UNIVERSIDAD DE EXTREMADURA

# TESIS DOCTORAL

## Los aspectos sociales y medioambientales como nuevas tendencias para el marketing agroalimentario y preferencias del consumidor

ALI TAHER MOHAMED HASSANIN ELDESOUKY

**PROGRAMA DE DOCTORADO EN CIENCIA DE LOS ALIMENTOS**

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# PHD THESIS

## Social and environmental aspects as new trends for Agri-food marketing and consumer preferences

ALI TAHER MOHAMED HASSANIN ELDESOUKY

**2020**

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# Introduction

## Introduction

The agri-food sector is one of the main priority areas of global sustainable production and consumption policies, aiming to create more balanced patterns of consumption and production, not only for supporting environmental protection, but also to increase businesses' competitiveness and social wellbeing (European Commission, 2008). This is one of the sectors that generate the greatest impact on environment along the production chain, from the cultivation phase, the food processing and the distribution phase to the end-of-life (Hospido et al., 2010).

In this context, sustainability is about building a society in which a proper balance is created between economic, social and ecological aims. Also, it is a critical issue in management and marketing of the food sector (Szekely & Knirsch, 2005). A sustainable food sector is seen as a sector that fully encompasses the various stages of food commodities from the point where they are sourced, produced, processed, packaged, stored, distributed, sold, and consumed (Wallgren & Hojer, 2009).

According to the Oslo definition, sustainable consumption is a set of economic, environmental and social factors that constitute the basis for the use of services and products that provide higher quality of life while minimizing the impacts on the environment (UNCSD, 1994). It refers to consumption patterns that are economically, socially, and environmentally compatible within all areas of the food system, from food production, processing, and distribution to the food purchases of consumers and to waste disposal (Pack, 2007). Also, it may be the result of a decision-making process that considers not only the individual needs of consumers (related to taste, price and convenience) but also attitudes towards social responsibility (environment and fair trade) (Hartikainen et al., 2014). Sustainable products are perceived by individuals as being of higher quality, with higher social and economic values, and with greater environmental sustainability (Biswas & Roy, 2015; Maniatis, 2016).

In general, public interest in sustainability issues has significantly increased in recent years and has become a concern in topics such as climate change and the environment (Risius et al., 2019). One of the main reasons for this growing interest in sustainability in the food sector is that consumers are changing their behaviour to integrate sustainable and environmental considerations into their lifestyles (Smith & Marsden, 2004). As a result, food companies have started to communicate sustainability-related information about food to consumers, introducing this information into the labels of the different products. Among the most popular pieces of

information are the logos, the best known being the Fair Trade logo, the Rainforest Alliance logo and various carbon index schemes and animal welfare-related logos (Grunert et al., 2014).

In this sense, consumers are today more concerned about the way their food is produced in the recent decades; while they care about the physical properties of their food, they also increasingly consider its social, ethical and environmental attributes (Briggeman & Lusk, 2011). The increased demand for environmentally friendly food is related to more interest in sustainable use of resources and consequently, future wellbeing (Reisch et al., 2013). This is having a significant impact on public and private sector policies towards food and has led to the growth of a number of voluntary and mandatory sustainability labeling schemes (Ellen et al., 2014; Caputo et al., 2013; Gadema, & Oglethorpe, 2011).

Environmentally friendly labels gain more attention at international level as a means for implementing a policy which can encourage producers to improving products' environmental performances (Clasadonte et al., 2013). At the same time, the implementation of eco-labeling tools could lead to a change in consumers' behavior connected to an increased ecological awareness (Matarazzo et al., 2016).

Likewise, food consumption is one of the most important areas to improve environmental sustainability because it is responsible for one third of a household's total environmental impacts (European Environmental Agency, 2005). However, consumers give little thought to the links between their consumption and the environmental impact of food production (Grunert et al., 2014). Behavioral change in food consumption can be powerful in reducing the use of natural resources (Gerbens-Leenes & Nonhebel, 2002). In this sense, many consumers claim to be willing to pay for environmentally food products. Nevertheless, the share of eco-friendly produced food in total has remained low (Rousseau & Vranken, 2013). This gap between consumers' attitude and their actual buying behavior has been referred to as the attitude / behavior gap (Vermeir & Verbeke, 2008).

Indeed, the world faces many environmental challenges in the last few years, such as resource depletion, environmental emissions, severe smog events, and dramatic climate change (Geng et al., 2015). One of the challenges the world faces over the next decades is to preserve its natural resources and at the same time how to produce enough food in order to satisfy the demand of a growing human population (Ibidhi et al., 2017). Therefore, society has expressed concern about

the environmental impacts caused by the growing need for food production to meet global demand (Florindo et al., 2017).

Food production significantly contributes to the increasing emission of greenhouse gases and presents therefore remarkable environmental impacts (Herrero et al., 2013). It can negatively impact human health and the environment, and consumers are becoming increasingly conscious of the consequences of their food purchases (Richter, 2014). This has resulted in a widespread community and industry interest in assessing the life cycle of food products with regard to greenhouse gas (GHG) emissions (Flysjo et al., 2011). Greenhouse gas emissions are considered a criterion for evaluating environmental performance of products and activities (Kollmuss et al., 2008). Among them, the carbon footprint (CF) is one of the most common tools to characterize a food product in terms of climate friendliness (Schlich, 2012).

A product's CF is defined as a measure of the total amount of carbon dioxide emissions that are directly and indirectly caused by an activity or are accumulated over the life stages of this product (Wiedmann & Minx, 2008). As a general rule, CF is increasingly used in the food supply chain to determine the quantity of GHG emitted at each stage of the production process, and may extend to the distribution and use phases (Jones et al, 2014). Also, it can be used to identify and assess environmental loads associated with a process, product or system, and this assessment allows for examination of potential bio-physical tradeoffs from proposed policy and other measures (Galli et al, 2020).

In this sense, the growing concern over the environmental impacts and different characteristics of food has increased consumer interest in the production methods and other attributes of food products (Forsman-Hugg et al., 2008). As well, increased interest in the GHG intensity of food products has spurred a flurry of discussion in the popular media regarding the climate impacts of meat production and the comparative performance of feedlot and grass-based production system (Pelletier et al, 2010). Thus, the concerns about reducing GHG emissions to mitigate climate change have recently led to the assessment of CF for various activities and products (Luo et al, 2015).

For instance, meat is a food product with the greatest environmental impact (Steinfeld et al., 2006). Livestock production, and especially beef production, has a major impact on the environment, as it is responsible for about 41% of the global emission of greenhouse gases from livestock (Cederberg et al., 2011). Therefore, the carbon footprint (CF) was used as an indicator

of the broader environmental impacts of meat production using life cycle assessments of different types of meat, such as pork, chicken, and beef (Roos et al, 2013).

Moreover, citizens are increasingly aware that sustainable consumption is fundamental to protect the environment, decelerate ongoing climate change and ensure social justice. Consumers prefer products positioned as sustainable over conventional products for reasons of animal welfare or environmental or social reasons (Balderjahn et al., 2013; Joerß et al., 2017). On the other hand, the extent to which consumers value and respond to environmentally friendly food products through value-consistent behavior still remains a questionable point (Haws et al., 2014).

In addition, these concerns would lead consumers to take aspects of the production process into account when choosing food products, and to be willing to pay higher prices for the product that has been produced with concern for ethical attributes such as animal welfare, health-related attributes or attributes related to environmentally friendly production systems (Liljenstolpe, 2008). With respect to farm animal production, many consumers expect food production processes to take into account aspects like animal welfare and other social and ethical attributes (Tonsor et al., 2009; Van Loo et al., 2014).

In this regard, Tully & Winer (2014) indicated that many consumers are displaying an increasing awareness of and preferences for environmental sustainability, as well as an increased willingness to pay for socially and environmentally responsible labeled products. Therefore, the environmental impact of food consumption can be improved by designing more user-friendly food labels that effectively convey the overall eco-friendliness of a product (Vlaeminck et al., 2014). However, Gleim et al. (2013) reported that despite the growing environmental awareness of consumers, they do not always engage in greener consumption behavior of food products.

Eco-labeling is an important tool used to communicate the characteristics of the products to consumers, including sustainability (Banterle et al., 2013). Eco-labels also convey information to consumers about the environmental attribute of food products and as a result may influence the consumer's decision to purchase environmentally friendly products (Roheim et al., 2011). Eco-labeling is used to differentiate food production and stimulate informed purchasing decisions, thus creating economic incentives for producers to adopt environmentally friendlier technologies (Jaffry et al., 2004). In the present context of increasing consumer awareness, food products with eco-labels have been found to be preferred by consumers (Bronnmann & Asche, 2016).

Additionally, Schumacher (2010) has shown consumers' stated preferences for eco-labeled goods increase with environmental consciousness and decrease with price-orientation.

In this context, environmentally friendly labels can be used to trigger positive market feedbacks by communicating clear and credible information about the environmental performance of product life cycles (Del Borghi et al., 2014). On the other hand, consumers encounter several barriers to go into a more sustainable eating behavior (Grunert, 2011), even with the growth in sustainability labels and accompanying communication initiatives. Label overload and gaps in the understanding of both the general concept of sustainability and of specific sustainability labels result in consumer confusion and limit the use of such labels (Comas & Seifert, 2012). Consequently, this misunderstanding of sustainable labels may lead consumers to have a limited ability to act in accordance with their interest in climate friendly behavior and change their buying decisions towards more sustainable products (Katajajuuri et al., 2014).

In this context, the objective of this work is to address environmental and social aspects as new trends in food marketing and consumer preferences. It also aims to estimate consumer´s willingness to buy or to pay a premium price for these social and environmentally friendly food products. The entire study is divided into 3 main chapters. The first is a study of CF in Spanish dehesa agroforestry systems. In this paper the role of CF in these extensive systems is of great interest through the analysis -within a case study framework of the various production systems available in dehesa systems and through the provision of the methodological adjustments required to generate results that are comparable with other livestock systems and species. The second chapter is a focus groups study and aims to explore the perceptions and attitudes of consumers towards sustainability labels and to identify those factors regarding the environmental and social aspects of food products that affect consumers' purchasing decisions. This research also aims to get an overview of the willingness to pay for this type of labeling, an aspect that could limit or enhance the growth of this type of products. It will help fill the knowledge gap between companies and consumers regarding a relevant aspect for the competitiveness of the agri-food sector, as is their role in climate change mitigation and care for the environment. Finally, the third chapter is a choice experiment study which tries to assess the influence of sustainability traits in meat production on consumers' purchasing decisions. The main objectives of this paper are to gain more insights on the consumers’ decision making process of beef and to determine the relative importance of sustainability claims and traditional attributes underlying Spanish consumers’ purchase intent of beef by applying the choice experiment technique.

Finally, this study is considered as one of the few studies that addresses the novel role of social and environmental aspects in food marketing and consumer preferences for food. It also investigates the consumers' environmental and social-ethical behavior towards food products. Additionally, results of this work would help to develop more appropriate strategies to increase public awareness of the environmental impacts associated with food production, as well as support producers who provide sustainable products.

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# General structured summary

## General structured summary

The current thesis is based on a collection of three publications independently published in international journals. In addition, those three publications address the use of environmental and social labels as a tool that convey environmental values and social aspects of certain agri-food products to consumers. In general, it aims to explore the new trends in food marketing which affect consumer preferences and their purchase decisions.

At an initial phase, the first study has gone through a practical approach to evaluate various production systems within the dehesa agroforestry systems with the aim to propose a unified adjusted methodology that ensures a fair comparison between different production systems (i.e. intensive vs. extensive) with regard to their environmental impact based on the calculation of Carbon Footprint (CF).Thus, based on those methodological adjustments, consumers would get clear messages about the real eco-friendly behavior of the products they are about to purchase.

With that in mind, the growing concern of consumers towards the environmental impacts and production systems should be of great relevance for all types of farms involved in the livestock sector, especially, those of extensive systems, where the environmental values associated with livestock production can be overshadowed by the comparatively higher emissions from these production systems.

In this context, the analysis of the CF and the variables included in livestock production may identify procedures or techniques in which emissions can be reduced by improving efficiencies. Among the various methodologies available to estimate the greenhouse gas (GHG) emissions, Life Cycle Assessment (LCA) is an internationally accepted method used to identify and quantify the environmental impact of a product. The methodological procedure followed in this research consisted of an LCA analysis of the CF taking into account the soil's carbon sequestration. Carbon sequestration refers to the changes in the levels of carbon (C) permanently stored in the soil. This research is based on the analysis of four case studies, which were selected as the most representative types of dehesa farms: 1) Extensive meat sheep farm, 2) Extensive beef/calf cattle farm, 3) Extensive beef/calf cattle farm with feedlot finishing of calves, and 4) Grazing dairy sheep farm.

The results of the study have revealed that extensive beef/calf cattle farm with feedlot finishing of calves are those with the lowest carbon footprint levels (8.62 kg of carbon dioxide equivalents

($CO_2$eq)/kg live weight), followed by extensive meat sheep farms and extensive beef/calf cattle farms. Enteric fermentation accounts for 43.63% - 64.10% of the total emissions, and it is linked to the extensification of these systems and to the grazing diet of the animals. The system's own emissions could reach up to 78% in meat production systems. Undoubtedly, feeding is the input that amounts for the highest percentage of off-farm emissions, as it can reach up to 44.60% of the total emissions in dairy sheep farms and 21.20% in meat production sheep farms. Moreover, manure and soil management are also an important source of differences in GHG emissions, ranging from 6 - 9% in sheep farms to 18 - 20% in beef farms. The results also highlight that soil sequestration has also been observed to range between 270.02 and 334.01 kg $CO_2$eq/ha are stored each year in the extensive farms under study, which represents a considerable carbon compensation. It should be noted that these systems cannot compete in product units with the more intensive ones and, therefore, CF in dehesa agroforestry systems should be referred to the territory.

In this paper, CF in extensive production improves and reaches lower values than those of intensive farms when soil sequestration is taken into consideration. In this sense, the compensated CF - including carbon sequestration - has been reduced by 20-30% in comparison to the baseline figures, with a higher reduction on those extensive systems (more linked to the territory). Thus, using this methodology consumer can clearly distinguish the difference between different livestock systems in terms of their environmental impact and appreciate the role that extensive systems play in maintaining the ecosystem and mitigating climate change.

However, many consumers are not yet familiar with CF information, making it difficult for them to evaluate and compare the different products on offer. In this context, food companies are interested in discovering how eco-friendly products can influence consumer choice and whether they are willing to pay a premium price if products are differentiated using the CF seal or others of a similar nature, a topic which is addressed in the second chapter.

The second study addresses the topic of consumers' perceptions towards the use of environmentally friendly labelling in food. This is related to the recent significant increase in awareness regarding environmental pressures linked to human activities. Consequently, there has been a tendency for consumers to become more environmentally conscious. Food consumption is one of the most important areas to influence environmental sustainability, although many consumers are not completely aware of the association between their

consumption and the environmental impact of food production. Additionally, some food companies and grocery stores have developed labelling schemes to help inform their consumers about the sustainability and the impact of a specific food product on the environment during its production cycle. Within this framework, the main objective of this study is to explore the perceptions and attitudes of consumers towards sustainability labels and to identify those factors regarding the environmental and social aspects of food products that affect consumers' purchase decisions. This paper also aims to get an overview of the willingness to pay for this type of labelling, an aspect that could limit or enhance the growth of this type of sustainable food products.

In this research, a focus group approach has been applied due to its adequacy to explore beliefs, perceptions and experiences. Focus groups provide a deep understanding of participants' experiences and beliefs by creating a process of sharing and comparing, facilitating an understanding of issues towards the topic under study, as they allow a wide range of responses and can be adapted for different research purposes. In this context, five sustainability labels, covering both ethical and environmental aspects, were chosen as example. Four of the labels refer to the environmental dimension of sustainability (Rainforest Alliance, Carbon Footprint, Water Footprint and sustainable label), while one of the labels deals with the ethical dimension (Fair Trade).

Four focus group sessions were held with a total of 36 participants. Data were analyzed using a specific program for qualitative analysis (Atlas.ti). The ideas and concepts repeatedly mentioned during the sessions were classified into categories.

The findings of this chapter were presented and discussed in four main sections explained throughout the manuscript: food purchase decision, social and environmental labels, information on labels and reasons for purchase, and lastly, willingness to pay for certified labels. The results of this study show that, with regard to the general opinion of the participants, price and quality are the main factors that influence their decision during purchasing food products. The results also indicate that consumers would pay more for the food products with this type of environmentally labelling. In addition, it was also widely regarded as important that these labels are certified with official certifications in order to generate more trust and reliability.

On the other hand, the lack of consumer awareness, the lack of understanding of the meaning of each label and the information provided by these labels, unfamiliarity and distrust in the label or

the brand are the main obstacles that hinder the consumers from purchasing food products with this type of environmentally labelling. Furthermore, this study will help filling the knowledge gap between companies and consumers regarding a relevant aspect for the competitiveness of the agri-food sector, as is their role in climate change mitigation and care for the environment.

Finally, the third study sought to deep in the study of sustainable labelling in food products. Thus, a specific product – beef- has been selected not only for being one of the most popular meats in Spain in terms of consumption, but also because it is one of the most targeted meats for its contribution to climate change. It was therefore considered that the improvement of sustainability in its production processes could be highly valued by consumers. Also this study has addressed some of the specific sustainable issues which are already established in the market labels such as organic labels, as well as those which have been recently developed, such as sustainable production, animal welfare and eco-labels.

Taking all this into account, this work focuses on the assessment of consumers for sustainability traits in meat production. Consumers are increasingly concerned about the way their food is produced, which would lead consumers to consider aspects of the production process when choosing food products, and to be willing to pay higher prices for the product that has been produced with concern for ethical and/or environmental attributes. If we assume that the global meat supply system demands some of the highest natural resource inputs compared to all other types of food, and emits the highest amount of GHG, as has been widely recognized in recent years, this work aims to study the influence of sustainable food labeling on consumers perceptions for meat.

Thus, the main objective of this paper is to gain more insights on the consumers' decision making process for beef and determine the relative importance of sustainability claims and traditional attributes underlying consumers' purchase of beef. This study also aims to identify profiles of beef consumers with similar perceptions and intentions. In this research, a choice experiment (CE) was adopted to evaluate the influence of certain attributes on consumers' buying decisions. CE is a technique frequently used to analyze consumer preferences for different product attributes, as it has the advantage of resembling a real buying situation. After a general review of the literature about environmental sustainability labels in consumer preferences for meat products, five attributes were selected: country of origin, price, production method, animal welfare label and eco label claim.

Data were collected through an online questionnaire. The sample was designed as a random stratified model, proportionally weighted against the gender and age of the population in Extremadura with the final sample including 285 valid completed questionnaires. A conditional logit model has been applied to assess consumer preferences towards sustainability claims and traditional attributes of beef meat.

