



DEPARTMENT OF AGRICULTURAL, FOOD AND  
ENVIRONMENTAL SCIENCES

DEGREE COURSE: Food and Beverage Innovation and Management

CIRCULAR ECONOMY FOR A  
SUSTAINABLE AGRI-FOOD SECTOR:  
CONSUMER PERCEPTION OF UPCYCLED  
FOOD PRODUCTS

TYPE OF DISSERTATION: Research

Student:

ALESSIA DEL CONTE

Supervisor:

Dr. DEBORAH BENTIVOGLIO

Assistant supervisor:

Dr. GIULIA CHIARALUCE

ACADEMIC YEAR 2022-2023

To my nephews,

I dedicate this thesis to you. I want you to always remember that even when challenges seem impossible and roads seem difficult to navigate, perseverance and tenacity are the keys to achieving your dreams. Never stop believing in your abilities, we can all do it, we just need to want it.

I love you more than anything in the world

Your aunt

# CONTENTS

LIST OF TABLES.....	5
LIST OF FIGURES.....	6
ACRONYMS AND ABBREVIATIONS.....	8
ABSTRACT.....	10
INTRODUCTION AND AIM OF THE THESIS.....	11
CHAPTER 1: CIRCULAR ECONOMY.....	13
1.1 Food losses and food wastes.....	13
1.2 Food losses and food wastes: causes, prevention, and their related impacts.....	15
1.3 Historical background: linear and circular economy.....	21
1.4 Definitions of circular economy.....	24
1.5 Application example to circular economy in food sector.....	29
CHAPTER 2: CIRCULAR ECONOMY POLICY.....	32
2.1 Introduction.....	32
2.2 An EU action plan for the circular economy.....	32
2.3 Green Deal and farm to fork strategy.....	36
2.4 New circular economy action plan.....	39
2.5 European initiatives to spread circular economy.....	41
2.6 The Italian situation.....	44
CHAPTER 3: LITERATURE REVIEW.....	48
3.1 Introduction.....	48
3.2 Consumers' perspective on circular economy in agri-food.....	48
3.2.1 Consumers' perspective on upcycled foods.....	53

3.2.2	<i>Consumers' recognition and acceptance of upcycled food</i>	55
3.2.3	<i>Evaluation of purchase intention for upcycled and traditional products</i>	56
3.2.4	<i>Demographic-based variations in purchase intent</i>	57
3.2.5	<i>Influential factors choosing upcycled food products</i>	58
CHAPTER 4: CASE STUDY ON UPCYCLED FOOD: CONSUMERS' PERCEPTION AND WILLINGNESS TO PAY		62
4.1	Introduction	62
4.2	Methodology	62
4.2.1	<i>Design of the questionnaire</i>	63
4.2.2	<i>Logit model</i>	68
4.3	Results and discussion	70
4.3.1	<i>Socio-demographic characteristics of the sample</i>	70
4.3.2	<i>Descriptive statistics</i>	73
4.3.3	<i>The econometric model for consumers' willingness to buy upcycled food products</i>	84
4.3.4	<i>Estimation of the willingness to pay for an upcycled margherita pizza</i>	87
CONCLUSION		89
BIBLIOGRAPHY		91
AKNOWLEDGEMENTS		98
ANNEX I		101
ANNEX II		111

## LIST OF TABLES

Table 1: Literature review database.....	49
Table 2: Journal articles on upcycling food products.....	54
Table 3: Socio-demographic characteristics.....	71
Table 4: Interval model estimation.....	85
Table 5: Distribution of responses for the price offered.....	87
Table 6: Descriptive statistics of the estimated variable WTP (€).....	88

## LIST OF FIGURES

Figure 1 Food system.....	133
Figure 2 Food supply chain.....	14
Figure 3 Food wastes in Europe in 2020.....	17
Figure 4 Percentage contribution of primary production on waste generation .....	188
Figure 5 Percentage contribution of food and beverage industries on waste generation .....	199
Figure 6 Percentage contribution of retail and other distribution on waste generation.....	199
Figure 7 Percentage contribution of catering and other food services on waste generation ..	20
Figure 8 Percentage contribution of households on waste generation .....	20
Figure 9 Sustainable development goals.....	221
Figure 10 Differences between linear and circular economy.....	233
Figure 11 Butterfly diagram from Ellen Macarthur Foundation.....	266
Figure 12 Salvatore Ferragamo’s campaign.....	30
Figure 13 Barò cosmetics.....	30
Figure 14 Food waste hierarchy .....	344
Figure 15 Summary of Italian and European Circular economy policies .....	477
Figure 16 Number of publications .....	49
Figure 17 Country of publications .....	50
Figure 18 Number of publication per country.....	50
Figure 19 Bibliometric map .....	51
Figure 20 Upcycling in the bibliometric map .....	53
Figure 21 Representation of our upcycled pizza.....	65
Figure 22 Circular economy model.....	67

Figure 23 Frequency of buy groceries .....	73
Figure 24 How much people buy .....	73
Figure 25 Attention to the production of food wastes.....	74
Figure 26 Domain specific innovativeness scale .....	75
Figure 27 Food neophobia scale .....	75
Figure 28 Podium of the three products preferred by consumers .....	76
Figure 29 Willingness to buy the product .....	77
Figure 30 Five main reasons to buy upcycled pizza .....	77
Figure 31 Five main reasons why they are unwilling to buy .....	79
Figure 32 Five main reasons that might convince consumers to buy .....	80
Figure 33 Have you never heard about circular economy .....	82
Figure 34 Word cloud circular economy .....	82
Figure 35 Results of attentive questions .....	83
Figure 36 Recycle product scale results.....	84

## ACRONYMS AND ABBREVIATIONS

AFS Agrifood Sector

CE Circular Economy

CVM Contingent Valuation Method

D3A Department of Agricultural, Food, and Environmental Sciences

DSI Domain Specific Innovativeness scale

ECESP European Circular Economy Stakeholder Platform

EMF Ellen MacArthur Foundation

EU European Union

EUFIC European Food Information Council

FAO Food and Agriculture Organization of the United Nations

FN Food Neophobia

FNS Food Neophobia Scale

FTN Food Technology Neophobia

GACERE Global Alliance on Circular Economy and Resource Efficiency

GHG Green House Gas

ICESP Italian Circular Economy Stakeholder Platform

NGO Non-governmental Organisation

ONU Organizzazione delle Nazioni Unite

RPS Recycled Product Scale

SDGs Sustainable Development Goals

SME Small and Medium Enterprise

SRM Secondary Raw Material



UK United Kingdom

WCED World Commission on Environment and Development

WoS Web of Science

WTB Willingness To Buy

WTP Willingness To Pay

WTT Willingness To Try

## ABSTRACT

Il presente lavoro approfondisce l'importante transizione da un sistema economico lineare, in cui i prodotti vengono scartati alla fine del loro ciclo di vita, all'economia circolare, che enfatizza il recupero e la rigenerazione delle risorse. L'Unione Europea ha avviato varie azioni governative per affrontare il deperimento delle risorse, l'inquinamento e il riscaldamento globale associati al modello lineare. L'economia circolare promuove la riduzione degli sprechi, la riparazione, il riutilizzo e il riciclo, offrendo una soluzione olistica. Il focus qui è sull'upcycling nel settore agroalimentare come risposta potente allo spreco alimentare. L'upcycling trasforma le risorse in nuovi prodotti, spesso più salutari, riducendo gli sprechi e il loro impatto ambientale. Questa pratica può favorire l'innovazione, la generazione di reddito e la resilienza nell'industria alimentare. Il presente lavoro ha come obiettivi quello di esplorare il concetto dell'economia circolare ed il quadro legislativo ad essa correlato, esplorare in dettaglio il concetto di alimento upcycled come pratica dell'economia circolare, investigare la conoscenza dei consumatori riguardo a questi due concetti ed infine, stimare la disponibilità a pagare dei consumatori per uno specifico prodotto upcycled. Questo studio presenta risultati significativi. Mostra che, sebbene la conoscenza dell'economia circolare e della pratica dell'upcycling sia ancora limitata tra i consumatori, questa conoscenza può essere incrementata con campagne di sensibilizzazione efficaci. Un aspetto notevole è che i consumatori sono disposti a pagare un prezzo più alto per questi prodotti upcycled, il che riflette una crescente sensibilità ambientale e la volontà di sostenere un approccio più sostenibile all'alimentazione. Questo risultato suggerisce che i consumatori valutano positivamente gli aspetti economici, ambientali e salutari associati agli alimenti upcycled. La consapevolezza e l'accettazione dei prodotti upcycled sono legate alla chiara comunicazione dei benefici, spesso attraverso etichette o marchi distintivi che evidenziano le caratteristiche positive di questi prodotti. La disponibilità di informazioni complete e trasparenti sui prodotti upcycled è quindi fondamentale per aumentare la loro accettazione da parte dei consumatori. Inoltre, il fatto che i consumatori siano disposti a pagare un prezzo premium per questi prodotti suggerisce che esiste un mercato potenziale per i prodotti upcycled, il che può incoraggiare ulteriori investimenti e sviluppi nell'industria alimentare in questa direzione.

## INTRODUCTION AND AIM OF THE THESIS

In the current panorama of global challenges, the adoption of sustainable and innovative strategies has become imperative to address the growing concerns related to the environment, health, and resource management. In this context, the circular economy has established itself as a fundamental model for addressing these challenges, placing emphasis on the reduction of waste, the reuse of resources and the creation of long-term value. The circular economy promotes a vision of the economy in which products, materials and resources are kept in a continuous cycle of use and not destined to become waste. This revolutionary approach aims to minimize waste and environmental impact, while promoting efficiency and economic sustainability. In particular, the European Union (EU) and Italy have adopted a robust but complicated regulatory framework to promote the circular economy and guide the transition towards a more sustainable society. These regulatory frameworks include laws, policies and incentives that aim to facilitate the transition towards a circular economy, with a specific emphasis on the sustainable management of resources and the reduction of waste. Within the circular economy paradigm, food upcycling emerges as an innovative practice that contributes to the objective of reducing food waste and promoting sustainability in the agri-food sector. Upcycling in agri-food involves recovering unused or discarded ingredients and transforming them into high-quality food products, creating a new source of value from what would otherwise have been wasted.

Therefore, the main objectives of this thesis are:

- explore the concept of circular economy and the regulatory framework linked to it.
- Explore in detail the concept of upcycled food within the context of the circular economy.
- Investigate consumers' knowledge about circular economy and upcycled food product, and the factors affecting the purchasing intention towards upcycled foods.
- Estimate consumers' willingness to pay for a specific upcycled food product.

The analysis is performed using a survey-based approach with an online questionnaire; the factors influencing the consumers' intention to purchase an upcycled food were evaluated using a logit model and the willingness to pay estimated with the contingent valuation method. Specifically, the structure of the thesis consists of 5 chapters in which the main aspects of circular economy and upcycled foods are treated. Chapter one is an overview of circular

economy concepts and definitions. The second chapter is dedicated to the circular economy policy at European and Italian level. The third chapter represents a literature review of studies on consumers' preferences, acceptance and willingness to pay for an upcycled food product. At last, in the chapter four, the case study on consumers' intention to buy and willingness to pay for an upcycled food, is outlined.

# CHAPTER 1

## CIRCULAR ECONOMY

### 1.1 FOOD LOSSES AND FOOD WASTES

One of the biggest problems in the agrifood sector is the production of wastes; each year, about one-third of the food produced ends up in the trash of consumers and traders, or it deteriorates due to poor transportation systems or farming practices (UNRIC, 2023). When food is wasted, all the resources used to produce and transport it such as land, water, and fuel, are wasted, without gaining any benefit; in fact, food waste is one of the major contributors to the emission of greenhouse gases, thus having a negative impact on the environment (Grizzetti et al., 2013; Scherhauser et al., 2018; Jeswani et al., 2021).

The food supply chain is defined by FUSIONS report as the connected set of activities used to produce, process, distribute and consume food (Stenmarck et al., 2016). The food supply chain, also known as the food system, outlines the various steps involved in bringing food from farms to our tables.

The cycle of production, processing, distribution, consumption, and disposal constitutes the basic processes. The food system operates through a chain of stages including production, processing, distribution, retail, and consumption. It follows a pattern similar to a domino effect, with food moving from farmers to consumers, while money paid by consumers moves in the opposite direction, from consumer to retailer, to distributor and finally to producer, as shown in the figure below (Figure 1)



*Figure 1 (Food system) Source: author's elaboration*

Food wastes are generated throughout the entire food chain, from production to consumption but, depending on where they occur along the supply chain, food losses and food wastes are distinguished:

- Food losses is the decrease in the quantity or quality of food resulting from decisions and actions of food suppliers in the supply chain at the early stages, excluding retail, food service providers and consumers.
- Food wastes is the decrease in food quantity or quality resulting from decisions and actions by retailers, food service providers and consumers.

Quantity refers to the decrease in mass of food for human consumption, while quality refers to a decrease in food attributes that reduce its value in terms of intended use (FAO, 2019). Figure 2 shows all stages of the supply chain and the division between those where food wastes and food losses materialize.



*Figure 2 (Food supply chain) Source: author's elaboration*

To understand how these losses occur throughout the supply chain, it is necessary to consider two different categories of food: plant products and animal products.

Plant products can be exposed to losses caused by various factors including mechanical damage and spillage during harvesting, waste during harvesting, degradation and/or breakage during processing and handling such as washing, peeling, slicing or the boiling. Storage, sorting by industry, market systems, and unsold or expired food during distribution can also contribute to these losses. Finally, losses can occur during consumption, which includes both individual and community waste from restaurants, canteens, and caterers.

When it comes to livestock products, losses mainly arise from livestock deaths during rearing, as well as deaths during transport, packing and storage. In the case of milk and its derivatives,

losses occur due to possible diseases of the dairy cows. In the case of fish, losses arise from cutting during processing and industrial transformation. Distribution losses, like vegetables, are attributable to market systems, consumer behaviour and retailers. (FAO, 2019)

In addition, it is important to note that while food losses during the early stages of the food chain are usually unintentional, those produced by distribution and consumers are almost always intentional and caused by the wrong and negligent behaviour of consumers and sellers (Parfitt et al., 2010).

## 1.2 FOOD LOSSES AND FOOD WASTES: CAUSES, PREVENTION AND THEIR RELATED IMPACTS

The loss and waste of food is not convenient from an environmental, social, and economic perspective.

FAO (2011) states that while in middle- and high-income countries (industrialized countries) food is largely wasted even though it is still suitable for human consumption, in low-income countries (developing countries), on the contrary, food is mostly lost during the early stages of the supply chain. There are different reasons for these industrialized countries, food is wasted when production exceeds demand, as to ensure delivery of the agreed quantities in anticipation of unpredictable climate change and pest attacks, farmers end up producing more than necessary, albeit with lower quality products. Another cause of waste is the demand for products with high quality standards in terms of appearance, even when it is not a quality factor in terms of nutrition. Furthermore, large quantities of products on display and a wide range of different brands increase the likelihood that some of them will reach their expiration date earlier and therefore be thrown away.

In developing countries food is lost as poor farmers, due to food shortages or desperate need for money, products are harvested prematurely, thus causing a decrease in nutritional and economic value which can be wasted if not suitable for human consumption. Yet another cause could be the lack of storage facilities suitable for food preservation, a widespread problem in developing countries (FAO, 2011; Alamar et al., 2018). These and many others are the main causes of food waste but, in the same report, there are also possible preventive measures to these wastes such as helping institutions to stimulate investments by private sectors for new and efficient food storage equipment, organizing the poorest farmers into groups so that they receive more financial aid from institutions, giving consumers the opportunity to choose from

heterogeneous and non-standardized products just to have a perfect outward appearance when this is not directly related to quality. There are, therefore, efficient solutions for each stage of the supply chain to reduce the amount of food lost and wasted, the actions, however, should not be put into practice by only some of these parties, but by all actors in the supply chain.

In developing countries, measures should have a producer's perspective, such as improving harvesting techniques, farmer training, and suitable facilities for storing produce; whereas, in industrialized countries, solutions aimed solely at producers would have only a marginal effect if consumers continue to waste at current levels, so households need to be informed and change their behaviour (FAO, 2011; Thi et al., 2015; Aschemann-Witzel et al, 2015; Ishangulyyev et al. , 2019; Vos et al, 2019).

The generation of food waste has a direct impact on the sustainability of the entire production chain on three different levels (European Parliament, 2023):

- environmental, as waste generation is a major contributor to greenhouse gas emissions, also negatively affecting climate change; in addition, reuse and recycling of products would decrease the exploitation of natural resources thus also limiting the loss of biodiversity.
- Social, as the world population increases exponentially as does the demand for food, thus necessitating actions to avoid or minimize food loss and waste.
- Economic, in that food loss is also related to a large loss of money by farmers, industries but also consumers; in addition, it could increase competitiveness, stimulate innovation and economic growth by creating new jobs.

To better understand the magnitude of this problem, it is useful to report some of the key statistics and facts on food wastes and losses from a 2021 report by EUFIC, the European Food Information Council (EUFIC, 2021). The following are some of the information as such:

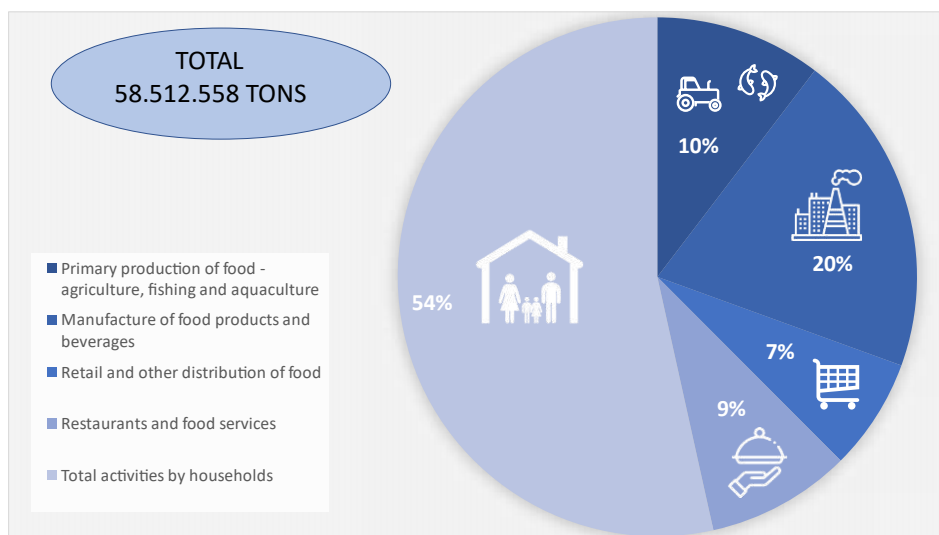
- food waste alone generates about 8-10% of global greenhouse gas emissions.
- If food waste were a country, it would be the third largest emitter in the world only after China and the United States.



- Latest estimates indicate that in 2019, about 931 million tons of food waste was generated worldwide, of which 61% came from households, 26% from catering and 13% from retail.
- About 88 million tons of food waste is generated in the Europe each year. This equals 174 kg per person, or 143 billion euros or 170 million tons of CO<sub>2</sub>.

Different foods have different environmental impacts (Jeswani et al., 2021). For example, the volume of meat that is wasted and lost is not very high compared to foods such as grains and vegetables. However, meat requires many more resources to produce, so meat waste still has significant impact on climate change (estimated to contribute 20% of the carbon footprint of total food waste and loss). The numbers in these statistics are very worrying from all points of view such as environmental primarily, social, and economic. Through an analysis of the most recent data obtained from EUROSTAT (2023), it was possible to construct a number of graphs showing the percentage contribution of the various stages of the production chain, from production to consumption, to Europe's total food waste production.

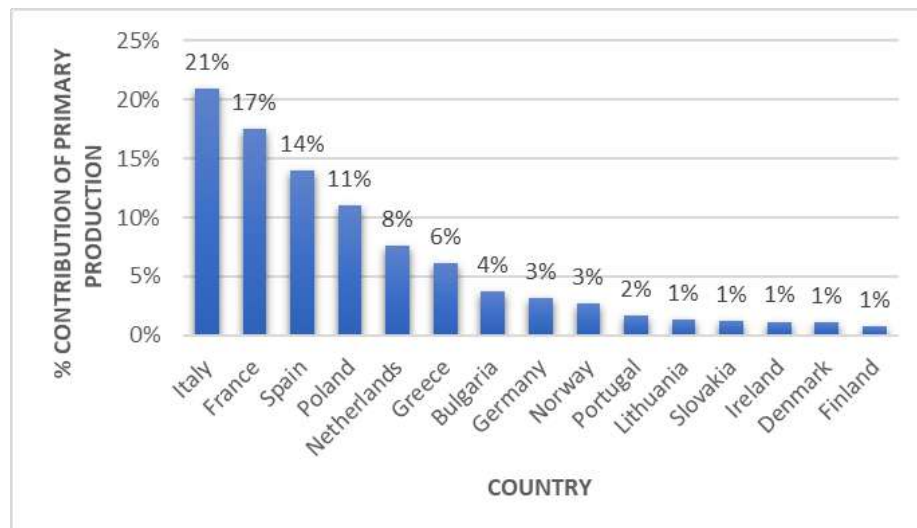
Figure 3 shows the percentage contributions of each stage of the food chain in waste generation to European total.



**Figure 3 (Food wastes in Europe in 2020) Source: author's elaboration from Eurostat data, 2023**

From the graph it can be seen that households have the greatest impact on waste generation (more than 50%), followed by industries, primary production, and finally retail and catering.

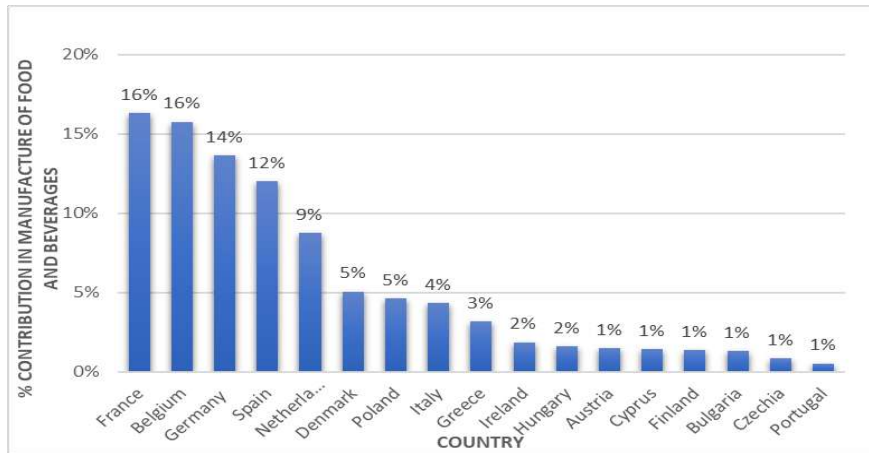
Next, based on the same data, other graphs were constructed showing the countries that have the greatest impact on waste generation for each stage of the supply chain. In Figure 4, it can be seen that in primary production, Italy has a percentage contribution to waste production of 21%, followed by France, Spain, Poland, etc. The European countries do not present in the graph in the figure such as the Czechia, Estonia, Switzerland, Hungary, Austria, Luxembourg, Malta, and Slovenia have a percentage contribution of less than 1% (primary production).



