Higher Education Institution

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ICHEC
BRUSSELS MANAGEMENT SCHOOL

Higher Education of the Long Type at University Level

Assessing the Environmental Impact of Coffee (Capsule) Consumption Patterns in Belgian Households: A comparative analysis from 2019 to 2023.

Dissertation presented by:

Zoé MATTHYS

For the attainment of the diploma of:

Master's degree in Business Management

Academic Year 2023-2024

Promotor:

Pierre-Alain SCHARFF

Boulevard Brand Whitlock 6 - 1150 Bruxelles

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I would additionally like to thank my close circle and support system. My mom especially. It is gold in life, to have people to lift you up, motivate you or give you grace when needed. Providing for external perspective as well as some distance for reflection held much value during this time. I would like to add that the power of communication and discussion on a topic knows no limits in terms of added value.

Lastly, I sincerely thank the Ichec Brussels Management School for giving me the opportunity to accomplish an International Business Master's degree and for allowing me to dive into the sustainable world of coffee thanks to this dissertation. It is with much honour and gratitude that I look back at this chapter of my life.

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Table of Contents

Abstract

This dissertation researches the environmental impact of in-home coffee consumption evolution in Belgium amidst major changes occurring around the world, notably the COVID-pandemic from 2019 to 2023. A particular focus is provided towards evolving consumer behaviour, changing coffee preparation methods, evolving capsule materials and capsule disposal methods, and the influence of sustainability certifications, allowing for a smaller environmental footprint.

« Coffee has become a trademark of friendly conversation all around the world ». It is one of those rare unifying forces of mankind. » (S., 2020, para. 6 & 7). This dissertation will explore if this hedonic need for socialising and communication has been a driving factor in the evolution of consumers' coffee consumption between 2019 and 2023. It's interesting and valuable to note the findings of a study which established that the COVID-19 crisis, a sanitary, economic, social and environmental crisis, has enhanced the importance of proximity values within society, of humanisation within management and increased worry for nature and social equity (Frimousse & Peretti, 2020). Values found within the consumption of coffee as well, somehow.

The dissertation commences with history on coffee, followed by a detailed overview of essential coffee concepts and properties to improve one's general understanding on the subject at hand. It further examines the current state of the global and Belgian coffee markets. Scientific literature, qualitative interviews and external surveys then dive into a detailed analysis on various factors affecting the environmental impact of in-home coffee consumption.

A particular focus is placed towards the single-serve coffee preparation method, coffee capsules, due to its contrasting reputation on environmental impact. Research conducted on certified, specialty and traditional coffee content within the coffee capsules reflect lower Co2 emissions generated. The same goes for the biobased, biodegradable, compostable and recycled capsule materials. The end-of-life phase of coffee capsules is a determining factor of the environmental impact. Its packaging material and mode of disposal have a role to play. Waste management and disposal systems, compostability, biodegradability, waste export, incineration or landfills are all options which will be analysed. Furthermore, polylaminate, aluminium, plastics, bioplastics, metals, paper, tinplate and other compostable materials are among the capsule materials which will be studied.

The psychological dimension is integrated as well, addressing the gap between consumer perceptions on the in-home coffee consumption methods' environmental impacts and the actual environmental impact generated. Emphasis is placed on certification schemes, sustainability standards and new technologies throughout this paper, as environmental sustainability regarding at-home coffee consumption forms the backbone of this dissertation. Trust is presented to the table as well here, as consumers are having a hard time knowing who and what to trust.

Significant resources have been invested in improving the Belgium in-home coffee market's environmental footprint. Whether the resources have yielded substantial-enough results to make a difference on planet-level is more challenging to determine. Ongoing education and accountability, awareness, innovation and regulation lead the way to reducing the environmental impact.

Glossary

Term	Definition
Noncommunicable diseases NCDs	A category of diseases, often requiring long-term treatment, which are responsible for 71% of deaths per year and disability worldwide. These conditions encompass mental health disorders, diabetes, cardiovascular diseases, chronic lung illnesses, cancers and injuries, to name the most common. Upon improvement of risk factors, such as alcohol, smoking, physical activity, healthy eating habits and palliative care, most can be prevented from occurring (Pan American Health Organisation, n.d.).
Biophenols	Biophenols, originating from bioactive phenols, and previously, less accurately, known as polyphenols, dates back to 30 years ago, in 1996, when scientists and consumers started gaining interest in this phenolic compound found in plants. Its antioxidative properties are to answer for its interest, as it has the potential of advancing in terms of food and human health preservation (Obied, 2013). Research has positively correlated the properties of the compound with cognitive enhancements, beneficial towards a decline of dementia and potentially beneficial for Alzheimer disease (Syed, 2018).
Anti-fibrotic properties	Antifibrocis, linked to drugs within clinical trials with substantial side-effects, is often given to people suffering from idiopathic pulmonary fibrosis. Its aim is to resolve the irregular accumulation of tissue within the body called fibrosis, also known as scarring. This is a common outcome of chronic inflammatory diseases (Mayo Clinic, 2018; Wynn & Ramalingam, 2012).
Composting	The collection of plant material for decomposition, generating less waste (Cambridge Dictionary, n.d.-b).
Recycling	The collection of materials for reuse (Cambridge Dictionary, n.d.-c).
Cupping scores	A system of coffee quality criteria evaluation (Lingle & Menon, 2017).
Sustainability	Allowing for a continuation over time (Cambridge Dictionary, n.d.-d)
Alloyed Capsules	The term coffee capsules is used in Europe, where “coffee pods” is used in the UK and the US (Thoden van Velzen et al., 2023). Alloyed: Combination of metals
Penetration rate	The rate of sales of a product or service (Cambridge Dictionary, n.d.-e).
Private Label	Products sold by store brands (Quelch & Harding, 1996).