The results demonstrate that consumer's perfect choice would be an organic beef produced in Spain with animal welfare label and eco-labelled. Later on, a cluster analysis was performed using socio-demographics, purchasing variables, believes and attitudes towards meat consumption. Three well-defined groups with different preference patterns were identified which can be described as follows: 1) Young men indifferent towards environment or sustainability: this cluster is the smallest group and includes only 21.1 % of the respondents who show the lowest level of consumption of environmentally friendly products, 2) Sustainability concerned mature women: this is the biggest group which includes 45. 6% of the sample and displays the largest percentage of women and mature consumers with the highest frequency of consumption of environmentally friendly products, and 3) Middle-aged meat eaters with established families: it includes 33.3% of the respondents of big family units who show the highest frequency and level of meat consumption. The results also highlight that consumers in cluster 1 present the lowest willingness to pay for all the analyzed attributes (they were very price-sensitive) while consumers in cluster 2 have the highest willingness to pay.

This study has intended to contribute to the understanding of beef production and food system sustainability issues in general, and of consumers' decision making process for beef in particular. Therefore, the results of this study would be relevant for developing more appropriate strategies in order to understand the perceptions and expectations of eco- friendly food consumers. These aspects contribute positively to clarify new consumption patterns and their impact on production systems, as well as in the implementation of new policies for a more responsible consumption. Lastly, the popularization of many social and environmental labels can influence consumer choices and the strategies of decision makers in the food industry.

# CHAPTER 1: Can extensification compensate livestock greenhouse gas emissions? A study of the carbon footprint in Spanish agroforestry systems.

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**Resumen**

Los sistemas agroforestales de Dehesa (pastizales ubicados en el suroeste de España) se caracterizan por sus condiciones semiáridas y a menudo marginales. Estas características condicionan el modelo productivo de las dehesas marcado por el aprovechamiento de los recursos pastables por el ganado, un bajo nivel de aprovisionamiento, y bajas cargas ganaderas en las explotaciones. En este sentido, el estudio del papel de la huella de carbono en los sistemas extensivos es de gran interés al analizar, dentro de un marco de estudio de caso, los diversos sistemas de producción disponibles en las explotaciones de dehesa y proporcionar los ajustes metodológicos necesarios para generar resultados comparables con otros sistemas de producción y especies ganaderas. Los resultados han revelado que las explotaciones de vacuno de carne con cebo de terneros son aquellas con que presentan los niveles más bajos de huella de carbono (8,62 kg de equivalentes de dióxido de carbono ($CO_2$ eq/kg de peso vivo), seguidas por explotaciones de producción de carne de ovino y las que venden los terneros al destete. La fermentación entérica representa del 64,10% al 43,63% de las emisiones totales, y está relacionada con el nivel de extensificación de estos sistemas y la dieta en pastoreo de los animales. Las emisiones propias del sistema podrían alcanzar hasta el 78% en los sistemas de producción de carne. Sin lugar a dudas, la alimentación es el insumo que representa el mayor porcentaje de emisiones fuera de la granja, ya que puede alcanzar hasta el 44,60% de las emisiones totales en las granjas de ovino de leche y el 21,20% en las de ovino de carne. También se ha observado que el secuestro del suelo oscila entre 270,02 y 334,01 kg de $CO_2$eq/ha en las explotaciones extensivas estudiadas, lo que representa una compensación considerable de carbono. Cabe señalar que estos sistemas no pueden competir en unidades de producto con los más intensivos y, por lo tanto, la huella de carbono en los sistemas agroforestales de dehesa debe ser relacionada al territorio.

**Can extensification compensate livestock greenhouse gas emissions? A study of the carbon footprint in Spanish agroforestry systems.**

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**Abstract**

Dehesa agroforestry systems (rangelands located in Southwest Spain) are characterised by their semi-arid and often marginal conditions. These features are behind the low supply of pastures available for livestock use, which leads to proper management being based on the use of reduced stocking rates which imply minimal animal pressure on the territory.

In this sense, the study of the role of carbon footprint in extensive systems is of great interest by analysing, within a case study framework, the various production systems available in dehesa farms and providing the methodological adjustments required to generate results that are comparable with other livestock systems and species.

Results have revealed that beef farms with fattening calves are those with the lowest carbon footprint levels (8.62 kg of carbon dioxide equivalents ($CO_2$eq)/kg live weight), followed by meat production sheep farms and farms selling calves at weaning. Enteric fermentation accounts for64.10% to43.63% of the total emissions, and it is linked to the extensification of these systems and to the grazing diet of the animals. The system's own emissions could reach up to 78% in meat production systems. Undoubtedly, feeding is the input that amounts for the highest

percentage of off-farm emissions, as it can reach up to 44.60% of the total emissions in dairy sheep farms and 21.20% in the meat production sheep farms.

Soil sequestration has also been observed to rangebetween 270.02 and 334.01 kg $CO_2$eqha$^{-1}$ y$^{-1}$ in the extensive farms under study, which represents considerable carbon compensation. It should be noted that these systems cannot compete in product units with the more intensive ones and, therefore, carbon footprint in dehesa agroforestry systems should be referred to the territory.

## 1.1. Introduction

One of the challenges the world faces over the next decades is the preservation of its natural resources, at the same time as the production of sufficient food to satisfy the demand of the growing human population (Ibidhi et al., 2017). But with the growing concern about climate change and the already significant contribution of food production to the emission of greenhouse gases (GHG) (Herrero et al., 2013) there can be a need to compensate food production and GHG emissions.

In this context, calculating the Carbon Footprint (CF) of products has become increasingly popular. Carbon Footprint provides an estimate of the total GHG emitted during part or all of the life of a good or service (BSI, 2011), expressed as $CO_2$eq. It can be used to identify and assess environmental loads associated with a process, product or system, and this assessment allows for the examination of potential bio-physical trade-offs from proposed policies and other measures (Galli, 2015). Carbon Footprint is increasingly used in the food supply chain to determine the quantity of GHG emitted at each stage of the production process, and it may extend to the distribution and usage phases (Jones et al., 2014). Carbon Footprint also enables carbon labelling of products -therefore allowing sustainable consumer purchasing decisions-, and provides an emissions' benchmark against which mitigation targets can be set and progress measured.

The major reason for the widespread use of CF in food products is the attention that climate change has received on the global environmental agenda (Röös et al., 2011), as food production significantly contributes to the increasing human input to the GHG emissions. Thus, society has expressed concern about the environmental impacts caused by the growing need for food production to meet the global demand (Florindo et al., 2017).

The growing alarm over the environmental impacts and different characteristics of food has increased consumer interest in the production methods and other attributes of food products

(Forsman-Hugg et al., 2008), also spurring a flurry of discussion in the popular media regarding the climate impacts of livestock production and the comparative performance of feedlot and grass-based production systems (Pelletier et al., 2010). Thus, the concerns about reducing GHG emissions to mitigate climate change have recently promoted the assessment of the CF for various activities and products (Luo et al., 2015).

### 1.1.1. The importance of using CF in animal production systems

The environmental impacts of agricultural production depend to a great extent on the production systems, which can be influenced by techniques, harvesting period and other technical issues. This primary phase is seen as the main contributor to the environmental impacts of food, related to biodiversity loss, GHG emissions and reduction of soil fertility (Mohamad et al., 2014).

According to the FAO's report "Livestock's Long Shadow", the livestock sector is seen as a major contributor to some of the most serious environmental problems at local and global levels (Steinfeld et al., 2006). The livestock sector represents 12% of all human-induced GHG emissions, with the ruminant sector being responsible for 80% of these GHG emissions (Havlik et al., 2014). The report also implies that the livestock sector increasingly competes for scarce resources and causes severe impact on air, water and soil. Since its publication, public and scientific awareness about the impact of animal production on the environment has increased (Steinfeld et al., 2006).

Among livestock food products, meat causes the greatest environmental impact. This is due to the inefficiency of animals to convert feed to meat, as 75–90% of the energy consumed is needed for body maintenance or lost in manure and by-products such as skin and bones (Röös et al., 2013). There are many processes contributing to major GHG emissions during meat production, mainly: (i) production of feed, (ii) enteric fermentation from feed digestion by animals (mainly ruminants), (iii) manure handling and (iv) energy use in animal houses (Steinfeld et al., 2006).

Furthermore, GHG emissions associated with meat production can be effectively reduced through: (i) improvements in animal productivity and fertility; (ii) intensification of production as output/ha (provided that higher input requirements of feed and/or fertilizer are offset by higher levels of productivity); and (iii) soil $CO_2$ sequestration in grasslands (Beauchemin et al., 2008; Crosson et al., 2011).

Therefore, the analysis of the CF and the variables included in livestock production may identify procedures or techniques in which emissions can be reduced by improving efficiencies (Wiedmann and Minx, 2007). Table 1.1 shows the CF for various production systems and functional units (FU, the unit selected to express the results of the analysis, e.g. kg of meat or litre of milk produced) and reflects the inherent variability of this indicator.

Table 1.1. Carbon Footprint of various production systems and FUs.

| Type of product | Production system | Carbon footprint | Functional unit | References |
|---|---|---|---|---|
| Sheep/lamb | Pasture-based | 25.9 | kg $CO_2$eq/kg lamb live weight | (Ripoll-Bosch et al., 2013) |
| | Mixed system | 24.0 | kg $CO_2$eq/kg lamb live weight | (Ripoll-Bosch et al., 2013) |
| | Zero-grazing | 19.5 | kg $CO_2$eq/kg lamb live weight | (Ripoll-Bosch et al., 2013) |
| | Lowland farms | 10.85 | kg $CO_2$eq/kg lamb live weight | (Jones et al., 2014) |
| | Upland farms | 12.85 | kg $CO_2$eq/kg lamb live weight | (Jones et al., 2014) |
| | Hill farms | 17.86 | kg $CO_2$eq/kg lamb live weight | (Jones et al., 2014) |
| | Conventional system | 17.5 | kg $CO_2$eq/kg lamb meat | (Williams et al., 2006) |
| | Organic system | 10.1 | kg $CO_2$eq/kg lamb meat | (Williams et al., 2006) |
| | Agro-pastoral system - crop-residues | 26.6 | kg $CO_2$eq/kg carcass weight | (Ibidhi et al., 2017) |
| | Pastoral system using barley | 21.1 | kg $CO_2$eq/kg carcass weight | (Ibidhi et al., 2017) |
| Milk | Semi extensive and local breed | 3.8 | kg $CO_2$eq/kg corrected milk | (Batalla et al., 2015) |
| | Semi intensive and local breed | 3.02 | kg $CO_2$eq/kg corrected milk | (Batalla et al., 2015) |
| | Mixed | 1.11 | kg $CO_2$eq/kg corrected milk | (Gollnow et al., 2014) |
| | Intensive and local breed | 2.06 | kg $CO_2$eq/kg corrected milk | (Petersen et al., 2013) |
| | Extensive and local breed | 2.18 | kg $CO_2$eq/kg corrected milk | (Petersen et al., 2013) |
| | Extensive system in New Zealand | 1 | kg $CO_2$eq/kg of energy corrected milk | (Flysjö et al., 2011) |
| | Intensive system in Sweden | 1.16 | kg $CO_2$eq/kg of energy corrected milk | (Flysjö et al., 2011) |
| Beef | Extensive system | 4.8-8.2 | kg $CO_2$eq/kg live weight | (Ogino et al., 2016) |
| | Intensive system | 10.6 | kg $CO_2$eq/kg live weight | (Ogino et al., 2016) |
| | Extensive (pasture) system | 14.0 | kg $CO_2$eq/kg live weight | (Ogino et al., 2016) |
| | Conventional system | 15.5 | kg $CO_2$eq/kg live weight | (Edwards-Jones et al., 2009) |
| Pork | Conventional system from feed | 6.70 – 8.70 | kg $CO_2$eq/kg live weight | (Noya et al., 2016) |
| | Conventional system from feed | 5.46 | kg $CO_2$eq/kg live weight | (Dolman et al., 2012) |
| | Conventional system from feed | 3.34 | kg $CO_2$eq/kg carcass | (González-García et al., 2015) |
| Chicken meat | Industrial system | 2.6 | kg $CO_2$eq/kg carcass weight | (Ibidhi et al., 2017) |
| | Conventional production system | 2.2 | kg $CO_2$eq/kg carcass weight | (Wiedemann et al., 2017) |
| | Free range production system | 1.8 | kg $CO_2$eq/kg. boneless chicken meat portions | (Wiedemann et al., 2017) |

Strangely enough, at least when it comes to environmental issues, intensifying animal production is generally advocated to mitigate certain environmental impacts, such as the GHG emissions associated with the production of foods of animal origin (Steinfeld and Gerber, 2010). In this regard, the intensification of animal production in feedlots or through changes in their diet allows an early slaughter and has been reported to be a strategy adopted in several countries to reduce GHG emissions in beef production (Ruviaro et al., 2016).

With that in mind, many consumers are still unfamiliar with CF information, which makes it difficult for them to evaluate and compare the different products which are on offer (Kemp et al., 2010). However, meat companies are interested in finding out how different product characteristics can influence consumer choice and whether there is a possibility for a price premium to be added if products are differentiated using the CF attribute (Koistinen et al., 2013).This topic is especially relevant for extensive systems, in which the environmental values associated to livestock production can be overshadowed by the comparatively higher emissions of these production systems, as carbon sequestration by the environment (soil, plants …) is usually not considered.

In this context, the study of the role of CF in extensive systems is of great interest through the analysis-within a case study framework-of the various production systems available in dehesa agroforestry systems (Spanish rangelands) and through the provision of the methodological adjustments required to generate results that are comparable with other livestock systems and species.

## 1.2. Materials and methods

Among the various methodologies available to estimate the GHG emissions, Life Cycle Assessment (LCA) is an internationally accepted, standardised method used to identify and quantify the environmental impact of a product (Buratti et al., 2017), and it has therefore been selected for this piece of research. Through the entire life cycle of a product, LCA accounts resource consumption, energy, pollutant emissions, etc. (Goldstein et al., 2016).

The calculation of CF has been made in accordance with British Standard PAS 2050 and the IPCC guidelines for national GHG inventories (IPCC, 2006). An adaptation of the methodology quoted by the Spanish Ministry of Agriculture has also been followed regarding the characteristics of livestock in the analysed areas and manure management (MAPA, 2012). The

methodological procedure followed in this piece of research consisted of an LCA analysis of the CF taking into account the soil's carbon sequestration.

### 1.2.1. Data collection

This study is based on the analysis of four case studies, which were selected as the most representative types of dehesa farms. Although global system information may be lost when we deal with technical-economic aspects, the choice of representative farms within a case study analysis allows us to delve more deeply into complex issues(Ripoll-Bosch et al., 2012)such as those related with inventory data collection that are necessary both for LCA and for the calculation of the CF in farms. This methodological choice can be found in other research on CF such as that of (Stanley et al., 2018).The analysed farms are described below.

#### Extensive meat sheep farm

This farm is devoted to the breeding and extensive production of meat sheep using the native Merina breed. The holding is located on dry land pastures in the southwest of the Iberian Peninsula. Feeding of adult animals is based on the use of grazing resources provided by the farm. The main outputs of the farm are lambs, which are sold to abattoirs for slaughtering after a production cycle of 85-90 days.

#### Extensive beef/calf cattle farm

This holding corresponds to the traditional beef production from suckler cows raised in the rangelands in the Southwest of the Iberian Peninsula. It is based on the grazing of cows and calves in the dehesas, using the available resources of pasture and the woodland pruning waste. The main products obtained are calves sold at weaning age to other farms of feedlots where they are finished. The production cycle lasts approximately 6 months and the final life weight is around 450-550 kg.

#### Extensive beef/calf cattle farm with feedlot finishing of calves

This case is a typical cattle farm in dehesas with suckler cows but where the sold animals -calves-have been fed in a feedlot for several months. Although the system is purely extensive, the last phase -the finishing of the calves- has a semi-intensive character. The production cycle is

longer than the previous one, as it extends up to 12 months of the calf's life and the animals are sold to abattoirs for slaughtering.

Grazing dairy sheep farm

This holding is based on dairy sheep systems but taking advantage of marginal rain-fed grassland areas. In these systems, farms have grazing areas, a differential element compared to other models of dairy sheep production. The management is semi-extensive with the use of natural pastures and supplementation with straw and concentrates. Its main production is milk, while the lambs are just a by-product for the farm.

The data were obtained by monitoring the various farms with field visits and interviews with the farmers being carried out between January and May 2017. The data collected reflect the average state of the farms for the previous year.

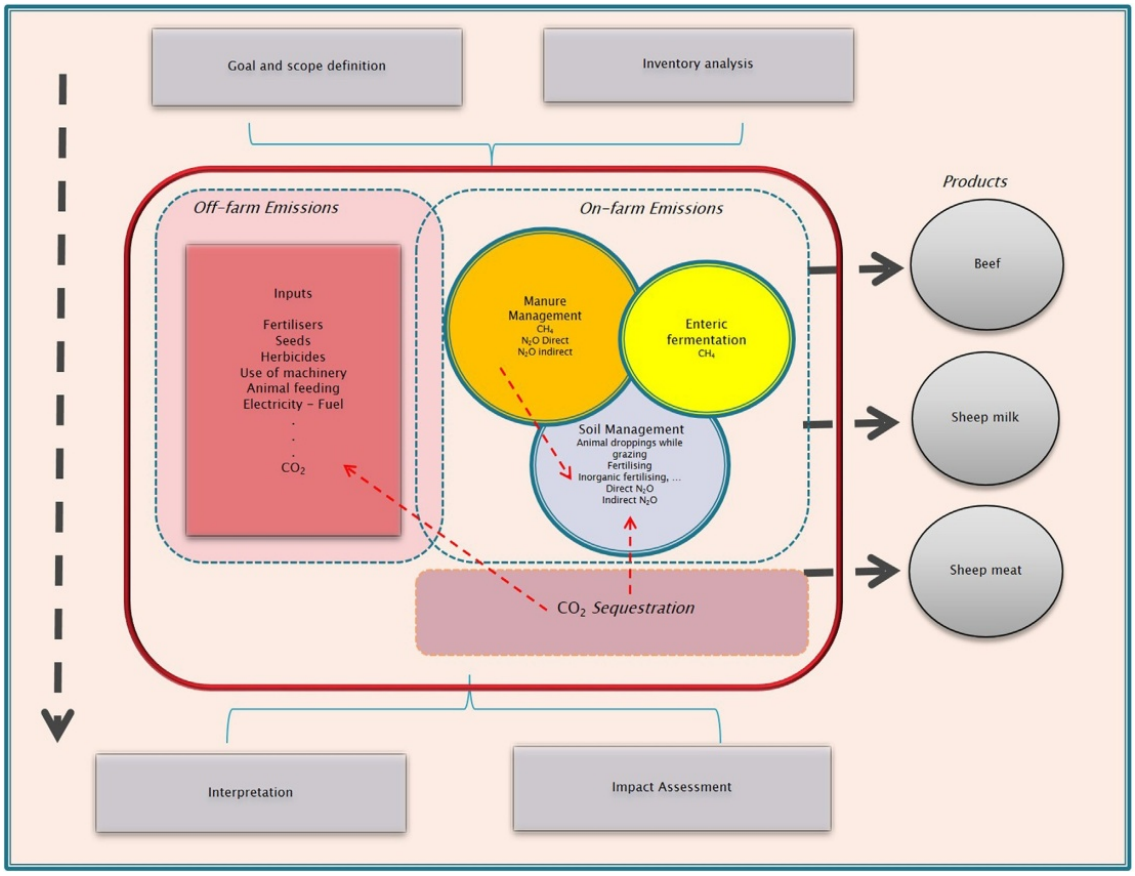
1.2.2. Definition of system boundaries and functional unit

System boundaries include all the emissions that are produced within the holding (enteric fermentation, manure management, management of soils...). It also includes the emissions from manufacturing and the transport for each input used in the system – feeding stuffs, consumption of fuel and electricity, etc.-. Figure 1.1 shows the various steps in this LCA study and the system boundaries.