**Figure 4 (Percentage of contribution of primary production on waste generation)**

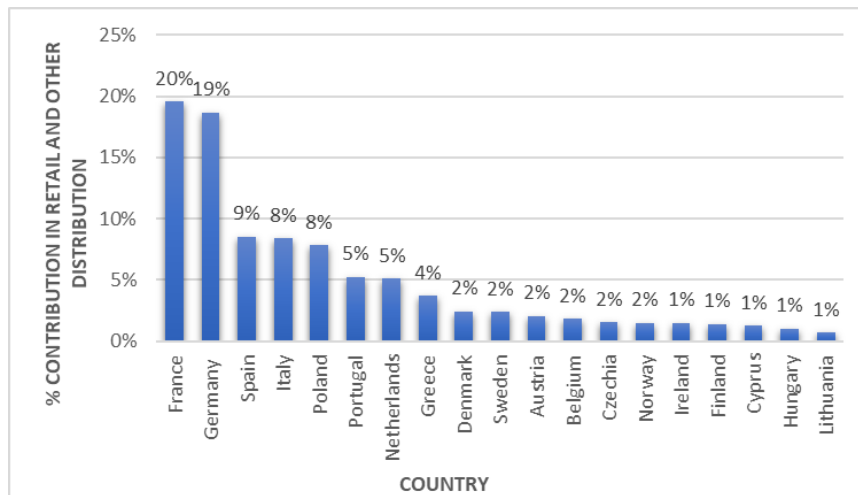
**Source: author's elaboration from Eurostat data, 2023**

Figure 5 shows the percentage contribution to waste generation by the food and beverage industries; it can be seen that France and Belgium are in first place, with a percentage contribution of about 16%, followed by Germany, Spain and all the others. Also in this case some countries are not present in the graph, such as Switzerland, Latvia, Estonia, Norway etc. because they have a percentage contribution of less than 1%.



**Figure 5 (Percentage of contribution of food and beverages industries on waste generation) Source: author's elaboration from Eurostat data, 2023**

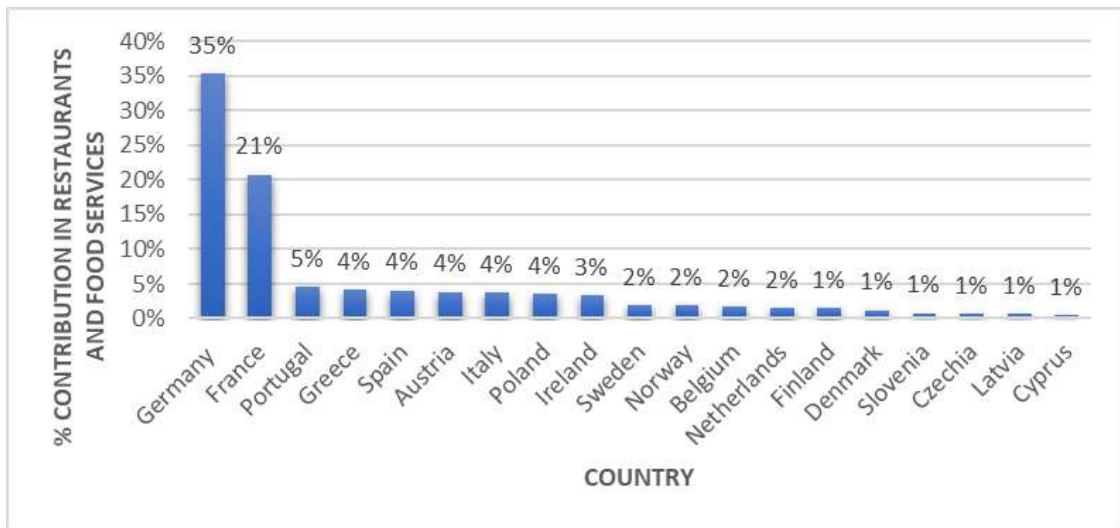
Figure 6 shows, however, the percentage contributions in waste generation during retail and other distribution. As can be deduced from the graph, France is in first place with a percentage contribution of around 20% of the total, followed by Germany with a similar contribution, Spain, Italy, Poland, etc.... As before, also in this case the countries with a percentage contribution of less than 1% are not present in the graph such as Estonia, Slovakia, Bulgaria, Slovenia etc.



**Figure 6 (Percentage of contribution of retail and other distribution on waste generation) Source: author's elaboration from Eurostat data, 2023**

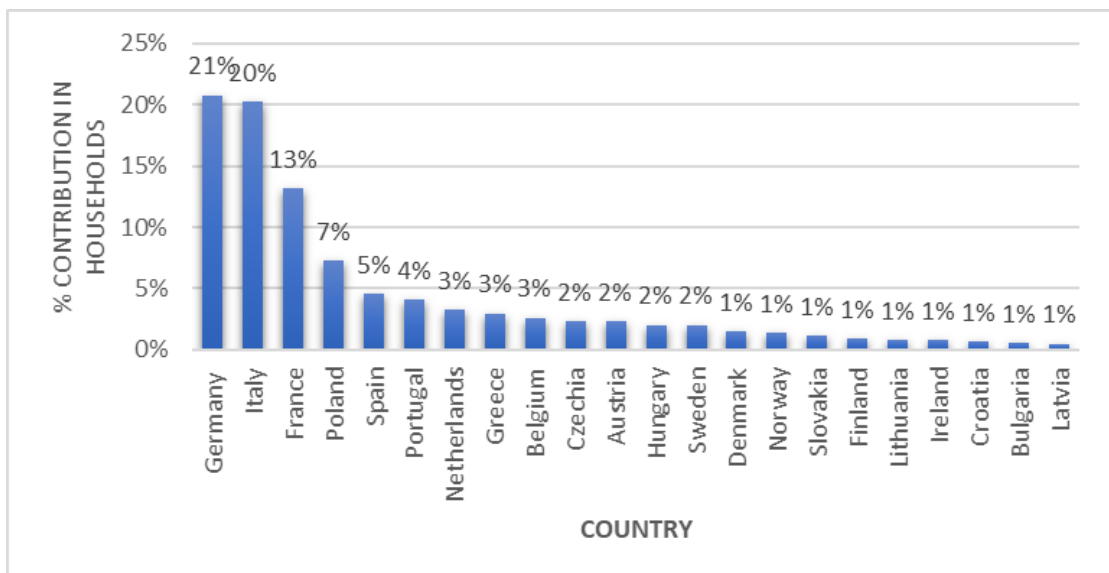
Figure 7, on the other hand, shows the percentage contribution in the production of waste by catering and food services. Germany ranks first with a percentage contribution of around 35%,

followed by France, Portugal, Greece, Spain etc. Again, some countries are not shown in the graph because they have a percentage contribution of less than 1%.



**Figure 7 (Percentage of contribution of catering and food services on waste generation) Source: author's elaboration from Eurostat data, 2023**

To conclude, Figure 8 shows the percentage contribution of households to the generation of waste. Also in this case, as shown by the graph, Germany has the greatest impact with around 21% contribution, followed by Italy, just below, France, Poland etc. As for all the previous graphs, countries with a contribution of less than 1% are not shown.



**Figure 8 (Percentage of contribution of households on waste generation) Source: author's elaboration from Eurostat data, 2023**

### 1.3 HISTORICAL BACKGROUND: LINEAR AND CIRCULAR ECONOMY

The loss of food at every stage of its production, transportation, and storage results in significant waste of resources (Beretta et al., 2016). The data seen are staggering and as the world population is projected to increase, the consumption and waste of food will also increase, exacerbating the problem (Tamasiga et al., 2022). Since the resources needed for food production are limited, it is imperative that they be used sustainably and efficiently (Beretta et al., 2016).

Considering the environmental, economic, and social implications of food waste, the first step toward a more sustainable solution is to adopt a sustainable production and consumption approach, without focusing only on the final part of the supply chain (Chiaraluce et al., 2021).

This concept is included in one of the goals of the Agenda 2030 for Sustainable Development, an action program launched by the European Commission in 2015 by the governments of the 193 member countries of the ONU that incorporates 17 goals (Figure 9) for sustainable development (Sustainable Development Goals SDGs).



*Figure 9 (sustainable development goals) Source: ONU*

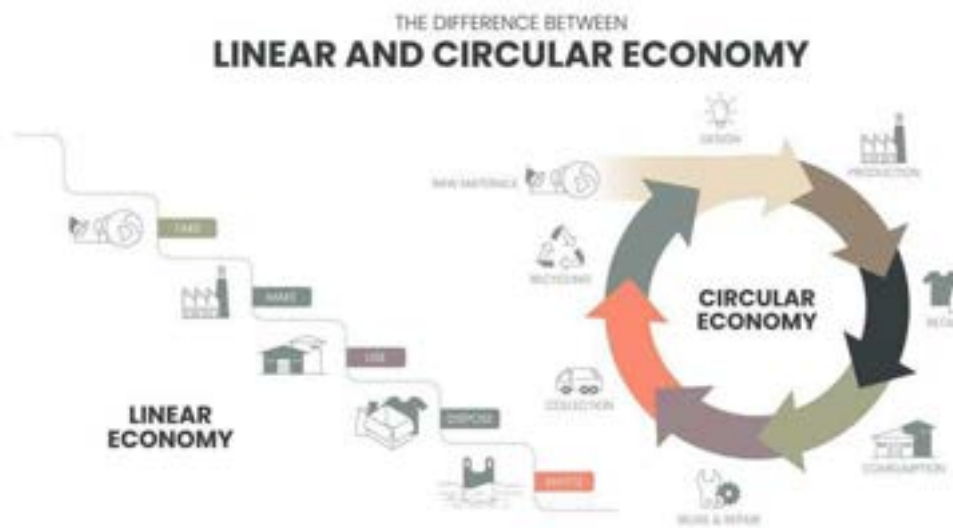
Among the goals it is important to highlight for the purpose of this thesis, number 12 of these goals, that of ensuring sustainable patterns of production and consumption. Sustainable consumption and production aim to "do more and better with less," increasing the benefits in terms of economic well-being by reducing resource use, degradation, and pollution throughout the production cycle, thus improving the quality of life. In particular, target 12.3 aims to "by

*2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses”*. This requires a cooperative approach among all actors in the supply chains, from producer to consumer (United Nations, 2015).

Sustainable consumption and production refer to an ideal model in which all actors in the supply chain learn to use resources efficiently while minimizing waste by, for example, giving it a new life or exploiting it to get something more out of it. This includes actions to reduce the negative impact of production and consumption on the environment, substantially reducing waste generation through recycling or reuse, encouraging companies to adopt sustainable practices, and also developing and implementing tools that monitor this transition to sustainability (Akenji et al., 2015).

The increase in the amount of waste and the difficulties connected with its management are becoming a problem that can be effectively solved in accordance with the principles of the circular economy (Szyba & Mikulik, 2022). Excessive waste production is one of the consequences of the traditional linear production model in which materials are extracted, processed, consumed, and disposed of at the end of their short useful life because they are designed with a single purpose in mind. This process, accelerated by economic development, has substantially increased the amount of waste generated, and it is precisely to limit the impact of this process that the idea of the circular economy was born, that of extending the life cycle of products as long as possible for the benefit of the environment (Neves & Marques, 2022).

The concept of circular economy (CE) originated in the 1970s with the goal of reducing resource consumption for industrial production, but it turns out to be potentially applicable to any resource. Through the possibility of making human activity more resilient, using the natural cycle model, EC proposes a change in the "extraction-production-disposal" paradigm of the linear economy (Arruda et al., 2021). In the figure below you can see the difference between the principles the linear economy and the circular economy (Figure 10).



*Figure 10 (Differences between linear and circular economy) Source: LinkedIn*

In principle, it can be said that the concept of CE is based on the design of high-value, extended-use products, thus extending their lifespan. The focus is on creating multipurpose goods that can be reused in different ways throughout their useful life. A key principle is to ensure the orderly return of solid waste to the industrial sector, where it can be cost-effectively recycled and used as secondary raw materials. In addition, CE requires a systems approach to supply chain management, taking into account the interconnectedness of energy production, material extraction, and the natural environment. (MacArthur, E., 2013).

This concept has been accepted to address sustainability in public policy in governments such as those in the European Union and has been implemented as a national development strategy in China (Arruda et al. 2021). Driven by population growth estimated at 9 billion people by 2050, serious anthropological and environmental impacts such as declining biodiversity and shortages of material raw materials are occurring due to the demand for extraction by millions of people, causing market price fluctuations and instability in the world economic system. In general, CE is based on:

- design of products with added value and maximum use over longer life cycles.
- Realisation of versatile products with different uses in different periods of their useful life, thus ensuring the reuse of a single good.

- The orderly return of solid waste to the industrial sector, where the cost of secondary raw materials from recycling is competitive in the market.
- A systems approach to supply chain management, assessing the interconnections between the energy produced, the material extracted, and the natural environment (Arruda et al. 2021).

A huge contribution to this "transition" was made, no doubt, by the Brundtland report also known as "Our Common Future," the first document to contain the phrase "sustainable development" described as development that meets the needs of the present without compromising the ability of future generations to do so. The report is named after Gro Harlem Brundtland, the then Prime Minister of Norway; the report compiled by the World Commission on Environment and Development (WCED), a commission of environmental specialists, policymakers and civil activists assembled by the United Nations in 1983, investigated environmental concerns in order to develop a package of visionary recommendations to usher in sustainable development in the 21st century, identifying the most pressing environmental challenges, devising approaches to encourage cooperation among countries while including strategies for the responsible exploitation of rich renewable resources.

Thus, in summary, among several possible solutions to the problem of food waste, the circular economy is a concept that has been given increasing attention, as it is closely related when thinking about a sustainable consumption and production model in which resources, which are not infinite, are exploited to their fullest potential thus reducing the negative impacts of traditional models in which resources are taken, used and then thrown away (Kristensen & Mosgaard, 2020).

#### 1.4 DEFINITIONS OF CIRCULAR ECONOMY

It is necessary, now, to define what the circular economy is. The European Commission's defined the circular economy as "*a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products for as long as possible by extending the life cycle of products and minimizing waste, thus creating additional value.*" In fact, this is only the first of many definitions on the circular economy, as reflected in the literature, there are hundreds of definitions that emphasize the importance of this concept.

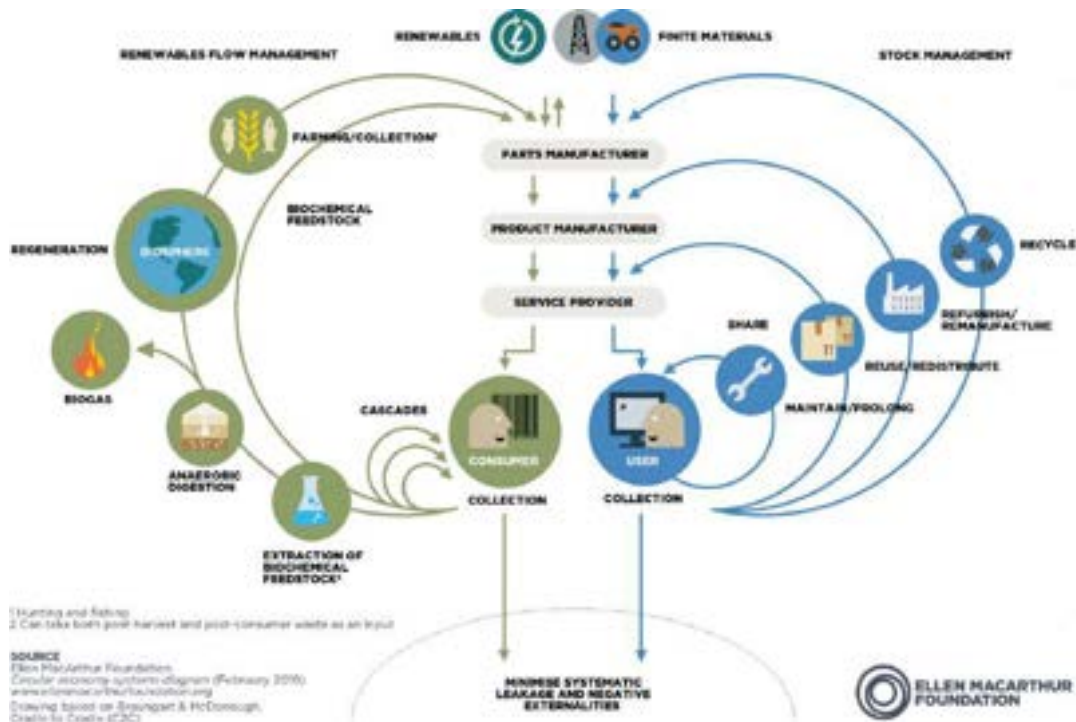


According to a review by Kirchherr (et al.) published in 2017, 114 definitions of circular economy have been collected that state different things creating confusion about the concept. One of them, believed by them to be the most widely used definition, is the one given by the Ellen MacArthur Foundation in 2013, which states, "*The circular economy is a restorative or regenerative industrial system by intention and design. It replaces the concept of end-of-life with restoration, moves toward the use of renewable energy, eliminates the use of toxic chemicals, which undermine reuse, and aims for the elimination of waste through superior design of materials, products, systems, and, within that, business models.*"

The Ellen MacArthur Foundation (EMF) is a non-profit organization that aims to inform the meaning and application of the circular economy. According to this foundation, the circular economy is based on three principles:

- eliminating waste and thus eliminating pollution
- circulating products and materials
- regenerating nature.

The circular economy is a resilient system that is good for business, people, and the environment; for business because the circular economy can increase business prosperity, for people because the implementation of a circular economy could create new jobs, and for the environment because it allows for a reduction in waste generation, thus pollution and greenhouse gas emissions (EMF, 2015). The Foundation also gives a graphic definition of the circular economy, the so-called "butterfly diagram" shown in the figure below (Figure 11).



**Figure 11 (Butterfly diagram) Source: EMF, 2019**

*“The butterfly diagram illustrates the continuous flow of materials in a circular economy. There are two main cycles: the technical cycle and the biological cycle. In the technical cycle, products and materials are kept in circulation through processes such as reuse, repair, remanufacturing and recycling. In the biological cycle, nutrients from biodegradable materials are returned to the Earth to regenerate nature (EMF, 2019)”.*

Another view of the circular economy is the one encapsulated in the principle of the 3Rs (reduce, reuse, and recycle), often used as a definition of the circular economy and considered limited by Geisendorf (et al.), as each R does not take all aspects into account. For example, the first R of "reduce" is about efficiency in the production and consumption of resources, but says nothing about the social aspect, which is closely related, because resource efficiency, which saves resources and reuses them for other purposes or future uses, indirectly increases social welfare. As for the second R of "reuse," which implies a cyclical business model in which a resource is regenerated or repaired to be used again, it can only be successful if consumers are then willing to purchase these goods, and to this end, companies need to invest further in marketing and public institutions need to educate and empower people. Finally, the third R for "recycle" refers to any recovery operation in which waste is reprocessed into new products for the same or different purposes, which includes the reprocessing of organic

materials but not the recovery of the energy that can be derived from them, a requirement that, by contrast, the European Commission's general definition includes.

A more recent article by Gustavo Cattelan Nobre (et al.) published in 2021, on the other hand, sought to provide clarity on the definition of circular economy, as it is believed that the existence of so many different definitions only lead to confusion, misinterpretation, and misuse of the topic. To this end, in this study, 44 PhD circular economy specialists were asked to describe the circular economy in their own words. Data processing resulted in a definition that combines all existing definitions but supplemented by input from specialists, and this one cites: *"The Circular Economy is an economic system that aims at zero waste and pollution during the life cycles of materials, from environmental extraction to industrial processing, and to final consumers, applying to all ecosystems involved. At the end of its useful life, materials return to an industrial process or, in the case of a treated organic residue, return safely to the environment as in a natural regeneration cycle. It operates by creating value at the macro, meso and micro levels and takes full advantage of the nested concept of sustainability. The energy sources used are clean and renewable. Resource use and consumption are efficient. Government agencies and responsible consumers play an active role by ensuring that the system functions properly in the long run"*. This is an articulate and comprehensive definition of the circular economy in that it creates a positive correlation between the three different aspects of environmental, industrial, and social, and also pushes all stakeholders in the production chain up to the consumer to be active participants in this change.

The change from a traditional linear economy to the circular economy is a necessary step in order to optimize resources and, at the same time, improve the environment and empower consumers.

Thus, the goal of the circular economy replaces the concept of waste with that of a resource in order to reduce the consumption of raw materials and increase efficiency in the use of materials to maximize reuse and recycling. The circular economy can be based on 5 pillars that define a rationale for implementing this type of economic system (EMF, 2015):

- resource sustainability, production operations must use renewable or recyclable sources and materials to decrease their environmental impact.
- Product as a service, the product must be designed in such a way as to facilitate its repair, reproduction, and upgrade.

- Sharing platforms, sharing of services and products is required to optimize costs and the amount of resources used to produce them.
- Life cycle extension, the use service of products rather than sale is favoured.
- Recovery and recycling, recovery of products is necessary to extend the life span through recycling, repair, and re-marketing or by changing the purpose for which they were originally designed.

With the circular economy, the notion of a product's life cycle is revolutionized with a new approach to production in which repairing, reusing, and recycling products can dramatically reduce waste. The circular economy thus provides, a potentially infinite life cycle for raw materials in which when a product reaches the end of its usefulness, it can be disassembled, and its individual components can be reused to create something new (European Parliament, 2015). The circular economy offers a promising economic model that maximizes the availability of raw materials while minimizing environmental impact, however, this transition from the traditional economy also depends on cultural changes in that turning waste into resources is a complex and long-term process that requires a change of mindset on the part of the entire community that must proactively collaborate in this transition process (Neves & Marques, 2022).

The agrifood sector (AFS) has been hard hit by problems such as resource scarcity, food loss, and waste generation along the global supply chain. The inefficiency of the food sector results in loss of productivity, energy, natural resources, and the cost of managing these wastes. More pollution and greenhouse gases are also created as a result of these processes and, in addition, unsustainable consumer consumption patterns have contributed significantly to these problems (Jurgilevich et al., 2016; Esposito et al., 2020). In recent years, the agrifood system has begun to pay close attention to issues such as food safety, production traceability, product quality, and respect for the environment and human resources leading to a shift toward sustainable production methods. As a result, agribusinesses are now integrating sustainability into their business models due to increased attention from policy makers, scholars, and nongovernmental organizations. In this context, the linear model of production and consumption needs to be radically redesigned, pushing the emergence CE as a potential solution to these challenges. To overcome food waste and loss and achieve sustainable development goals, the integration of circular economy models and tools in the agribusiness sector is crucial (Esposito et al., 2020).

## 1.5 APPLICATION EXAMPLES TO CIRCULAR ECONOMY IN FOOD SECTOR

As previously mentioned, food waste is also a resource and sustainability issue. The food production process consumes large quantities of resources generating environmental disadvantages such as the loss of biodiversity, soil and water degradation and greenhouse gas emissions. As food is wasted, resources and environmental impact are needlessly sacrificed. To sustainably meet the growing food demand in the face of climate change and dwindling resources, it is necessary to improve the use of the food produced and reduce waste. Food is wasted throughout the supply chain, but the largest waste stream is generated at the end of the food chain by consumers. One of the first example of circular economy was to use the food waste as feed for animals. Food Waste Recycling (ReFeed) for animal feed is a viable option, which could address waste management issues at the same time food security and resource and environmental challenges (Dou et al., 2018; Shurson, 2020; Rajeh et al., 2021). The administration of food waste and food production residues to farm animals has been practiced for many years in some parts of the world (Westendorf, 2000).

Another important example of a circular economy that starts from food waste can be the production of biogas. Biogas is a mixture of methane (40–80%), carbon dioxide (16–48%) and other trace gases, obtained from the fermentation of organic waste. which can be used as an energy source by recovering food waste. A study by the World Bank has shown that around 50% of the organic waste produced could be used for the production of biogas. Biogas plants are the best way to manage organic waste generated in the agribusiness and municipal sectors because they reduce the amount of greenhouse gases emitted into the atmosphere by burning fossil fuels (Szyba & Mikulik, 2022).

There are other hundreds of examples of circular economy model starting from food waste in the world spanning a wide range of industries, from fashion to technology, food to packaging. The following are some of these examples.

One of the earliest examples, is that of one of Italy's most famous fashion companies, Salvatore Ferragamo. In 2017, a capsule collection was born called "Ferragamo Orange Fiber Collection," an exclusive project dedicated to sustainability and innovation launched by the company on Earth Day 2017. Orange Fiber was born in 2014 from the idea of two women Adriana Santanocito and Enrica Arena in Catania, Italy, with the mission of creating sustainable and innovative materials for fashion from the by-products of the citrus juice industry, which amounts to more than 700,000 tons of by-product in Italy. Salvatore

Ferragamo was the first brand to use this special fabric for the construction of a capsule collection (figure 12) entirely dedicated to this circular economy project, in which citrus processing waste is given a new life, giving it a value that is not only economic but also ethical and sustainable.



