4.91) | 3.85*** (2.63 - 5.06) | 0.437 | 3.62*** (2.25 - 4.98) | 4.58*** (3.17 – 5.99) | 0.180 |
| LGPALL | 4.38*** (3.13 - 5.64) | 4.50*** (3.32 - 5.69) | 0.450 | 5.34*** (4.01 - 6.68) | 6.42*** (4.92 - 7.93) | 0.168 |
| D200 | 15.51*** (12.79 - 18.22) | 15.13*** (12.62 - 17.64) | 0.436 | 14.92*** (12.31 - 17.53) | 15.12*** (12.27 - 17.97) | 0.463 |
| D1000 | 13.09*** (10.91 - 15.27) | 11.73*** (9.88 - 13.58) | 0.191 | 12.03*** (9.86 - 14.20) | 12.92*** (10.53 - 15.31) | 0.333 |
| D5000 | 7.20*** (5.60 - 8.80) | 6.88*** (5.43 - 8.34) | 0.405 | 6.77*** (5.10 - 8.45) | 7.73*** (5.93 - 9.52) | 0.234 |

***, **, * denotes significance at 1%, 5% and 10% level

## 4. Discussion

The increasing interest in meat production practices and their environmental and social consequences boosts the importance that consumers attach to credence attributes linked to sustainability (Hocquette et al., 2018; Burnier et al., 2021). Meat from silvopastoral systems contributes to shaping biodiverse landscapes and providing numerous ecosystem services (Plieninger et al., 2015). Its differentiation at the market stall could contribute to increasing their economic sustainability and reverse current trajectories of decline of these production systems (Flinzberger et al., 2020). This study assessed consumer preferences and WTP for beef and lamb meat from silvopastoral systems through a DCE survey.

Targeted grazing with extensive cattle and sheep systems is being promoted through several wildfire prevention programs for achieving biomass reduction in southern Europe (Varela et al., 2018) where wildfires are a prominent risk (Dupuy et al., 2020). Furthermore, previous studies show that citizens attach a greater importance and WTP for landscape management towards wildfire prevention provision than for other ecosystem services (Rodríguez-Ortega et al., 2016) and hence they may subordinate their economic preferences in favour of expressive motivations (Holmes et al., 2013; Varela et al., 2014). Therefore, assessing consumers preferences for meat associated with wildfire prevention may lead to lexicographic preferences where consumers ignore some of the attributes. For this purpose, we tested two different versions (forest grazing to reduce biomass and forest grazing to prevent wildfires) of the targeted grazing attribute level. No statistically significant differences arose in WTP between the two versions while the targeted grazing attribute did not lead to overriding the rest of the attributes either in any of the versions or lamb and beef samples, indicating the robustness and stability of our results.

Our results revealed that distance of production (distance travelled) significantly determined consumers' preferences, being the closest distance the attribute level most valued across the four models These results are in line with those obtained by Grebitus et al. (2013) and Hasanzade et al. (2022) where consumers showed a noticeable preference for closer products. The distance of production concept proposed by Grebitus

et al. (2013), avoids considering the region or country of origin that can trigger affective associations from consumers, as well as cognitive, and normative mechanisms (Verlegh and Steenkamp, 1999). Moreover, distance since it is not related to the political boundaries of the territory, allowed a more objective indication of the origin minimizing the ethnocentrism and emotional and affective relations with origin (Feldmann and Hamm, 2015).

Country or region of origin is one of the most important attributes for lamb and beef consumers (e.g., Bernués et al., 2003; Henchion et al., 2017) being domestically produced beef or lamb mostly preferred (Verlegh & Steenkamp, 1999), tied safety and animal welfare (Verbeke et al., 2010) and the values of locality and authenticity (Shimp and& Sharma, 1987;Henchion et al., 2021) besides the symbolic and emotional meaning for consumers (Hersleth et al., 2012). Specifically in the case of Spanish consumers, these preferences may not always be linked to sustainability issues, but rather to personal ethnocentrism or as a system to reinforce the sense of identity (Font-i-Furniols & Guerrero, 2022). Our results showed that those consumers that agree with the importance of origin because they prioritize local food have a higher preference than the average for the nearest distance. This aligns with previous studies indicating that consumers may deem more appropriate to call "locally produced" these animal products made in a closer distance (Hasanzade et al., 2022). Despite many studies use the "local" tag to study consumers preferences, it could be ambiguous (de-Magistris and & Gracia, 2014) since there is no consensus about what declaration of maximum distance should hold for a food to be considered local (Hu et al., 2012; Hasanzade et al., 2022).

Our results also revealed that frequent beef consumers reduced their utility with meat from the nearest production distances. These consumers are expected to have a high knowledge, and positive attitude towards quality differentiated beef from other Spanish regions (Olaizola et al., 2005).