Life Cycle Assessment uses the FU concept to compare various food products. In essence, the FU strives to provide a common basis of comparison between different means of achieving the same end (Owsianiak et al., 2014).

In this paper, the FU is the reference unit with which all the produced emissions of the system will be associated. The FU varies according to the analysed case and uses the main type of production in each system as a reference. In beef and sheep meat systems, the defined FU is the kg of live weight of product, i.e. the kg of live weight of lambs or calves. In dairy sheep systems the FU is a litre of milk. The FU is often based on the mass of the product under study (Cederberg and Mattsson, 2000). Therefore, mass allocation will be used as the method of assignment in this study.

Figure 1.1. Stages of LCA and system boundaries




1.2.3. Estimation of GHG emissions and calculation of CF level in farms.

There are various methodologies in the literature used in the estimation of GHG emissions and their contribution to the CF level of a product, organisation or service. For the purposes of this study it was decided that the IPCC guidelines for national inventories of GHG (IPCC, 2006) should be used.

All emissions are expressed in kg $CO_2$eq. Thus, it is necessary to use the concept of potential global warming, which is defined as the impact caused by a certain GHG for a period of 100 years. So, global warming potentials proposed by the IPCC (2007) have been used to convert the raw data of methane (CH4) or nitrous oxide sources (N2O) emissions. Each gas has a specific value, 1 for $CO_2$, 25 for CH4 and 298 for N2O. In this way, data from raw emissions of CH4 and N2O gases are multiplied by 25 and 298, respectively, in order to convert these data to kg $CO_2$eq.

In order to estimate the emissions, the emission factors of the gases produced by the system, in addition to the inputs shown in Table 1.2, have been used. These emission factors have been

taken from IPCC for most of the farming processes - enteric fermentation, manure and soil management. Local emission factors, adapted to the characteristics of livestock farming in the analysed areas and their manure management, have also been used according to MAPA (2012). Emission factors regarding the derived emissions from the inputs of the livestock systems were obtained from Bochu et al. (2013).

GHG emissions from animal feeding are caused by manufacturing and transport, including raw materials production, processing, packaging, storage and transport from the industry to the farm. The emissions from fossil fuels take into account the generation and combustion emissions. Electricity consumption in the farms derives from the use of lighting in the facilities, the operation of milking systems, the operation of machinery, etc.

Table 1.2. Emission factors used to quantify GHG emissions

| Emission and source | Type of GHG | Emission factors | Unit |
|---|---|---|---|
| On-farm | | | |
| Enteric fermentation | $CH_4$ | 8.64kg$CH_4$/per sheep a year[a]<br>57kg$CH_4$/per cow a year | Kg $CH_4$/year |
| Manure management | | | |
| Manure management $CH_4$ | $CH_4$ | 0.19 - 0.37 kg $CH_4$/per sheep a year[b]<br>2.23 kg $CH_4$/per cow a year | Kg $CH_4$/year |
| Manure management direct $N_2O$ | $N_2O$ | 0.005 kg $N_2O$ eN/kg N Solid storage system | Kg $N_2O$/year[c] |
| Manure management indirect $N_2O$ | $N_2O$ | 0.01kg$N_2O$ eN/volatilized | Kg $N_2O$ /year |
| Soil management | | | |
| N from organic fertilizers (compost, manure) | $N_2O$ | 0.01 kg $N_2O$ eN (kg N input)$^{-1}$ | Kg $N_2O$ /year |
| N from urine and dung inputs to grazed soils in Sheep | $N_2O$ | 0.01 kg $N_2O$ eN (kg N input)$^{-1}$ | Kg $N_2O$/year |
| N from urine and dung inputs to grazed soils in Cow | $N_2O$ | 0.02 kg $N_2O$ eN (kg N input)$^{-1}$ | kg $N_2O$/year |
| Indirect emissions | | | |
| Management Soils | $N_2O$ | 0.01 kg $N_2O$ eN (kg % Nvolatilised/leaching)$^{-1}$ | kg $N_2O$/year |
| Off-farm | | | |
| Concentrates Dairy sheep | $CO_2$ | 0.655 kg $CO_2$eq/kg | kg$CO_2$eq/year[d] |
| Concentrates Meat sheep | $CO_2$ | 0.512 kg $CO_2$eq/kg | kg$CO_2$eq/year[d] |
| Concentrates Meat cow | $CO_2$ | 0.513 kg $CO_2$eq/kg | kg$CO_2$eq/year[d] |
| Electricity | $CO_2$ | 0.308 kg $CO_2$eq/kWh | kg$CO_2$eq/year[e] |
| Fuel | $CO_2$ | 2.664 kg $CO_2$eq/litre-Combustion<br>0.320 kg $CO_2$eq/litre-upstream | kg$CO_2$eq/year[d]<br>kg$CO_2$eq/year[d] |

Most of the emission factors have been taken from IPCC Guidelines(IPCC, 2006)
a Emission factor adapted to the area (MAPA, 2012)
b With average temperature
c $N_2O$eN*44/28 ¼ N20.
d Bochu et al. (2013)
e MAPAMA(2017)

### 1.2.4. Inclusion of carbon sequestration in LCA. Calculation of compensated

Carbon sequestration refers to the changes in the levels of carbon (C) permanently stored in the soil. These changes take place in the soil of farms due to crop residues, grassland and manure.

Furthermore, the changes in the land use and the various management practices by the farm can significantly affect C levels in the soil.

In extensive farming systems, carbon sequestration in grasslands can be considered as a mitigation option (Soussana et al., 2010). However, it is not common to take into account carbon sequestration in the LCA. There are various methods that can be used to estimate carbon sequestration: for example, IPCC (2006) estimated the changes in soil C according to inventories and with a 20-year time horizon. For the purposes of this piece of research, it was decided that the balance of net C flows in the livestock-manure-grazing system proposed by Petersen et al.(2013) and later adapted to systems with similar characteristics to those analysed here (Batalla et al., 2015) would be used.

According to Batalla et al. (2015) the main difference between the chosen method and other methods is the use of a 100-year perspective in order to allocate the changes taking place in the soil's C levels. For our purposes it has been estimated that 10% of C added to the soil will be sequestered in a 100-year time horizon (Petersen et al., 2013).

### 1.3. Results

The analysed production systems are defined by their technical characteristics, their products or system outputs and their needs for input procurement. Table 1.3 includes a list of these parameters in the studied cases.

Table 1.3. Economic and technical indicators of the studied farms

| Indicators | Extensive meat sheep farm | Extensive beef/calf cattle farm | Extensive beef/calf cattle farm with feedlot finishing of calves | Grazing dairy sheep farm |
|---|---|---|---|---|
| Type of systems | Extensive | Extensive | Extensive Semi-extensive | Semi-intensive |
| Pasture area(ha) | 270 | 150 | 187.5 | 250 |
| Average annual temperature (ºC) | 16 | 18 | 20 | 16 |
| Kg DM pasture/ha | 1,100 | 1,200 | 1,200 | 1,000 |
| Permanent labour force (No. AWU) | 1 | 1 | 1 | 1 |
| Family labour force (No.AWU) | 1 | 0.3 | 0.5 | 1 |
| No. of reproductive sheep or cows (average population) | 900 | 50 | 73 | 600 |
| Livestock Units/ha | 0.46 | 0.36 | 0.40 | 0.30 |
| Lambs born per sheep | 1.12 | - | - | 1.2 |
| Calves born per cow | - | 0.81 | 0.84 | - |
| % Grazing time/year | 100 | 100 | 100 | 60 |
| Other economic activity | No | Yes | 50 in fattening No | No |
| Inputs purchased by the farm | | | | |
| Total kg Concentrate bought (per sheep or cow/year) | 105 | 417 | 1,495 | 225 |
| Fodder bought (per sheep or cow/year) | 60.71 | 1,221 | 1,595 | 200 |
| Fuel (litres/year) | 520 | 1,168 | 1,830 | 3,000 |
| Electricity (kwh/year) | 4,200 | - | - | 6,789 |
| Outputs produced by the farm | | | | |
| Lambs sold/ reproductive sheep | 1 | - | - | 0.8 |
| Calves sold/Cow | - | 0.74 | 0.79 | - |
| Average weight of sold lamb/calf | 25 | 220 | 400/550 | 22-25 |
| Kg concentrate/lamb or calf | 32.62 | - | 1,000/1,750 | 41.96 |
| Milk, litres/reproductive sheep | - | - | - | 350 |
| Kg concentrates/litre milk | - | - | - | 1.07 |
| Meat, total kg of lamb/calf meat produced | 25,300 | 9,020 | 27450 | - |
| Milk, total litres produced | - | - | - | 210,000 |

Table 1.3 shows how the farms under study correspond to systems ranging from the extensive (meat production) to semi-intensive (milk production). As a common characteristic, they all have animals being raised on grazing to a greater or lesser degree. This proportion of time devoted to

grazing decreases in dairy sheep and fattening calves, however it is 100% in meat sheep and in the farms selling calves at weaning age.

Farm sizes range between 150 and 270 hectares with stocking rates of 0.30 to 0.46 LU/ha. Born lambs range from 1.12 in meat systems to 1.20 in dairy sheep. The number of calves born per cow goes from 0.81 to 0.84. Generally, livestock activities are the only economic activity of the farm.

When the inputs of the system are analysed, fodder consumption is seen to become double in dairy sheep farms when compared to meat sheep systems. The resources needed for feeding also increase in beef farms which fatten calves. Fuel consumption is also higher in milk sheep farms because of the operation of milking rooms and the preservation of the milk in refrigerated tanks.

Table 1.4 includes the contribution of the various GHG in the four analysed systems expressed in kg $CO_2$eq per FU. It also includes the contribution percentage of the various production processes.

Table 1.4. Carbon Footprint per functional unit in the systems under analysis

| | Extensive meat sheep farm | | Extensive beef/calf cattle farm | | Extensive beef/calf cattle farm with feedlot finishing of calves | | Grazing dairy sheep farm | |
|---|---|---|---|---|---|---|---|---|
| GHG Emissions | kg $CO_2$eq/kg product | % | kg $CO_2$eq/kg product | % | kg $CO_2$eq/kg product | % | kg $CO_2$eq/l | % |
| Enteric fermentation $CH_4$ | 9.01 | 64.10 | 8.69 | 48.99 | 3.84 | 44.57 | 0.80 | 43,63 |
| Manure management | | | | | | | | |
| $CH_4$ | 0.25 | 1.78 | 0.41 | 2.32 | 0.33 | 3.88 | 0.02 | 1,16 |
| Direct $N_2O$ | 0.27 | 1.92 | 0.21 | 1.16 | 0.07 | 0.87 | 0.02 | 1,07 |
| Indirect $N_2O$ | 0.10 | 0.71 | 0.08 | 0.43 | 0.04 | 0.43 | 0.01 | 0,43 |
| Total manure management | 0.64 | 4.55 | 0.69 | 3.91 | 0.45 | 5.18 | 0.05 | 2,66 |
| Soil management | | | | | | | | |
| Direct $N_2O$ soil | 1.09 | 7.73 | 3.23 | 18.21 | 1.45 | 16.80 | 0.10 | 5,16 |
| Indirect $N_2O$ soil | 0.22 | 1.54 | 0.32 | 1.81 | 0.14 | 1.68 | 0.02 | 1,03 |
| Total soil management | 1.32 | 9.39 | 3.55 | 20.02 | 1.59 | 18.48 | 0.11 | 6,19 |
| Total On-Farm Emissions | 10.97 | 78.04 | 12.93 | 72.92 | 5.88 | 68.23 | 0.97 | 52,48 |
| Feeding | | | | | | | | |
| Fodder for sheep | 2.12 | 15.08 | - | - | - | - | 0.70 | 38,04 |
| Fodder for lambs | 0.66 | 4.70 | - | - | - | - | 0.05 | 2,71 |
| Silage for cows | - | - | - | - | 0.38 | 4.38 | - | - |
| Fodder for cows | - | - | 2.87 | 16.20 | - | - | - | - |
| Fodder for calves | - | - | 0.80 | 4.50 | 2.11 | 24.48 | 0.00 | 0,00 |
| Straw | 0.08 | 0.57 | 0.75 | 4.20 | 0.05 | 0.61 | 0.00 | 0,00 |
| Hay | 0.12 | 0.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 3,10 |
| Total Feeding | 2.98 | 21.20 | 4.42 | 24.90 | 2.54 | 29.47 | 0.81 | 43,84 |
| Electricity | 0.05 | 0.36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1,75 |
| Fuel | | | | | | | | |
| Burning | 0.05 | 0.36 | 0.34 | 1.94 | 0.18 | 2.06 | 0.03 | 1,72 |
| Production | 0.01 | 0.04 | 0.04 | 0.23 | 0.02 | 0.25 | 0.00 | 0,21 |
| Total Fuel | 0.06 | 0.40 | 0.39 | 2.18 | 0.20 | 2.31 | 0.04 | 1,92 |
| Total Off-farm Emissions | 3.09 | 21.96 | 4.80 | 27.08 | 2.74 | 31.77 | 0.85 | 47.52 |
| TOTAL CF kg $CO_2$eq/FU | 14.06 | 100.00 | 17.74 | 100.00 | 8.62 | 100.00 | 1.84 | 100,00 |
| | | | | | | | | |
| Total kg $CO_2$eq | 357,321 | - | 159,991 | - | 236,585 | - | 425,036 | - |
| Total kg $CO_2$eq per ha | 1,319.03 | - | 1,066.61 | - | 1,265.16 | - | 1,700 | - |

As Table 1.4 reveals beef farms with fattening calves are those with the lowest CF levels (8.62 kg $CO_2$eq/kg live weight), followed by meat sheep farms and by farms selling calves at weaning age. Enteric fermentation ranges between 64.10% and 43.63% of the total emissions, and it is linked to the extensification of these systems and to the grazing diet of the animals. The system's own emissions could reach up to 78% in meat production systems.

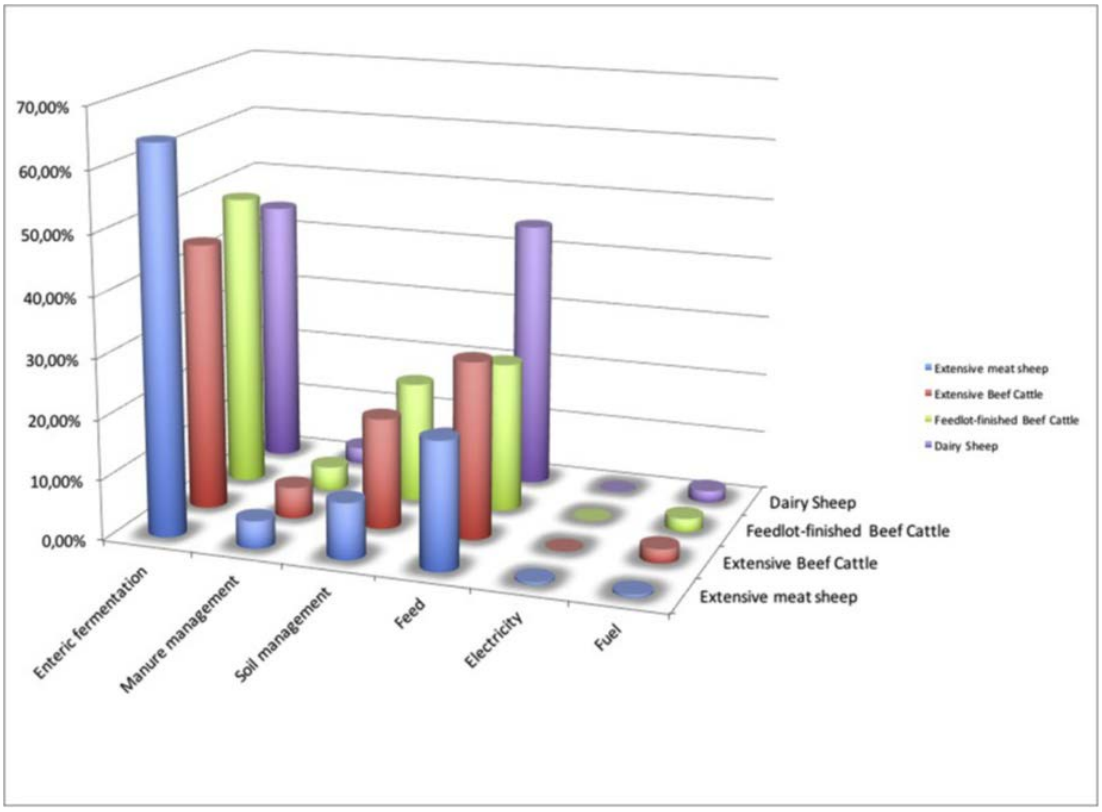
Undoubtedly, feeding is the element that amounts for the highest percentage of off-farm emissions. It can reach up to 43.84% of the total emissions in dairy sheep farms and 21.20% in the meat sheep farms.

Enteric fermentation and feeding are the factors with the highest variability, with their figures being largely subject to farming systems based or not on grazing, which also affects the final CF level. As shown, farms that need to purchase large quantities of off-farm feed for livestock tend to account for a lower carbon footprint per head taking into consideration the larger number of product units they produce.

Manure and soil management are also an important source of differences in GHG emissions, ranging from 6-9% in sheep farms to18-20% in beef farms. The higher value for beef farms is in accordance with other results found in extensive beef farms (Stanley et al., 2018), and can be related with the amount of N excreted per species and with the manure management system. It must also be considered that in extensive systems more than 90% of animal droppings are left directly on the soil.

Figure 1.2 shows the importance of the GHG emissions levels from the different livestock systems in terms of enteric fermentation, management of manure, soils and off-farm inputs (feeding stuffs, electricity and fuel).

Figure 1.2. Importance of the GHG emission levels by type of farm




Enteric fermentation has an important role in all the systems under analysis and especially in those with a purely extensive character based on grazing breeding animals. Meat sheep farms are associated to the highest percentage of emissions due to enteric fermentation, followed by beef cattle farms, where calves are sold at weaning age. Emissions from soil management are mainly found in beef cattle farms.

Despite the lower productivity level of the extensive systems with respect to other systems, they have a buffer capacity of CO2 emissions due to the waste biomass left in the soil. This factor is totally related to the level of pasture production and the land area of the farms. This buffering capacity is also due to the transformation process of N to C owing to the droppings of grazing animals and the applied manure.