*Figure 12 (Salvatore Ferragamo's campaign) Source: Orange Fiber*

Another example in the world of cosmetics is Barò Cosmetics, a high cosmetics company which was founded in 2015 in the heart of the Langhe, the territory of Barolo wine. This company wanted to enhance an excellence of the area, namely the Barolo grape, by creating a model of circular economy in which, after the process of crushing and pressing grapes, seeds and skin are recovered to extract polyphenols, powerful antioxidants that represent a gold mine for cosmetics (Figure 13), as they possess many beneficial activities for the skin.



*Figure 13 (Example of Barò cosmetic) Source: Barò Cosmetics*

Another example, this time in the construction sector, is RICEHOUSE a complete example of circular economy born from an ingenious intuition and observation by Tiziana Monterisi and Alessio Colombo in 2016, that uses by-products of rice processing as an alternative to the use of materials of petrol-chemical origin, to develop a line of building products with the mission of “building a house out of rice”. There are, also, a number of initiatives based on the key principles of the circular economy, such as the “Too Good To Go” app, created in 2015 in Denmark with the aim of combating food waste, allows bars, restaurants, bakeries, pastry shops, supermarkets and hotels to reclaim and sell unsold food online at reduced prices; the users simply geolocate themselves and search for nearby participating establishments.

As can be seen from the examples, circular economy models can be applied to a wide variety of sectors, and these are just some of the examples of application. Precisely because the circular economy model is a proactive response to the linear model, which is often inefficient and a consumer of finite and non-infinite resources (EMF, 2015; Murankoet al., 2018; Garcés-Ayerbe et al., 2019), it is necessary, in order to promote the transition from the traditional linear model to a circular one, to establish policies supported by a clear legislative framework applicable to all kinds of sectors.

## CHAPTER 2

### CIRCULAR ECONOMY POLICY

#### 2.1 INTRODUCTION

This chapter will present all policies at European and Italian level with respect to the circular economy. The circular economy represents an innovative approach that aims to reduce the environmental impact and promote economic sustainability, trying to overcome the traditional linear model of production and consumption, in this sense the European Union and Italy have adopted various legislative policies specifications to encourage and regulate the implementation of the circular economy, which start from 2015. From 2015 onwards, the policy framework on the circular economy has seen important developments at national and international level, with a growing commitment from governments, organizations international and global communities to promote the adoption of circular practices and policies. Subsequently, all the different components of the political framework, first European and then Italian, will be analysed in more detail.

#### 2.2 AN EU ACTION PLAN FOR THE CIRCULAR ECONOMY

The implementation of circular economy policies in Europe has a relatively recent history. In 2011, the European Union published a communication regarding the efficient use of resources. Within this communication, one of the measures identified to support this objective was the circular economy approach, which aimed to reduce waste generation and reuse waste as a resource. Four years later, in 2014, the European Union took a more definitive position on the issue with the communication "Towards a circular economy: a zero-waste program for Europe". This document has placed great emphasis on the importance of adopting circular economy practices to address global resource scarcity and promote sustainable economic growth that is not tied to resource consumption. The European Commission has outlined several measures in these documents to promote resource efficiency and establish a circular system (Domenech et al., 2019; Zarbà et al., 2021). These measures include creating a new policy framework, allocating funds for investment, and modernizing waste policies. The ultimate goal is to extend the life of products and eliminate waste to keep their value for as long as possible (Chiaraluce, 2021). Subsequently, the European Commission started concretely to develop policies focused on the circular economy from 2015 onwards.



So, 2015 is the starting point for the European policy framework about circular economy with the publication of the first Circular Economy Action Plan entitled “Closing the loop - An EU action plan for the Circular Economy”.

Intended to facilitate the transition to a circular economy, it aimed to improve Europe's financial competitiveness, encourage sustainable growth, and create new job opportunities.

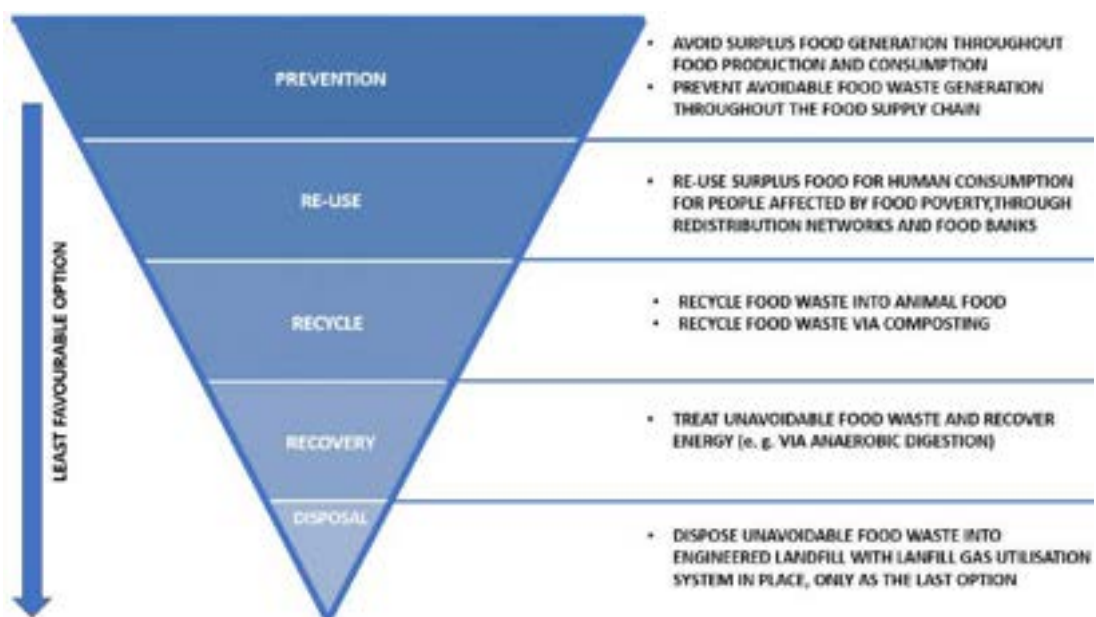
The action plan presented a bold and concrete roadmap, outlining steps that encompassed every aspect of the product life cycle, from production, to consumption, to waste management and the secondary raw materials market. By prioritizing recycling and reuse, the plan aimed to "close the loop" on product life cycles, providing environmental and economic benefits.

The transition to a more circular economy focuses on maintaining the long-term value of products, materials, and resources, and minimizing waste. This first action plan of Europe is closely linked to various priorities of the Union, as the transition to a circular economy will have several positive impacts: on the society, by creating jobs; on the environment, by saving energy and avoiding irreversible damage in terms of climate, biodiversity, and air, water, and soil pollution; and finally on development, as the circular economy will boost the competitiveness of companies by creating innovative and more efficient methods of production and consumption. This action plan aims to ensure a regulatory framework that will entice all economic actors, such as businesses and consumers and society at large. Moreover, it seeks to contribute to the transition by preparing a broad set of concrete and ambitious actions to be implemented by 2020. These proposed actions support the circular economy at every stage of the value chain from production to consumption, repair and remanufacturing of materials, waste management, and reuse of secondary raw materials.

Regarding the production, Europe calls on industry to design products lasting as long as possible, and to make the recovery of useful parts easy. For this purpose, the Commission proposes economic incentives so that products are designed that are easier to recycle or reuse. Also, regarding production processes, the Commission calls on industry to use sustainable raw materials and to cooperate with other industries by promoting, for example, industrial symbiosis, whereby waste or by-products become raw materials for another.

Considering consumption, the Commission stresses the importance of the role of consumers in this transition, which can affect it positively or negatively. It becomes important to inform them clearly and accurately in order to raise their awareness in avoiding and reducing waste, preferring more sustainable products. An example could be the campaigns promoting the voluntary EU Ecolabel, which identifies products with a reduced environmental impact.

Regarding waste, the Commission emphasizes the prominent role of waste management in the circular economy. In this regard, the commission recalls the waste hierarchy, an order of priority contained in the Waste Framework Directive (Directive 2008/98/EC), which establishes a set of preferential methods for managing waste with the lowest possible environmental impact. The goal is to minimize the negative impacts of waste generation and management and improve resource efficiency. However, the waste hierarchy contained in this directive refers to waste in general and not to food waste. According to Papargyropoulou et al. (2014), food waste is increasingly gaining recognition in the ever-evolving field of waste management. The harmful effects it has on the environment, society and the economy are becoming increasingly apparent, and the urgency of global food security further underlines the importance of addressing this issue. As a result, food waste is now recognized as a crucial element in achieving a sustainable solution to the global waste problem. To this end Papargyropoulou et al (2014), by relating the general waste hierarchy to food waste, have produced a Food Waste Hierarchy (figure 14) which aims to serve as a guide to establish the most appropriate options to address the challenge of increasing food waste.



**Figure 14 (Food waste Hierarchy) Source: author's elaboration from Papargyropoulou et al. (2014)**

In this regard, the Commission adopts a series of proposals for the revision of waste legislation to improve waste management, also intensifying the collaboration among Member States. Even if from the hierarchy is considered one of the least options, Europe also commits to an

initiative on the transformation of waste into energy, such as waste-to-energy, to recover as much as possible from waste.

Another topic covered in this action plan is the promotion of secondary raw materials (SRM), i.e., production waste or materials from recycling processes that can be fed back into the economic system as new raw materials, through the introduction of common quality standards to increase confidence in these materials. In addition, the Commission proposes to revise the Union Fertilizer Regulation, so as to facilitate the recognition of organic fertilizers made from waste throughout the EU, and to promote the reuse of treated wastewater by establishing minimum requirements to be applied.

The plan identifies a number of areas defined as "priority" due to their great negative environmental impact. These are:

- plastics, where the Commission proposes to necessarily increase their recycling in order to avoid the steady increase in ocean pollution.
- Essential raw materials, the extraction of which has a major impact on the environment, and in this case the Commission encourages the recycling of products containing such materials like electronic devices.
- Construction and demolition waste, which is considered among the largest sources of waste in Europe, and the Commission aims to develop separate collection systems for this type of waste.
- Biomass and biological products, such as wood, crops and fibres, whose reuse and recycling are encouraged because they can be used in a wide range of products, such as construction or textiles, and because they can be exploited for energy uses (biofuels, biogas, ...).
- Food waste. In this regard, the Commission proposes to develop a common methodology, together with all Member States and stakeholders, to measure food waste, which produced at all stages of the food supply chain is difficult to quantify, so it is difficult to assess its environmental impact. In addition, the Commission calls on all Member States to implement awareness campaigns for consumers along with the dissemination of good practices on food waste prevention by creating a platform dedicated to this issue that will function as a meeting point between the States to exchange information on this issue and propose innovations to achieve this goal.

In the last part of the document, topics such as innovation, investment and monitoring of the circular economy are addressed. Finally, in order to assess the progress made, and thus the effectiveness of actions taken at the EU and Member State level, the Commission promises to develop circular economy indicators based on existing data. To this main document, there is an annex that specifies, for all stages, the 54 measures proposed by the EU and the year in which these are to be achieved. It is important to note that, in 2019, the European Commission declared concluded the First Circular Economy Action Plan, meaning that all the 54 actions were achieved or where almost done.

Subsequently, the interest in becoming the leader of the transition at a global level of the EU leads to the publication, in 2018, of four amending directives which constitute the so-called "Circular Economy Package". The directives concern some of the key topics discussed in the action plan such as end-of-life vehicles, batteries, and electronic devices (Dir. EU 2018/849), landfilling of waste (Dir. EU 2018/850), waste in general (EU Dir. 2018/851) and on packaging and packaging waste (EU Dir. 2018/852). Therefore, there is no directive that deals specifically with food and/or agricultural waste, but directive 2018/851 which amends the "Waste Framework Directive" (Dir. EU 2008/98), contains a series of useful definitions:

- "Bio waste" means biodegradable garden and park waste, food and kitchen waste from households, offices, restaurants, wholesalers, canteens, caterers and retail premises and comparable waste from food processing plants.
- "Food waste" means all food as defined in Article 2 of reg. (EC) 178/2002 ("General Food Law") of the European Parliament and of the Council, that has become waste.

There is also the concept of by-product. By the directive, a by-product is a substance resulting from a production process where the primary aim is not the production of that substance. Consequently, a by-product should not be considered as waste. This opens up a huge spot for the recovery and valorisation without incurring in all the limitations provided by the law in the reuse of waste.

### 2.3 GREEN DEAL AND FARM TO FORK STRATEGY

A great boost to the transition from a linear to a circular model should be provided by the issue of the European Green Deal in 2019.

It is a package of strategic initiatives to address the European Union towards a green transition, with the ultimate goal of achieving climate neutrality by 2050. The aim is to facilitate the

development of a modern and competitive economy, and a fair and prosperous society within the EU. To achieve this ambitious overall climate goal, it is essential to adopt a comprehensive, multi-sectoral strategy incorporating all relevant policy areas. The strategy outlined by the European Green Deal provides a roadmap composed of actions to promote the efficient use of resources by moving to a clean and circular economy to restore biodiversity and reduce pollution. The strategy will be implemented through non-binding European acts, binding European acts and financing instruments.

The strategy aims to increase the well-being and health of citizens and future generations by committing to offer them:

- clean air and water, healthy soil and protection of biodiversity and ecosystems.
- Refurbished and energy efficient buildings.
- Efficient, safe, and environmentally friendly transport.
- Cleaner energy and cutting-edge clean technology innovation.
- Longer lasting products that can be repaired, recycled, and reused.
- Jobs and professional training adapted to the future needs of the ecological transition.
- A globally competitive and resilient industry.
- A healthy food system for people and the planet.

In May of the following year (2020), in a communication, the European Commission presented two strategies that are part of the Green Deal: the "Farm to Fork" and the "Strategy for Biodiversity for the 2030".

On the subject of ensuring a healthy food system for people and for the planet, the Farm to Fork strategy is at the heart of the European Green Deal. It aims to make food systems fair, healthy, and respectful of the environment. As reported in the strategy, these systems currently generate almost a third of global greenhouse gas emissions and consume enormous quantities of natural resources; furthermore, they pose a threat to biodiversity and contribute to the harmful health effects of undernutrition and overnutrition. Primary producers particularly suffer from unequal livelihoods and minimal economic returns. A redesign of the sustainable food system is key to achieving equitable livelihoods for all stakeholders. Furthermore, such a change offers new opportunities for actors in the food value chain. The Farm to Fork strategy seeks to accelerate this transition to a sustainable food system that should:

- have a neutral or positive environmental impact.
- Help mitigate climate change and adapt to its impacts.
- Reverse the loss of biodiversity.

- Ensure food security, nutrition, and public health, ensuring that everyone has access to sufficient, safe, nutritious, and sustainable food.
- Preserve the accessibility of food products by generating fairer economic returns, promoting the competitiveness of the EU supply sector.

The strategy supports the diffusion of energy obtained from renewable sources, such as the use of agricultural waste and residues, and the adoption of socially responsible and sustainable production methods, like circular business models in food processing and retailing, especially for small and medium-sized enterprises. The implementation of a sustainable and circular economy presents a promising prospect of new business opportunities, particularly in reducing food waste.

The strategy has been designed in order to achieve a sustainable food system by taking into consideration several themes including: ensuring more sustainable food systems; guarantee the security of the food supply; encourage the implementation of sustainable practices within various sectors involving food, including food processing, wholesale and retail trade, hotels and food services; encourage the adoption of sustainable eating habits and make it easier for people to switch to a healthy and environmentally friendly diet; minimize food losses and waste; combat food fraud throughout the supply chain.

Finally, the strategy establishes a series of concrete objectives to be achieved by 2030:

- to reduce the use and risk of chemical pesticides and the use of the most dangerous pesticides by 50%.
- Reduce nutrient losses by at least 50% while ensuring that no deterioration of soil fertility occurs and reduce the use of fertilizers by at least 20%.
- Reduce the use of antimicrobials such as antibiotics for farm animals and aquaculture by 50%.
- See at least 25% of the agricultural area devoted to organic farming.

In conclusion, the European Commission states that the transition to sustainable food systems requires a collective approach that involves public authorities at all levels of governance (including cities, rural and coastal communities), private sector actors along the food value chain, non-governmental organizations, social organizations partners, academics, and citizens. The Commission also calls on all citizens and stakeholders to engage in a broad debate to formulate a sustainable food policy including in national, regional, and local assemblies.

## 2.4 NEW CIRCULAR ECONOMY ACTION PLAN

Since the First Plan was almost fully accomplished within 2019, and to fulfil the objectives established by the European Green Deal, in March 2020 the New Circular Economy Action Plan was released.

*“There is only one planet Earth, yet between now and 2050 the world will consume resources equal to three planets”*; thus begins the New Action Plan for the circular economy. Limited resources and climate change make it necessary to move from what was once a produce-consume-waste society to a zero-carbon, environmentally sustainable, non-toxic, and fully circular economy by 2050. To achieve this, the EU must accelerate its transition towards a regenerative growth model that gives back more than it absorbs to the planet. As far as citizens are concerned, a circular economy will provide high quality, functional, safe, efficient, and affordable products that last longer and are designed to be reused, repaired, or put through a high-quality recycling process. The action plan sets out a future-oriented agenda to build a cleaner and more competitive Europe in co-creation with businesses, consumers, citizens, and civil society organisations, aiming to accelerate the profound change required by the Green Deal.

The plan also aims to ensure that this new economic model benefits people, regions, and cities, contributes fully to climate neutrality, and realizes its full potential in research, innovation and digitization (using tools like the Internet of Things, big data, blockchain and artificial intelligence).

The plan proposes a series of initiatives aimed at establishing a strategic framework for sustainable products.

With regards to product design, the Commission states that up to 80% of the environmental impact of products is determined at this stage. Some initiatives and EU legislation already partially address this aspect, both on a mandatory and voluntary basis (i.e., Eco-design Directive or the EU Ecolabel), but without any set of specific requirements. In this sense, the Commission intends to issue a legislative initiative with the aim of improving the already existing directive concerning eco-design, extending its scope to the widest possible range of products, with a certain priority for some of these such as electronics, ICT (information and communication technologies), textiles, plastics, food, packaging and, finally, waste. Furthermore, to support the effective and efficient implementation of the new framework for sustainable products, the Commission aims to:

- establish a European data space for smart circular applications containing data on value chains and product information.
- Step up, in cooperation with national authorities, efforts to ensure compliance with the sustainability requirements applicable to products placed on the EU market, in particular through concerted inspections and market surveillance actions.

Furthermore, to enhance consumer participation in the circular economy, the Commission will propose a revision of EU consumer legislation to ensure that consumers receive reliable and relevant information on products including on lifespan and availability of services repair kits, spare parts, and repair manuals. In addition, the Commission will consider proposals aimed at strengthening consumer protection against ecological facades and premature obsolescence.

The actions proposed by the plan concern, as already mentioned, some categories of products that have a higher priority due to their environmental impact as Electronics and ICT, Batteries and vehicles, packaging, plastics, textile products and construction and buildings.

In detail, addressing the issue of food, water, and nutrients, the European Commission will propose a target related to the reduction of food waste as the key action presented in the Farm to Fork strategy. In addition, the Commission will also facilitate the reuse of water in industrial processes, propose new legislative initiatives on reuse to replace single-use packaging, tableware, and cutlery with reusable products in food services, as well as targets to reduce packaging waste.

The implementation of the sustainable products strategy and its translation into specific legislation will be essential to make progress in waste generation. The initiatives mentioned are functional for achieving the goal of significantly reducing waste production and halving non-recycled waste by harmonizing separate collection systems. Furthermore, in order to compete with primary raw materials, the Commission must promote the market of secondary raw materials by ensuring their safety, availability, convenience and standardization by evaluating the possibility of setting up a market observatory for key secondary materials. Between 2012 and 2018 the number of jobs linked to the circular economy in the EU grew by 5%, so it is necessary to understand the positive effects of circularity also on job creation. For this reason, the Commission will set up useful tools for training dedicated to the jobs that have emerged in the green sector. The efforts of the European Union in terms of circular economy will be considered successful only when they will manage to drive the transition globally. In this regard, the Commission intends to:

- establish a global agreement on plastics.



- Propose a global alliance for the circular economy.
- Launch a debate on an international agreement for the management of natural resources.
- Create a partnership with Africa maximizing the benefit in the transition to circular models.
- Intensify awareness-raising activities.

Finally, the Commission envisages further development in terms of monitoring circular activities, to possibly be checked every six months, updating the "Monitoring Framework for the Circular Economy" and further developing indicators on the use of resources, such as the consumption footprint and that of materials. The transition to the circular economy will be profound and transformative, inside and outside the borders of the EU, with consequences that will at times be destabilizing but necessary. Doing so requires cooperation between all stakeholders at all levels, from the national to the to the international.

## 2.5 EUROPEAN INITIATIVES TO SPREAD CIRCULAR ECONOMY

When it comes to the transition to a circular economy and resource efficiency, it is essential to talk about two important initiatives launched by Europe, the Global Alliance on Circular Economy and Resource Efficiency (GACERE) and the European Circular Economy Stakeholder Platform (ECESP). These initiatives aim to foster collaboration, knowledge exchange, and policy support among stakeholders, including governments, organizations, businesses, and civil society. GACERE focuses on promoting global cooperation and action and serves as a platform for sharing experiences, best practices, and innovative solutions worldwide, with the ultimate goal of accelerating the transition to a circular economy on a global scale. ECESP, on the other hand, is a European-led initiative that brings together stakeholders within Europe, and it acts as a hub for networking, knowledge-sharing and collaboration among European Businesses, governments, NGOs, and academia. Through the ECESP, stakeholders can exchange ideas, discuss challenges, and drive the implementation of circular economy policies and initiatives at the European level.

In detail, in 2017 ECESP was born, as has already been said, is an initiative launched by the European Commission to create a network of stakeholders and promote collaboration in the transition to a circular economy in Europe the platform serves as a hub for sharing knowledge, exchanging best practices, and fostering dialogue among various stakeholders, including

businesses, governments, civil society organizations, and research institutions. The primary goal of ECESP is to facilitate the implementation of the European Union's circular economy policy agenda by promoting the exchange of information and promoting the development of circular economy initiatives. It aims to connect stakeholders from different sectors and encourage cooperation and synergies to accelerate the transition towards a circular economy in Europe.

The European Circular Economy Stakeholder Platform operates through an online portal that serves as a central repository of information and resources related to the circular economy.

The platform provides a range of services and features, including:

- **networking and Collaboration:** ECESP enables stakeholders to connect and collaborate through its online community. It offers a space for sharing ideas, experiences, and best practices, as well as facilitating networking opportunities among stakeholders across Europe.
- **Knowledge Hub:** The platform serves as a knowledge hub, providing access to a wide range of resources, research, reports, case studies, and policy documents related to the circular economy. It helps stakeholders stay up to date with the latest developments, initiatives, and innovations in the field.
- **Events and Workshops:** ECESP organizes events, workshops, and webinars to facilitate discussions, foster dialogue, and facilitate knowledge exchange among stakeholders. These events provide opportunities for stakeholders to learn from experts, participate in interactive sessions, and showcase their own circular economy projects and initiatives.
- **Policy Support:** The platform offers policy support by providing insights, analysis, and recommendations to policymakers at the European, national, and regional levels. It serves as a platform for stakeholders to provide feedback, contribute to policy discussions, and influence the development and implementation of circular economy policies.

By bringing together diverse stakeholders, ECESP aims to create a dynamic and collaborative ecosystem for the circular economy in Europe. It recognizes that the transition to a circular economy requires the collective effort and engagement of all relevant actors, and the platform serves as a catalyst for such collaboration.