Type of pasture was the second most important attribute for the choice of beef and lamb meat. While previous studies have shown that consumers increasingly appreciate pasture-based systems due mostly to animal welfare and to a lesser extent to environmental reasons (Morales et al., 2013; Risius and Hamm, 2017; Schulze et al., 2021; Stampa et al., 2020), our study provides insights on preferences linked to silvopastoral systems and these that contribute to provide wildfire protection services.

Consumers showed greater preferences for targeted grazing (both as wildfire prevention and biomass reduction), followed by forest grazing and forage crops. While we found no significant differences in WTP between targeted grazing and forest grazing, the Poe test revealed a lower WTP for grazing on crops. Similarly to Stampa and Zander (2022), where consumers already perceived pasture grazing to support biodiversity, we hypothesize that wildfire prevention may be perceived as an intrinsic aspect of forest grazing by consumers and hence targeted grazing added only negligibly additional utility and WTP to forest grazing. In the same way, Schulze et al. (2021), argued that adding an environmental advantage to a beef production process already associated with a positive environmental output only produces a marginal increase in the utility of consumers.

However, our results show heterogeneous preferences among consumers where sociodemographic shifts may induce different perceptions (Liu et al., 2023). These that agreed with environmental reasons to select their preferred type of pasture showed also higher preferences than the average for targeted grazing when this was displayed as forest grazing to reduce biomass both in beef and lamb meat consumers. Furthermore, lamb consumers living in Zaragoza exhibited a disutility for targeted grazing when it was displayed as forest grazing to reduce biomass. This may indicate that an emphasis on biomass reduction could be detrimental to increase lamb consumption from silvopastoral systems in Zaragoza.

Length of grazing period influenced consumer choices to a lesser extent than other attributes. Grazing the whole year was preferred over grazing during shorter periods. However, pasture availability in the Mediterranean often requires housing and use of supplementary feedstuff when pasture availability is scarce (Olaizola et al., 2015). Lamb consumers in Zaragoza seem to be more aware of this limitation since outdoor grazing all year round reduced their utility.

**Implications for labelling**

The long-term continuity of silvopastoral systems and their coupled ecosystem services require effective communication strategies to increase the demand for differentiated meat. Meat associated with the provision of wildfire prevention services may constitute a sustainability attribute appreciated by consumers and could stimulate new business opportunities through labelling (Soy-Massoni et al., 2022).

Results drew insights for the development and improvement of such labels, that in some regions have already started to be developed, frequently linked to research projects, at a local scale and in an incipient status (Pulido et al., 2021; Nuss-Girona et al., 2022) but missing the assessment of consumers' perception. Our results provide key insights for the ulterior enhancement of these initiatives, highlighting that nearby production distance determines most of the preferences and WTP of lamb meat and beef consumers. Consumers also placed higher value on targeted grazing than on forest grazing. However, consumers usually do not have access to this kind of information in labels. Therefore, complementing distance with the type of pasture information could increase the quality perceived by consumers and increase the purchases while supporting deprived rural areas and maintaining landscapes with high cultural and environmental values (Flinzberger et al., 2020). Our results suggest that both forest grazing and targeted grazing labelling can influence the choice for beef and lamb meat positively. However, including label information on targeted grazing would not be rewarded at the market stall compared to forest grazing labelling. Indeed, further specifications could reduce the preferences of consumers in some context, as it is the case of lamb consumers in Zaragoza when target grazing for biomass reduction was emphasized.

## 5. Conclusions

Our study contributes to the increasing strand of literature that highlights the influence of meat production practices and environmental sustainability claims on the preferences of consumers for food quality. We studied preferences and WTP for beef and lamb meat from silvopastoral systems associated with wildfire prevention services.

The results confirm that nearby distance of production is the attribute that influences the most preferences and WTP of lamb and beef consumers. Those consumers declaring high importance of origin because they prioritize local food showed a higher preference than the average for the nearest distance, suggesting that normative and emotional values drive their preferences.

Findings highlighted that beef consumers considered targeted grazing as their second preferred attribute irrespective of whether it is presented as wildfire prevention or biomass reduction. In the case of lamb meat consumers, outcomes follow the same pattern when targeted grazing is presented as wildfire prevention. Despite differences in

preference parameters between forest and targeted grazing, these do not hold between WTP estimates in the two versions both for lamb meat and beef samples.

Therefore, using forest grazing as a claim could complement the intrinsic value of the distance reinforcing the geographical characteristics and traditional management of silvopastoral systems.

Our study was conducted in two cities in Spain, considering large sample sizes, lamb meat and beef consumers and two survey versions. The ambitious sampling and the robustness of our results across samples and versions could be reinforced in the future by replicates in other regions with different socio-economic characteristics that allow to extend our findings. Future studies could involve the provision of other relevant ecosystem services to further explore preferences for meat produced in pastored-based livestock systems.

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