Table 1.5 shows the estimation of carbon sequestration in the farms under analysis. It is based on the use of the carbon balance in the livestock-grazing system proposed by Petersen et al. (2013) and later adapted by Batalla et al. (2015). Table 1.5 includes pasture residues (differentiating between above-ground and below-ground contributions) and their transformation into carbon and then into $CO_2$. The transformation of the soil´s organic Nitrogen into $CO_2$ has also been taken

into consideration, whether it is generated during grazing or from the spreading of livestock manure.

Table 1.5. Carbon sequestration (kg $CO_2$eq/year) per farm

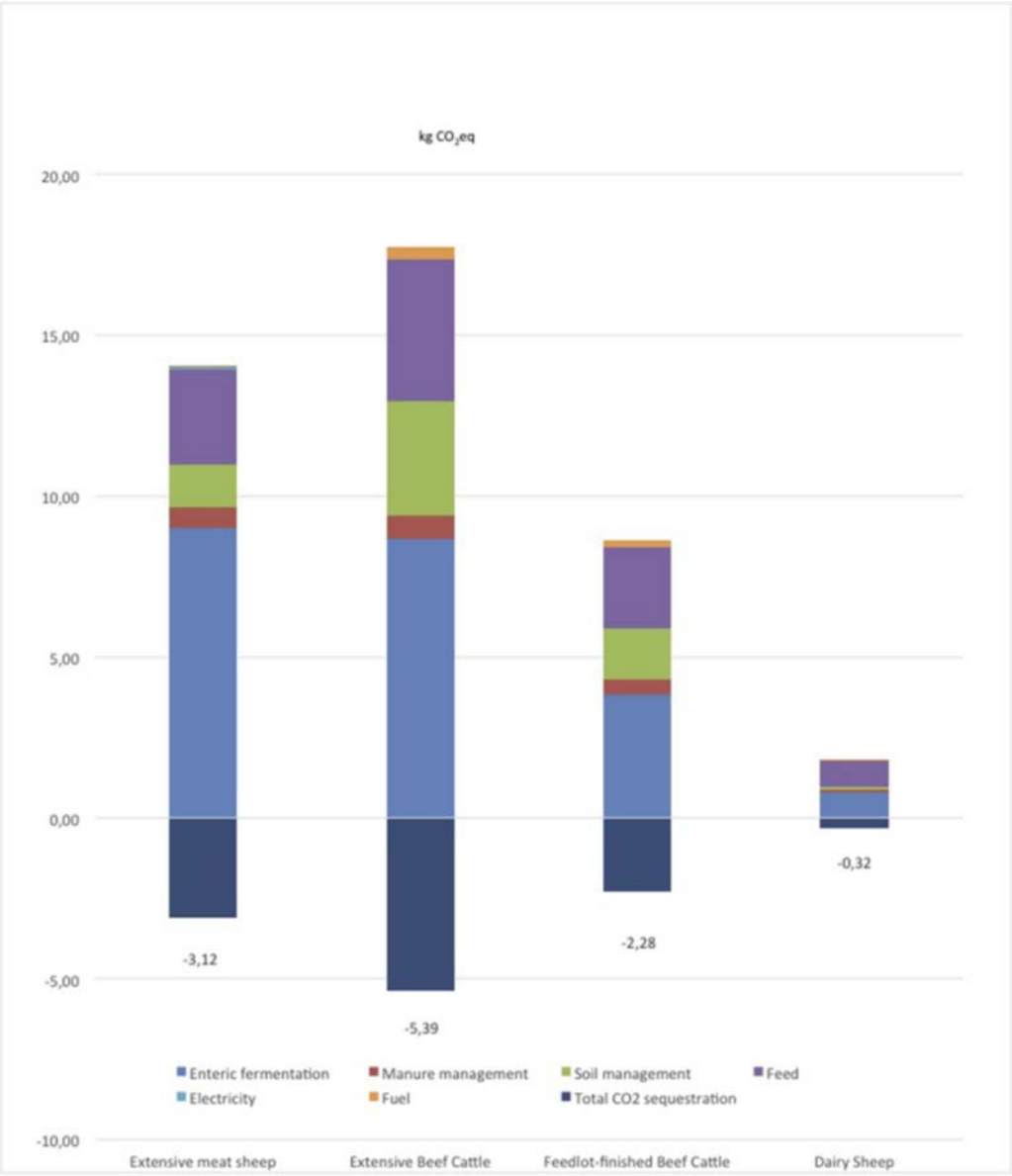
| $CO_2$ stored | Extensive meat sheep farm | Extensive beef/calf cattle farm | Extensive beef/calf cattle farm with feedlot finishing of calves | Grazing dairy sheep farm |
|---|---|---|---|---|
| C from pasture residues | | | | |
| Pasture residues (kg DM)[a] | 451,440 | 273,600 | 342,000 | 380,000 |
| Above ground kg C | 53,460 | 32,400 | 40,500 | 45,000 |
| Below ground kgC[b] | 149,688 | 90,720 | 113,400 | 126,000 |
| Total kg $CO_2$eq pasture | 744,876 | 449,973 | 564,300 | 627,000 |
| | | | | |
| C from organic N (manure and grazing) | | | | |
| kg N excreted | 9,011.35 | 3,833.96 | 5,339.34 | 4,872.43 |
| kg C from applied manure | 9,197.5 | 1,246.05 | 3,050.44 | 4,254.86 |
| kg C during grazing | 20,085.84 | 11,214.32 | 13,852.38 | 11,589.53 |
| Total kg $CO_2$eq manure-soil[c] | 107,372.09 | 45,688.02 | 61,977.00 | 58,063.12 |
| | | | | |
| Total kg $CO_2$eq per farm | 852,248.00 | 511,950.00 | 636,277 | 685,063.12 |
| Total kg $CO_2$eq manure-soil/ha | 397.67 | 304.59 | 331.42 | 232.25 |
| Total kg $CO_2$eq/ha | 3,156.47 | 3,304.41 | 3,340.14 | 2,740.25 |
| Total $CO_2$ sequestration (kg $CO_2$eq $ha^{-1}year^{-1}$[d] | 315.64 | 330.44 | 334.01 | 270.02 |

[a] It has been estimated that pasture residues account for 40% of the total production of pasture, with a C content of 45%.
[b] According to (IPCC, 2006) the default expansion factor for below-ground biomass in semi-arid pasturelands is 2.8
[c] The conversion factor for N to C is 13/4 and 44/12for C to CO2
[d] Annual C sequestration of 10% is considered

The final outcome on Table 1.5 reflects that an amount between 270.02 and 334.01 kg of $CO_2$eq/ha are stored each year in the extensive farms under study, which represents considerable carbon compensation. Finally, Figure 1.3 shows the compensated CF per FU. Positive values in Figure 1.3 represent the farms' emissions in kg of $CO_2$eq per FU, while the negative values

reflect the annual carbon sequestration in these systems -also in kg of $CO_2$eq per FU. Carbon sequestration is proven to be greater in extensive systems than in the semi-intensive ones.

Figure 1.3. Compensated CF per functional unit (kg of $CO_2$eq per FU)




## 1.4. Discussion

Livestock production is considered to be responsible for a significant impact on the environment, especially regarding GHG emissions. However, not all livestock production systems generate the same level of pollution, as extensive systems - such as the Spanish dehesas - have a territorial

component which compensates emissions with biological factors (soil, pasture, trees…)(Moreno and Pulido, 2009).

Although intensive production systems have been found to be more efficient economically than extensive production systems (Horrillo et al., 2016), intensive livestock production is widely regarded by consumers as having a more harmful impact on the environment. This is due to the livestock supply chain requiring significant resources in terms of feed, energy and water, the production of CH4, NH3 and other emissions to the air, together with pollution risks arising from inefficient waste management practices. However, the global warming potential shows that the higher the intensification of production, the lower the $CO_2$eq per kg of product.

In this context, CF and LCA have become common tools to assess the environmental impact of livestock systems, although this approach reveals some methodological weaknesses which can lead to inaccurate results. In this paper, LCA methodology has been followed as a basis for CF evaluation (McAuliffe et al., 2016). Nevertheless, the lack of consensus on a method selection-system boundaries, functional units, allocation approaches- and the assumptions under consideration hinder the feasibility of a comparative analysis against other studies (de Vries and de Boer, 2010; Edwards-Jones et al., 2009). Besides methodological differences, variability in results also reflects differences in animal productive systems, geographical locations and market conditions.

In this study, the main areas of production (cattle and sheep) found in dehesa agroforestry systems have been analysed regarding their CF.A clear relationship between intensification and lower CF per product unit has been identified, a result which is in agreement with previous studies such as those of Batalla et al. (2015)or Buratti et al. (2017).

Regarding the CF in beef production systems, this is one of the most widely discussed environmental issues within the current agricultural community, due to its association with climate change. In beef production, the total emissions -per kg of live weight-of an animal slaughtered with 430 kg live weight ranged between18.30 kg $CO_2$eq (502 days production cycle and intensive system) and 42.60 kg $CO_2$eq (840 days production cycle and extensive system) (Ruviaro et al., 2015). The results of this research are outside this range of values, as the CF of the beef farms under analysis varied from 8.62 kg $CO_2$eq (semi-extensive) to 17.74 kg $CO_2$eq (extensive), although the production cycles in dehesa farms are shorter. In accordance to the above-mentioned results, organic beef systems -usually more extensive than conventional due to

regulatory constraints-have been found to produce more GHG emissions (24.62 kg $CO_2$eq/kg live weight) than conventional ones (18.21 kg $CO_2$eq/kg live weight) (Buratti et al., 2017).

Sheep farming systems in Spain are generally pasture-based and extensive, although large differences in off-farm inputs utilisation, land use and intensification level exist. As a result, the GHG emissions of these systems varied between 19.5-25.9 kg $CO_2$eq per kg of lamb live weight in Northern Spain (Ripoll-Bosch et al., 2013)and12.48-25.97 kg $CO_2$eq per kg of lamb live weight in Andalusian dehesas (Batalla et al., 2014), with the later figures being similar to those obtained in our study, on account of the similarity of the systems.

There are also numerous studies dealing with the measurement of CF in dairy products. One of these studies was reported by Flysjö et al. (2014) who presented a model to calculate the farm-to-customer CF for different dairy products. The results from that study showed that the largest share of CF of dairy products is produced at farm level. In this context, CF in dairy sheep farms varies from 2.02 kg $CO_2$eq/litre of milk in semi-intensive farms to 5.17 kg $CO_2$eq/litre of milk in semi-extensive farms (Batalla et al., 2015). Such figures are in line with those obtained in our study, where semi-intensive farms produce 1.84 kg $CO_2$eq/litre of milk.

In ruminants, CH4 production depends on animal type and size, and on feed intake and its digestibility. Emissions of CH4 decreases as feed digestibility increases (Beauchemin et al., 2008). As intensive systems generally rely more on highly-digestible concentrates, a decrease is expected in CH4 emissions when intensification level increases (Gerber et al., 2011). The findings of our study are in line with this argument, as CH4 in extensive meat sheep farms is 64.1% while in dairy sheep the figure goes up to 43.63%.In this sense, improving the quality of feed and the general efficiency of the use of nutrients in the diets are effective practices to reduce the GHG emissions per unit of animal product.

When soil sequestration is considered, CF in extensive production improves and reaches lower values than those of intensive farms. In this context, the compensated CF –including carbon sequestration- in our study has been reduced by 20-30% as compared to the baseline figures, with a higher reduction on those systems more linked to the territory. Trees play a central role in the carbon cycle and therefore the quantification of the balance between carbon emission and carbon sequestration is one of the main challenges if carbon sequestration is to become a management objective of dehesa agroforestry systems (Montero et al., 2005). Although carbon stocks in dehesa areas are currently known, no information on annual sequestration due to the

tree layer is available. Therefore, this aspect has not been considered in this paper even though it should be taken into account as one of the objectives of future research.

Nevertheless, some estimations can be done for the period of maximum tree growth (100 years) from data of Howlett et al. (2011) and Ruiz-Peinado et al. (2013) for soils and vegetation, respectively. Assuming a temporal frame of 100 years to explain the differences between soil C beneath trees and in open grasslands, carbon sequestration for soils can be estimated at 48.1 kg C $ha^{-1}$ $y^{-1}$ for a typical dehesa with 35 trees per ha and canopies 10 m in diameter (27.5% of canopy cover). Carbon accumulated in these trees in the same 100 years can be estimated at 300 kg C $ha^{-1}$ $y^{-1}$. Overall, carbon sequestration is estimated in the order of 350 kg C $ha^{-1}$ $y^{-1}$. Indeed, the above-mentioned values fall into the lower part of the range reported by Nair et al. (2009) for agroforestry systems (290-15,210 kg C $ha^{-1}$ $y^{-1}$).

Apart from the above mentioned role of trees in extensive dehesa systems, another important challenge is the accurate adjustment of the emissions due to extensive cattle ranching. In this sense, if pasture was not consumed by livestock it could be thought that the emissions due to rotting vegetation and to the microbial flora of the soil would increase. Therefore, in an adjusted system of emissions, these should be discounted from those of livestock. Accordingly, the level of respiration of the ecosystems, and the increase of $CO_2$ storage associated with grazing have been studied by Gomez-Casanovas et al. (2018).

The fact that the estimation of carbon sequestration has followed a conservative approach with a time horizon of 100 years, as opposed to the one proposed by IPCC -20 years-(IPCC, 2006; Petersen et al., 2013) must be taken into consideration. Similarly, the CF figures found would have also been substantially higher if the proposal developed by Vleeshouwers & Verhagen (2002) had been applied, as the emissions they found for grasslands were1.907 kg $CO_2$eq$ha^{-1}$ $y^{-1}$.

## 1.5. Conclusions

Life Cycle Assessment is a useful tool for measuring the potential environmental performance of livestock production. LCA may be combined with other methods to assess economic sustainability of animal production in order to reveal on-farm efficiencies. It also could help to reduce both environmental and monetary costs associated with animal rearing.

The clear definition of LCA models is essential for a comprehensive and detailed assessment of the environmental burden associated with the production of food products. This clarification is

important especially when results of LCA studies are used to define policies and initiatives aiming at reducing the environmental impact of animal production systems and to achieve sustainable food supply. According to this study, there is a need to develop a common framework to assess CF in order to reinforce the reliability of LCA as a decision-support tool.

Direct comparison between the production systems is very difficult due to the optimised nature of commercial livestock rearing and the difference amongst the functional units used in the systems. However and likewise other studies, a clear and inverse relationship between intensification and CF per product unit has been found. This is due to the higher efficiency of intensive production systems, which implies that each unit produced in an intensive farm requires less inputs than its equivalent in an extensive holding.

However, extensive farms usually have a territorial component (hectares of agricultural land, with pastures, trees…) which can help to compensate for $CO_2$ emissions, due to C sequestration. Nevertheless, it is not common to take into account carbon sequestration in LCA studies, which creates a disadvantage for extensive systems, and can send confusing messages to the consumers and endanger the persistence of these valuable and complex systems.

### 1.6. Acknowledgements

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# CHAPTER 2: Perception of Spanish consumers towards environmentally- friendly labelling in food.

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**Resumen**

El consumo de alimentos es una de las áreas más importantes que afectan a la sostenibilidad ambiental, ya que es responsable de un tercio del impacto ambiental total de un hogar. Sin embargo, muchos consumidores no son plenamente conscientes de la asociación entre su consumo de alimentos y las consecuencias medioambientales. Recientemente, algunas empresas del sector han desarrollado esquemas de etiquetado para ayudar a informar a sus consumidores sobre el impacto que un producto alimenticio específico tiene sobre el medio ambiente durante su proceso de producción.

El objetivo principal de este estudio es descubrir las percepciones y actitudes de los consumidores hacia estas etiquetas ambientales y su impacto en las decisiones de compra de los consumidores. En este documento, se eligieron cinco etiquetas de sostenibilidad, que cubren aspectos tanto éticos como ambientales. Se adoptó un enfoque de grupo focal (Focus Group) debido a su capacidad para explorar creencias, percepciones y experiencias. Se realizaron cuatro sesiones de grupos focales con 36 participantes en total. Los datos han sido analizados utilizando un programa cualitativo específico (Atlas.ti). Finalmente, los resultados fueron presentados y discutidos en cuatro secciones principales explicadas a lo largo del manuscrito: decisión de compra de alimentos, etiquetas sociales y ambientales, información sobre etiquetas y razones de compra, y finalmente, disposición a pagar por etiquetas certificadas. Los resultados de este estudio muestran que, aunque los consumidores tienen actitudes positivas hacia los atributos de sostenibilidad en los productos alimenticios, todavía existen restricciones que impiden su materialización en su comportamiento de compra.

**Perception of Spanish consumers towards environmentally- friendly labelling in food**

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**Abstract**

Food consumption is one of the most important areas to influence environmental sustainability since it is responsible for one third of a household's total environmental impact. However, many consumers are not completely aware of the association between their food consumption and the environmental consequences. Recently, some food companies have developed labelling schemes to help inform their consumers of the impact a specific food product has on the environment during its production. The main objective of this study is to uncover consumers' perceptions and attitudes towards these environmental labels and their impact on consumers' purchase decisions. In this paper, five sustainability labels, covering both ethical and environmental aspects, were chosen as examples. A focus group approach has been taken due to its adequacy to explore beliefs, perceptions and experiences. Four focus group sessions took place with 36 participants in total. The data has been analysed using a specific qualitative program (Atlas.ti). Finally, the findings were presented and discussed in four main sections explained throughout the manuscript: Food purchase decision, Social and environmental labels, Information on labels and reasons for purchase, and lastly, Willingness to pay for certified labels. The results of this study show that, although consumers have positive attitudes towards sustainability attributes in food products, constraints still remain that prevent their materialisation in their purchasing behaviour.

**Keywords**: Eco-labelling, Focus group, Sustainable labels, Consumer perception.

## 2.1. Introduction

There has been a rapid and significant increase of awareness of the environmental pressures relating to human activities among local authorities, enterprises and individuals over the last years (Asdrubali, Presciutti, & Scrucca, 2013).In this context of environmental issues such as global warming, air and water pollution, the general concerns about the environment have become increasingly pressing public issues (Saba & Messina, 2003), and awareness of environmental issues seems to be growing (Vermeir & Verbeke, 2006). Additionally, ethical awareness, including concerns about the fair distribution of wealth and the use of child labour, seems to have become more salient (Carrigan Carrigan, Szmigin, & Wright, 2004; Carrington, Neville, & Whitwell, 2010).

According to Tukker, Eder, and Suh (2006), food production affects the environment and accounts for almost one-third of the environmental impact. This sector is widely known as one of the major impacting sectors, due to its main contribution to land occupation and use (Bonamente, Pelliccia, Merico, Rinaldi, & Petrozzi, 2015)). Production and food supply employ natural resources in their processes, thus generating environmental impacts (Bollani, Bonadonna, & Peira, 2019). Some of the impacts are the exhaustion of the resources, environmental pollution, acidity of the waters, deterioration of biodiversity, increase of the greenhouse gas emissions, excessive water consumption and therefore, the increase of the planet’s global temperature. No doubt that these environmental impacts have consequences on human health and consumers are increasingly aware of it when purchasing food (Richter, 2014).