The European Circular Economy Stakeholder Platform plays a vital role in driving the circular economy agenda forward, facilitating knowledge sharing, and enabling stakeholders to

contribute to the transition to a more sustainable and resource-efficient economic model in Europe.

GACERE, instead, was created in February 2021, in collaboration with the United Nations Environment Program and in coordination with the United Nations Industrial Development Organization, during the Fifth United Nations Environment Assembly. So, this is an alliance of governments globally willing to work together and support a global transition to a fair circular economy and more sustainable management of natural resources at the political level. The alliance aims to accelerate the global adoption of the principles of the circular economy, resource efficiency and sustainable consumption and production by facilitating the exchange of knowledge between countries, the development of global policies and collaboration among its members. So far eleven countries (Canada, Chile, Colombia, Japan, Kenya, New Zealand, Nigeria, Norway, Peru, Rwanda, and South Africa) have joined the EU in this alliance.

The work areas of the GACERE are to:

- contribute to the goals of the Paris Agreement, thus halting and reversing biodiversity loss and reducing pollution and waste by supporting an equitable global change, towards a resource-efficient and circular economy that promotes sustainable consumption and production through equitable use of resources.
- Conduct an in-depth analysis of national policies, as well as tax and regulatory frameworks, in relation to the sustainable management of natural resources, as well as the transition to a circular economy and industrial symbiosis. Particular emphasis will be placed on examining policies and regulatory frameworks that have proven effective in supporting transition policies and practices that have a positive impact on sustainable human development, while ensuring that no one is left behind.
- Analyse obstacles such as knowledge gaps, governance issues and barriers that prevent circular and fair transitions, as well as "bottlenecks" that hinder the decoupling of economic growth from resource use, greenhouse gas emissions and international and global biodiversity loss, and potential opportunities to make global value chains more resource efficient, circular, and environmentally friendly.
- Identify research requirements and suggest improvements in global governance that can help governments and stakeholders overcome these obstacles and challenges, particularly related to specific resources.
- Avoid duplication of efforts. It is imperative to continue and strengthen sectoral, bilateral and/or regional partnerships in the transition to the circular economy and to share best practices to ensure their effective deployment.

- Encourage more global discussion on improving natural resource governance, explore options to improve the current state, and embrace circular and resource-efficient approaches on a larger scale.

The Alliance should provide the global impetus for initiatives by building on ongoing efforts at the international level, including the G7 Alliance on Resource Efficiency and the G20 Dialogue on Resource Efficiency. The Alliance will bring together governments, charged with developing policies and initiatives in their jurisdictions, international organizations, which play a key role in accelerating the achievement of sustainable consumption and production and management of natural resources, economic stakeholder circular platforms at regional level, business leaders, professional associations and industrial clusters, who want to seize the opportunities offered by the circular economy model, environmental NGOs, civil organizations and representatives of indigenous peoples who want to share their experience on circular practices.

Finally, it is established that the high-level representatives of the Alliance members meet once a year to decide the priorities to be addressed and monitor progress. The expert representatives of the members should meet, when necessary, even remotely, to advance the work of the Alliance and implement the agreed priorities.

Both GACERE and ECESP play vital roles in promoting the circular economy by facilitating dialogue, providing platforms for collaboration, and offering policy support. These initiatives contribute to the global and European efforts to create a more sustainable and resource-efficient economic model, fostering innovation and driving the transition towards a circular economy for the benefit of society and the environment.

## 2.6 THE ITALIAN SITUATION

The European Union is one of the areas most involved in the transition to the circular economy, together with China (EMF, 2015). Italy has approved a series of political actions towards the adoption of the CE in the country such as the law 221 (December 28, 2015). Furthermore, in a recent document from 2017, called "Towards a circular economy model for Italy", the Ministry of the Environment and the Ministry of Economic Development outline Italy's strategic positioning on the CE and recall the principles and basic general characteristics of the model (Ghisellini & Ulgiati, 2020). This document aims to provide a general overview of the circular economy as well as to define Italy's strategic positioning on the concept of circular

economy, in continuity with the commitments adopted in the context of the Paris Agreement on climate change and the United Nations 2030 Agenda on sustainable development. For Italy, it is necessary to implement a paradigm shift that initiates a new, sustainable, and innovative industrial policy capable of increasing the competitiveness of the Italian product and manufacturing, and which also forces us to rethink the way of consuming and doing business. Italy has the characteristics and capabilities to do so and must seize this opportunity to develop new business models that can make the most of Made in Italy and the role of Small and Medium Enterprises (SMEs).

The measurement of circularity is another essential requirement to give substance to the actions to be pursued in the field of circular economy, towards greater transparency for the market and for the consumer.

Italy is still one of the most important economies within the European Union and in the world. The country is scarce in natural resources and depends largely on imports (particularly fossil energy and metals). The transition to CE would make the national economy more sustainable, competitive, and secure by reducing its exposure to the negative effects of its high resource dependency. Natural resources are important for the internal economy and in particular for the production of goods that Italy exports extensively all over the world (Ghisellini, & Ulgiati, 2020).

Also in 2017, following the publication of the first Circular Economy Action Plan, the "Bioeconomy Strategy" was released. The aim is to implement sustainable production using renewable resources and the re-evaluation of waste. It is a strategy that seeks to coherently integrate the principles of the bioeconomy and the circular economy to create business models that are economically sustainable in the long term. The national government has adopted various legislative decrees to implement the European Directives derived from the Circular Economy Package. But, conversely, none of these decrees explicitly addresses the agricultural sector. However, Legislative Decree 116/2020 indicates that the "National Waste Prevention Program" has been implemented to promote waste prevention. The program has established specific qualitative and quantitative indicators and targets since 2013 to evaluate the effectiveness of waste reduction. In particular, for the agri-food sector, it defines specific measures for the use of by-products and the promotion of short supply chains, also encouraging the donation of surplus products. It is important to mention the definition of by-product, contained in Decree 264/2016, which states that a by-product is not waste if:

- the substance is the result of a manufacturing process whose primary purpose is not the production of that particular substance.

- The substance will certainly be used in other processes.
- The substance can be used without any other transformation other than the industrial process.
- Further use is legal.

This concept is not to be confused with the status of end of waste which, according to Decree 152/2006, loses its status if subjected to recovery operations, including recycling and reuse, and if it satisfies certain conditions:

- the substance is commonly used for specific purposes.
- There is a market or demand for that specific substance.
- The substance complies with the regulations and standards and fulfils specific requirements.
- The use of the substance is not harmful to human health.

Thus, the substantial difference between the two is that a by-product is never recognized as waste, while the status of end-of-waste is the requalification of a product that initially had to be discarded. This difference must be clear to companies in order to facilitate the recovery, valorisation and reuse process in a circular system.

Subsequently, in line with the actions undertaken by the European Union, the Italian platform of actors for the circular economy (ICESP) was born in 2018, the aim of which is to create a point of national convergence on initiatives, experiences, critical issues, perspectives, and expectations on the circular economy, mirroring the European ECESP platform (Chiaraluce, 2021).

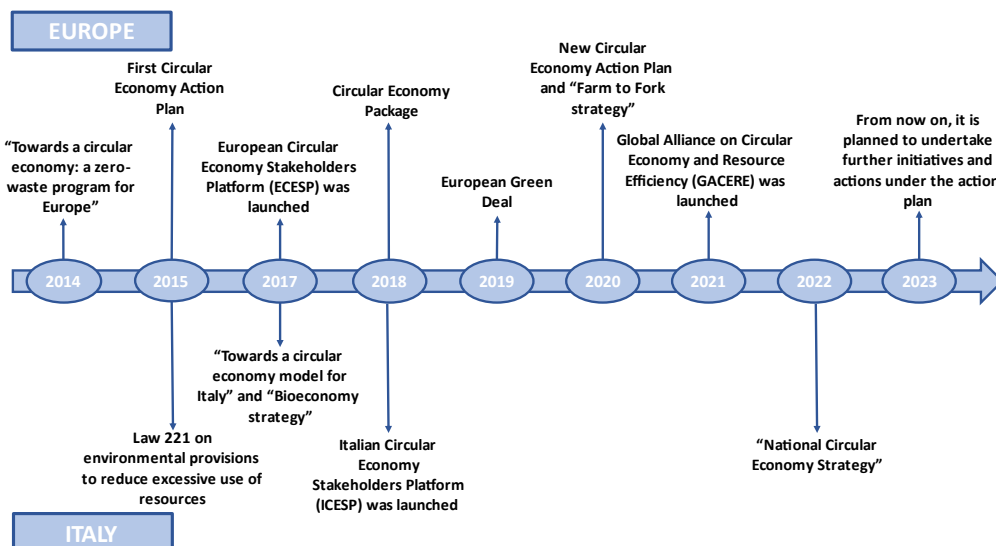
Furthermore, Italy introduced the national circular economy strategy in July 2022. This position paper aims to outline the strategic approach to the circular economy within the country. The identification of actions, objectives, and measures to be pursued in the process of defining institutional policies dedicated to facilitating a smooth and efficient transition towards a circular economy is established. The objective, in particular with the implementation of the "National strategy for the circular economy", is to establish innovative methodologies and approaches to improve the secondary raw materials market and ensure its competitiveness by focusing on both administrative and fiscal aspects. As far as the food sector is concerned, the strategy aims to reduce food waste by promoting the farm to fork strategy, and also includes measures on food distribution, elimination of packaging and disposable cutlery, water reuse and water efficiency and an integrated waste management plan nutrient (with their recovery).

In order to evaluate the feasibility of using recycled materials, the Strategy focuses on three key aspects: availability, performance and cost in relation to virgin raw materials. In pursuing this objective, the Strategy addresses the entire supply chain.

When it comes to acquiring materials, there are specific criteria to consider (Minimum Environmental Criteria for Green Procurement in the Public Administration). The focus is on multiple aspects: the cessation of waste status (also known as End of Waste), the expansion of producer responsibility and the role of the individual in this process. The impact of consumers on the diffusion of sharing practices and on the concept of "product as a service" is a topic of great importance. The strategy also constitutes a fundamental tool for achieving climate neutrality objectives and defines a roadmap of measurable actions and targets up to 2035.

Finally, it is useful to conclude by taking stock of the current situation through the report on the circular economy in Italy. The report states that, unfortunately, the objective of decoupling between growth and resource consumption in Italy has not been achieved as the economic recovery of 2021 has driven an increase in resource consumption. However, despite the difficulties, Italy remains one step ahead of the other European countries, ranking first, together with France, in the ranking of the 5 main European economies for the rate of circular use of the material, with a percentage of around 22 % out of the 13% European total (Report on the circular economy in Italy, 2022).

To summarize, Figure 15 shows all the actions taken in order to allow the transition to the circular economy both by Europe and by Italy in comparison.



**Figure 15 (Summary of Italian and European circular economy policies) Source: author's elaboration**

# CHAPTER 3

## LITERATURE REVIEW

### 3.1 INTRODUCTION

The food system alone is responsible for a third of global greenhouse gas (GHG) emissions, and food waste (a term that includes both food loss and waste) accounts for a large part of these emissions, which translates into an inefficient and irresponsible use of planetary resources that are finite and not infinite. However, in recent years, food waste has been recognized as an international problem and there are more and more initiatives aimed at reducing it, and constant searches for solutions to this problem. One of the most recent concepts for waste reduction is upcycled food, also discussed with the terms "waste for value", "products with added value" or "collateral valorisation" (Aschemann-Witzel & Stangherlin, 2021; Coderoni & Perito, 2020; Teigiserova et al., 2020). In the current context, society faces a global challenge: the need for a fundamental revision of the economic and environmental paradigm. The accelerated economic growth has led to a situation of unprecedented prosperity but has also triggered an acceleration in the depletion of natural resources and the irreversible alteration of the earth's ecosystem. In response to this global crisis, the circular economy has emerged as an innovative model, promising to transform the economic system into a more sustainable, responsible, and resilient approach. In this context, the consumer plays a central role in the transformation towards a more circular model since his purchasing decisions and preferences can significantly influence the adoption of sustainable practices. This literature review aims to examine in depth the circular economy and its related practices from the perspective of the consumer in the agri-food sector.

### 3.2 CONSUMERS' PERSPECTIVE ON CIRCULAR ECONOMY IN AGRIFOOD

To understand the current state of the art in the literature relating to the consumption analysis of food products deriving from agri-food supply chain waste (from a circular economy perspective), a bibliographic search was carried out.

The bibliographic search was done on two separate databases: Scopus and Web of Science (WoS). The search string used was: "circular economy" AND "food" AND "consumer". The initial search produced a database of 589 scientific papers, to which a series of filters was



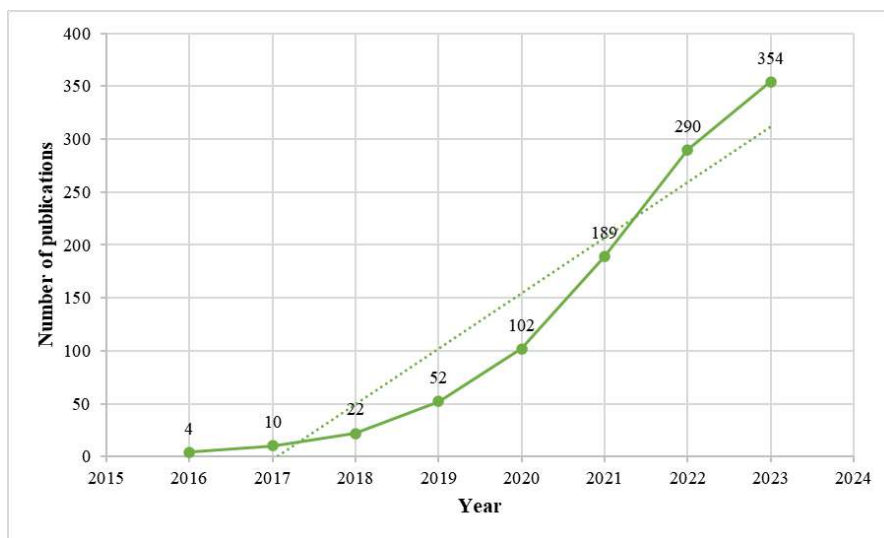
applied (keep only articles and reviews in English and remove overlaps) which led to obtaining a final database of 354 papers (Table 1).

*Table 1 (Literature review database)*

<b>Initial database</b>	369	220
<b>Article, review &amp; book chapter (English)</b>	297	210
<b>Overlapping</b>		153
<b>Final database</b>		354

A productivity analysis was applied to this database to verify the evolution over time of the number of publications (from the first year available up to the works published by July 2023) and the countries that are studying the subject the most. Then, to extract the relevant field of research, co-occurrence was studied through VOSviewer software (1.6.18). VOSviewer is a tool that can be used to create, visualize, and explore maps based on any type of data. The map is a visual depiction of the subject showing the relation among the items, grouped in clusters. Clusters are non-overlapping; thus, an item may belong to only one cluster (Van Eck & Waltman, 2022). Maps normally guide the analysis, but field expertise is still required for proper interpretation (Heersmink et al., 2011).

The analysis of the evolution over time highlighted a growing trend starting from 2016, recording an increase of almost 300% in the number of publications between 2020 and 2023 (Figure 16). This denotes a growing interest in the subject by the scientific community in recent years.



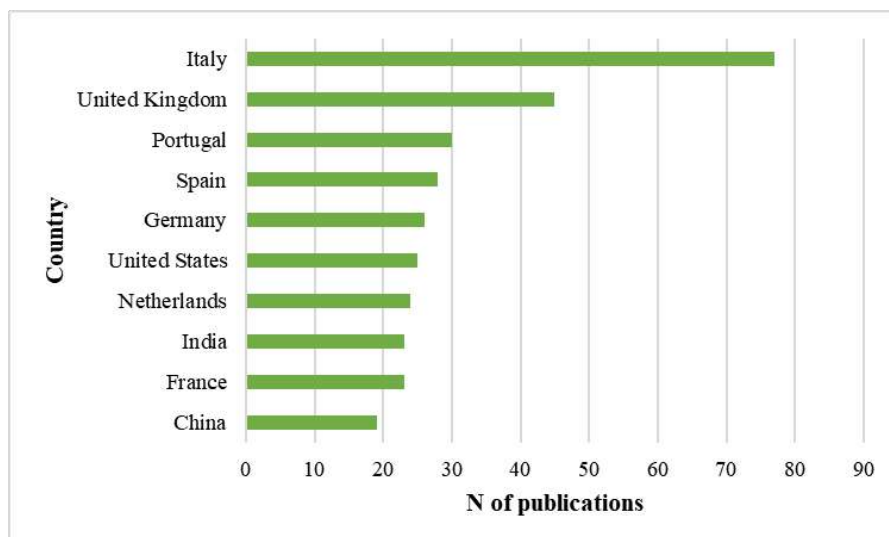
*Figure 16 (Number of publications)*

As far as countries are concerned, the world map shows a widespread interest in the subject, even in developing countries (Figure 17).



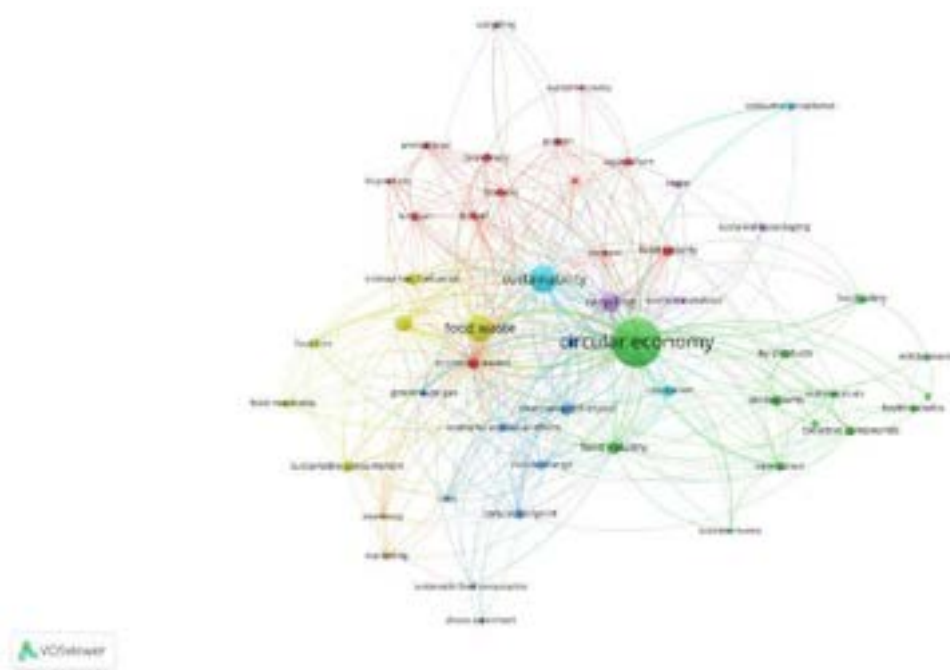
**Figure 17 (Country of publications)**

The 10 most active countries on the subject are represented in the Figure 18, with Italy standing out at the top of the ranking. This is not surprising, as in general Italy is the most circular country in Europe (Circular Economy Network, 2023), and the Italian scientific community is generally very active on the circular economy theme in the agri-food sector (Chiara et al., 2021).



**Figure 18 (Number of publications per country)**

Wanting to outline what are the current research ideas regarding the consumption analysis of circular products deriving from food waste, we proceeded to use a bibliometric tool (software VOSviewer 1.6.18) to build a map of keywords co-occurrence. A co-occurrence network analyses the most frequent keywords and the relationships between them, providing a deeper insight into the main research topics to understand the transition and trend of research in a specific scientific field (Rejeb et al., 2021). The keywords identified by the software and clustered in a bibliometric map are visible in Figure 19.

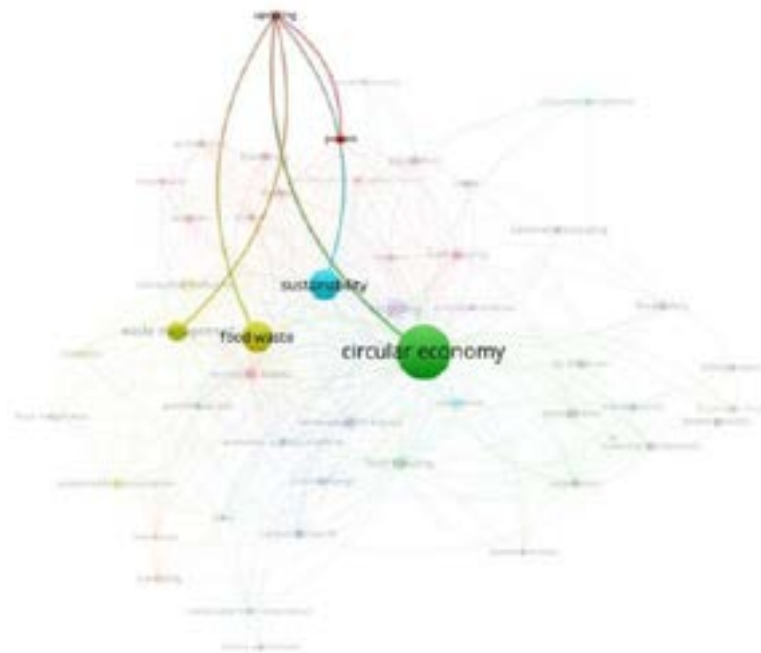


**Figure 19 (Bibliometric map)**

The map shows the formation of eight different research clusters:

- Red cluster: this can be considered as the recovery cluster for processing with the more "conventional" and well-known solutions, such as energy recovery, fertilizer production and animal feed. However, when it comes to these issues, the consumer is also aware of the economic aspects deriving from the recovery of waste, the importance of conserving natural resources and food safety.
- Green cluster: the cluster of functional foods. This cluster includes all the recycled nutraceutical compounds (polyphenols, antioxidants...), and the importance that the consumer gives to the beneficial effects on health. The consumer knows that it is possible to recover important molecules starting from agri-food waste, which is indeed extremely rich in them.

- Blue cluster: the environmental sustainability cluster. When hearing about the circular economy, the consumer also thinks of the impacts that agri-food production has on the environment, and which could be mitigated by the implementation of circular practices.
- Yellow cluster: this cluster begins to approach the topic of our research. Of recent development (and, therefore, less connected with the other clusters) is the theme of consumer analysis for products deriving from food waste. Consumer behaviour is evaluated on the basis of waste management and neophobia towards these products containing waste.
- Pink cluster: this cluster somewhat represents the "origin" of the concept of circular economy when we spoke "simply" of recycling and reusing products. It is no coincidence that even in the overlay view the colours are darker, representing more "old" research topics.
- Blue cluster: despite being made up of only three elements, this cluster represents a nodal point of the bibliometric map, as the concepts of sustainability and innovation act as a pivot for the interconnection of almost all the other clusters, representing that for the consumer the application of a circular model in the agri-food sector is closely connected to the achievement of sustainable productions under the banner of innovation.
- Orange cluster: very different from the others, these two elements come together as it is important to consider consumer awareness of the circular economy, since in this way it is also possible to use these tools as a form of corporate marketing. However, we must not forget that, precisely because of the awareness acquired by consumers towards environmental and sustainability issues, many of the circular economy-themed initiatives are perceived solely as marketing strategies, without a real corporate commitment behind them.
- Brown cluster: the term upcycling finds itself isolated from the other keywords. This is not surprising, as it is one of the latest research topics currently spreading. In fact, the literature lacked a wording that defined a product obtained from waste and not simply recycled, but that had a much higher quality than the starting raw material (food waste, in this case). Upcycling is not only connected to the circular economy, but also to food waste and sustainability, which therefore represent the development points for future research (Figure 20).