Introduction

Changing Landscape & in-Home Coffee Market Assessment in Belgium

As the world is evolving, so is psychology and the realm of understanding of individuals' actions. The world is filled with unanswered questions, leading to unresolved issues making up today's most widespread catastrophes. Throughout this dissertation we'll be diving into one of them being our environmental impact, and whether our actions since the COVID-19 pandemic are generating improvement or deterioration.

Regarding the environmental dimension, the subject being analysed in this paper is the evolution of the coffee sector's environmental footprint, post-COVID-19 pandemic. We will explore how shifts in Belgian consumers' consumption patterns are affecting our earth from an environmental perspective, with a focus on single-use coffee capsules.

The psychological field, as a representing example, has significantly deepened throughout the 21st century. Thanks to the new generation of research, the empirical investigations and scientific understanding, the study on goals and behaviour changes has made significant strides (Berkman, 2018). As the article states: "Setting goals is easy; achieving them is hard". Berkman (2018) is not able to provide us an answer as to why this is. However, he does advocate that all is not lost (Berkman, 2018). This is what will be investigated within the Belgian in-home coffee market. Are our environmental impact strides lost within this industry in this country, as the years go by, or are we implementing sustainable change? The repercussions of a recent catastrophic event, the Coronavirus disease in2019, characterised as a pandemic by the World Health Organization, will be taken into account (Bakaloudi et al., 2022).

This multidimensional crisis has impacted our planet as a whole, whether it be economic, ecological, social or political (Trespeuch et al., 2021). New behaviours reared their head during this time, impacting ways of consumption. Measures and restraints put in place affected lifestyle habits and patterns (Bakaloudi et al., 2022). This study stated that this global pandemic affected our values, in turn changing behaviours (Trespeuch et al., 2021). Soft mobility has witnessed a rise (walking, biking, …), together with overland travel (Trespeuch et al., 2021). A change in behaviour generated the appearance of new and upcoming trends as well. Consumption patterns that had been achieved have now been challenged. Are Belgian in-home coffee consumers advancing towards more or less environmentally responsible consumption?

It has been stated that a change in behaviour starts with a change in values (Trespeuch et al., 2021). The pandemic has been shown to have the potential to drive such a change due to its striking impact. This article has identified two scenarios for post-COVID evolution. The first one being sustainable change in consumers' behaviours and habits, and the second one being a "return to reality" so to say. The path towards sustainable change traces back to the subprime crisis of 2008, which underscored the increasing significance of three key principles: self-transcendence (looking past one's self-interest), continuity (embracing conformity and tradition) and ethnocentrism (valuing local interests such as our heritage, community and family) (Trespeuch et al., 2021). Can this be identified throughout the evolution of the Belgian in-home coffee consumption post-COVID?

The second scenario introduced in the paragraph above on temporary change and reverse effects, suggests that the distance created by a crisis separates individuals from its subjects such as climate change, reducing their concerns, control and motivation towards these environmental impacts (Trespeuch et al., 2021). We mentioned psychology at the start of this chapter. Indeed, it has a role to play in studying habits. The psychological approach of the connectionist perspective suggests that habits strongly depend on their context. New behaviours become habits. As the context evolves, so do habits (Trespeuch et al., 2021). Therefore, will the current developing trends maintain their importance and expand or drift away?

The COVID-19 pandemic has been characterised as a disease of the Anthropocene, emphasising that natural factors are not the sole cause of the crisis. Instead it is the increased contact between humans, wildlife and the environment (Trespeuch et al., 2021). This situation could generate a higher environmental awareness of potential risks of this human-planet relation. As a result, today's consumers might place more importance on environmental considerations, recognising that adaptation is not just desirable but necessary (Trespeuch et al., 2021). Does this represent today's consumers?