Furthermore, food consumption is one of the most important areas where environmental sustainability can be improved since it is responsible for one third of a household's total environmental impact (European Environmental Agency, 2005). Many consumers however give little thought to the association between their consumption and the environmental impact of food production (Grunert, Hieke, & Wills, 2014). Behavioral change in food consumption can be powerful in reducing the use of natural resources (Gerbens-Leenes & Nonhebel, 2002).

Over the last three decades, a number of public and private initiatives have attempted to communicate sustainability-related information about food to consumers, introducing in-store and on-pack labels and logos (European Commission, 2012). In this context, sustainability can be defined as the attribute of something that is ecologically rational, economically feasible, socially fair and culturally acceptable (Agrillo et al., 2015). In the food industry, sustainability is one of the several quality requirements (Peri, 2006).One of the main reasons for this growing

interest in sustainability in the food sector is that consumers are changing their behaviour to integrate sustainable and environmental considerations into their lifestyle choices (Smith & Marsden, 2004).

In the food system sustainability becomes multidimensional, including food safety and ethical aspects (Aschemann-Witzel, Ares, Thøgersen, & Monteleone, 2019; Bollani et al., 2019). Sustainable production leads to economic growth at the same time as allowing for the preservation of the natural resources by means of their rational use and the generation of less waste. In conclusion, the integration of an important ethical component in its definition makes the agrifood system appropriate these attributes and integrate them within the concepts of circular economy and product quality.

Labelling has been given an increasingly important role in achieving sustainability goals, providing consumers with the opportunity to consider the environmental, social and ethical impacts of their food choices (Van Loo, Caputo, Nayga, & Verbeke, 2014). Some studies have shown that eco-labelled products are gaining ground throughout Europe; Brugarolas, Martinez-Carrasco, Bernabeu, and Martinez-Poveda (2010) revealed that Spanish consumers were interested in purchasing eco-labelled wine and were willing to pay a premium price for it. Also, In Belgium organic chicken has a 1.9% market share (Van Loo et al, 2014). The number of buyers of organic-labelled meat has doubled in Belgium since 2005 (Samborski &Van Bellegem, 2013).The European Commission(2009) showed that 72% of a sample of EU citizens believe that a label indicating a product's carbon footprint should be mandatory in the future, as there is high demand from the consumers for food products with carbon footprint labels.

The case of EU Eco-label is also very curious, since it has been recently awarded to thousands of different products across Europe**.** In 2019, 1,575 licenses have been awarded to72,797 products and services available on the market, thus showing an 88% increase in the number of EU Eco-labelled products/service since 2016. The highest number of licenses were awarded in France (19.5%), followed by Germany (18%), and Spain **(**12%) (European commission, 2019).

While the growth in sustainability labels and accompanying communication initiatives may be interpreted as a sign of success, and sales of products carrying sustainability labels are reported to have increased, label overload and gaps in the understanding of both the general concept of sustainability and of specific sustainability labels may result in consumer confusion and limit the use of such labels (Comas & Seifert, 2012).In turn, misunderstanding of these sustainable labels

may lead consumers to have limited ability to act in accordance with their interest in climate-friendly behaviour and change their buying decisions towards sustainable products (Katajajuuri, Silvennoinen, Hartikainen, Heikkilä, & Reinikainen, 2014).

In addition, consumers are becoming more aware of the unintended negative impacts of food production (Gadema & Oglethorpe, 2011). However, consumers' attitudes have not translated into corresponding purchase behaviours (Carrington et al, 2010), as there are many barriers such as price, quality, availability, convenience, or time needed to source sustainable alternatives (Johnstone & Tan, 2014).

In order to reduce information asymmetry and consumer perceived skepticism with regard to sustainable products, companies must build trust attributes such as labels into their products (Thogersen, Haugaard, & Olesen, 2010). This in turn depends largely on the societal awareness of these issues and the availability of data and tools to effectively communicate these products (Galloway et al., 2014).

Although some food companies and grocery stores have developed labelling schemes to help inform their consumers about sustainability, these labels typically focus on a specific environmental impact. Taken together, these indicators may provide information about how a specific food product affects the environment during its production (Leach et al., 2012). The combination of the various footprints and identification of their sustainable values can help identify the human environmental footprint and the reductions that are necessary to approach sustainability (Hoekstra &Wiedmann, 2014).

However, most of the research in sustainability seems to focus on a single issue in a specific context rather than on a variety of sustainable behaviours (Thogersen & Olander, 2003; Papaoikonomou, 2013). Only a few recent studies have investigated both environmental and social-ethical behavior (Sirieix, Delanchy, Remaud, Zepeda, & Gurviez, 2013; Van Herpen, Nierop, & Sloot, 2012; Zander & Hamm, 2012).

In contrast with many other recent studies in the literature, which used one or two labels focusing on only one pillar of sustainability, this study has included both the environmental and social (ethical) dimensions. Moreover, in this study five different labels have been chosen as examples for measuring understanding and use. Four of the labels deal with the environmental dimension of sustainability (Rainforest Alliance, Carbon Footprint, Water Footprint and Sustainable label) while one of the labels deals with the ethical dimension (Fair Trade), with considerable

differences being expected regarding consumer awareness and understanding of the labels. Furthermore, all five labels are used internationally and can be considered most widespread in their use on food and drink products.

Given the limitations, an appropriate approach towards understanding consumer perceptions and behaviour when choosing food and the influence of the environmental and social aspects on the food purchasing process would be to apply qualitative research techniques (Roininen, Arvola, & Lahteenmaki, 2006; Vidal, Ares, & Giménez, 2013).Qualitative research methods give us a unique insight into opinions and perceptions. This research method is very appropriate when exploring opinions, attitudes and experiences (Vermeire et al, 2002).It enables a preview of the attitude, opinion, perception, behaviour and consumer habits towards food products (Hashim, Resurreccion, & McWatters, 1996).

Among qualitative techniques, the use and application of focus groups has a long history in market research where they have been used for a range of consumer-related marketing purposes (Morgan, 1997).Focus groups provide a deep understanding of participants' experiences and beliefs by creating a process of sharing and comparing, facilitating an understanding of issues in depth and in context (Morgan, 1998).They are considered one of the most important methodologies generally used in marketing and consumer research (Krueger, 2014).

Moreover, their application allows for major issues to be addressed, such as understanding the perceptions, preferences and consumer behavior in relation to a product category; or finding the expressions, language and concerns of a segment of consumers (Morgan & Krueger, 1998); or getting impressions on the concepts of a new product, getting participants interpretations of results from earlier studies (Marshall & Rossman, 1999).

Indeed, the main advantage of the focus groups is that they allow much more freedom of expression from the participants than other methods. With this method, the attendants choose the way in which they will answer, allowing interaction, debate, and exchange of views during the discussion with the other participants, adding complexity to the qualitative information (Dransfield, Morrot, Martin, & Ngapo, 2004)

In this study, focus groups were used to explore the perceptions and attitudes of consumers towards sustainability labels and to identify those factors regarding the environmental and social aspects of food products that affect consumers' purchase decisions. This paper also aims to get an overview of the willingness to pay for this type of labelling, an aspect that could limit or

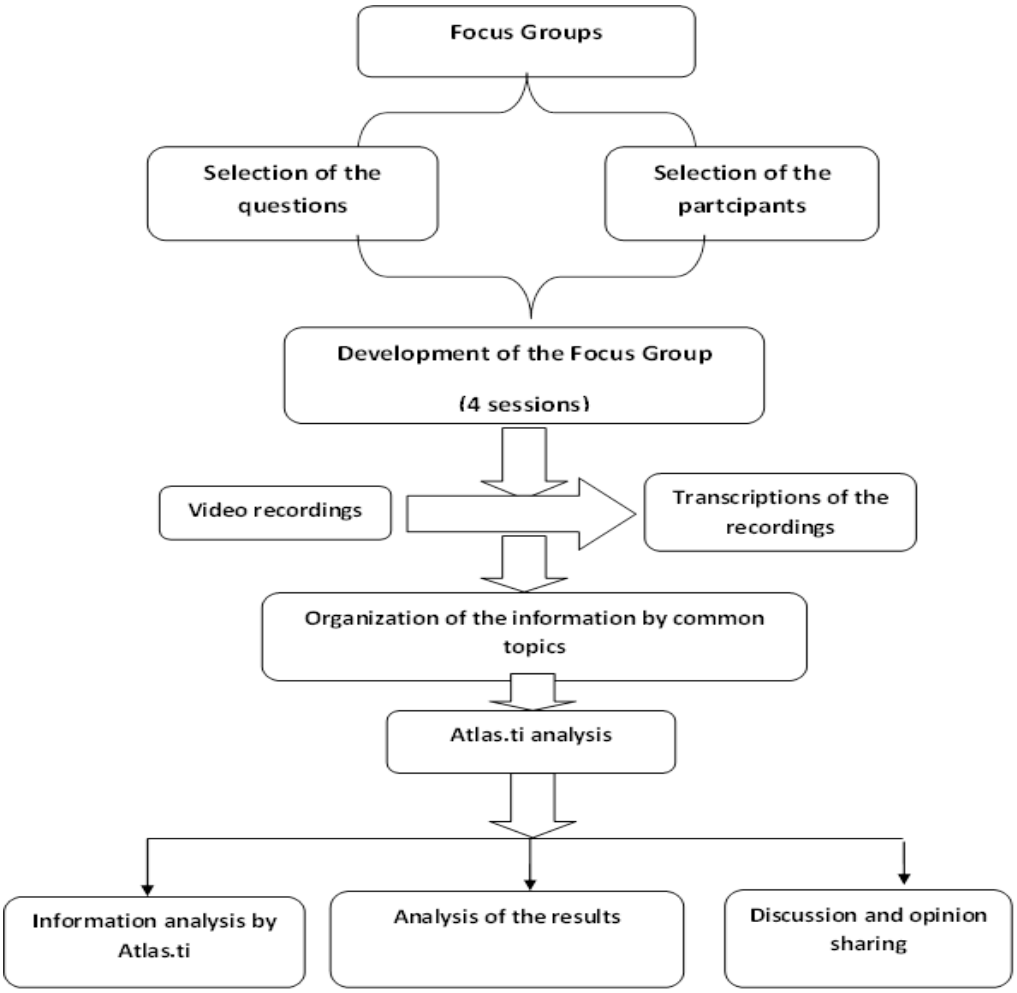
enhance the growth of this type of products. Our research will help fill the knowledge gap between companies and consumers regarding a relevant aspect for the competitiveness of the agri-food sector, as is their role in climate change mitigation and care for the environment.

## 2.2. Materials and Methods

### 2.2.1. Focus group: procedure and development

Figure 2.1 shows the procedures followed during the focus group sessions carried out for this piece of research.

Figure 2.1: Methodological procedures of focus group.




At the beginning of each focus group, the researcher outlined the study purpose and introduced a presentation to explain the meaning of the concepts for the various labels. All participants were given a one-page explanation of the study, which included a consent to videotape the session (all

group discussions were video-recorded). For better illustration, Table 2.1 shows examples of the various labels that were given to the participants. The focus groups lasted between 70 and 90 minutes. The focus groups sessions were moderated by the first author who took the notes from each focus group.

Table 2.1. Selected labels and message details.

| Labels | Description | Logos |
|---|---|---|
| Fair Trade | Label that guarantees that production has taken place under adequate working conditions and fair prices | FAIRTRADE |
| Carbon Footprint | Label that informs consumers about the product's environmental impact in terms of taking into account the carbon emissions at every stage of the lifecycle. | $CO_2$ |
| Rainforest Alliance | Label that indicates that the products were obtained using agricultural practices that had a low impact on the environment and were also socially responsible. | RAINFOREST ALLIANCE CERTIFIED EST 1987 |
| Water Footprint | Label that promotes the efficient use of fresh water resources in the production of the goods and services consumed by the individual or community or produced by the business. | Water Footprint |
| Sustainable Products | Label that indicates that the products provide environmental, social and economic benefits while protecting public health and the environment over their entire life cycle, from the extraction of raw materials until the final disposal. | PLS PRODUCTOS LÁCTEOS SOSTENIBLES ¡En beneficio de todos! |

The moderator started the discussion by introducing himself and informing participants that there were no right or wrong answers to the questions, but rather just personal opinions and beliefs. Subsequently, the participants were asked to briefly introduce themselves, and the discussions commenced.The discussion began with questions about food purchase decisions, social and environmental labels, information on the labels and the reasons for purchase, and finally the willingness to pay for the certified labels. Table 2.2 shows the script followed by the moderator during the various focus group sessions.

All the participants received a gift worth € 5 as an incentive for their participation. Finally, as a validity check, participants were sent a summary of the focus group discussion and were asked to comment on whether this was a fair and accurate reflection of the session. Also the participants were given the opportunity to provide further comments.

Table 2.2. Guideline to conduct the four focus group sessions.

| Questions |
|---|
| (Food purchase decision) |
| 1. What are the main attributes that influence your decision when purchasing food products? |
| 2. Does the environmental aspect play any role in your decision? |
| 3. And what about the social aspects (fair wages, adequate working conditions and fair prices received by farmers)? |
| 4. What does the concept of sustainability mean to you? Does this concern you? What do you think about it? |
| 5. What do you think about climate change and the environment? |
| (Social and environmental labels) |
| 6. Were you aware of the labels you were presented with previously? Have you ever seen them in a store or on the Internet, etc.? Do you know what information is being provided to the consumer? |
| 7. Could these labels affect your perceptions towards food products? |
| (Information on the label and reasons for purchase) |
| 8. Do you think that these labels really inform the consumer about the environmental impacts caused by food production? If yes, is it easy to deduce the information from the labels? |
| 9. What are the main reasons for your purchase of social or environmental food products? If you have no reasons, why are you not concerned about the degradation of our planet? |
| (Willingness to pay and certified labels) |
| 10. Would you pay more for food products with this type of labeling? |
| 11. Do you think it is necessary for these labels to be officially certified (AENOR or other official certification) to provide increased guarantees to the consumer? |

### 2.2.2. Data collection

The nature of the focus group methodology is to promote interactive discussions on topics prompted by a moderator in a permissive and non-threatening environment (Krueger, 2014). It has been used for its adequacy to explore beliefs, perceptions and experiences (Fern, 2001). Focus groups are generally integrated by 8 to 12 people who have not previously met each other and who are selected because they share certain characteristics relevant for the study's questions.

In this study, four focus group sessions were held with a total of 36 participants, whose sociodemographic characteristics are shown in Table 2.3.

Table 2.3. Sociodemographic characteristics of the participants in the focus groups (n=36) in the region of Extremadura (Spain)

| | | % |
|---|---|---|
| Gender | Men | 47 |
| | Women | 53 |
| Age | 18-35 years | 31 |
| | 36-55 years | 50 |
| | > 55 years | 19 |
| Education | Primary/ Secondary | 28 |
| | University | 72 |
| Employment | Student | 19 |
| | Employee | 78 |
| | Retired | 3 |

Due to the nature of the study, it was decided that all the participants should be at least partially responsible for food purchasing in their household. For this purpose the method used was convenience sampling, a non-probability method commonly used in qualitative research when the aim is to obtain an approximation to a specific topic (Kinnear & Taylor, 1993). Sessions were held at the University Campus of Badajoz and Caceres (Spain) between December 2017 and February 2018.

### 2.2.3. Data analysis

After each focus group, a report summarising the main points of interest was generated, as there was a previous debriefing with the research team regarding the main points of interest. The video recordings of the focus groups were transcribed and made anonymous for subsequent analysis.

The transcriptions were then edited for clarity and summarised by removing comments unrelated to the discussion before being analysed.

The analysis of the information collected was carried out using the content analysis technique (Stewart & Shamdasani, 2014). Content analysis attempts to obtain valid and replicable inferences from texts, with an aim to reduce the source material (Flick, 2002).The data were initially processed and organised into common subjects using qualitative software Atlas.ti 7.0. The ideas and concepts repeatedly mentioned during the sessions were classified into categories. Subsequently, and with the purpose of providing an overview of the relative importance of the various concepts that emerged throughout the sessions, we proceeded to determine the frequency of mention, which was obtained by counting the number of consumers who had used the relevant words or phrases within each category.

In order to improve the validity of the findings, and given the qualitative nature of the research, analyst triangulation was used to carry out the analysis, a procedure frequently used in qualitative surveys (Antmann, Ares, Salvador, Varela, & Fiszman, 2011; Da Silva et al., 2014; Eldesouky, Pulido, & Mesias, 2015).

## 2.3. Results

This section presents our findings in relation to the four general themes of the discussions: Food purchase decision, social and environmental labels, information on labels and reasons for purchasing, and finally, the willingness to pay and certified labels, which are further explained through a set of sub-themes that emerged from the qualitative analysis (Table 2.4). The themes are not mutually exclusive and independent, but somewhat overlapping. Finally, tables 2.5 to 2.8 show the main comments associated to the various topics of discussion. It must be highlighted that there were no specific issues emerging for any individual gender or age group.

Table 2.4. Key themes and sub-themes

| Theme | Sub-themes |
|---|---|
| Food purchase decision | Price, quality, brand and labels, environmental and social aspects, origin, sustainability and climate change. |
| Social and environmental labels | Fair trade label, need for information and consumers' perceptions. |
| Information on the labels and reasons for purchase | Lack of information, awareness of labels, their meaning and trust in labels. |
| Willingness to pay for certified labels | Official certification, consumer guarantee and trust in labels. |

### 2.3.1. Food purchase decision

Table 2.5 shows the main comments regarding the food purchase decisions of the attendants to the focus groups. With regard to the general opinion of the participants, price is the main factor and this depends on the financial status of consumers. The majority of participants reported that certified labels and the information provided by these labels about the product and its characteristics play an important role in their purchase decision; Many participants stated that "price is very important, also the labels and information on labels about the product and its characteristics". On the other hand, some participants stated that the quality of the products is an important attribute, and it may be more important than the price during their purchase. A participant said that "the quality of the products is a fundamental factor as for example, in the case of organic milk for the children". In addition, other participants mentioned that the product brand name makes consumers trust the products and leads to consumer trust in the labels. Additionally, some participants said that the origin of the products is an essential attribute to determine their buying decision, as they prefer Spanish products and products produced in countries near to Spain, which are considered as more environmentally friendly due to the near distance.

Moreover, many participants stated that environmental issues play an important role in their decisions. A few participants mentioned that these aspects don't play any role in their buying decision, while some participants reported that the level of consumer education and/ or training affects their level of awareness of environmental issues. In this sense, a higher degree of consumer training often runs parallel with a better understanding of environmental issues, and these consumers even show a greater degree of sensitivity or willingness to consider them as relevant attributes during their purchases.

Additionally, other participants reported that they prefer buying organic products and they suggested that organic products should be placed in the same section in the supermarkets in order to make it easy for consumers to choose between products; one of them said "I buy organic products to protect nature and the environment". Some participants mentioned that time affected the purchase process as sometimes there is no time to read labels or considering the environmental aspects during the buying process.