**Figure 20 (Upcycling in the bibliometric map)**

### *3.2.1 Consumers' perspective on upcycled foods*

Given that upcycling represents a new research topic in consumer analysis for products deriving from waste from the agri-food chain, it was decided to proceed with this topic for the study in question. The literature review investigation on upcycled foods was aimed at better understanding consumer awareness, perceptions, and attitudes, in order to better understand the behaviour and factors that determine purchase intention and willingness to pay for it type of food products. Given the enormous environmental, social, and economic impacts of waste across the entire food chain, the transition towards more sustainable food systems is considered urgent. The practice of upcycling applied to the agri-food sector is gaining more and more relevance. The idea of upcycling is based on the circular economy model which would alleviate the problem of food waste by creating new products and allowing the recovery of resources. Despite the great attention and importance aroused by this topic, its concrete application still seems to encounter numerous obstacles, including consumer perception towards these products (Hellali & Korai, B, 2023).

In this regard, a second bibliographic search was carried out in the Scopus and WoS databases using the string "consumer" AND "upcycled food". The research produced a final database of 18 scientific publications, as the initial number of publications was filtered considering only those publications with free access, in English and which were not reviews. The table X divides

the articles according to four different lines of research and shows, for each of these, the authors, year of publication and methodology used to analyse the results.

**Table 2 (Journal articles on upcycling food products)**

<b>Main topic</b>	<b>Author(s)</b>	<b>Publication year</b>	<b>Methodology</b>
<b>Consumers' recognition and acceptance of upcycled food</b>	Goodman-Smith et al.	2021	Descriptive statistics with Excel (2011)
	Sousa et al.	2021	PCA with Verimax Rotation and Kaiser normalization;
	Aschermann-Witzel et al.	2022	hierarchical analysis with Wardi's method ANOVA, SPSS 28 SYSTEM and RStudio
	Yilmaz & Kahveci	2022	ANOVA tests and binary logistic regression
<b>Evaluation of purchase intention for upcycled and traditional products</b>	Grasso et al.	2023	McNemar test and t-test using Excel and SPSS statistical software (version 27)
	Aschermann-Witzel & Peschel	2019	ANOVA and t-tests with SPSS25 software
	Bhatt et al.	2020	General Lineal Model and ANOVA
	Ye et al.	2022	Three-variable covariate analysis and a General Linear Model and a mediation analysis with the PROCESS macro
<b>Demographic-based variations in purchase intent</b>	Ghazanfar et al.	2022	General linear model
	Coderoni & Perito	2021	Binary logistic regression model
	Zhang et al.	2021	ANOVA
<b>Influential factors choosing upcycled food products</b>	Grasso & Asioli	2020	Mixed Logit model and Latent Class Logit
	Peschel & Ashermann-Witzel	2020	General Linear Multilevel Model
	Yang et al.	2021	ANOVA, t-test and Bootstrap method
	Asioli & Grasso	2021	Discrete choice models, Mixed Logit and Bootstrapping method of Krinsky and Robb
	Thorsen et al.	2022	Qualitative analysis software program NVivo Version 12 Pro
	Hellali & Korai	2023	IBM SPSS (version 28) statistical software
	Taufik et al.	2023	ANOVA

### *3.2.2 Consumers' recognition and acceptance of upcycled food*

The first line of research analysed addresses precisely this topic, the recognition and acceptance of upcycled foods by consumers. Goodman-Smith et al. (2021) state that understanding consumers' concerns and desires towards upcycled products is essential to arouse their interest. In their study, in fact, they explore the aspects of acceptance of upcycled foods by a group of consumers in New Zealand with the aim of investigating what are the most significant aspects of consumer evaluation. The results of this study show that despite the lack of knowledge of these foods by the interviewees, of which only 10% had heard of upcycled food, after an explanation of the term more than 75% of them declared they were willing to purchase them. Furthermore, consumers declare that the presence of labels with various information on the product including, for example, the list of ingredients and their origin, represent an important element of evaluation. Another interesting result of this study was also the fact that upcycled foods become more attractive if they cost less, as even consumers who had declared their unwillingness to purchase these products increased their willingness to purchase as the price decreased. The same authors also discovered that many consumers are willing to purchase upcycled foods for other people in their family and for their pets. Sousa et al. (2021) instead, assessed consumers' perception and knowledge regarding the circular economy and the use and valorisation of food by-products (practice of upcycling). They showed that most consumers were much more familiar with the concept of circular economy than with the concept of upcycling. The same authors concluded that the lack of knowledge and information regarding the use of by-products can represent a major obstacle to the acceptance of the promising upcycling solution. Thus, Sousa et al. (2021) state that it is necessary to understand consumer perceptions towards these foods to reduce the risk of launch failure of these products due to aversion and fear of consuming them, and that government bodies, educational institutions, and industry food. They should invest in awareness campaigns to increase consumer knowledge about circular economy practices. Aschemann-Witzel et al. (2022) explored what type of information, with particular attention to the concept of frugality of upcycled products, and what consumer characteristics explain a favourable attitude towards some upcycled products. The results of this study showed that adding phrases on the product that emphasize the frugality of upcycled foods, such as "use everything you have" or "do more with less", could improve the favourable perception of these foods. Furthermore, confirming previous studies, Aschemann-Witzel et al. (2022), also state that environmental concern, therefore the communication of environmental benefits, and food neophobia, influence

consumers' willingness to purchase these products, respectively a positively and the other negatively. Yilmaz and Kahveci (2022), studied both Turkish consumers' awareness of the concept of upcycling and the factors that influence their willingness to purchase upcycled foods. The results showed that, of the total sample, 35% had heard of the concept of upcycling and that among the variables influencing consumer awareness of the concept, sociodemographic factors had no effect. Instead, the factors that significantly and positively influenced consumer awareness were the frequency of cooking at home, following a special diet and the frequency of recycling at home. Grasso et al. (2023), however, studied consumer knowledge and attitudes towards upcycled products in the United States and China, which represent two completely different consumer markets. Initial awareness for the concept of “upcycled food” self-reported by survey participants was 20% in the US and 30% in China. However, the results of the qualitative analysis showed that only half of those who declared it really know the concept. This result suggests that there is still a need to raise awareness about this concept in general. Positive results, however, for WTT (willingness to try) and WTB (willingness to buy), for upcycled foods in both countries: for WTT in the United States, 70% of consumers interviewed would try these foods and 60% in China; for WTB, however, 68% United States and 61% in China.

### *3.2.3 Evaluation of purchase intention for upcycled and traditional products*

The second line of research concerns how purchasing intentions are evaluated and how these vary from upcycled products to traditional products. For example, Aschemann-Witzel & Peschel (2019) studied Danish consumers' attitudes towards traditional soy-based cocoa-flavoured drinks, commonly consumed in Denmark under a well-known brand, and cocoa-flavoured drinks containing potato or grass resulting from industrial by-products. The results generally show a less positive attitude towards the new drink obtained with upcycled ingredients. A significant effect of brand and gender on consumer attitudes was also found, in fact consumers preferred the traditional drink because they knew the brand, but a more positive attitude for the new drink was discovered among men who adopt, in general, more innovative approaches than women. Bhatt et al. (2020) also tested the change in willingness to pay (WTP) for some upcycled products due to the addition, on the label, of a rational and emotional message suitable for these products. The results of the study indicate that the WTP for upcycled foods was lower than for conventional alternatives, especially for some products such as granola bars, chicken nuggets and ice cream, while for products such as muffins and



pasta sauce the results were somewhat higher. positive. Regarding the use of messaging, the results of this study indicate that a message that provides more rational arguments in support of the consumption of upcycled foods to address the serious problem of food waste is much more effective than an emotional message. It is important, however, to underline that a positive effect of communications on the product has been discovered, in fact Aschemann-Witzel & Peschel (2019) also found that when the sustainability effect they have is explained in foods with upcycled ingredients, attitudes towards these products change positively. Ye et al. (2022) instead, studied the acceptance of upcycled foods as pet food by their owners. The topic of this study is completely different from others in the literature, but important because the pet food industry is one of the fastest growing segments in the food industry. Ye et al. (2022) found that, at an affordable price, pet owners have a greater purchase intention for upcycled pet food compared to conventional pet food as it is perceived to be better in terms of quality and sustainability. The authors also asked the owners themselves whether they were willing to pay a higher price like that for premium conventional pet food, and in this case at the higher end of the price spectrum, pet owners accepted the foods with ingredients upcycled in the same way as conventional ones with top quality ingredients. Ghazanfar et al. (2022) investigated the influence of sustainability claims on the willingness to pay for upcycled and conventional vice and virtue products. Virtue products are understood as those products that do not provide immediate pleasure, therefore less attractive, but which do not have a negative impact on long-term health, while vice products are those products that are more attractive and rewarding but which have long-term negative consequences on health. The results, in the first part of the study, showed that the WTP for conventional vice and virtue products was higher than that for the same upcycled products, without any communication on the sustainability of the latter. In the second part of the study, however, the change in WTP was analysed for both conventional and upcycled product categories, accompanied by a statement of sustainability on the upcycled ones. In this case the results showed that the sustainability statement had a significant effect on willingness to pay for both upcycled products, but a little more for products in the vice category than for virtue ones.

#### *3.2.4 Demographic-based variations in purchase intent*

Regarding the third line of research, some authors have studied how demographic factors influenced the purchase intention for upcycled products. Zhang et al. (2021), for example, studied how consumers of different generations, who, having different ages, also have

different behavioural characteristics, perceive upcycled foods, in order to provide marketers with segments that can be used in the marketing of these products. To analyse these differences, consumers were divided by age into 4 categories: Gen Z (born 1995–2015), Gen Y or Millennials (born 1980–1994), Gen X (born 1965–1979) and Baby Boomers (born in the period 1944-1964). The results of this study showed that three out of four groups (Baby Boomers, Gen Y and Gen Z) showed strong purchase intentions for upcycled products, and that therefore there is a considerable market for these products when considering these generations. However, it was discovered that Generation X (born between 1965-1979) showed a lower perception of the quality of these foods, and consequently a lower purchase intention. Probably the result, as stated by the authors, is due to the fact that this generation, being a group of consumers who are more cost-conscious, difficult to persuade and confident in taking action, is more difficult to convince. For this reason, to increase their willingness to purchase upcycled foods, it is necessary to guarantee the quality of these products and communicate their benefits. Another study in this line of research is that of Coderoni and Perito (2021) who instead studied the potential market of upcycled products for a single generation of consumers, that of generation Y or Millennials. Millennials, as stated by the authors, represent a very significant market share (25%) and impactful as they are a very active segment of consumers in the digital space and with a high level of involvement. To this end, the authors evaluated these consumers' acceptance of upcycled products and the possible role played by Food Neophobia (FN), Food Technology Neophobia (FTN), characteristics of the products in terms of benefits for the environment and health and other relevant purchasing preferences. The results show that FN and FTN, even for Millennials, represent hindering factors in the willingness to purchase upcycled products, while instead the presence on the label of the environmental and health benefits of these products have a more than positive impact on the willingness to buy upcycled foods.

### *3.2.5 Influential factors choosing upcycled food products*

The last line of research identified in the literature, the most consistent in terms of number of studies, is that which concerns the identification of the factors that influence the purchase decision of upcycled products. Grasso and Asioli (2020) for example, investigated UK consumer preferences for upcycled products, using four attributes: price, flour (with conventional flour or recycled sunflower flour), protein and presence or absence of a “Carbon Trust” label (it verifies that a brand is working to measure and reduce a product's carbon

emissions. The study used a hypothetical biscuit made with flour obtained from sunflower processing waste (residues left after oil extraction) through an evaporation and steam extrusion process which has a high protein content as the food to be evaluated. The results of this study showed that the majority of consumers (85%) had never heard of upcycled ingredients, but that, however, the same percentage of consumers would be willing to purchase them because they would be good for the environment, because they would reduce waste and out of curiosity to know its flavour. Furthermore, Grasso and Asioli (2020) also observed that price was the attribute that most influenced consumers' WTP, followed by the Carbon Trust label, protein and finally flour information, and therefore the Consumer acceptance of these biscuits could be changed by promoting upcycled biscuits with a lower price, the Carbon Trust label, and nutritional claims on proteins. Peschel and Ashermann-Witzel (2020), on the other hand, study the effect of transparency in communicating the benefits and information of upcycled products which, in this case, are potato proteins recovered from the starch processing waste of a Danish company. The results of this study show that: even if plant-based alternatives of some products are less preferred than other current food trends (organic, healthy...) an upcycled product with high transparency in sustainability communication, i.e. the communication of the why and how of upcycling can increase the probability of choosing over the other; in a scenario where a plant-based version and a normal version of the same product are available, regardless of the sustainability communication, consumers were more likely to purchase the plant-based one; and finally, that cost transparency increases the fair perception of the price of the upcycled product, but this greater acceptance of higher prices could be compensated by a lesser choice of these products. Bhatt et al. (2020), unlike the other authors, focused on consumers' willingness to pay for an upcycled product compared to the same conventional product. They stated that the price of a product is crucial in evaluating consumers' willingness to purchase that product. Furthermore, the study by Yang et al (2021)., unlike other studies, evaluated the effect of mental simulation on consumers with respect to purchase intentions for upcycled products. Mental simulation can significantly improve consumer attitudes and willingness when it comes to new products. This research, through three studies, found that without marketing intervention, the purchase intention for upcycled products was lower than for conventional ones, as already found in other studies. The results of this study show that mental simulation, for example the use of slogans or posters to promote upcycled products, proved to be very useful in increasing consumers' purchase intention, even more effective than rational messaging (Bhatt et al., 2020). Still in the same line of research, Asioli and Grasso (2021) also evaluated the effect of nutritional and environmental information on UK consumers' WTP for

biscuits containing upcycled ingredients (recycled defatted sunflower cake flour. The messages used by the study are states: "higher protein content" for the nutritional one and "lower carbon footprint" for the environmental one. The results showed that when nutritional and/or environmental information on the benefits of upcycled biscuits was provided, consumers were willing to pay a higher price compared to when this information was not provided, in the same way for the two types of information. A study with a different point of view is that of Thorsen et al. (2022) who investigated the opinions of retail sales managers on attributes that they evaluate to approve an upcycled product on their shelves. The results of this study advise upcycled food manufacturers to carry out in-depth research on all aspects of the product to be presented, focusing not only on the environmental benefits but also on all others, and to establish a marketing plan focused on the 4 Ps, Product, Price, Promotion and Place. In particular, the authors have drawn from their research that it is necessary to: create a product that is unique, innovative, and relevant to a consumer trend; have a competitive price to be attractive enough but financially sustainable for the manufacturer itself; create a clear marketing plan; and finally, position the product within the same quality range as conventional products. Another study in the research line on the factors that influence consumers' purchase intention for upcycled products is that of Taufik et al. (2023), who examined the extent to which purchasing upcycled foods can evoke morally self-rewarding feelings depending on whether the environmental or nutritional benefits are communicated in an abstract or concrete manner. The results show that the way in which upcycled food is communicated to consumers influences their purchase intention and this is because variations in communication lead to variations in the moral signalling consequences that consumers associate with purchasing upcycled foods. Furthermore, when the benefits are communicated in a more concrete way, study participants perceived more rewarding feelings and, consequently, their purchase intention increased. The latest study in this line of research is that of Hellali and Koraï (2023) who investigated the variables capable of explaining the acceptability and the role of the perception and emotional response of upcycled foods, the role of environmental motivations in the decision of purchase and finally, the effect of the level of innovation on the purchase intention of these products. The results show that: food neophobia, as already stated by previous studies, is an obstacle to the intention to purchase upcycled products; that consumers who are more aware of the positive effects of circular economy practices and the importance of the problem of food waste are more likely to purchase these products; that the emotional response plays a significant role in the acceptability of these products, so those who feel emotions of admiration are more inclined to purchase these foods, rather than those who feel

emotions of disgust; that consumers in Quebec (where the research was carried out), despite their environmentalist beliefs, have a low purchase intention for upcycled products; and finally, that in this study young adults (25-34 years) and middle-aged adults (35-54 years) are those who have a greater purchase intention than younger people.

# CHAPTER 4

## CASE STUDY ON UPCYCLED FOOD: CONSUMERS' PERCEPTIONS AND WILLINGNESS TO PAY

### 4.1 INTRODUCTION

The purpose of this chapter is to present the various stages of the methodological process employed in this research. An online questionnaire was used to collect the data. The survey produced a series of information which, after careful analysis, proved to be crucial in obtaining a deeper understanding and interpretation of the consumer profile. This includes their familiarity with the circular economy and upcycling, their level of interest in and perception of this new food trend, and their willingness to pay for a specific upcycled product. Once collected, the survey data was carefully checked, organised, and archived in a database for future processing. In particular, this study had two key objectives.

- An exploratory analysis that delves into the various factors that shape consumer behaviour when it comes to purchasing upcycled food products. This analysis will examine the level of consumer awareness, interest, and perception of these products.
- An economic analysis to estimate the willingness to pay for food products defined as upcycled compared to the same types of products, but conventional. This analysis aims to understand consumers' WTP for upcycled foods, while analysing which factors can influence consumers' purchasing choices.

### 4.2 METHODOLOGY

The objective of this study was therefore to determine the factors that influence consumers' purchase intention for upcycled food products. In detail, using an online questionnaire, consumer awareness was investigated regarding food waste, the circular economy and upcycled food, the attitude and willingness of consumers to buy this type of product. The logit model was used to determine the factors influencing the consumers' intention to buy upcycled food products, and the contingent valuation was used to explicit the willingness to pay.

#### *4.2.1 Design of the questionnaire*

This analysis was performed using a survey-based approach with an online questionnaire. The questionnaire mainly contains closed-ended questions and some open-ended questions. The questionnaire could be found in Annex I. In the questionnaire the consumer was asked about his/her perception and willingness to pay for an innovative food product partially deriving from waste and by-products.

The questionnaire contains a total of 34 questions, and after a short general presentation it is divided into 5 main sections:

1. Consumer attitude towards food waste
2. Consumer behaviour towards innovative upcycled food products
3. Willingness to pay for an upcycled food product
4. Consumer behaviour towards circular economy
5. Socio-demographic characteristics

##### SECTION 1

The first section aims to investigate the attitude of consumers in buying groceries and towards the production of food waste. In particular, they were asked if they bought foodstuffs and how often, if they bought only what was necessary or extras, how much they consider themselves attentive to the production of waste home and even if they are aware that industrial transformation generates losses and by-products.

##### SECTION 2

Section two investigates consumer behaviour towards innovative upcycled food products. To do this, two different Likert agreement scales, ranging from 1 to 5, were used (where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree). The first scale is the Domain Specific Innovativeness Scale (DSI) applied to food products, taken from Barcellos et al., (2009). The original DSI was developed by Goldsmith & Hofacker in 1991. The DSI comprises 6 items and aims to measure the consumer's innovativeness for a specific product category, thus reflecting the consumer's tendency to adopt innovations within a specific domain of interest, food in this case. Following Barcellos and colleagues, three of the six items of the original scale have been inverted in a positive way, so as to improve their understanding.

The second scale used is the Food Neophobia Scale (FNS), created by Pliner & Hobden in 1992, specifically to measure food neophobia, considered a consumer personality trait, measurable through the propensity to approach or avoid novel foods. While in the original scale the items are formulated in a positive and negative way, in this case five of the ten items were reversed in a negative way, to make them all negative and better understandable (Barcellos et al., 2009).

After the two scales, the interviewees were briefly explained how upcycled foods are produced, followed by an image depicting some of these foods already on the market. Subsequently, consumers were asked if they have ever heard of upcycled foods and, with both positive and negative answers, they were asked to rank three products that they would be willing to buy among those on the market:

- Energy bars enriched with fruit by-products
- Fizzy drink based on whey
- Biscuits with sunflower seed flour
- Soy-based cocoa drink with potato proteins
- Salty snack based on potato peelings
- Pasta made with flour deriving from cereals used to produce beer
- Energy drinks made from spent coffee
- Beverages from fruit and vegetable by-products (seeds, peels, stems, ...)
- Granola made with the whole cocoa bean
- Cookies made with oat milk scraps
- Salty snack based on beer by-products
- Savory snack based on dried and fried salmon skins
- Crackers made with carrot pulp and peels
- Beer obtained from discarded bread

### SECTION 3

Section three investigates the willingness of consumers to buy and then to pay, for a product made from by-products of the food industry. A product devised by Nartea et al. (2023) was used as a base to hypothesise the upcycled food used in the analysis: a margherita pizza enriched with orange cauliflower stem flour, a by-product of the industrial processing of cauliflowers. The base of this pizza is 30% enriched with this flour which, thanks to the bioactive components contained in the cauliflower stems, can have beneficial effects (Figure 21).





*Figure 21 (Representation of our upcycled pizza)*

The WTP was studied using the contingent valuation method (CVM). It is an approach based on estimating the stated WTP of respondents for a hypothetical question about a non-market good or service to determine their possible level of acceptance (Atkinson, 2018)

CVM is applicable for various scenarios thanks to its flexibility which provides wide range of application area for non-market goods or changes in past, current or future. Contingent valuation method has been in use for a long time and there are many studies in this subject, particularly for environmental issues, policy evaluations and public improvements (Carson, 2000). In the contingent valuation surveys, participants are directly asked to emphasize their preferences with an aim of understanding their future intentions for a non-market good or service in a hypothetical market. The CVM allows a direct estimation of WTP by means of different elicitation techniques. The choice of elicitation technique has a significance importance as different techniques produce different estimates. The elicitation question can be asked in various ways including open ended questions, payment card, single-bounded dichotomous choice, double-bounded dichotomous choice, and different specifications of bidding games. The design of the hypothetical scenario and of the value elicitation questions are the key elements of the contingent valuation method (Atkinson, 2018). The choice of elicitation technique depends on several factors such as the nature of the good being investigated, cost of the survey and nature of the respondents. In our questionnaire, we used the double-bounded dichotomous choice.

In detail, firstly, a filter question was created in which consumers were asked if they were willing to buy this upcycled food. If they answered yes, they were asked to choose 3 reasons why they were interested in buying this product. Otherwise, they were asked to choose three

reasons why they were not interested in buying this product and, subsequently, which of some reasons could convince them to buy this product. The reasons and motivations derived from an extensive review of the current literature about upcycled and innovative food products. If the consumer was available to buy the pizza, they were addressed to a series of questions to estimate the WTP. To define the initial price of the upcycled product, a market analysis was carried out on the average selling price of a classic margherita pizza or with particular flours (gluten-free, with cereals...). This survey was carried out in the period from January to February 2023 at various Supermarkets, Hypermarkets and Discounts located in different parts of Italy (Marche, Lombardia, Lazio, Puglia, Basilicata ed Emilia Romagna). In particular, the stores analysed are: Conad, Conad City, Coop, Eurospin, Lidl, Iper-Conad, Despar, Margherita Conad, Natura Si, and Si con Te. From the survey, we obtained an average price of 4.05€. The WTP was estimated using a bid system: the first price proposed was 4.50€; if they were willing to pay this value, they were asked if they were willing to pay 5.00€. If they were not available, they were asked to pay 4.00€. The market survey is available in Annex II.

#### SECTION 4

The fourth section of the questionnaire concerns consumer behaviour towards the circular economy. Therefore, consumers were asked if they have ever heard of this concept and, if so, to give a personal definition of circular economy. Subsequently, a clear definition of circular economy is given: *“the circular economy is a model of production and consumption that requires to waste as less as possible and consume as less environmental resources as possible. Everything that is produced should find a sustainable way to be put back into circulation, including through the reduction, recovery and valorisation of waste and by-products. Some examples of the circular economy are refurbished smartphones, recycled items, the purchase of second-hand clothing, and the production of renewable energy from agricultural and food waste”* (Figure 22).



**Figure 22 (Circular economy model)**

The definition was followed by some attention questions to verify consumer understanding of it. Finally, another Likert agreement scale was used, ranging from 1 to 5 (where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree). The scale (RPS) was taken from Calvo-Porrá & Lévy-Mangin (2020). Recycled Product Scale aims to provide a survey on the acceptance and purchase intention of recycled circular goods by consumers and examine which are the most important variables driving consumer behaviour towards these circular products. The scale includes 14 items concerning the perception of the quality of recycled products, the image of the product, the sustainability and environmental benefits deriving from these products, the safety, and the purchase intention for these products.