Current Trends

As the world evolves, so do our trends. In 2022, coffee consumers have become more knowledgeable and demanding (CBI, 2024). A quest for unique flavours and specialty coffee has been growing in popularity in Belgium (Statista, n.d.). Indeed, an increase in specialty coffee consumption has been on the radar in Western Europe (CBI, 2021a). Similarly, single-serve coffee methods, such as capsules, have seen increased adoption as convenience gains importance. Furthermore, there is a growing demand for coffee traceability and transparency, driven by the rising interest in ethically-sourced coffee. This aligns with the increasing interest in direct trade (Statista, n.d.; CBI, 2024). Additionally, the trend towards healthy living and concerns for coffee sustainability are gaining traction, impacting consumer preferences (CBI, 2024; Mordor Intelligence, 2024). Lastly, there is a notable increase in coffee consumers' awareness of its social and environmental impact, particularly regarding sustainability labels. This may influence consumers' preferences and willingness to pay more for coffee (Fuller & Grebitus, 2023).

Reasons Behind this Research

o Second Internship – Master's Degree

The 6-month internship is an integral part of the Master's degree in International Business and Management at the ICHEC Brussels Management School. Completed at Nestlé Belgilux in the coffee department in February of last year, 2023, it offered the opportunity to build a link between real-world business challenges and the focus of this dissertation.

Upon entering the office building on the first day and throughout the duration of the internship, one significant issue stood out: the amount of plastic water bottles used by the employees on a daily basis. 500ml and 1L plastic water bottles were at the unlimited disposal of Nestlé employees for their daily water consumption. Based on observations and data available from Statista (2021), Nestlé Belgilux, with an average of 300 employees, disposes of 900 plastic 1L bottles per week, or 3,600 plastic water

bottles a month. This is an astounding observation. The striking extent of this insight led to the identification of the sustainable dimension, which is further analysed throughout this dissertation. The focus of the next six months was directed towards gathering information on the evolution of today's post-COVID 19 coffee market in Belgium, while questioning the environmental impact of the different coffee segments.

As a marketing intern, daily tasks resemble attending multiple meetings and managing new product introductions, working on advertising projects and company partnerships and analysing data. A well-integrated intern works on all of the steps leading to a product launch, such as product data introduction for factory production and packaging re-reads and approvals, and making sure that all is produced and ready on time. Furthermore, uploading all necessary product data for retailers and being the point of contact for commercial campaigns for Starbucks® at home and NESCAFÉ® Farmers Origins® coffees is an integral part of the role.

Working in the coffee category and attending meetings opened the door to knowledge surrounding Nestlé initiatives for more durable coffee. A lot of resources have been and are spent in R&D, to preserve the coffee industry, produce responsibly-and-ethically sourced coffee and improve the social responsibility that this sector bears. The Nescafé Plan 2030, the Nespresso AAA Sustainable Quality program and the Starbucks® C.A.F.E. practices are examples of such initiatives (Nestlé, 2023a; Nestlé n.d.; StarbucksAtHome, n.d.).

○ First Internship - Bachelor's Degree

During my bachelor's degree, I sourced and completed an internship at the Paris Marriott Rive Gauche Hotel in Paris, focusing on human resources. Though brief, this experience generated a train of thought and further reflection on the hotel's environmental impact. I dove into practices which could be implemented to further reduce the hotel's environmental footprint and make the hotel industry more responsible.

○ Upbringing – the Developed and the Developing World

As I spend part of my upbringing in the developed and developing world, I witnessed the social and environmental impacts that both economic development and insecurity have on the planet first hand. I have, since then, allocated a growing importance towards taking care of our surroundings and consuming respectfully. I use the word "respectfully", instead of "responsibly", because I believe the meaning of the word is understood in an easier manner by consumers. Responsible consumption, as communicated by the European Parliament (2020) encompasses considerations for environmental, social and economic sustainability. It focuses on the negative impacts on the environment, on local communities and on the viability of our economies (European parliament, 2020). To further highlight its importance, responsible consumption forms the twelfth sustainability goal, led by the United Nations (United Nations, 2023). The twelfth SDG states that changing the way we consume is crucial as the planet is running out of resources. The United Nations goes further by sharing that food waste must be tackled straight on, as the numbers are staggering: a total of 931 million tons of food is wasted a year. Change can be obtained through big initiatives and small adjustments. Notions such as the circular economy, integrating longevity through recyclability, reusability and repairability are brought

up here. It's about adopting a sustainable lifestyle, by implementing two activities; reducing waste and consuming and purchasing in a thoughtful way (United Nations, 2023). Start small, work your way up.