With regards to social aspects, the majority of participants mentioned that these aspects influence their buying decisions of food products, although they don't take them into account during the

food purchasing process, as they mainly look for price and quality. But some of them indicated that trust in the label or the brand, awareness and the meaning of these labels are very important to provide more guarantees on the production cycle of the products and securing the social conditions for the workers: One participant reported that "brand name and brand or label trust are major attributes that drive our buying decisions".

Furthermore, many participants reported that, in spite of being aware of the current environmental and social issues, this does not mean they would buy the sustainable products at a higher price. Some of them reported that producers must adjust the prices of sustainable products to be acceptable for consumers, while other participants linked sustainability to the packaging of the products and their capability for being recycled. Finally, they reported that climate change is an essential and dangerous issue for the environment and that people must consider it, but they did not know the relationship between this and their consumption of food, which could indicate a clear lack of information. A few of them mentioned "this issue relates to producers and how they care about the environment during the production cycle of the products".

Table 2.5. Comments about food purchase decisions and their percentages mentioned by the participants

| Comment | Percentage |
|---|---|
| Price is the major factor influencing the purchase decision. | 86.1% |
| Product quality is a main attribute influencing food choice. | 80.6% |
| Environmental and social aspects affect the purchase decision. | 69.4% |
| Specific brands lead to trust in food products. | 66.7% |
| The Spanish origin of food products is an essential factor. | 61.1% |
| Certified labels play an important role in the purchase process. | 47.2% |
| Climate change is an essential and dangerous issue. | 11.1% |

### 2.3.2. Social and environmental labels

Table 2.6 summarises the remarks made by the participants regarding environmental and social aspects. All of the participants stated that they are only aware of the fair trade label. While, some of them reported having seen some of these labels before, they did not know the meaning of each label. In addition, they had seen some of these labels (mainly fair trade and rainforest alliance labels) on the Internet. A few participants said that they had seen the Carrefour's sustainability label before, but they did not know the meaning of it. As a consumer stated, "I had

seen this label before in the supermarkets or the Internet, but I did not know the meaning of it, as there is a need for more information".

Table 2.6. Comments about social and environmental labels and their percentages mentioned by the participants

| Comment | Percentage |
|---|---|
| The fair trade label is the most common label. | 61.1% |
| Other factors such as price and purchase time are more important for consumers. | 44.4% |
| There is a need for more information about these labels. | 38.9% |
| There is a lack of knowledge about the meaning of each label. | 30.6% |
| The awareness of the label and the trust placed in it influence consumers'perceptions towards food product. | 22.2% |
| Some participants had seen some of these labels on the Internet. | 13.9% |

In addition, many participants had no knowledge of the information provided by the labels. Some of them mentioned that they didn't trust these labels, especially the fair trade label. Some participants said that they had heard about the water footprint before, but they were not aware of the label. Others suggested the importance of having the concept of each label written near the products that contained it in the markets. Attendants also mentioned that they had not heard anything about the carbon footprint label before the session, although they had seen it on some products.

Regarding consumer perceptions of the labels, some participants said that these labels did not affect their perceptions towards food products, because there are other more important factors for them, such as price and purchasing time-the time required to make a purchase. One of them said "these labels do not have any effect as there are other attributes that are more important during the purchasing process".

Additionally, other participants mentioned that these labels affect their perceptions due to their concern about the environment; however, it depends on the product. Some participants mentioned that awareness of a label and label trust influence their perception towards the products. Finally, participants reported that the problem is the lack of consumer awareness, but perhaps the information will become more public in the future.

### 2.3.3. Information on the labels and reasons for purchase

Table 2.7 shows the main remarks on this issue. Concerning the information displayed on the labels, the majority of participants mentioned that these labels are not clear for them to deduce the information they include. A few of them stated: “Labels do not indicate or inform consumers about the environmental impacts”. Furthermore, they recommended that each label should bear a clear message that may be more obvious to consumers. One of the respondents said: “It is not easy to understand or infer the information, especially from the water and carbon footprint labels”.

Regarding the reasons for social or environmental purchase of food products, many participants reported the awareness of the labels and their meaning, together with the trust in these labels, however there is a need for the labels to gain more trust. Some of them stated: “There are main reasons, such as the trust of consumers in the label or the brand of a product”. They also mentioned that the price of these products should be close to the price of other products in the same category, rather than twice the price of other products. Other participants stated that they take into account the protection of the environment and the improvement of the life and social conditions of the workers. Additionally, one of the attendants said that he looked for the quality of food products more than for these social or environmental aspects, as the purchase of these products depended on the economy and educational factors. They believed that there is no relationship between the degradation of our planet and the purchase of these products. However, one of them said: “Packaging and recycling of the product may be important in this matter”.

Table 2.7. Comments about information and reasons for purchase and their percentages mentioned by the participants.

| Comment | Percentage |
|---|---|
| The importance of label awareness and its meaning, and the trust in these labels. | 91.7% |
| These labels do not allow consumers to clearly deduce the information. | 66.7% |
| There is lack of information about these labels. | 61.1% |
| The price of these products must be near to the price of other products in the same category. | 44.4% |
| There is no relationship between the degradation of our planet and the purchase of these products. | 25% |

2.3.4. Willingness to pay for certified labels

Finally, Table 2.8 shows the comments concerning the last section of the focus groups. Many participants mentioned they would pay more for the food products with this type of environmentally labelling, but it depended on the difference between the price of these products and that of other products in the same category, as they would pay more for these products but a little more over the price (10% - 20%) in comparison with the products of the same category. Some participants reported that it depended on the product quality, the budget destined to purchasing food, the economic level of consumers and the characteristics of the products. One of the participants said: "There is no problem in paying more if I like and trust the brand".

In addition, it was also widely regarded as important that these labels be certified with official certifications in order to generate more trust and reliability. All the participants mentioned that it is essential for consumers to have more guarantees and gain them more trust in these labels. In their own words: "With this certification there will be more guarantee and more trust in these labels".

Table 2.8. Comments about willingness to pay and certified labels and their percentages mentioned by the participants.

| Comment | Percentage |
|---|---|
| Official certification of the labels is very important for consumers. | 100% |
| Certified labels provide more guarantees to the consumers and make them trust these labels more. | 94.4% |
| Many participants would pay more for these products. | 88.9% |
| There is a small difference between the price of these products and other products in the same category. | 66.7% |

## 2.4. Discussion

2.4.1. Food consumers and the most important factors

The factors that were considered most relevant during the focus group sessions of this study (price, brand name, environmental and social aspects, purchasing time, quality of the product and its origin) are frequently mentioned in consumer research as some of the determining attributes guiding consumers' purchase decisions of environmentally-friendly food products (Annunziata, Ianuario, & Pascale, 2011; Annunziata & Scarpato, 2014; Meise, Rudolph, Kenning, & Phillips,

2014). Additionally, these factors have been addressed in other studies relating to consumer behaviour towards conventional products (Dantaset al., 2011; Eldesouky & Mesias, 2014). This consensus may somehow show the behaviour of consumers towards food purchase decisions.

In this context, price is the major factor affecting the purchase decision of sustainable products (Annunziata & Scarpato, 2014; Barrena & Sanchez, 2010; Verain, Dagevos, & Antonides, 2015). In this sense, Gleim and Lawson (2014) found that product, price and availability are the typical external barriers to sustainable consumption and especially for carbon footprint-labelled products.

Additionally, Roos and Tjarnemo(2011) mentioned that high price is one of the main barriers to buying sustainable products. However, Meise et al. (2014) found that consumers who buy green products do not consider the price as an obstacle to their purchase.

Furthermore, some participants stated that food quality is the most important aspect regarding their choice of food. This behaviour is in line with the research made by Brunsø, Fjord, and Grunert (2002) who reported that the expected quality motivates consumers to buy certain food products. Additionally, Feng, Feng, Tian, and Mu (2012) reinforced the argument of quality and safety being the most important factors affecting consumers' purchase decisions of food products.

It is evident that brand name is an essential factor affecting the purchase decision. In this sense, Rana and Paul (2017) mentioned that brand equity has a strong influence on the perceived quality and consumer buying behaviour in the organic food market. These results are similar to those of Hanzaee et al. (2011), who found that brand loyalty is one of the main factors determining consumer's purchase choices of food products. Also, Ares, Giménez, and Deliza (2010) reported (2010) reported that brand name is a key factor influencing consumers' choice of functional yoghurt.

It is noteworthy to highlight the influence of product origin in purchasing decisions, a factor that has also been stated in other studies (Kim, 2008) which indicated that information about the country of origin had an important impact on consumer choice behaviour, because consumers relate this information with food safety. Papanagiotou, Tzimitra-Kalogianni, and Melfou (2013) also presented product origin as one of the most salient factors for consumers' purchase decisions, being even more important than price. In line with these findings, Grunert et al. (2014)

found that consumers preferred locally-produced products, as they considered that transportation of food over long distances was not good for the environment.

2.4.2. Are the social and environmental aspects relevant?

In harmony with our findings about the social and environmental aspects influencing the purchase decision of consumers, Grebitus, Lusk, and Nayga (2013) indicated that consumers are becoming more interested in the environmental labels as their concern grows about the environmental impact of food. Additionally, Torjusen, Lieblein, Wandel, and Francis (2001) showed that consumers considered the ethical, environmental and social factors as being very important when it came to choosing food products. In this context, consumers have positive preferences towards sustainability labels (Van Loo et al., 2014) and the environmental concern affects the attitudes of consumers towards green products or sustainable products (Aman, Harun, & Hussein, 2012). Within the context of the tendency towards green products in farming and especifically in the production of food, consumers have been seen to use attributes such as green, eco-friendly or sustainable indistinctively to name products causing a lesser impact on the environment, either at the production, use or distribution stages. Therefore, consumers who are more aware of the environmental and social concerns are more likely to purchase sustainable products (Sirieix et al, 2013).

However, the limited availability of sustainable products is often associated to the non-continuous presence of these products in supermarkets or to their inadequate visibility in the stores (Annunziata et al., 2011) and this could affect their purchase (Van Herpen et al., 2012). Finally, Annunziata and Scarpato (2014) reported that the low level of information available in the market, but also the limited availability of time consumers have to do theirshoppingare the main reasons behind the limited purchase of these products.

Hartikainen, Roininen, Katajajuuri, and Pulkkinen (2014)) indicated that the fundamental reason for the lack of success of carbon footprint labels is consumers' low level of awareness of the carbon footprint labels. Also, Gadema and Oglethorpe (2011) reported that most consumers felt confused when trying to comprehend carbon footprint labels. Therefore, consumers' lack of knowledge influences negatively on climate-friendly buying decisions (Zander & Feucht, 2018).

Equally, the consumption of fair trade goods has gained in popularity over the last years due to the growing interest in business ethics. Corporate social responsibility issues have stimulated consumers and producers to provide a more sustainable and more ethically-oriented production

and consumption (Kirezli & Kuscu, 2012). However, fair trade products are not well known by consumers (Annunziata & Scarpato, 2014).

The consumers' knowledge of the social and environmental issues positively affects their attitude and purchase behaviour towards organic food products (Smith & Paladino, 2010).Thus, labels are probably the most effective marketing tool used to inform consumers, to stimulate positive attitudes and foster the selection of sustainable products over conventional ones (Prieto-Sandoval, Alfaro, Mejía-Villa, & Ormazabal, 2016).

2.4.3. Information on the labels

Concerning the information on the labels and the reasons for purchase, the findings resulting from this paper are coherent with those of other authors. McDonald and Oates, (2006) stated that information is crucial, as consumers are usually interested in seeking detailed information about the products, their production cycle, origin and environmental footprint of sustainable products. In addition, Cerri, Testa, and Rizzi (2018) mentioned that a lack of information about product sustainability could also be a barrier preventing people from selecting more environmentally friendly products.

Similarly, other researchers such as Pickett-Baker and Ozaki (2008) showed that the lack of adequate provision of information to consumers could prevent them from identifying green products. This is in line with the research of Vecchio and Annunziata (2013), who found that the lack of information represents a significant obstacle to the widespread practice of sustainable food consumption. Finally, the lack of knowledge and increased confusion regarding the concept of sustainable food choices is associated with the unawareness of the logos and labelling (Grunert, Verbeke, Kügler, Saeed, &Scholderer, 2011).

Moreover, Kimura et al. (2012) mentioned that consumers' intention to purchase fair-trade products is influenced not only by an individual's intrinsic motives, but also by extrinsic social factors such as the improvement of the life of workers or their social conditions. They also stated that the knowledge of the labels and standards can play a significant role in influencing consumer purchase decisions of sustainable products (McEachern & Warnaby, 2008). Thus, consumers of sustainable goods look for information and wish to be continuously informed on the characteristics of the products to guide their purchase behaviour (Stolzenbach, Bredie, Christensen, & Byrne, 2013).

### 2.4.4. Willingness to pay

Consumers when purchasing pay more attention to other variables such as the brand name and price, while the environmental and social attributes are still considered as a secondary factor (Annunziata & Scarpato, 2014). Shuai, Ding, Zhang, Guo, and Shuai (2014) indicated that the level of education and monthly income were identified as the major influencing factors for carbon-labelled products.

On the subject of willingness to pay a premium for certified labels, the results of the focus groups have been confirmed by different researchers. Zander and Hamm (2010) noticed that consumers are willing to pay price surcharges of 10% for Fair Trade-labelled products. Also, VanDoorn and Verhoef (2011) found that consumers are willing to pay a price premium of up to13% for organic products. Additionally, Aprile, Caputo, and Nayga (2012) indicated that certified labels promote the purchase of sustainable products and discourage the purchase of conventional products.

In this respect, labelling certifications promoting animal welfare and reduced environmental impacts in beef production systems may be considered additional values by Japanese consumers (Sonoda, Oishi, Chomei, & Hirooka, 2018). Similarly, Deliana (2012) reported that official certification is an important factor which encourages consumers to buy organic food.Therefore, certified labels gain more trust and reliability in consumers' minds when they have been certified with official certification (Noblet & Teisl, 2015).

## 2.5. Conclusions

A focus group study was conducted to determine the perception of consumers and their attitudes towards environmentally-friendly labelling in food products. The results of this study show that despite the positive attitude shown by the consumers to products characterised by sustainability attributes, there are still several factors that limit the transformation of this attitude into real acts of purchase.

In this sense, it is deemed as necessary to make these products more accessible to a greater number of consumers, as currently, the higher price and reduced distribution are barriers to their development and expansion. Equally, lack of awareness of these products and even the lack of differentiation against conventional products are determining for their success in the market.

This fact limits the consumption of these products to certain economic segments or segments that are more ethically sensitive towards them.

If we want to effectively reinforce the social and environmental impact of food labels, it is necessary to provide additional information so that consumers can understand and value them. Sustainability labels give consumers the opportunity to take into account environmental and ethical considerations when making food choices. In this sense, they could be used as a valuable tool to improve marketing strategies, differentiate products and enhance their competitiveness in the market.

In the same way, in order for these products to be successful the sustainability aspects must be included within the product quality criteria or a production model, where the private and public sectors play an important role. Such is the case that the information provided to the consumer on the potential benefits of a product, its manufacturing and environmental impact are transcendental. In this context, the certification and labelling programs highlighting sustainability of a food product are strategies that guarantee their differentiation.

Finally, sustainable labels can help consumers compare across and within food product types and make more sustainable and environmentally conscious decisions. The incorporation of these labels onto food products could both increase public awareness of the environmental impacts associated with food production as well as support producers who provide sustainable products.

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# CHAPTER 3: Consumer Assessment of Sustainability Traits in Meat Production. A Choice Experiment Study in Spain.

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**Resumen**

Los consumidores están cada vez más preocupados por la forma en que se producen los alimentos. Esto es particularmente relevante en el caso de la carne debido a los impactos que sus métodos de producción pueden tener sobre las emisiones de gases de efecto invernadero y su papel en el cambio climático. En relación con este tema, el objetivo de nuestra investigación es obtener más información sobre el proceso de toma de decisiones del consumidor en relación a la carne de vacuno con el fin de determinar la importancia relativa de los atributos de sostenibilidad y de los tradicionales, e identificar perfiles de consumidores con percepciones y actitudes de compra similares. Se utilizó un experimento de elección para evaluar la influencia de estos atributos en las decisiones de compra del consumidor. Los resultados revelan que la mejor opción de compra para el consumidor sería la carne orgánica, producida en España, con una etiqueta de bienestar animal y una etiqueta ecológica. Luego, se realizó un análisis de conglomerados utilizando las creencias y actitudes de los consumidores hacia el consumo de carne, junto con las variables de comportamiento de compra. Se obtuvo una solución con tres segmentos de consumidores bien definidos que muestran diferentes patrones de preferencia: Grupo 1 (millennials masculinos indiferentes en su comportamiento hacia el medio ambiente o la sostenibilidad), Grupo 2 (mujeres maduras preocupadas por la sostenibilidad) y Grupo 3 (comedores de carne de mediana edad con familias). Los resultados de este estudio son relevantes para desarrollar estrategias más apropiadas que puedan adaptarse al comportamiento y las expectativas de los consumidores de alimentos ecológicos.

## Consumer Assessment of Sustainability Traits in Meat Production. A Choice Experiment Study in Spain

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### Abstract

Consumers are increasingly concerned about the way their food is produced. This is particularly relevant in the case of meat due to the impacts that its production methods can have on greenhouse gas emissions and its role in climate change. In relation to this issue, the purpose of our research is to obtain more information on the consumer decision-making process for beef in order to determine the relative importance of sustainability claims and traditional attributes and identify consumer profiles with similar perceptions and intentions. A choice experiment was used to assess the influence of these attributes on consumers' purchasing decisions. The results reveal that the best purchase choice for the consumer would be organic beef, produced in Spain, with an animal welfare label and eco-labelled. Later on, a cluster analysis was carried out using consumer beliefs and attitudes towards meat consumption as inputs, together with purchasing behaviour variables. A solution was obtained with three well-defined consumer segments showing different preference patterns: Cluster 1 (Male millennials indifferent towards environment or sustainability), Cluster 2 (Sustainability-concerned mature women) and Cluster 3 (Middle-aged meat eaters with established families). The results of this study are relevant to develop more appropriate strategies that may be adapted to the behaviour and expectations of eco-friendly food consumers.

**Keywords:** consumer preferences; beef; choice experiment (CE); willingness to pay; sustainable marketing; eco-friendly products; country of origin (COO); greenhouse gas emissions (GHG).

## 3.1. Introduction

During recent years, there has been growing public interest in food products produced using sustainable or ethical production methods [1]. In this regard, the increased demand for environmentally-friendly food products is associated with a growing interest in the sustainable use of resources and thus, in future wellbeing [2]. In general, consumers are increasingly aware of the fact that sustainable consumption is fundamental to protect the natural environment, counteract ongoing climate change and ensure social justice [3,4]. In this sense, livestock products largely contribute to greenhouse gas emissions (GHG) and climate change [5]. Moreover, consumers prefer products identified as sustainable to conventional products based on animal welfare, environmental or social reasons [6,7]. On the other hand, the extent to which consumers value and respond to environmentally-friendly food products through value-consistent behaviour still remains a questionable point [8].