## SECTION 5

The last section deals with questions related to socio-demographic data, such as gender, age, education, occupation, marital status, household income, country of origin, region of residence, number of household members and finally, the number of children under 18 in the of the family nucleus.

### *Pre-test*

The questionnaire was designed in the period from January to April 2023 and pre-tested in May 2023. The pre-test was conducted through a group of experts of the Department of Agricultural, Food and Environmental Sciences (D3A) of Marche Polytechnic University and the University of Évora, to evaluate the understanding of the questionnaire and to discuss its effectiveness. The purpose of the pre-test was to evaluate any changes to be made to the

existing questionnaire to improve its clarity. This preliminary step is essential to ensure the effectiveness of the online questionnaire before its publication. After conducting the pre-test, some survey questions were revised to improve their comprehensibility.

#### *Sampling and data collection*

The data collection was carried out in the period from June to August 2023, through the use of an online questionnaire, designed and administered to a sample of 348 Italian people. People were reached using various social media such as Facebook, WhatsApp and Instagram, and the questionnaire was designed by using the software called “Google Forms”, online available. The use of an online survey brings with it numerous advantages such as the speed of diffusion, the ease of creating the database with the answers, and the ease of processing; on the other hand, it makes it impossible to reach people who do not have this technology. In addition to this risk, it is possible that the sample is not very representative of the reference population (consumer universe), but through a wide sample, we were able to collect the main characteristics of the population (Bentivoglio et al., 2020). A copy of the whole questionnaire is available in the Annex I of this thesis. The questionnaire was anonymous, and the data collected have been processed in compliance with the law on privacy.

#### *4.2.2 Logit model*

A logit model was employed in order to pursue the objectives of the work and in particular to analyse the factors that influence consumers’ intention to buy upcycled food products. In general, the binary logit model can be specified as:

$$\log\left(\frac{p}{(1-p)}\right) = \chi\beta$$

where,  $\chi\beta$  is the vector of the independent variables and the estimated parameters, and  $(p/1-p)$  is called the odds ratio. The logistic coefficient is interpreted as the change in the logit that is associated with a one-unit change in the independent variable, while holding all the other variables constant. The exponential of the logistic coefficient is the effect on the odds rather than probability. It is interpreted as a one-unit change in the independent variable; the odds are expected to change by a factor of  $\exp(\beta)$  when other things are equal (Manski et al., 1981). Because the aim of this study was on consumers’ intention to purchase, the dependent variable represents the probability of the consumers buying upcycled foods. The variable is a 0-1-type dependent variable, and it was coded as 1 if the consumers buy upcycled food and zero if it

was otherwise. The independent variables in the choice model represented the factors that might have an influence on the consumers' buying behaviour. In details, the choices of variables included in this study derive from a literature review on consumers' buying behaviour towards upcycled foods, and they were converted into questions. The explanatory variables (independent variables) included in the models can be grouped into four main areas:

1. variables connecting to socio-demographic characteristics of the sample:
  - Female: dummy variable that takes value 1 if the respondent is female and 0 otherwise (GEND).
  - Age: the age of the respondent (AGE).
  - Education: a variable that takes values from 1 to 7 and corresponds from lower to higher education (1 = No formal education; 2 = Primary school; 3 = Middle school; 4 = High school; 5 = Bachelor's degree; 6 = Master's degree; 7 = Postgraduate education) (EDU).
  - Income range: a variable that takes value from 1 to 6 and corresponds to increasingly high-income brackets (1 = < 10,000 EUR; 2 = 11,000–20,000 EUR; 3 = 21,000–35,000 EUR; 4 = 36,000–50,000 EUR; 5 = 51,000–75,000 EUR; 6 = >75,000 EUR) (INCO).
  - Family unit: a variable that takes value from 1 to 5 according to the number of family's members (1 = One component; 2 = Two components; 3 = Three components; 4 = Four components; 5 = Five or more components) (FAM).
2. Variables related to consumer attitude towards food waste:
  - Attention: dummy variable that takes value 1 if the respondents are attentive when preparing food at home, and 0 otherwise (ATTEN).
3. Variables related to consumer behaviour towards innovative upcycled food products:
  - Innovation: variables that include attitudes towards innovative food products. They assume values from 1 to 5 (on a 5-point Likert scale) (DSI).
  - Neophobia: variables that include attitudes towards new food products. They assume values from 1 to 5 (on a 5-point Likert scale) (FNS).
  - Upcycled foods: dummy variable that takes value 1 if the respondent knows upcycled foods and 0 otherwise (UPCY).
4. Variables related to consumer behaviour towards circular economy:
  - Circular economy: dummy variable that takes value 1 if the respondent knows the concept of circular economy and 0 otherwise (CIR\_EC).
  - Recycling: variables that include attitudes towards recycled products. They assume values from 1 to 5 (on a 5-point Likert scale) (RPS).

The specific equation of the logit model can be presented as follows:

$$\text{logit}(\text{model}) = \beta_0 + \beta_1\chi_{\text{socio-demographic}} + \beta_2\chi_{\text{waste}} + \beta_3\chi_{\text{upcycled foods}} + \beta_4\chi_{\text{circular economy}}$$

where  $\beta_0$  is the constant and is the coefficient of  $\chi_i$ . Descriptive statistics were used to identify respondents background, behaviour towards food waste and innovative products, and whether respondents are able to recognize upcycled foods. Logit procedures were used to determine which factors influenced the respondents' intention to buy upcycled foods. This study used STATA software (version 14.0) for the analysis.

### 4.3 RESULTS AND DISCUSSION

In this section, the main results, obtained from the online survey questionnaire, are presented and discussed.

#### *4.3.1 Socio-demographic characteristics of the sample*

The final sample is represented by 348 Italian people. Out of them, 55% are female. 16% of the respondents are between 18 and 25 years old, 29% between 26 and 35 years old, 24% between 36 and 45 years old, 17% between 46 and 55 years old, 11% between 56 and 65 years old, and the remaining 2% are over 65 years old. As for the educational level, 30% have a high school diploma, 18% have a bachelor's degree, 31 % have a master's degree, 17% have doctorate or undergone post-graduate training, 4 % have a middle school license and only 1% don't have a formal education. About occupation, 28% of the sample is represented by private sector workers, 28% by public sector workers, 19% by students, 16% by self-employed, 4% by unemployed, and 3% by retirees. The remaining 2% is made up of various occupation categories. About the annual average household income (before taxes), 7% have an annual income lower than € 10,000, 18% of respondents are in the range between € 11,000 - € 20,000, 30% are between € 21,000 - € 35,000, 12% are between € 36,000 - € 50,000, 8% are between € 51,000 - € 75,000, and 5% are over € 75,000. The remaining 20% of the interviewees preferred to not declare the average income. The sample is distributed throughout the national territory, with particular concentration in the Marche region, which represents 50%. The concentration of the sample in this region is linked to the place of launch of the questionnaire. Other highly represented regions are Puglia with 20% and Abruzzo with 5%, Emilia Romagna with 5%, and Lazio with 4%. Furthermore, there is a variability in the size of households: only

10% of the sample has a family unit made up of more than 5 people, while in most cases the households are formed by four, two and three individuals, respectively 29%, 24% and 23%. Finally, 14% of the sample lives alone. In addition, 67% of respondents don't have a child under 18 years in their family unit, 20% have one child, 10% have two children and only 3% have three or more children in their family unit. The following table (Table 3) shows in detail the results described above from the socio-demographic analysis of the sample.

*Table 3 (Summary of the socio-demographic characteristics of the sample)*

<b>DATA</b>	<b>DESCRIPTION</b>	<b>PERCENTAGE</b>
<b>GENDER</b>	Female	55%
	Male	44%
	I prefer not to declare	1%
<b>AGE</b>	18-25	16%
	26-35	29%
	36-45	24%
	46-55	17%
	56-65	11%
	>65	2%
<b>EDUCATIONAL QUALIFICATION</b>	No formal education	1%
	Primary school	0%
	Middle school	4%
	High school	30%
	Bachelor's degree	18%
	Master's degree	31%
Postgraduate education	17%	
<b>OCCUPATION</b>	Private sector workers	28%
	Public sector workers	28%
	Students	19%
	Self-employed	16%
	Unemployed	4%
	Retirees	3%
	Other	2%
<b>STATUS</b>	Married	40%
	Single	34%
	Separated/Divorced	4%
	Widowed	1%
	Cohabitant	20%
<b>ANNUAL AVERAGE HOUSEHOLD INCOME CLASS</b>	Less than €10,000	7%
	From €11,000 to €20,000	18%
	From €21,000 to €35,000	30%
	From €36,000 to €50,000	12%
	From €51,000 to €75,000	8%
	More than €75,000	5%

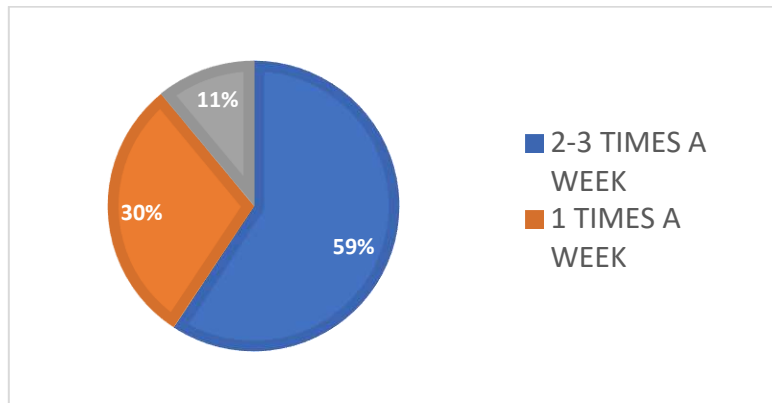
	I prefer not to declare/ I don't know	20%
<b>COUNTRY</b>	Italy	97%
	Other	3%
<b>REGION OF RESIDENCE</b>	Marche	50%
	Puglia	20%
	Abruzzo	5%
	Emilia-Romagna	5%
	Lazio	4%
	Lombardia	3%
	Veneto	2%
	Campania	2%
	Toscana	2%
	Calabria	1%
	Liguria	1%
	Piemonte	1%
	Umbria	1%
	Basilicata	1%
	Sicilia	1%
	Molise	0%
Sardegna	0%	
No reply	3%	
<b>NUMBER OF FAMILY MEMBERS</b>	One	14%
	Two	24%
	Three	23%
	Four	29%
	Five or more	10%
<b>CHILDREN UNDER 18 YEARS IN THE FAMILY UNIT</b>	One	20%
	Two	10%
	Three or more	3%
	Nobody	67%

The socio-demographic data can provide a wide range of information that helps to better understand how perceptions and practices related to the circular economy and upcycling foods vary between different groups of people. This data makes it possible to divide participants into homogeneous groups based on characteristics such as age, gender, education, income and place of residence, a segmentation that can reveal trends and significant differences in perceptions and practices. Furthermore, the collection of socio-demographic data can reveal any disparities in access to information on the circular economy and in the adoption of sustainable practices. This information can then guide efforts to make information and products related to the circular economy more accessible and inclusive.



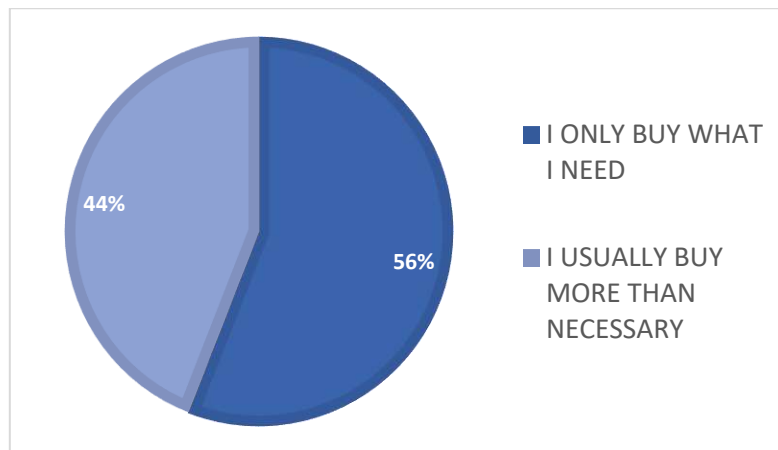
#### 4.3.2 Descriptive statistics

The first part of the questionnaire asked consumers about their purchasing habits and their attitudes towards waste production. Analysing the results, it was possible to observe that 95% of respondents stated that they are in charge of buying groceries. Among these, 59% go shopping 2-3 times a week, 30% one time a week, and 11% go shopping once a day (Figure 23).



**Figure 23 (Frequency of buying groceries)**

The 56% of the respondents buy only what they need, while 44% of them usually buy more than necessary (Figure 24).

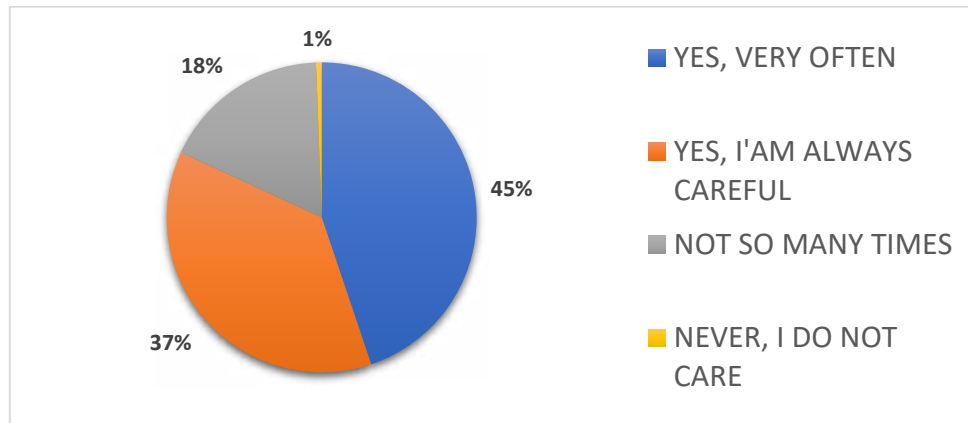


**Figure 24 (How much people buy)**

From this response it is possible to observe that more than half of the sample, declaring that they buy only what is necessary, are consciously or unconsciously reducing the production of food waste by avoiding the production of waste at home.

Moreover, 94% of the interviewees check the expiration date or the minimum conservation term when shopping, a further confirmation of the fact that most consumers are careful to buy products based on their shelf life, thus avoiding further production of food waste.

In this first section it was then asked if the consumers were attentive to the production of scraps and waste at home. Only 1% of them said they don't worry about it, 18% said they aren't often careful in the waste generation, 45% said they are very often careful, and 37% said they are always attentive (Figure 25).



**Figure 25 (Attention to the production of food wastes)**

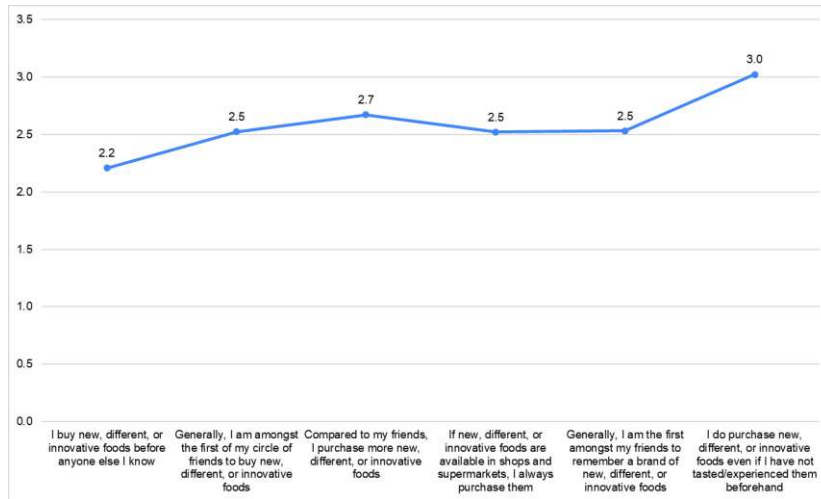
77% of the sample is aware that its behaviour can affect the amount of food wasted. Moreover, 93% is aware that the industrial production of food produce wastes and by-product.

This first part of the questionnaire is important to know the purchasing habits of consumers and how they behave towards the production of waste. Knowing consumers' habits in buying and preparing food is critical to:

- help identify areas where food waste occurs.
- Promote sustainable food practices that minimize waste and encourage the use of resources more efficiently.
- Develop food effective waste prevention strategies.
- Promote behavioural changes and work together with stakeholders towards a more sustainable management of food resources.
- Promote the production of innovative food products based on consumer preferences. In this way it could be possible to develop new products or solutions to reduce food waste, such as foods with longer expiries or products made with waste from the supply chain.

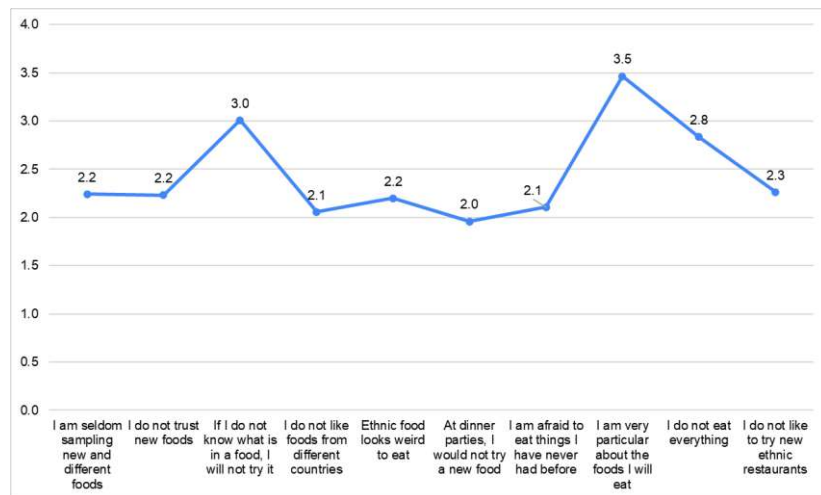
The second section of the questionnaire regards the consumer behaviour towards innovative upcycled food products. The consumer is then asked to express the degree of agreement or disagreement on a 5-point Likert scale (where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree) on some statements concerning innovative foods

using the DSI scale. The higher the score, the higher the propensity of the consumer towards innovative foods (Figure 26).



**Figure 26 (DSI scale results)**

The figure highlights a linear trend of responses around an average value of 3 (undecided). The higher results were obtained for "I do purchase new, different, or innovative foods even if I have not tested/experiences them beforehand" (3.0), and for "compared to my friends, I purchase more new, different, or innovative foods " (2.7). This highlights the fact that the consumers interviewed tend to be reluctant to try and buy innovative foods. The second question concerns the FNS, a scale widely used in the literature to investigate the propensity of consumers towards new foods. Also in this case a 5-point Likert scale of agreement and disagreement is used. The higher the score, the higher the consumers' food neophobia (fig. 27).



**Figure 27 (FNS scale results)**

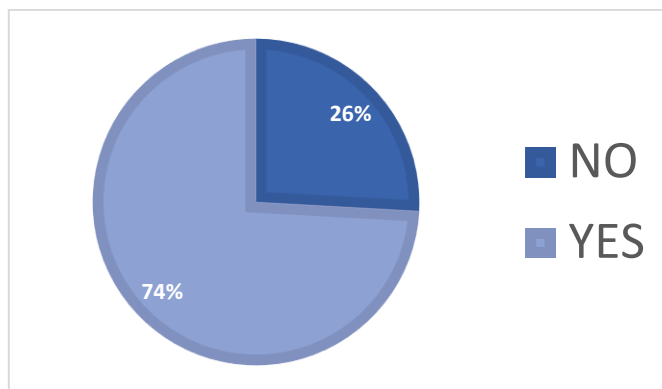
As shown in the figure above, in the food neophobia scale we have a positive peak of 3.5 for the statement "I am very particular about the foods I will eat", a peak of 3.0 for the statement "If I do not know what is in a food, I will not try it", and a value of 2.8 for "I do not eat everything". Therefore, it is possible to state that the majority of consumers believe they have somewhat particular tastes with respect to what they eat and that they feel a little distrustful of foods with never-tried ingredients. Therefore, it is possible to state that the majority of consumers in the sample analyzed were more neophobic than neophilic.

At the end of this section consumers were asked if they have ever heard of foods made from food by-products (upcycled foods). 59% of the sample had never heard of these products, so a major part of the sample that is a result in line with previous studies (Goodman-Smith et al. 2021; Sousa et al. 2021; Ylmaz and Kahveci 2022; Grasso et al. 2023). Subsequently, they were asked to choose and rank from 1 to 3 (1 the first I will buy; 2 the second I will buy; 3 the third I will buy) three upcycled foods among 14 already on the market. The three most preferred products by consumers were: salty snack made with potato skins, crackers made with carrot skin and pulp and energy bars enriched with fruit by-products (seeds, peels...) (Figure 28).



*Figure 28 (Podium of the three products preferred by consumers)*

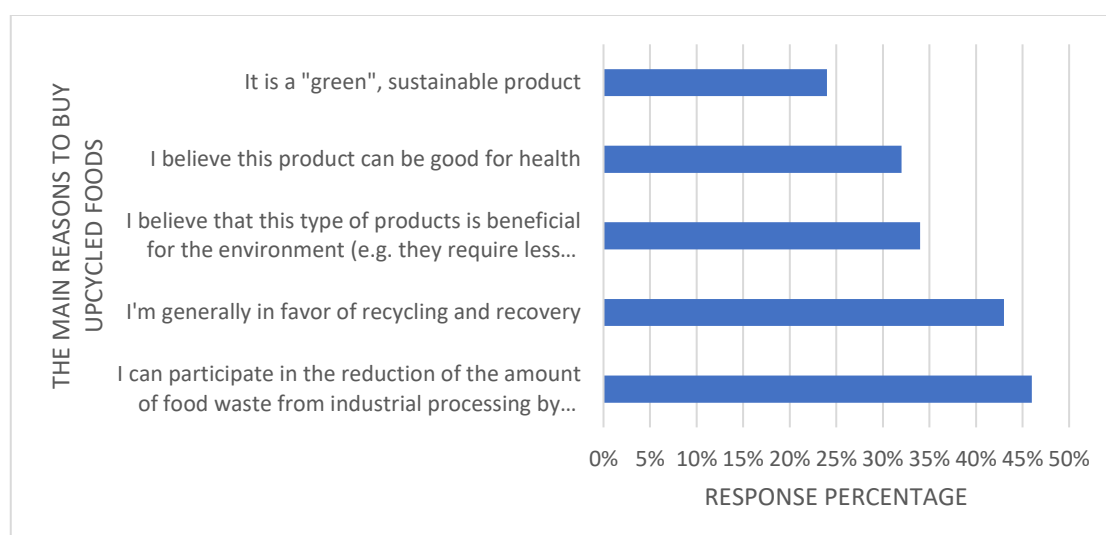
The third section of the questionnaire regards the willingness to buy and pay for an upcycled margherita pizza enriched with flour from orange cauliflower stalks. The results shows that 74% of respondents would be willing to buy it (Figure 29).



**Figure 29 (Willingness to buy the product)**

Also this results was in line with the existing literature (Grasso & Asioli, 2020; Goodman-Smith et al., 2021; Grasso et al., 2023).

After this response, all those who said they were willing to buy the product were asked to indicate three of the reasons why they would buy it, among those proposed (Figure 30).

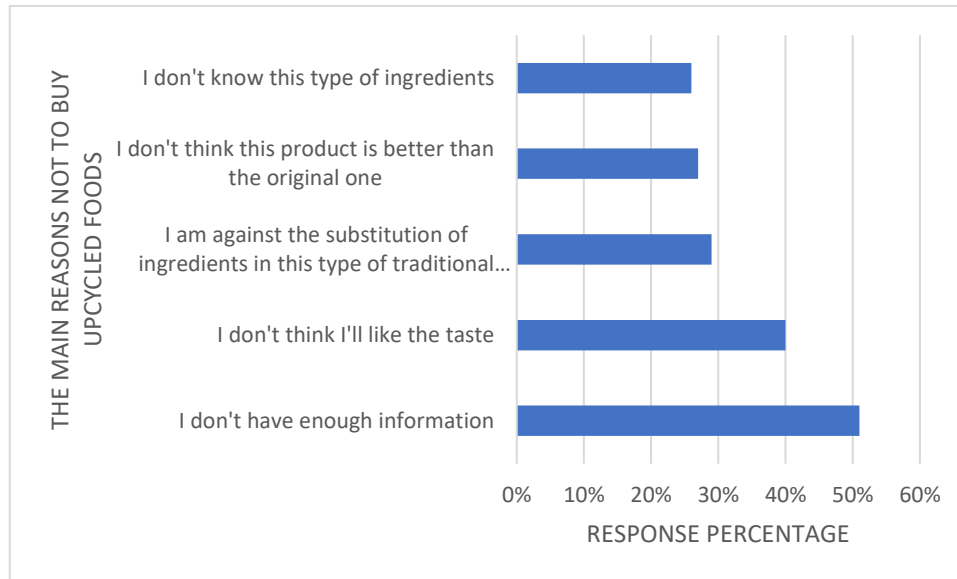


**Figure 30 (Five main reasons to buy the upcycled pizza)**

As can be seen from the figure above, there are five main reasons that prompted the sample to buy upcycled pizza. The results of the present work are perfectly in line with the works present in the literature. Concerning waste reduction motivation, several studies claim that consumers choose to buy upcycled foods because they can contribute to the reduction of waste and by-products production (Lakatos et al., 2016; Aschemann-Witzel & Peschel, 2019; Grasso & Asioli, 2020; Aschemann-Witzel & Do Carmo Stangherlin, 2021). The behaviour in favour of recycling and recovery is also in line with the results of previous works of Kuah & Wang (2020) and that of Ylmaz & Kahveci (2022), which states that consumers who are attentive to

recycling and recovery are then more interested in buying an upcycled food product. Regarding the possibility that foods obtained from by-products are beneficial for the environment, this motivation was also found to be important for consumers in the studies by Lakatos et al. (2016), Aschemann-Witzel & Peschel (2019), Calvo-Porrall and Lévy-Mangin (2020), Kuah & Wang (2020), Coderoni & Perito (2020), Spratt et al. (2020) and Taufik et al. (2023). Also the motivation about the health is in line with the current literature because previous work had already detected that consumers were more interested in purchasing upcycled food products if they considered these products to have health benefits (Aschemann-Witzel & Peschel, 2019; Peschel et al., 2019; Coderoni and Perito, 2020; Aschemann-Witzel & Do Carmo Stangherlin, 2021). This is because, as Aschemann-Witzel and Stangherlin (2021) state, products that include the use of food by-products such as, for example, potato proteins as a by-product of potato starch processing, can serve to increase the fibre or protein content of other products thus generating an improved health benefit in the new product. And finally, another reason why consumers are encouraged to buy upcycled products is the perception of the sustainability of these products. The sustainability linked to upcycled products is also a positive correlation widely discussed in the literature (Aschemann-Witzel & Peschel, 2019; Grasso and Asioli, 2020; Kuah & Wang, 2020; Coderoni and Perito, 2020; Aschemann-Witzel & Do Carmo Stangherlin, 2021). Calvo Porrall and Lévi-Mangin (2020) state that the image of these products as “green” represents consumers' beliefs regarding the positive environmental impact these products have on the environment. This, accompanied by the growing sensitivity towards environmental issues, is one of the main causes of the increase in demand and greater acceptance of these products.

On the other hand, the 26% of consumers who declared themselves unwilling to buy upcycled pizza were first asked to indicate three reasons why they are not available to purchase it, and then to indicate three reasons which would push them to buy it in the future. Figure 31 show the main reasons why consumers are not willing to buy upcycled pizza.

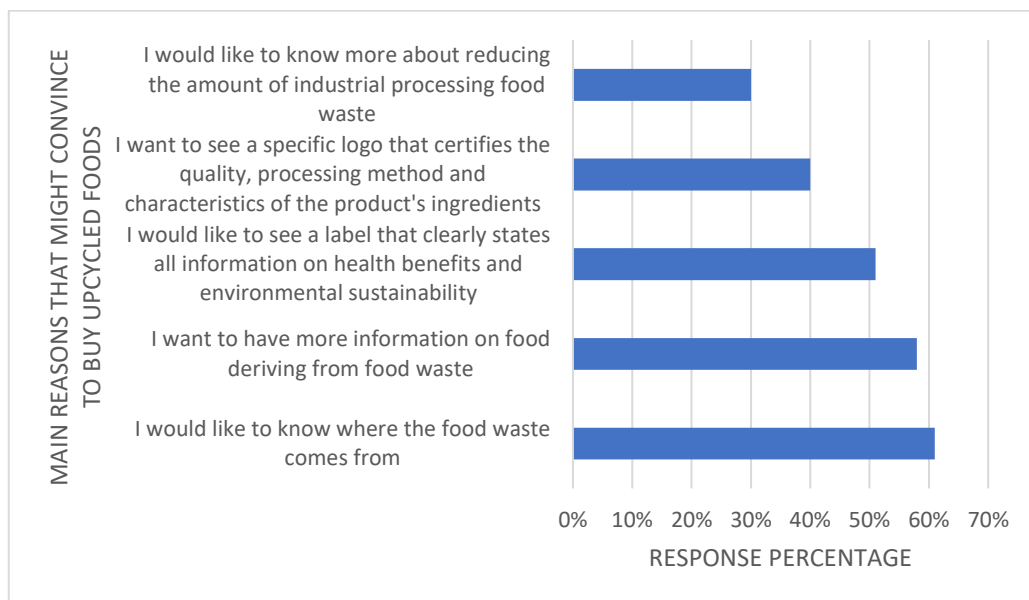


**Figure 31 (Five main reasons why they are unwilling to buy)**

Regarding the reasons why consumers are not encouraged to buy upcycled pizza, they are perfectly in line with the existing literature. For example, Aschemann-Witzel et al. (2022) found that the way upcycled foods are communicated significantly affects consumers' willingness to buy. A few years earlier, Grasso and Asioli (2020) also stated that the willingness to purchase increases if more information is given about the upcycled product. Therefore, it is possible to state that the more the consumer is informed about the product, the more his willingness to buy it increases. The second motivation concerns the taste, i.e., the consumer is not encouraged to buy an upcycled food because he thinks that the taste is not good. For example, Abbey et al. (2015) state that the perception of dirtiness and feelings of disgust, deriving from a raw material obtained from something that should be discarded, represent a determining factor in reducing the attractiveness of upcycled products. This motivation is confirmed by subsequent studies as Savchenko et al. (2019) and Aschemann-Witzel & Stangherlin (2021), who argue that the hedonic aspect of upcycled products influences consumer acceptance. The ingredient replacement also represents an obstacle for the consumer. The literature indicate, in various observations, that the fact of not wanting to replace traditional ingredients with upcycled ingredients may be linked to the cultural attitudes of a country (Ylmaz & Kahveci, 2022), but also to unfamiliarity with these new ingredients, therefore food neophobia, widely discussed in the literature (Moshtaghian et al., 2021; Aschemann-Witzel et al., 2022, Hellali & Korai, 2023). Another important factor that influences the public acceptability of upcycled foods is the perception of the quality, also a topic investigated in the literature, of these foods compared to the same conventional product,

therefore the comparison of the two products in terms of quality. The influence of hedonic characteristics studied in the literature is found in line with our results. For example, Moshtaghian et al. (2021) states that the perception of quality is one of the factors that guides consumer choices and if, for example, the taste and texture of an upcycled food differs from its respective conventional one, this food may appear less attractive to consumers, especially if, as in our and other studies, the consumer has not tasted a product but has evaluated a hypothetical one, therefore the perceived acceptability is highly conditioned. Knowledge of ingredients represents, in this study, another barrier to the acceptance of recycled foods. This result is also in line with existing studies, since as previously mentioned there is a general aversion on the part of consumers towards new foods, defined as food neophobia. Because upcycled foods contain ingredients that would otherwise not be used for human consumption, food neophobia can influence their acceptance (Moshtaghian et al., 2021). Food neophobia, therefore the fear of the new, the fear of the unfamiliar and consequently the lack of knowledge of the food, in fact, have a more than negative impact on the willingness to buy upcycled foods (Coderoni & Perito, 2020; Perito et al., 2020).

Then, for the consumer stating that they are not willing to purchase the upcycled pizza, we proposed a series of motivations to convince them to buy it. Figure 32 represent the five main reasons detected.



**Figure 32 (Five main reasons that might convince consumers to buy)**

As can be seen in the figure above, almost all the motivations are strongly connected with the fact that the consumer wants to know more about the product. This is a common aspect already



underlined in several studies about consumer perception on upcycled food products. For example, regarding the origin of food waste, Peschel et al. (2019), Coderoni & Perito (2020), Goodman-Smith et al. (2021) spoke about it. Savchenko et al. (2019), Grasso and Asioli (2020) and Aschemann-Witzel & Do Carmo Stangherlin (2021) spoke about the need of more information and benefits deriving from these products, such as the reduction of waste and the reduction of environmental impacts and all the other information about the product that positively influence the willingness to buy upcycled foods. Also, the influence of a logo, certifying the environmental benefits, was found to increase the willingness to purchase upcycled food products in Bhatt et al. (2020), Peschel and Aschemann-Witzel (2020), Goodman-Smith et al. (2021) and Coderoni and Perito (2021). The authors found that the presence of a brand with a key element (for example, a recycling logo or a logo stating the percentage of recycled raw material) leads to receiving a more positive evaluation of upcycled foods. Regarding the certification about the quality of these products, Thorsen et al. (2022) in their study on the attributes that upcycled products must have to be admitted to the shelves of the supermarket, found that quality is an important factor for the market positioning of upcycled products. Therefore, we can conclude that our results are in line with the current literature, highlighting the importance of some key elements to consider when we talk about, and want to increase the willingness to purchase upcycled foods.

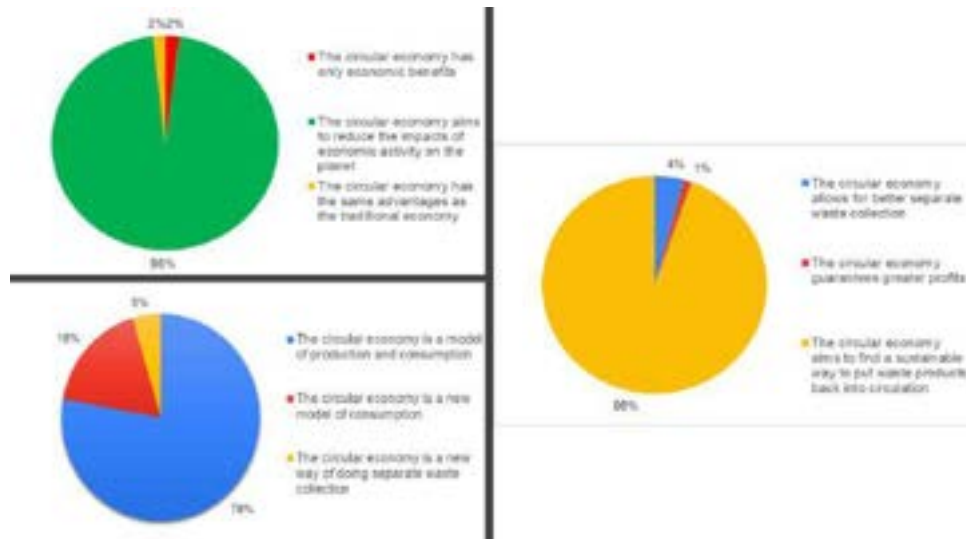
The study of the reasons that have convinced, do not convince, and could convince consumers to buy upcycled foods is necessary to promote this practice and bring consumers closer to a more sustainable economic model. In fact, the widespread adoption of upcycled foods, which transforms "discarded" food ingredients into new products with added values and different benefits, not only reduces food waste but also fits perfectly into the context of the circular economy. This practice not only improves efficiency in the use of resources, but also promotes a more sustainable food chain, thus contributing to an economic system that aims to maximize the value and use of inputs, while minimizing waste and environmental impact.

The fourth section of the questionnaire regards circular economy and the knowledge of the consumers about this concept. Consumers were first asked if they have ever heard of the concept of circular economy, and only 67% of these answered yes (Figure 33).



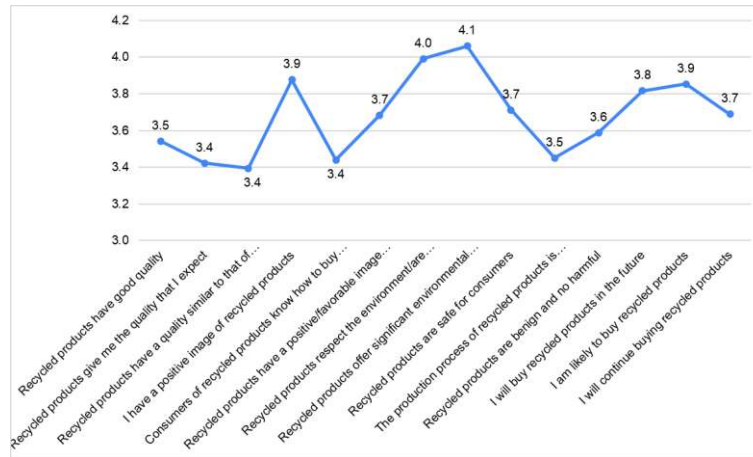
is “economic model”. This means that, even if the given definitions were basic and not too articulated, consumers are aware that the circular economy is a true economic model of production and consumption, which requires standards, business models, and economic indexes to spread. Participants were also resolved in asserting the importance of “recovery and reduction of waste”, the necessity to explore an economic model which brings “less costs” and “less impacts”, in particular on the “environment”, seeking for an “eco-sustainability”. Moreover, the presence of “secondary raw materials” suggests that consumers know about the fact that waste and by-products could potentially have a second life and be reused somehow even in different supply chains. Surprisingly, “upcycling” was not a common word used to describe circular economy, even if the concept was introduced before in the questionnaire. This shows how poor is the knowledge of this concept and how much it is necessary to work towards its diffusion.

After giving to all the participants the proper definition of CE, three attention question were asked to verify their understanding of the concept. It was curious to detect that in all three questions, some interviewees were not able to provide the correct answer, even after a simple and clear explanation of the circular model. Figure 35 shows the results of the attentive questions.



**Figure 35 (Results of attentive questions)**

The final part of the questionnaire concerns the recycled product scale in which agreement or disagreement of consumers about recycled products was evaluated on a scale from 1 to 5 (where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree). The higher the score, the higher the opinion that consumers have on recycled products (Figure 36).



**Figure 36 (Recycled product scale results)**

Consumers agree that recycled products offer significant environmental benefits (4.1) and are environmentally friendly products (4.0). Furthermore, consumers report that they have a positive image of recycled products and that they are likely to buy recycled products in the future (3.9). The result makes it clear that consumer awareness of upcycled products is constantly growing. Consumers know that upcycled products help reduce waste and use resources more efficiently. The growing positive image of these foods among consumers is growing, first of all due to their concern for the environment. Furthermore, consumers are attracted to these new foods which not only reduce the waste of resources, but also have health benefits as upcycled ingredients are often rich in bioactive compounds that would otherwise be wasted. Overall, therefore, the positive image of upcycled food among consumers is growing as more and more people recognize the environmental and social benefits of these products.

#### 4.3.3 The econometric model for consumers' willingness to buy upcycled food products

The results of the investigation carried out have so far been presented only from a descriptive point of view. The table below (Table 4) is the result of the logit model to understand the factors affecting consumers' intention to purchase upcycled food products. Only 345 responses were considered to have been appropriately filled out, and therefore suitable for the analysis with the logit model and for the WTP estimation.

**Table 4 (Interval model estimation)**

VAR_DIP	Coef.	St.Err.	t-value	p-value	[95% Conf ]	Interval	Sig
GEND	.234	.31	0.75	.45	-.374	.842	
AGE	-.022	.012	-1.89	.059	-.045	.001	*
EDU	-.065	.13	-0.50	.62	-.32	.191	
INCO	.145	.143	1.01	.312	-.136	.425	
FAM	.158	.123	1.28	.199	-.083	.399	
ATTEN	-.137	.375	-0.37	.714	-.872	.598	
UPCY	.266	.309	0.86	.389	-.34	.872	
CIR_EC	.341	.338	1.01	.313	-.321	1.003	
DSI	.037	.029	1.31	.189	-.018	.093	
FNS	-.074	.017	-4.23	0	-.108	-.04	** *
RPS	.071	.014	5.13	0	.044	.098	** *
Constant	-1.109	1.217	-0.91	.362	-3.494	1.277	
Mean dependent var		0.745	SD dependent var			0.437	
Pseudo r-squared		0.224	Number of obs			345	
Chi-square		87.811	Prob > chi2			0.000	
Akaike crit. (AIC)		327.998	Bayesian crit. (BIC)			374.121	

\*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

In our specific case, the model is used to analyse which, among the independent variables (explanatory variables) shown previously, have a significant influence on consumers' intention to purchase upcycled products. As can be seen from the table, there are three variables that have a significant influence on consumers' intention to purchase upcycled products, and these are: age, the food neophobia scale (variable that represents consumers' attitude towards new products) and, the recycled product scale (variable that represents consumers' attitude towards recycled products).

In detail, age, which has a lower significance than the other two variables, has a negative coefficient, which means that as age decreases, consumers' purchase intention for upcycled products increases, therefore the younger the consumers, the more interested they are in these products. This result agrees with what emerged from the literature consulted previously. In detail it agrees with Zhang et al. (2020), who in their research had studied how purchase intention changes between different generations, discovering, as in this study, that younger consumers indicated strong intentions to purchase upcycled foods. Furthermore, the result obtained from our study also agrees with Coderoni & Perito (2021) who studied the perception of upcycled foods for Millennials (aged between 29 and 43 years), discovering that this consumer target has a high intention to purchase for these products. The interest of younger

consumers in upcycled foods may be due to several interconnected motivations. For example, the growing interest in environmental issues and sustainability among young people may be one such motivation. Concern for the environment is positively correlated with a greater awareness of the need to reducing the waste of resources and a loss in economic terms. For this reason, the choice of these products by young people represents a concrete way of contributing positively to the environment. Furthermore, health and well-being play a significant role. Younger consumers tend to pay more attention to nutrition and seek more nutritious and healthy options. Many of the upcycled foods are designed to be not only sustainable, but also rich in nutrients that would otherwise be wasted. Curiosity is another key factor. Young people are often driven by the desire to discover and experiment. Upcycled foods, with their diversity of ingredients and preparations, stimulate curiosity and offer an adventurous culinary experience. From a social and ethical point of view, young people are often guided by values of corporate social responsibility and sustainable consumption. Food upcycling aligns perfectly with these values, as it represents a responsible way of addressing environmental and social challenges related to the food industry. In conclusion, younger consumers' interest in upcycled foods is a combination of environmental sensitivity, health, curiosity and ethical values. All these motivations intertwine to create an environment conducive to the adoption of upcycled foods among younger generations.

The other significant variable appears to be the Food Neophobia Scale, also with a negative value which in this case means the lower the neophobia, the greater the intention to purchase upcycled products, therefore the more consumers they are neophobic, the less they intend to purchase upcycled products. This result is also consistent with the literature analysed previously, in fact food neophobia, the fear of the new, represents one of the main barriers to the acceptance of these upcycled products, as has already been said previously. For example, Coderoni & Perito (2020), studying consumers' purchase intentions for upcycled foods, discovered that one of the drivers influencing consumers' choices for these products is food neophobia, and that this negatively influences the intention of consumer purchasing combined with neophobia for food technologies. Similarly, Aschermann-Witzel et al. (2022) concluded their study by stating that food neophobia is one of the main barriers in consumers' positive attitude towards upcycled products. Same result also for Moshtaghian et al. (2021), Aschermann-Witzel & Stangherlin (2021), Ylmaz & Kahveci (2022), Hellali & Korai (2023) and Grasso et al. (2023).

The last significant variable is that of the recycling product scale, also with a high significance value. As has already been said, it measures consumers' attitude towards recycled products

and is positively correlated with the intention to purchase upcycled products, i.e., the more consumers recycle, the more they intend to purchase upcycled products. This result is particularly interesting, as the RPS has been little used by other research to study consumer behaviour towards upcycled foods. However, the result of this study is in line with existing literature confirming the fact that those who recycle more are, consequently, more inclined to purchase upcycled products. For example, Ylmaz & Kahveci (2022) in their study found that consumers who have a high frequency of recycling at home, know the concept of upcycling and are more willing to purchase towards these products, as they are aware that recycling, so like upcycling they have a significant reduction in impact on the environment. Also, the study of Kuah & Wang (2019), who studying consumer acceptance towards the circular economy found that consumers who are attentive to recycling and recovery are then more interested in buying an upcycled food product.

#### *4.3.4 Estimation of the willingness to pay for an upcycled margherita pizza*

74% of the sample declared that they are willing to buy the upcycled margherita pizza. We asked to this group how much they would be willing to pay for our product, using a bid system. Table 5 shows the percentages of the different response combinations.

***Table 5 (distribution of responses for the price offered)***

<b>Initial price</b>	<b>NO/NO</b>	<b>NO/YES</b>	<b>YES/NO</b>	<b>YES/YES</b>	<b>TOT</b>
4.50€/330 g	11%	13%	23%	53%	100%

Out of a total of 257 people considered, 53% declared themselves willing to pay 4.50 € for the purchase of the upcycled pizza, also accepting the subsequent proposal of 5.00€, while 23% were willing to pay only the first amount of 4.50 €. As for the others who refused to pay the initial price of 4.50€, 13% were willing to buy the product at a lower price, and the remaining 11% also refused the second offer, not being willing to buy the product. Therefore, the result was generally positive, as more than 50% of the consumers interviewed are willing to pay a higher price for upcycled pizza than for a conventional pizza. Also this results is in line with the existent literature, for example Ye et al. (2022), in their study had found that pet owners were willing to pay a higher price for upcycled pet food, but also Ghazanfar et al. (2022), who in their study discovered that consumers were willing to pay more for upcycled products, when these were accompanied by a claim on the sustainability of these products. Also Asioli and Grasso (2021), affirm that consumers were willing to pay more for upcycled products, but only

when nutritional and/or environmental benefits of these products were communicated. The table below (Table 6) shows the results of the descriptive statistics of the WTP.

*Table 6 Descriptive statistics of the estimated variable WTP (€)*

Average	5.0601
Median	5.7064
Minimum	3.5874
Maximum	5.7064
Standard deviation	0.74452
Coeff. of variation	0.14911

As we can observe from the highlighted row in the table, the average price that consumers interviewed in our study are willing to pay for the margherita pizza enriched with orange cauliflower stem flour (by-products of the industrial processing of cauliflowers) rich in bioactive components is 5.06€. Knowing that the average price for a frozen margherita pizza is 4.00€, consumers are willing to pay a premium price of around 1.00€ for a product made with some ingredients obtained from industrial processing waste.



## CONCLUSIONS

During this thesis we have explored in depth the crucial importance of the transition from a linear economic system, characterized by the discarding of products at the end of their life, to the circular economy, in which products and resources are recovered and regenerated, transforming them into new products with added values. This need for transition is accompanied by various government actions, programs and action plans launched by the European Union, which states that if we continued to follow a linear economic model, resources would run out in a short time. The circular economy, as has been explained throughout this thesis, represents an effective response to the growing environmental crisis that afflicts our planet. This economic model promotes waste reduction, repair, reuse, and recycling of materials, offering an integrated solution to the problems of resource depletion, pollution, and global warming. In particular, among the circular economy practices, the practice of upcycling in the agri-food sector is explored, one of the most promising solutions to the enormous problem of food waste. The practice of upcycling would make food systems circular, reducing the waste of material and economic resources and reducing the environmental impact that this waste causes. Upcycling in this sector allows the recovery of resources which can then be transformed into new products, often rich in substances beneficial to health, which would otherwise be wasted. Furthermore, upcycling, designing products with a longer life cycle and recycling materials can lead to increased innovation in the food industry, generating new sources of income and employment. This process can also increase the resilience of food companies, as they become less dependent on limited resources and more capable of adapting to fluctuations in global markets.