Such concerns should ideally lead consumers to be willing to pay higher prices for products that have been produced in respect of ethical/environmental attributes, such as animal welfare, health-related features or aspects related to environmentally-friendly production systems [9]. This is especially relevant in the animal production sector, where many consumers expect animal welfare and other social and ethical attributes to be taken into account in the production processes of these foods [10–12].

Furthermore, consumer preferences for meat products are reflected in a multi-factor interaction that is shaped by multiple aspects, both related to marketing and to the sensory properties of meat [13–15]. These aspects range from life events, cultural ideas, personal factors, resources, social factors and choice context, as well as personal characteristics [14].

Nowadays, interest in the environmental and social production externalities is increasing and so is the market share of meat products with sustainability labels [16]. Consumers are no longer concerned just with adequate economic returns, but also with environmental sustainability [17]. Consequently, there has been a tendency for consumers to become more environmentally conscious, and therefore for more willingness to contribute to environmental protection.

The scope of this piece of research is to analyse various attributes involved in the purchasing decision of meat with special attention to those that are based on the production method, sustainability and animal welfare. In contrast with the large number of studies that only analysed

the willingness to pay (WTP) for animal welfare or sustainability attributes [18–20], only a few studies have segmented consumers according to preference for a broader range of sustainability-related attributes (animal welfare, environmental impact and production method) as well as for the more traditional product characteristics (e.g. country of origin and price) [21–23].

Several alternatives are available for the analysis of consumer preferences [24] with choice experiment (CE) being one of the most relevant techniques due to its capacity to study preferences for "complex goods", as it is the case of food products. Conditional logit, a model of CE, has been applied in this paper [25–27]. In this sense, the use of the CE to evaluate consumer preferences towards meat attributes has been reported by various authors [28–33].

Within this framework, the main purposes of this paper are: (i) to gain more insights on the consumer decision-making process for purchasing beef; (ii) to determine the relative importance of sustainability claims and traditional attributes underlying the purchasing intention of Spanish consumers of beef by applying the CE technique; (iii) to identify profiles of beef consumers with similar perceptions and intentions; (iv) to characterise these profiles according to their socio-economic features and behaviour.

This paper is structured as follows. First of all, the following section presents a literature review on the concepts of sustainability claims and food purchasing. Subsequently, section 3 details the data collection procedure and methodology applied for this piece of research. In section 4 the paper deals with the main findings of this piece of research and discusses them in light of previous research on the topic. Finally, section 5 outlines the main conclusions of the study and indicates some recommendations for stakeholders together with guidelines to improve future research.

### 3.2. Literature review

Literature on environmental sustainability labels has improved the understanding about what may lead consumers to choose such labels and the corresponding products. For example, [34] reported that a sustainability label is the most efficient method to increase consumer ability to choose an environmentally friendly food product. Also, [35] and [36] showed that many consumers are displaying increased awareness and preference for environmental sustainability, as well as a greater willingness to pay for socially and environmentally-responsible labelled products.

Ecolabelling is an increasingly used tool being used to differentiate food production and stimulate informed purchasing decisions, thus creating economic incentives for producers to adopt environmentally-friendlier technologies. Food products with eco-labels have been found to be preferred by consumers [37,38]. Moreover, [39] has shown that consumer stated preferences for eco-labelled goods increase with environmental consciousness and decrease with price-orientation. In addition, [40] revealed that consumer desire to preserve the environment is a key concern when choosing eco-labelled products.

In this context, over the last three decades various product standards certifying sustainable production and labels communicating sustainability-related information about the production method of food products have been put in place [41]. The standard of organic production has been one of the most widely known to consumers, both in Europe and the rest of the world, with organic food products becoming suitable examples of sustainable food due to their lower environmental impact[42,43].

[21] found that consumers place increasing importance on the extrinsic quality attributes of meat products in response to rising concerns on safety, health, convenience, ethical factors, etc. Nevertheless, a study carried out with European consumers on their awareness of sustainability issues -such as carbon footprint, animal welfare or Fair Trade- found that consumer concern does not necessarily translate into purchasing behaviour, due to the various trade-offs consumers need to consider when shopping. Furthermore, a lack of transparency, credibility, and availability of information about ethical characteristics of production can also reduce the role of ethical product attributes in decision-making [44].

In parallel to the development of markets for sustainable food products, the geographical origin of food has become more important for consumers. Consumer preferences for the country of origin (COO) have been studied in various contexts [45–47]. Moreover, a recent study showed that COO might be an important product attribute to target a wider range of consumers and to differentiate markets for sustainable food products [1]. However, some consumer segments that are interested in sustainable production have also been found to place little importance on COO [1,48].

In addition, there is plenty of evidence that COO affects consumer food choices and that consumers are more willing to buy food products originating in some countries than others

[49,50]. Nonetheless, knowledge about the COOs that are preferred by consumers for their food remains insufficient and seems to differ by food product type [51].

Furthermore, previous studies suggested that animal welfare was a significant determinant and an important reason for the purchase of eco-friendly produced foods [52,53]. Animal welfare is receiving increased attention by consumers and is seen as an emerging quality attribute that is linked to specific food products such as beef, with many exporting countries often having this type of certification available [47]. Consumers are concerned about the way animals are bred, fed, and how animals are taken care of. However, animal welfare is often not the most important choice attribute in meat [54].

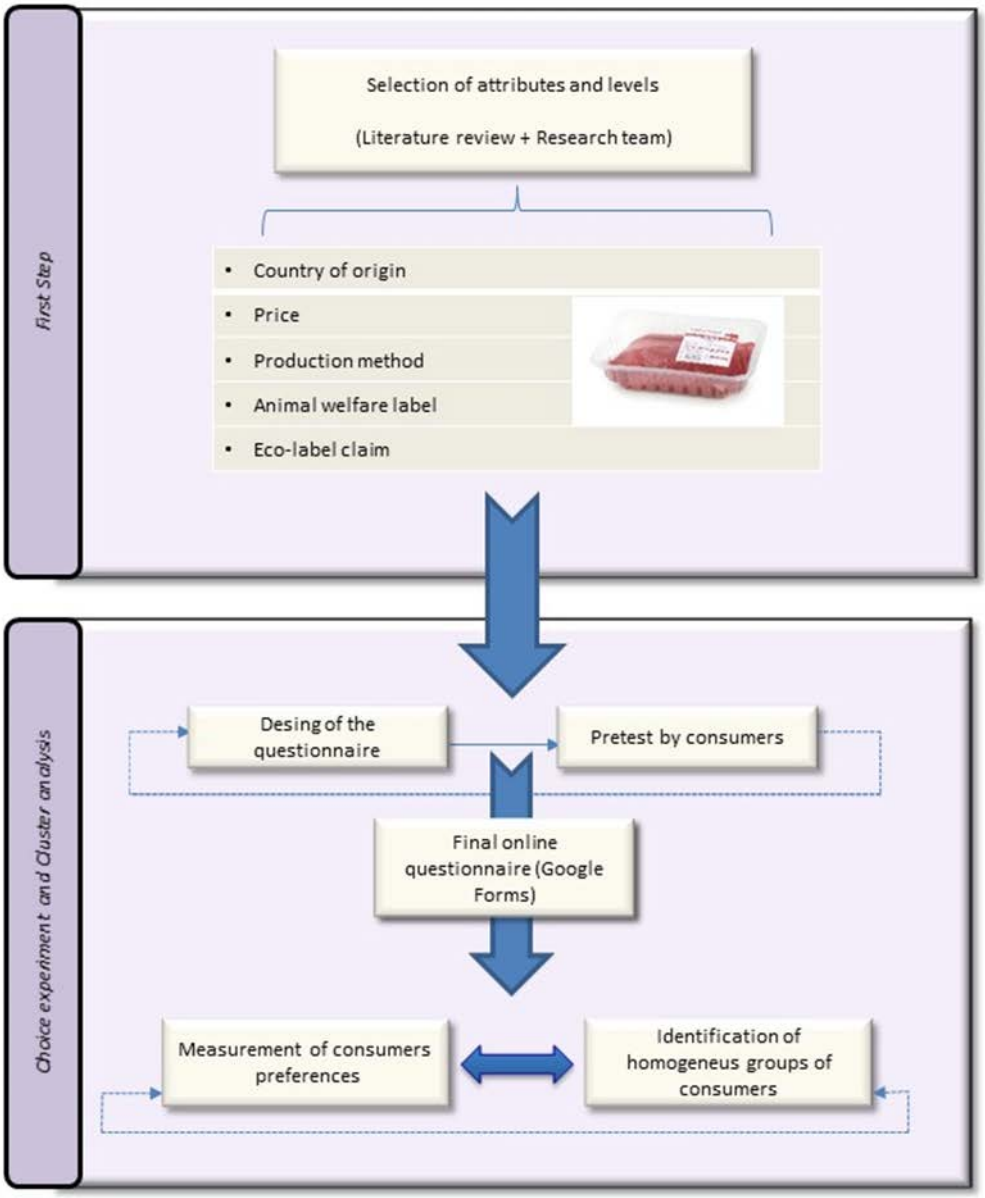
Finally, price is another important extrinsic factor that can affect consumer purchase decisions [55]. Moreover, price sensitivity has been reported to be of great influence in consumer decisions, as people with higher price sensitivity may compromise their environmental concerns to choose cheaper but less environmentally-friendly products [56]. However, a recent study showed that consumers who were less sensitive to price, shifted their attention from product appearance and price to environmental aspects when evaluating eco-labelled products [57].

## 3.3. Materials and Methods

### 3.3.1. Methodological Procedure and Data Collection

The data used in order to develop the present study were obtained from an online survey carried out in Extremadura, a region in SW Spain. The region was selected to be representative of Spain because its socio-demographics are similar to the Spanish Census of Population and also because it has some characteristics that were considered of potential interest, as it is one of the main beef production areas in Spain and with highly relevant extensive and sustainable livestock production systems. Figure 3.1 presents the methodological procedure followed for this piece of research.

Figure 3.1. Methodological procedure.




The survey was designed and distributed using Google Forms (www.docs.google.com), which was chosen for its flexibility and benefits for the development of surveys. Although according to [58] online surveys present important advantages (i.e. lower research costs and little time-consuming for respondents), this data collection technique might introduce some bias in terms of overrepresentation of some socio-demographic characteristics, which limits the potential inference of its results.

The sample was designed as a random stratified model, proportionally weighted against the gender and age of the population in Extremadura, with the final sample including 285 valid completed questionnaires. The maximum margin of error was 5.9% at a 95% confidence level.

Data were collected during March 2020 and respondents were recruited from databases that had been created from previous marketing studies conducted by the research team. The online questionnaire was organised in five sections to measure the following aspects: (a) purchasing habits of meat; (b) personal concerns for the environment; (c) lifestyle and willingness to pay for meat; (d) choice experiment and consumer preferences; (e) socio-demographics aspects. The questionnaire was pre-tested on a sample of 12 individuals (not included in the final sample) to detect any possible misinterpretation, error or duplication. Adjustments were made to the final questionnaire based on this test. Table 3.1 shows the socio-demographic characteristics of the final sample compared with those of the population of Extremadura.

Table 3.1. Socio-demographic characteristics of the sample compared to the population of Extremadura.

| Variable | | Sample % | Extremadura %* |
|---|---|---|---|
| Gender | Women | 51.2 | 50.9 |
| | Men | 48.8 | 49.1 |
| Age | 18–34 years | 28.6 | 24.2 |
| | 35–49 years | 26.5 | 26.5 |
| | >50 years | 44.9 | 49.2 |

*[59]

### 3.3.2. Choice Experiment

In order to analyse consumer preferences for meat attributes, a choice experiment approach was carried out in this piece of research. CE is a technique used to analyse consumer preferences for various product attributes [60]. Due to its potential, CE has been widely applied in studies dealing with the analysis of individual preferences for food, including meat [28–33,61,62].

CE is based on Lancaster's consumer theory [63]and assumes that the utility a consumer obtains from a product derives from the attributes that make it up, and which, therefore, affect his/her purchasing decisions. In a CE, participants are provided with alternative configurations of the product being assessed and are asked to choose between the range of options. The selection of the attributes -and their levels- that will define the product is a key stage which must display the

product characteristics and dimensions that are most relevant regarding the consumer's purchase decision process.

Compared to other methods used to analyse consumer preferences (e.g. contingent valuation, experimental auctions), CE has the advantage of resembling a real purchasing situation [36,62]. The CE approach also allows to explore how attributes are related to each other, even though respondents are not asked to directly answer how important each attribute is for them [47].

For this piece of research, the attributes and levels to be used in CE were selected after a review of the existing literature in consumer preferences for meat [12,13,15,30,33,45,61,64] and according to preliminary research. The attributes finally selected for the study and their corresponding levels are presented in Table 3.2.

Although the study had a main focus on meat in general, it was considered that it should be narrowed down to a specific type of meat that the participants could assess more easily. Therefore, the product presented to the participants in the CE was pre-packaged sliced beef (500g tray). Beef was chosen not only for being one of the most popular meats in Spain in terms of consumption, but also because it is one of the most targeted meats for its contribution to climate change. Therefore, the improvement of sustainability in its production processes could be highly valued by consumers.

Table 3.2. Beef attributes and their various levels.

| Attributes | Levels | | |
|---|---|---|---|
| Country of Origin | Spanish | | Imported |
| Price (Euro/500g) | 6 | 7 | 8 |
| Production Method | Conventional | | Organic |
| Animal Welfare Label | With | | Without |
| Eco-label Claim | With | | Without |

After the selection of the attributes and levels, these are merged to create hypothetical products, which are later on combined in pairs to create a choice set. Each choice set consisted of three alternatives: alternative product A, alternative product B and the "no purchase" option, which allowed the participants to choose none of the products offered (see Figure 3.2 for an example). Based on the chosen attributes/levels, the total number of hypothetical products would have been 48 (2×3×2×2×2) with 2,256 (48×47) possible combinations. As this figure was considered to be

too large for participants to evaluate, an orthogonal fractional factorial design was used to reduce the number of comparisons, with 8 choice sets being finally presented to the participants. The order of presentation and allocation to respondents of the various choice sets was randomised. Figure 3.2 presents an example of choice set.

Figure 3.2. Example of a choice set.

Imagine you are in your usual grocery store and you would like to purchase 500g of sliced beef: Would you choose Alternative A, Alternative B or Alternative C?

| **Attributes** | **Option A** | **Option B** | **Option C** |
|---|---|---|---|
| Country of origin | Imported | Spanish | I would not buy any of these options |
| Production method | Organic | Conventional | |
| Animal welfare label | Without | With | |
| Eco-label claim | With | Without | |
| Price | 7 Euros/500g | 8 Euros/500g | |
| I would choose option | (  ) | (  ) | (  ) |

3.3.3. Conditional Logit

Conditional logit, a model based on the Random Utility Theory [25–27], has been applied in this paper to assess consumer preferences. The clogit module of R statistical package version 3.6.3, was used, following the guidelines described by [65]. Base levels have been defined for all the qualitative attributes, which allow to set a zero-utility level with respect to the other levels of the attribute. The selected base levels were “Imported” (for the attribute Country of origin), “Conventional” (for Production method), “Without” (for Animal Welfare Label) and “Without” (for Eco-label claim).

The econometric specification is therefore defined as follows:

$$\begin{aligned} U_{njt} = \beta_0 ASC + \ & \beta_1 Spain_{njt} + \beta_2 Organic_{\ njt} \\ & + \beta_3 \text{With Animal Welfare Label}_{\ njt} \\ & + \beta_4 \text{With Eco} - \text{label claim}_{njt} + \beta_5 Price_{njt} + \varepsilon_{njt} \end{aligned} \quad (1)$$

The inclusion of price as an attribute in a choice experiment allows to calculate the marginal substitution ratio between a coefficient and the price, that is, the willingness to pay for the specific attribute. WTP is calculated as follows:

$$\mathrm{WTP_k} = -\left(\frac{\beta_k}{\beta_{Price}}\right) \quad (2)$$

Therefore, WTPk reflects the amount of money that a consumer would be willing to pay to go from the base level to the level of the attribute k provided by the product.

### 3.3.4. Cluster Analysis

The identification of subgroups of consumers with similar preference behaviour towards sustainable meat was considered to be a valuable finding of this research. Therefore, a k-means cluster analysis was carried out with the Cluster module of IBM SPSS Statistics v 21.

The inputs used were variables related to beliefs and attitudes towards meat production/consumption and environment, together with others measuring purchasing habits and following the procedure developed by [66]. Although various solutions were checked, a 3-cluster solution was finally chosen due to the groups generated being adequate in size and its being of the highest statistical significance.

## 3.4. Results and Discussion

### 3.4.1. Choice Experiment Model

Table 3.3 shows the aggregate results of the conditional choice model. The value of the coefficient of each level indicates the utility added (positive sign) or detracted (negative sign) to or from the reference level.

Table 3.3. Results of the choice model for the whole sample.

| Variable | Coefficient | Standard Error | p-value[a] |
|---|---|---|---|
| Origin Spain | 1.69334 | 0.07641 | *** |
| Organic Production | 0.48936 | 0.07663 | *** |
| With Animal Welfare Label | 0.87733 | 0.08021 | *** |
| With Eco-label | 0.67481 | 0.07915 | *** |
| Price | –0.35956 | 0.06484 | *** |

[a]Significance at: * p <0.1, ** p < 0.05, *** p < 0.001;n.s.: not significant.

The results in Table 3.3 show that all the attributes (except price) have a positive impact with respect to their reference levels on the utility of the respondents. For example, the results for the "Country of origin" attribute indicate that consumers obtain more utility when choosing beef produced in Spain than imported beef. Something similar happens with organic production or the presence of animal welfare and eco-labels, which have a positive impact on the preferences of respondents compared to their baseline reference levels.

These results are in consonance with those found by [67], who reported that consumers showed greater preference for local food products than for imported ones. [68] mentioned that one of the main drivers of consumer preferences and attitudes towards foods is country of origin. Moreover, [21] found that the origin of beef was the most important piece of information demanded by European consumers.

On the other hand, there are studies which indicate that consumer concern about animal welfare is the most important factor when purchasing meat products [69,70]. In a similar way, [71] found that organic production is very relevant for consumers when buying meat, while [72] found that 74% of European participants preferred animal-friendly meat to conventional meat.

In addition, the fact that the sign of the price attribute is negative indicates that, as the price of beef decreases, its utility for consumers increases. This means that the probability of choosing a product with a lower price is higher, a result that is consistent with the habitual behaviour of demand. These results are in line with those reported by [73], who found that the higher price of eco-friendly food products is often perceived as a limiting factor in the purchase of these products.

### 3.4.2. Consumer Segmentation

Table 3.4 presents the detailed socio-demographic characteristics and purchasing habits of the three segments that were generated by the cluster analysis, together with those of the general sample. It also shows the results of Chi-squared tests carried out to look for significant differences between the clusters.