The results of this study show that knowledge of the circular economy and the practice of upcycling are still limited among consumers, but also that with adequate information consumers are willing to purchase upcycled products deriving from a circular economic system. For this reason, advertising campaigns, slogans, awareness campaigns and information in general are necessary to communicate to consumers the economic, environmental, social, and even health benefits that these products have, trying to increase their awareness that resources must be exploited to the maximum because they are not infinite. It is also necessary to reach older consumers with information, who, as the results of our study show, are not easily reachable by digital channels. Furthermore, the results show that the creation, for example, of a logo or label for upcycled foods, which reports all the benefits and

the origin of the ingredients, added to the nutritional values without forgetting the quality, are necessary to increase the acceptance of these products by all types of consumers and reduce their neophobia, one of the main barriers to the acceptance of these products. After consumers have been informed and have become aware of the benefits of upcycled products, as the results of this study show, they are more willing to purchase these products, and even more interestingly, to pay more compared to the same conventional products. The willingness to pay a premium price of around €1 is an important result of this study which highlights several aspects. First of all, the willingness to pay more for these products makes us understand that consumers are increasingly responsible towards the environment and towards reducing food waste. Furthermore, the recovery of wasted resources that still contain many bioactive substances and the reuse of these allows the creation of new products rich in these substances beneficial to health therefore, this added value can justify a slightly higher price for consumers looking for a more sustainable and healthy diet.

In conclusion, it is necessary to inform all consumers of the importance of this practice, not only those most inclined to recycling, who already know this practice, increasing their awareness of the problem of food waste and, consequently, increasing their willingness to purchase these products. Finally, it is important to state that the study carried out is subject to several limitations that could be addressed in future research. In particular, the biggest limitation of this study is the size of the sample, which appears to be poorly representative of the entire Italian population.

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## AKNOWLEDGEMENT

Ed ecco la fine, la fine di un lungo, a volte difficile ma bellissimo percorso. All'inizio non pensavo di poter arrivare fino a qui, ho combattuto con ansie, paure e tanti pianti ma, nonostante tutto questo, oggi sono qui, sono arrivata alla fine, felice di aver intrapreso e concluso questo percorso nel migliore dei modi. Ovviamente, se sono arrivata fino a qui, non è solo merito mio, ma di tutti quelli che in questi ultimi due anni hanno camminato insieme a me e mi hanno aiutato a non mollare anche quando tutto mi sembrava troppo difficile per me. Dopo questi due anni posso dire che niente è difficile quando hai un obiettivo da raggiungere, tiri fuori tutta la determinazione e la perseveranza che mai pensavi di avere e soprattutto, ti circondi di persone positive che vogliono solo vederti felice. Per tutto questo è doveroso da parte mia ringraziare alcune di queste persone.

In primis voglio ringraziare la mia professoressa Deborah, una Persona prima che una professoressa, mi ha accompagnata in questo percorso di tesi per me completamente nuovo con una disponibilità ed una dolcezza che poche persone possiedono. Grazie perché, se sono arrivata fino a qui è anche perché mi sono fidata di te dal primo giorno in cui ci siamo incontrate.

Ringrazio Giulia, Santa Giulia, una ragazza con un'intelligenza fuori dal comune, una persona che dal giorno in cui l'ho incontrata per la prima volta a lezione ho visto come un esempio da seguire. Una di quelle persone che ti fa innamorare di ciò che ti sta spiegando perché ti rende curiosa di sapere. Grazie perché ci sei stata ogni qualvolta ho avuto un dubbio, grazie per il tuo aiuto e grazie perché sei una di quelle persone che fa dell'Università un posto migliore, non cattivo, non superbo, ma quell'Università che ti insegna a voler sapere sempre di più. Grazie Giulia

Grazie a mamma e papà, senza il vostro aiuto, soprattutto economico, non sarei arrivata fino a qui. Siete e sarete per sempre il mio esempio di vita, grazie perché, se ho imparato a non mollare è grazie a voi. A voi devo tutto, e questo successo è anche vostro.

Grazie alle mie big sisters, i miei cognati e i miei nipotini, grazie perché ci siete sempre stati, ad ogni mio piccolo successo ed insuccesso (anche se questa volta ce ne sono stati pochissimi), grazie perché siete la famiglia più pazza, ma più bella che potessi desiderare, grazie per le

vostre chiamate e videochiamate quando mi sentivo giù pensando di non farcela e grazie per ogni singolo messaggio di “in bocca al lupo” che mi avete inviato. Grazie di esserci, vi amo.

Grazie a te, Amore mio, la mia Persona. Grazie per avermi supportato e sopportato, grazie per esserci stato in questi due anni, grazie per aver sopportato i miei pianti ma anche per aver festeggiato con me quando raggiungevo un nuovo obiettivo. Mi hai insegnato tanto in questi due anni, mi hai insegnato il coraggio di non mollare davanti a niente, mi hai insegnato a fregarmene della gente che se ne frega di me e mi hai insegnato che si può condividere ogni momento pur stando a 350 chilometri di distanza. Grazie amore mio, sei la persona più bella che potessi desiderare al mio fianco, il mio successo è anche tuo.

Grazie a tutta la mia big family, a Mariella e Giovanni, zii, cugini e tutti quelli presenti a questo mio grande giorno, siete la famiglia migliore che potessi avere.

Grazie a te, amico mio Diego, una di quelle persone che incontri per caso e diventa parte della tua vita senza rendertene conto. Sei una persona speciale, come poche e ti meriti tutta la felicità del mondo. Grazie perché dal primo giorno ci sei sempre stato, abbiamo riso tanto e ci siamo confessati una vita intera, senza di te questo percorso non sarebbe stato lo stesso. Grazie!

Grazie agli amici di sempre Annamaria, Valentina, Maia, Matteo, Filippo, Luana e Melissa, l'Università è un percorso bellissimo solo se ti circonda di persone come voi, siete stati la mia seconda famiglia. Grazie!

Ed infine ringrazio me stessa, il mio coraggio, la mia forza, la mia determinazione e la mia voglia di farcela che ha superato ogni piccolo ostacolo incontrato ed è arrivata fino a qui, fino a FARCELA.



## ANNEX I

### ○ CONSUMER PERCEPTION OF UPCYCLED FOOD PRODUCTS FROM FOOD WASTE



UNIVERSIDADE  
DE ÉVORA

Dear Participant,

You are invited to take part in a survey conducted by the groups of Agri-food Economics and Policy of the Department of Agricultural, Food and Environmental Sciences (UNIVPM) and the Department of Management (UÉvora) about "**CIRCULAR ECONOMY FOR A SUSTAINABLE AGRI-FOOD SECTOR: CONSUMER PERCEPTION OF UPCYCLED FOOD PRODUCTS**". In this questionnaire, you will be asked to express your opinion about **your perception and willingness to pay for an innovative food product partially deriving from waste and by-products**. Every year millions of tons of waste are produced from the processing of raw materials for food production. These by-products are rich in nutrients and highly versatile. Their recovery represents an opportunity to increase the sustainability of the agri-food sector, even with an impact on the consumer wallet.

It will take approximately **10 minutes** to complete the questionnaire. Your participation is completely voluntary and anonymous. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. It is very important for us to learn from your opinions. Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate level, in compliance with the in-force law on privacy\*. All information will be coded and will remain confidential.

If you have questions at any time about the survey or the procedures, you may contact **Giulia Chiaraluce** or **Alessia del Conte** at [g.chiaraluce@pm.univpm.it](mailto:g.chiaraluce@pm.univpm.it) or [delcontealessia22@gmail.com](mailto:delcontealessia22@gmail.com). Thank you very much for your time and support.

By clicking on the Accept button below, you will be directed into the survey.

I have accurately read and fully understood the information given in this form, and I give my consent to participate in the questionnaire.

- Yes
- No

\*In accordance with Regulation (EU) 2016/679, GDPR (General Data Protection Regulation), and Legislative Decree 196/2003, and subsequent amendments and additions, all information collected with the questionnaires will be used exclusively for scientific research purposes. Furthermore, the data collected in the context of this survey are protected by statistical confidentiality, and therefore cannot be disseminated or disclosed except in aggregated form. No individual reference can be made to them and may only be used for statistical purposes.

- 1. Consumer attitude towards food waste
- 1. Do you ever buy groceries for your household?
- Yes
- No (**Question 5**)
- 2. How often do you buy groceries?
- Once a day
- 2-3 times a week
- Once a week
- 3. When shopping for food, do you buy only the bare necessities, or you go for extras?
- I only buy what I need
- I usually buy more than I need
- 4. Do you check food expiration/best before date when shopping for groceries?
- Yes
- No
- 5. When preparing food at home, are you attentive to the waste production?
- Yes, I am always attentive
- Yes, very often
- Not so many times
- Never, I do not care
- 6. Do you believe that your food purchasing behavior may affect the amount of food wasted?
- Yes
- No
- 7. Are you aware that the industrial processing of food generates losses and by-products (i.e., skins, seed, gristles, whey, ...)?
- Yes
- No

- 2. Consumer behaviour towards innovative upcycled food products
- 8. Please indicate how much you agree / disagree on a scale from 1 to 5 (where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree) with the following statements about innovative food products:

	1	2	3	4	5
I buy new, different, or innovative foods before anyone else I know					
Generally, I am amongst the first of my circle of friends to buy new, different, or innovative foods					
Compared to my friends, I purchase more new, different, or innovative foods					
If new, different, or innovative foods are available in shops and supermarkets, I always purchase them*					
Generally, I am the first amongst my friends to remember a brand of new, different, or innovative foods*					
I do purchase new, different, or innovative foods even if I have not tasted/experienced them beforehand*					

○ \*Original scale reverse items were changed for better comprehension (Barcellos et al., 2009) DSI scale original from Goldsmith & Hofacker (1991)

- 9. Please indicate how much you agree / disagree on a scale from 1 to 5 (where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree) with the following statements about new food products:

	1	2	3	4	5
I am seldom sampling new and different foods*					
I do not trust new foods					
If I do not know what is in a food, I will not try it					
I do not like foods from different countries*					
Ethnic food looks weird to eat					
At dinner parties, I would not try a new food*					
I am afraid to eat things I have never had before					
I am very particular about the foods I will eat					

I do not eat everything\*

I do not like to try new ethnic restaurants\*

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○ \*Original scale reverse items were changed for better comprehension (Barcellos et al., 2009)  
FNS original from Pliner & Hobden (1992)

Through the recovery of processing waste and by-products of the food industry it is possible to produce new foods, called upcycled foods. Some examples are energy drinks made with whey, salty snacks made from beer flour, dried snacks with fruits pulp and skin, and pasta with beer flour.



10. Have you ever heard about the term “upcycled food”?

- Yes
- No
- 11. If you found the following upcycled foods available on the market, which of these would you be willing to buy? Please, rank top 3 products from the above list according to your preferences (where: 1 – the first I will buy; 2 – the second I will buy; 3 – the third I will buy):
- Energy bars enriched with fruit by-products (seeds, peels, ...)
- Sparkling beverage made from whey
- Biscuits with sunflower cake flour
- Soy-based cocoa drink with potato protein
- Salty snack made with potato skins
- Pasta made with flour deriving from the beer production
- Energy drinks made with spent coffee
- Beverages from fruit and vegetable by-products (seeds, peels, stalks, ...)
- Granola made with the whole cocoa bean
- Cookies made with oat milk waste
- Salty snack made from beer by-products
- Salty snack made from dried and fried salmon skins
- Crackers made with carrot pulp and skins
- Beer obtained from discarded bread



○ 3. Willingness to pay for an upcycled food product

Suppose that you find available on the market a new upcycle food product: an upcycled margherita pizza, enriched with flour from orange cauliflower stalks, a recovered by-product from the fruit and vegetable industry rich in nutritional compounds that may contribute to lowering cholesterol in the blood, therefore the onset of coronary heart disease.



12. Would you be willing to buy this new upcycled food products, made from food waste?

- Yes
- No (**Question 14**)

13. For which reason are you interested in buying this upcycled product? (Please choose 3 reasons) (**Question 16**)

- I believe this product has health benefits
- I believe that this type of products is beneficial for the environment (i. e., requiring less energy and natural resources)
- I can participate in reducing the amount of waste and by-products produced by the food industry when I buy this products
- I believe that this kind of products is beneficial for the economy
- I think it is perfect for people who like to try new stuff like me
- I think it will have a great taste, even better than the original
- It is a "green", sustainable product
- It is a product that I know
- I generally support recycling and recovery
- I think it is a natural product
- This product is rich in nutrients
- Other (Please specify)

14. For which reason are you not interested in buying this upcycled product? (Please choose 3 reasons)

- I will not like the taste
  - I do not believe that this product is better than the original one
  - I do not know the brand
  - I do not trust the health effects
  - I perceive this product as expensive
  - I believe this product is suitable only for people on special diets (i.e., vegetarian)
  - I do not believe this product is natural
  - I am against substitution of ingredients in this kind of traditional products
  - I do not know this type of ingredients
  - I do not care about recovering the waste and by-products from the food industry
  - I am disgusted of consuming a product containing waste from the food industry
  - It is not safe to eat food containing waste from the food industry
  - I do not have enough information
  - I had never tasted it
  - I do not believe that this product helps in reducing the amount of waste produced by the food industry
  - I pay attention to certification of the products, so I do not trust the upcycle label
  - Other (Please specify)
- 

15. Which of the following motivations would convince you to buy this new product? (Please choose 3 motivations) **(Question 19)**

- I would like to taste it
  - I would like to know where the food waste come from
  - I would like to have low price
  - I would like to know more about food waste reduction in the food industry
  - I would like to see a specific logo certifying the quality, processing, and characteristics of the ingredients and the product
  - I would like to see more advertising about this product
  - I would like a different name
  - I would like to have more information about upcycled foods
  - I would like to see a label clearly stating all the information about health benefits and environmental sustainability
  - Other (Please specify)
- 

16. If you are willing to buy the upcycled pizza, knowing that the average price for a frozen margherita pizza (330 g) with alternative flour (gluten free, Kamut, organic flour, protein flour, whole wheat flour, ...) is about 4.00 €, would you be willing to pay **4.50 €** for a frozen upcycled margherita pizza (330 g), enriched with flour from orange cauliflower stalks, a recovered vegetable by-product rich in nutritional elements?

- Yes

- No (**Question 18**)
- 17. If yes, would you be willing to pay **5.00 €** for a frozen upcycled margherita pizza? (**Question 19**)
- Yes
- No
- 18. If no, would you be willing to pay **4.00 €** for a frozen upcycled margherita pizza?
- Yes
- No
- 4. Consumer behaviour towards circular economy
- The recovery and valorisation of waste and by products to produce upcycled foods are part of the circular economy concept.
- 19. Have you ever heard about the concept of circular economy?
- Yes
- No (**Definition**)
- 20. Could you give your personal definition of circular economy?

**Definition of circular economy: The circular economy is a model of production and consumption that requires to waste as less as possible and consume as less environmental resources as possible. Everything that is produced should find a sustainable way to be put back into circulation, including through the reduction, recovery and valorisation of waste and by-products. Some examples of the circular economy are refurbished smartphones, recycled items, the purchase of second-hand clothing, and the production of renewable energy from agricultural and food waste.**



- 21. What is circular economy?
- Circular economy is a model of production and consumption
- Circular economy is a new consumption model

- Circular economy is a new way to perform the separate collection of waste
22. Which is the main objective of the circular economy?
- Circular economy allows a better separated collection of waste
  - Circular economy aims to find a sustainable way to put waste and by-products back into circulation
  - Circular economy ensures higher profits
23. Which are the advantages of circular economy?
- Circular economy has only economic benefits
  - Circular economy has the same advantages as the traditional economy
  - Circular economy aims to reduce the impacts on the planet of the economic activity
24. Please indicate how much you agree / disagree on a scale from 1 to 5 (where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree) with the following statements about recycled products:

	1	2	3	4	5
Recycled products have good quality					
Recycled products give me the quality that I expect					
Recycled products have a quality similar to that of products that are not sustainable					
I have a positive image of recycled products					
Consumers of recycled products know how to buy (buy intelligently)					
Recycled products have a positive/favorable image in the market					
Recycled products respect the environment/are good for the environment					
Recycled products offer significant environmental benefits					
Recycled products are safe for consumers					
The production process of recycled products is safe and reliable					
Recycled products are benign and no harmful					
I will buy recycled products in the future					
I am likely to buy recycled products					

I will continue buying recycled products

RPS scale original from Calvo-Porrà & Lévy-Mangin (2020)

5. Socio-demographic characteristics

- 25. Gender
- Male
- Female
- I prefer not to say
- 26. Age

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27. Education

- No formal education
- Primary school
- Middle school
- High School
- Bachelor's degree
- Master's degree
- Postgraduate education (Master, PhD, ...)

28. Employment

- Student
- Independent worker
- Private-sector worker
- Public-sector worker
- Retired
- Unemployed
- Not seeking work
- Other work (Please specify) \_\_\_\_\_

29. Status

- Married
- Single
- Separated /Divorced
- Widowed
- Cohabitant

30. Annual household income before taxes

- Less than € 10,000
- € 11,000 to € 20,000
- € 21,000 to € 35,000
- € 36,000 to € 50,000
- € 51,000 to € 75,000
- € 76,000 or more
- I do not want to declare/I do not know

31. Country

- Italy

- Other (Please specify) \_\_\_\_\_ **(Question 33)**
- 32. Region of residence
- Abruzzo
- Basilicata
- Calabria
- Campania
- Emilia-Romagna
- Friuli-Venezia Giulia
- Lazio
- Liguria
- Lombardia
- Marche
- Molise
- Piemonte
- Puglia
- Sardegna
- Sicilia
- Toscana
- Trentino-Alto Adige
- Umbria
- Valle d'Aosta
- Veneto
- 33. Household size
- One
- Two
- Three
- Four
- Five or more
- 34. Number of children under 18
- No children
- One
- Two
- Three or more

## ANNEX II

### Conventional margherita pizza

BRAND	SHOP	CITY	kg	€
CAMEO	OASI	ANCONA	375	2.49
CONSILIA	OASI	ANCONA	370	2.99
ITALPIZZA	OASI	ANCONA	435	3.49
CAMEO	COOP	ANCONA	375	3.49
COOP	COOP	ANCONA	660	3.29
ITALPIZZA	COOP	ANCONA	485	4.79
BUITONI	COOP	ANCONA	400	4.59
CAMEO	SI CON TE	ANCONA	620	5.64
RONCADIN	PAM	ROMA	415	5.00
BUITONI	PAM	ROMA	400	4.70
ITALIAMO	LIDL	MILANO	390	2.29
ITALPIZZA	LIDL	MILANO	485	4.79
SIMPL	CARREFOUR	MILANO	960	4.57
MAMAMIA	PENNY MARKET	ROMA	385	2.59
LE SPECIALITÀ DI BEPPE	MD	VICO DEL GARGANO	620	3.99
LETTERE DALL'ITALIA	MD	VICO DEL GARGANO	390	3.99
CAMEO	CONAD	MATERA	330	3.77
BUITONI	CONAD	MATERA	660	5.55
BUITONI	CONAD	MATERA	280	3.79
CAMEO	CONAD	MATERA	620	5.26
CONAD	CONAD	MATERA	640	3.29
CAMEO	CONAD	ANCONA	330	3.59
CONAD	CONAD	ANCONA	285	2.14
BUITONI	CONAD	ANCONA	650	5.59
ITALPIZZA	CONAD	ANCONA	485	5.09
ITALPIZZA	INTERSPAR	MATERA	485	4.49
CONAD	CONAD	BOLOGNA	640	3.29
BUITONI	CONAD	BOLOGNA	400	3.99
BUITONI	SI CON TE	OSIMO STAZIONE	280	4.03
VALE	SI CON TE	OSIMO STAZIONE	660	3.79
BUITONI	SI CON TE	OSIMO STAZIONE	650	6.15
BUITONI	SI CON TE	OSIMO STAZIONE	300	3.47
CAMEO	SI CON TE	OSIMO STAZIONE	300	3.73
CAMEO	SI CON TE	OSIMO STAZIONE	375	4.29
CAMEO	SI CON TE	OSIMO STAZIONE	620	5.64
TAVERNA GIUSEPPE	LIDL	ANCONA	960	4.99
TAVERNA GIUSEPPE	LIDL	ANCONA	385	2.59
TAVERNA GIUSEPPE	LIDL	ANCONA	210	2.19
CAMEO	LIDL	ANCONA	375	3.49
ITALPIZZA	LIDL	ANCONA	485	4.79

ITALIAMO	LIDL	ANCONA	350	3.19
TAVERNA GIUSEPPE	LIDL	ANCONA	360	1.99

### Special margherita pizza

BRAND	SHOP	CITY	g	€
CONSILIA	OASI	ANCONA	350	3.69
SCHAR	OASI	ANCONA	280	4.69
SVILA	COOP	ANCONA	220	2.75
VIVI VERDE COOP	COOP	ANCONA	340	3.80
SCHAR	COOP	ANCONA	280	4.60
BENESI'	COOP	ANCONA	340	4.30
ITALPIZZA	PAM	ROMA	350	3.60
TAVERNA GIUSEPPE	LIDL	MILANO	280	3.19
TAVERNA GIUSEPPE	LIDL	MILANO	390	2.99
CARREFOUR NO GLUTEN!	CARREFOUR	MILANO	330	4.92
BUITONI	CARREFOUR	MILANO	360	4.19
CARREFOUR BIO	CARREFOUR	MILANO	350	3.77
SCHAR	CARREFOUR	MILANO	280	4.61
LE STAGIONI D'ITALIA	CARREFOUR	MILANO	350	4.50
LE STAGIONI D'ITALIA	CARREFOUR	MILANO	350	4.50
FREE	PENNY MARKET	ROMA	330	3.75
TRADIZIONE ITALIANA WELLESS	PENNY MARKET	ROMA	390	3.99
VERSO NATURA CONAD	CONAD	MILANO	345	3.49
LA PIZZA ITALIANA GIANNI	MD	VICO DEL GARGANO	320	3.79
BUITONI	INTERSPAR	MATERA	360	3.99
TAVERNA GIUSEPPE	LIDL	ANCONA	390	2.99
TAVERNA GIUSEPPE	LIDL	ANCONA	280	3.19
VERSO NATURA CONAD	SPAZIO CONAD	ANCONA	345	3.29
ALIMENTUM	SPAZIO CONAD	ANCONA	350	3.99

### Pizza bases

BRAND	SHOP	CITY	g	€
BUITONI	PEWEX	ROMA	400	4.39
BUITONI	PEWEX	ROMA	460	2.89
CARREFOUR	CARREFOUR	ROMA	385	1.65
BUITONI	PAM	MILANO	385	2.40
PAM PANORAMA	PAM	MILANO	385	1.75
CONAD	CONAD	MILANO	385	1.49
BIANCA BONTA'	OASI	ANCONA	385	1.39
BUITONI	OASI	ANCONA	385	2.49
RUSTICANA	OASI	ANCONA	450	4.15



BUITONI	ESSELUNGA	MILANO	460	2.99
BUITONI	ESSELUNGA	MILANO	350	2.55
Cà BIANCA	MD	VICO DEL GARGANO	400	1.49
DI MARCO	SI CON TE	OSIMO STAZIONE	230	2.90

### Special pizza bases

BRAND	SHOP	CITY	g	€
SCHAR	PEWEX	ROMA	300	4.39
RUSTICANA	OASI	ANCONA	250	2.95