Table 3.4. Descriptions of the clusters and the general sample by socio-demographic characteristics and purchasing habits (%)

| Variable | Cluster1 (n=60) | Cluster 2 (n=130) | Cluster 3 (n=95) | Total (n=285) | Significance[a] |
|---|---|---|---|---|---|
| Sex | | | | | |
| Man | 61.7 | 43.4 | 47.9 | 48.8 | * |
| Woman | 38.3 | 56.6 | 52.1 | 51.2 | |
| Age of the Respondent | | | | | |
| 18–35 years | 48.3 | 23.3 | 23.4 | 28.6 | *** |
| 36–50 years | 26.7 | 24.8 | 28.7 | 26.5 | |
| >50years | 25.0 | 52.0 | 47.9 | 44.9 | |
| Family Size | | | | | |
| 1–2 | 55 | 53.5 | 39.4 | 49.1 | * |
| 3–4 | 35.0 | 32.6 | 51.1 | 39.2 | |
| 5 or more | 10.0 | 14.0 | 9.6 | 11.7 | |
| Level of Studies | | | | | |
| Primary education and below | 13.3 | 7.8 | 14.9 | 11.3 | n.s. |
| High school | 10.0 | 16.3 | 17.0 | 15.2 | |
| University | 76.7 | 76.0 | 68.1 | 73.5 | |
| Income Level | | | | | |
| <1,500 €/month | 30.0 | 27.1 | 22.3 | 26.1 | n.s. |
| 1,500–2,500 €/month | 30.0 | 34.1 | 35.1 | 33.6 | |
| 2,501–3,500 €/month | 25.0 | 17.8 | 26.6 | 22.3 | |
| >3,500 €/month | 15.0 | 20.9 | 16.0 | 18.0 | |
| Regular Food Buyer | | | | | |
| Yes | 40.0 | 25.6 | 31.9 | 30.7 | n.s. |
| No | 60.0 | 74.4 | 68.1 | 69.3 | |
| Frequency of Meat Consumption | | | | | |
| Never | 15.0 | 24.0 | 12.8 | 18.4 | *** |
| Once a week | 61.7 | 57.4 | 46.8 | 54.8 | |
| Twice a week | 13.3 | 16.3 | 38.3 | 23.0 | |
| Three times a week or more | 10.0 | 2.3 | 2.1 | 3.9 | |
| Level of Meat Consumption | | | | | |
| Low | 63.3 | 72.9 | 39.4 | 59.7 | *** |
| Medium | 23.3 | 20.9 | 45.7 | 29.7 | |
| High | 13.3 | 6.2 | 14.9 | 10.6 | |
| Place of Purchase | | | | | |
| Butcher's | 0.0 | 42.6 | 93.6 | 50.5 | *** |
| Supermarket | 100.0 | 49.6 | 0.0 | 5.6 | |
| Other (direct from the farmer) | 0.0 | 7.8 | 6.4 | 43.8 | |
| Frequency of Consumption of Environmentally-Friendly Products | | | | | |
| Never | 10.0 | 0.8 | 1.1 | 2.8 | *** |
| Less than once a month | 8.3 | 3.9 | 6.4 | 5.7 | |
| At least once a month | 61.7 | 85.3 | 64.9 | 73.5 | |
| At least once a week | 20.0 | 10.1 | 27.7 | 18.0 | |

[a]Significance at: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$; n.s.: non-significant.

Table 3.5 shows the data regarding beliefs and attitudes towards meat consumption/ production and environment of the three clusters and the general sample.

Table 3.5. Descriptions of the clusters and the general sample regarding beliefs and attitudes towards meat production/consumption and environment (%).

| Variable | Cluster1 (n=60) | Cluster 2 (n=130) | Cluster3 (n=95) | Total(n=285) | Significance[a] |
|---|---|---|---|---|---|
| Is Meat Fundamental for Health? | | | | | |
| No | 8.3 | 20.2 | 3.2 | 12.0 | |
| Do not know | 3.3 | 3.9 | 2.1 | 3.2 | *** |
| Yes | 88.3 | 76.0 | 94.7 | 84.8 | |
| I Like Meat Because It Is | | | | | |
| Easy to prepare | 5.0 | 7.7 | 8.1 | 7.1 | |
| Nutritious and healthy | 66.7 | 62.7 | 66.6 | 65.0 | n.s. |
| Good taste | 28.3 | 29.6 | 25.3 | 27.9 | |
| Are You Worried About Environment and Climate Change? | | | | | |
| (1: not worried at all; 5: very worried) | 3.73 | 4.81 | 3.89 | 4.28 | *** |
| Are You Changing Your Behaviour in Order to Protect the Environment? | | | | | |
| (1: not at all; 5: completely agree) | 3.35 | 4.52 | 3.79 | 4.03 | *** |
| Do You Exercise Regularly? | | | | | |
| (1: not at all; 5: completely agree) | 3.15 | 3.59 | 3.42 | 3.44 | ** |
| Do You Regularly Recycle Your Waste at Home? | | | | | |
| No | 21.7 | 7.0 | 13.8 | 12.4 | ** |
| Yes | 78.3 | 93.0 | 86.2 | 87.6 | |
| Would You Pay More for Meat with Minimal Environmental Impact? | | | | | |
| No | 23.3 | 5.5 | 10.6 | 11.0 | *** |
| Yes | 76.7 | 94.5 | 89.4 | 89.0 | |
| Willingness to Pay for Meat with Minimal Environmental Impact (% Increase in Price) | | | | | |
| 0% | 26.7 | 15.5 | 12.8 | 17.0 | |
| 10% | 56.7 | 49.6 | 57.4 | 53.7 | ** |
| 15% | 10.0 | 23.3 | 25.5 | 21.2 | |
| 20% | 6.7 | 11.6 | 4.3 | 8.1 | |

[a]Significance at: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$; n.s.: non-significant

This information is complementary to that presented in Table 3.4 and allows to better define consumer typologies:

- Cluster 1 (Male millennials indifferent towards environment or sustainability). This segment has the highest percentage of men and of people under 36 years old. This group has the lowest level of consumption of environmentally-friendly products, but also has the poorest scores on all variables relating to environmental and sustainable behaviour, despite its high level of education.
- Cluster 2 (Sustainability-concerned mature women) displays the largest percentages of women and mature consumers (over 50 years of age). This cluster has the highest frequency of consumption of environmentally-friendly products, and it is also the one that gives the greatest scores to aspects relating to the environment and sustainability. It is also the group with the lowest consumption of meat.
- Cluster 3 (Middle-aged meat eaters with established families) presents the highest percentages of consumers between 36 and 50 years and of larger family units. It also has the highest frequency and level of meat consumption (which can be related to family size). Their members are middle ground, in terms of their attitudes towards sustainability and the environment.

### 3.4.3. Consumer Preferences within each cluster

Once the clusters had been identified, CE was carried out again for each of the consumer groups. Table 3.6 lists the results of the choice model for each cluster.

Table 3.6. Results of the choice model for each cluster.

| | Cluster 1 Male Millennials Indifferent Towards Environment or Sustainability | | Cluster 2 Sustainability-Concerned Mature Women | | Cluster 3 Middle-Aged Meat Eaters with Established Families | |
|---|---|---|---|---|---|---|
| Variable | Coefficient (p[a]) | S.E.[b] | Coefficient (p[a]) | S.E.[b] | Coefficient (p[a]) | S.E.[b] |
| Origin Spain | 1.499 (***) | 0.143 | 1.893 (***) | 0.155 | 1.924 (***) | 0.136 |
| Organic Production | 0.171 (n.s.) | 0.150 | 0.936 (***) | 0.154 | 0.337 (**) | 0.136 |
| With Animal Welfare label | 0.813 (***) | 0.161 | 1.205 (***) | 0.158 | 0.774 (***) | 0.143 |
| With Eco-label | 0.564 (***) | 0.157 | 0.997 (***) | 0.157 | 0.616 (***) | 0.141 |
| Price | –0.746(***) | 0.152 | –0.166 (*) | 0.093 | –0.415 (***) | 0.122 |

[a] Significance at: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$; n.s.: non-significant; [b] Standard error

Consumers in cluster 1 are characterized by showing no significant preference between organic or conventional beef production. They look for beef with animal welfare label although they show the lowest preference for beef with eco-labels. Noticeably, they are the most price-sensitive group of the whole sample, a fact that could relate to their lower income level. These results are consistent with those reported by [44], who found that price-sensitive segments are slightly overrepresented by men. Additionally, [74] mentioned that price seems to have a higher impact than logo and/or label when purchasing meat products. It is also well known that attitudes and behaviour towards sustainable food consumption differ in multiple ways between genders [75].

Cluster 2 shows the highest preference of the three clusters for organic production and for the purchase of beef with animal welfare label and eco-label; these results are consistent with the sustainability concerns of the cluster. Consumers in this group also present the lowest sensitivity to price of the entire sample. These results are in agreement with those found by [76], who stated that women generally show higher willingness to pay for environmentally-friendly food products. These findings are also in line with previous research where female participants declared higher levels of sustainable consumption compared with male participants [75]. Moreover, [77] found that, with higher levels of education men revealed increased meat consumption, while women showed reduced consumption. However, and contrary to other studies conducted in other European countries, [78] found that men showed more environmental concern and more positive outlook towards green purchase compared with women.

Finally, Cluster 3 shows similar preferences to those obtained for the overall sample. In this group, consumers have the highest preference for the Spanish origin, a behaviour that could be related to their age structure (middle-aged consumers) and to the fact that they have children in their families. As many prior studies have noted, the preference for national/local food products is quite common, so that consumers are usually willing to pay a premium price for domestic and local food [49,79].

When making food purchasing choices, consumers can rely on those attributes that are most important to them or make trade-offs amongst a range of attributes [80]. Moreover they also need to make trade-offs between both positive benefits -such as animal welfare- and (additional) price [81,82]. In addition, it has been found that consumers who show preference for food products associated with ethic-related claims are those also genuinely concerned about environmental sustainability[83]. Also, [84]mentioned that providing detailed information about beef processing technology increased consumer acceptability of beef products. It seems clear that label information does more than just provide product-related knowledge to consumers, as it affects their acceptance and purchase intention with respect to the corresponding beef products. Finally, [85]showed that beef labels are important sources of information about meat quality for consumers.

### 3.4.4. Willingness to Pay

One of the most interesting aspects of choice experiments when price is included as an attribute is the possibility of determining the WTP or the implicit price for each attribute. The WTP should be understood as the difference in euros between the price the consumer is willing to pay for a particular level, in comparison to the baseline reference level. Table 3.7 presents the WTP for the overall sample and for each of the clusters.

Table 3.7. Willingness to pay for the overall sample and for each cluster (€/500g).

| Variable | Cluster 1 Male Millennials Indifferent Towards Environment or Sustainability | Cluster 2 Sustainability-Concerned Mature Women | Cluster 3 Middle-aged Meat eaters with Established Families | Overall Sample |
|---|---|---|---|---|
| Origin Spain vs Origin Imported | 2.01 | 11.40 | 4.64 | 4.71 |
| Organic Production vs. Conventional Production | 0.23 | 5.63 | 0.81 | 1.36 |
| With Animal Welfare label vs Without Animal Welfare label | 1.09 | 7.26 | 1.87 | 2.44 |
| With Eco-label vs Without Eco-label | 0.76 | 6.01 | 1.48 | 1.88 |

The explanation of the results shown in table 3.7 is that the respondents in the overall sample would be willing to pay € 4.71/500g more for a beef produced in Spain compared to imported beef, or that they will pay € 1.36/500g more for organic beef compared to beef produced by conventional production means. These results are consistent with those reported by [23] who indicated high consumer preference and WTP for local food. [86] reported that consumers were ready to pay premium prices for food products deriving from quality production methods. Additionally,[87] found that consumers in Italy were willing to pay a premium price for organic beef, with similar results also being reported by [88].

On looking at the figures for the various clusters, we can deduce that they are in agreement with their previously defined characteristics. Thus, consumers in cluster 1 present the lowest willingness to pay for all the attributes under analysis (they were very price-sensitive), while consumers in cluster 2 show the highest willingness to pay, which is consistent with the low importance they placed on price. In this context, a recent study [89] revealed that consumers are willing to pay a price premium of approximately 20% for carrots and strawberry jams, if these products are eco-friendly labelled. Similar findings have also been reported for wine [90] and coffee [91]. However, [92] found that gender affected the understanding of sustainability labels and indicated that young male consumers had a better understanding of such labels.

In this sense, it should be noted that many consumers actually have little understanding of the real meaning of sustainability labels [93]. In this sense, lack of comprehension of the labels could lead to consumers processing information about the claim incompletely or incorrectly [94], resulting in misinterpretation or misunderstanding.

### 3.5. Conclusions

Public interest in sustainability issues has grown significantly in recent years due to growing awareness of climate change and the environment. Thus, an increasing number of consumers are concerned about the environmental, ethical and animal welfare impact of their food. In this context, this study has explored consumer preferences and willingness to pay for sustainable and environmental attributes of beef, using a choice experiment.

As stated in this paper, one of the contributions of this study is the segmentation of consumers based on their preferences for a wide range of sustainability-related attributes (animal welfare, environmental impact and production method) and other more traditional product characteristics (country of origin and price). This is in contrast with most consumer studies that have essentially analysed the willingness to pay for animal welfare or sustainability attributes. The selection of these variables was based on a preliminary review of the literature, which identified potential items to include in the survey. Subsequently, those items that were considered most relevant were selected to generate information on the previously mentioned aspects.

A conditional logit model showed that consumers preferred beef which had been organically produced in Spain, bearing an animal welfare label as well as eco-labelled. In addition, a cluster analysis was carried out using variables relating to beliefs and attitudes towards meat production/consumption and the environment, along with others that measure purchasing habits, resulting in three well-defined clusters. In this sense, "the Indifferent Millennials", the most numerous group, proved to be the cluster that least consumes environmentally-friendly products, as well as having the worst environmental and sustainable behaviour. On the other hand, the "Sustainability-concerned women" presents the highest percentage of mature consumers, with the largest frequency of consumption of environmentally-friendly products, but with the lowest consumption of meat. Finally, cluster 3 (Middle-aged meat eaters)includes consumers with the highest frequency and level of meat consumption and who are middle ground in terms of their attitudes towards sustainability and the environment.

This study will help develop more appropriate strategies to understand the behaviour and expectations of eco-friendly food consumers. Nonetheless, given the monetary constraints that prevented the study from being carried out nationwide, we regard our findings as not fully inferable to the rest of the population. In this sense, future research should aim at obtaining a deeper insight into certain consumer segments. This would allow an exhaustive analysis of the various environmental labels available in order to measure the willingness to pay and to discriminate the real importance that consumers attribute to the sustainable quality of a product. In future, these aspects will positively contribute to clarify new patterns of consumption and their incidence in the production systems, as well as in the implementation of incentive policies for a more responsible consumption.

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# General conclusions

## General conclusions

There are various certifications for food products that focus on the environmental, social or ethical benefits they provide and that empower consumers to make informed purchasing decisions. Sustainable and ethical consumption in the food sector is a desirable goal which is often difficult to achieve depending on the interaction of a broad set of factors, such as market prices or consumer preferences. The proliferation of many social and environmental factors as new trends in food marketing can influence the choices of consumers and the strategies of decision makers in the food industry. Nevertheless, the agri-food sector is still not making the best use of these aspects.

In this context, Life Cycle Assessment is a useful tool for measuring the environmental impact of food production and specially livestock production. LCA may be combined with other methods to assess economic sustainability of animal production in order to reveal on-farm efficiencies. It also could help to reduce both environmental and monetary costs associated with animal rearing. The clear definition of LCA models is essential for a comprehensive and detailed assessment of the environmental burden associated with the production of food products. This clarification is important especially when results of LCA studies are used to define policies and initiatives aiming at reducing the environmental impact of animal production systems and to achieve sustainable food supply.

According to this research, there is a need to develop a common framework to assess the carbon footprint (CF) in order to reinforce the reliability of LCA as a decision-support tool. Direct comparison between production systems is very difficult due to the nature of livestock production and the difference amongst the functional units used in the systems. Therefore, and in line with what has been published in other studies, a clear and inverse relationship between intensification and CF per product unit has been found. This is due to the higher efficiency of intensive production systems, which implies that each unit produced in an intensive farm requires fewer inputs than its equivalent in an extensive holding.

However, extensive farms usually have a territorial component (hectares of agricultural land, with pastures, trees …) which can help to compensate for $CO_2$ emissions, due to carbon sequestration. Nevertheless, it is not common to take into account carbon sequestration in LCA studies, which creates a disadvantage for extensive systems and can send confusing messages to the consumers and endanger the persistence of these valuable and complex systems

On the other hand, focus group methodology can be used as a valuable tool to improve marketing strategies, differentiate products and enhance their competitiveness in the market. Thus, in order for these products to be successful, the sustainability aspects must be included within the product quality criteria or production model, where private and public sectors play an important role. This is why the information provided to the consumer about the potential benefits of a product, its manufacturing and environmental impacts are crucial. Within this framework, the certification and labelling programs highlighting sustainability of a food product are strategies that guarantee their differentiation.

In a context where public interest in sustainability issues has significantly increased in recent years due to concerns about climate change and the environment, our findings show that it is necessary to make food products with sustainable and environmental labeling more accessible to a greater number of consumers, as currently, the higher price and reduced distribution are barriers to their development and expansion. Equally, lack of awareness of these products and even the lack of differentiation against conventional products are determining for their poor success in the market. This fact limits the consumption of these products to certain economic segments that are more ethically sensitive. However, if we want to effectively reinforce the social and environmental impact of food labels, it is necessary to provide additional information so that consumers can understand and value them.

Furthermore, sustainability labels give consumers the opportunity to take into account environmental and ethical considerations when making food choices. Sustainability labels can help consumers compare across and within food product types and make more sustainable and environmentally conscious decisions. The incorporation of these labels onto food products could both increase public awareness of the environmental impacts associated with food production as well as support producers who provide sustainable products.

Regarding the barriers that prevent consumers from buying sustainably and environmentally labeled food products, the main obstacles are the lack of consumer awareness, the lack of understanding of the meaning and information of these labels, together with ignorance and consumer distrust of the label or brand. Therefore, and despite the previously mentioned positive attitudes towards these products, these restrictions still remain, preventing the transformation of those attitudes into actual purchasing actions.

In order to explore consumer preferences and willingness-to-pay for sustainability attributes in beef, a choice experiment technique was applied to evaluate the influence of different attributes on consumers' buying decisions. The use of the choice experiment has also provided a useful approach to gain an insight into consumer's willingness to purchase beef, allowing for an assessment of consumer preferences towards sustainability claims and traditional attributes of beef. Consumers were subsequently segmented based on a cluster analysis was carried out using variables relating to beliefs and attitudes towards meat production/consumption and the environment, along with others that measure purchasing habits.

Finally, our findings will help develop more appropriate strategies to understand the behaviour and expectations of eco-friendly food consumers. Nonetheless, given the monetary constraints that prevented the study from being carried out nationwide, we regard our findings as not fully inferable to the rest of the population. In this sense, future research should aim at obtaining a deeper insight into certain consumer segments. This would allow an exhaustive analysis of the various environmental labels available in order to measure the willingness to pay and to discriminate the real importance that consumers attribute to the sustainable quality of a product. In the future, these aspects will positively contribute to clarify new patterns of consumption and their incidence in the production systems, as well as in the implementation of incentive policies for a more responsible consumption.