In the emerging country I grew up in, the consequences of consumption are strikingly visible. Waste of all sorts is apparent to the bare eye, whether it be floating in rivers, generating the smells that go with it, or overflowing out of big dated aluminium trash cans on the streets. A significant economic disparity, and consequently, a social gap, is flagrant as well. Next to a mansion secured by guards and accessorised with a Bentley, you may find worn-down brick structures, each only about 10 square feet, with mud floors and barely equipped with basic amenities. Both are homes to two different social classes.

Now, living in my developed home country in Belgium, and going to work in the offices of Nestlé, my surroundings are striking. The ways of consumption are striking. Unfinished plates being disregarded, plastic bottles being consumed by the day unquestioningly. I wonder how our current post-COVID coffee consumption in Belgium is affecting our planet. Are we evolving for better or worse after a devastating pandemic? Have our mindsets taken a turn for the better?

Current Aim

Working in a field that resonates with meaningful work, particularly within a humanitarian role, surrounded by a proactive community, reflects a major aspiration of mine. Keeping this in mind, uncovering durable consumer practices that have reared their head in the in-home coffee market in Belgium since the COVID-19 pandemic is the current challenge. All the while maintaining an objective view on the matter, as a researcher, throughout this paper.

Methodology

To comprehensively analyse, challenge and respond to this issue, a literature review will be conducted. This review will cover topics related to the coffee market and coffee itself as well as on the notions of sustainability, environmental impact and life cycle assessment. The *secondary data,* making up the literature review, will include scientific literature and published documents of organisations.

To compare and contrast the literature with real-world insights, both *primary and secondary data* have been incorporated in the practical review. Interviews with employees of Nestlé Belgilux will be included to complement the *secondary data* on coffee itself. The interviews will provide qualitative secondary data on the evolution of the coffee market, on consumption in Belgium and on sustainable initiatives by Nestlé (Ponto, 2015). Transcripts of interviews will be appended. Additionally, internal documents from the Nestlé Belgilux company as well as pre-conducted surveys on sustainable consumption in Belgium and on Belgian consumption behaviours during and post-COVID, will be incorporated. The surveys which include close-ended questions, numerical data and a larger sample size, constitute *quantitative secondary data* (Ponto, 2015).

Our chosen scope focusses on Belgian in-home coffee consumers. The analysis of the internal documents, survey responses and the interviewees' valuable knowledge will complement the literature review on in-home coffee consumption habits, responsible consumption and the perceived versus the actual sustainable footprint. This approach will enable us to better understand and clarify the environmental impact generated by the in-home coffee market since the Coronavirus.

Literature Review

The History of Coffee

The history of coffee isn't stuck in stone. Its earliest use is said to originate in the fifth and sixth centuries, as Persian invaders discovered the plant in forbidden areas of northeast Africa, home of the Arabica coffee variety (see Figure 1) (Cramer, 1957). Studies say it had initially been used in sorcery and medicine and was drunk as a pleasure drink until the followers of Islam began to symbolise it with speciality and uniqueness during their exploitation. It later on spread to Europe, the Netherlands especially. It is said that coffee trade was a means for the Dutch East India Company, the Netherlands, to make their mark in the world in the early 1600s. Individuals highly valued coffee, treating it as luxurious, similar to gold (Cramer, 1957). The Dutch East India Company went on to send coffee seeds to western Java in Indonesia, as the Dutch had signed a treaty with the Sultan in 1597, seeing the land's agricultural potential. This land was wanted by the French and English too. The settlement of the Dutch in the East Indies in the 1600s was a sign of supremacy (Cramer, 1957).

Sources trace the cultivation of coffee back to Yemen, in the middle east (National Coffee Association, n.d.-a; Everett, 2023). Many legends surrounding its discovery have been told. However, one legend has been included in thorough research sources, dating back centuries to coffee forests in Ethiopia. It is said that a goat herder in Ethiopia (see Figure 1) discovered the virtues of the coffee bean upon realising his goats were becoming increasingly energetic and developed sleep issues since consuming coffee berries from the trees. He went to the local monastery to share his findings. Word and trade began to spread, first east to Arabia, due to the trade being conducted across the Red Sea at that time, which is where the journey of coffee cultivation began in the 15th century, in Yemen (National Coffee Association, n.d.-a; Vega, 2008; Everett, 2023). PhD author, M. Vega (2008) shared findings suggesting that the first use of coffee dates back to practitioners of Sufism. Coffee cultivation and trade started out in Yemen, as confirmed by multiple sources, and subsequently spread to regions such as Egypt, Syria and Turkey (National Coffee Association, n.d.-a; Everett, 2023). It is not only in homes that the coffee was drunk, but in coffee houses as well. They were a main centre of communication, also called "Schools of the Wise". Coffee was known as the "Wine of Araby" among pilgrims visiting the holy city of (National Coffee Association, n.d.-a; Vega, 2008). A published description on coffee houses in Turkey has been found dating back to 1627. Venice, Oxford and later Boston called "London Coffee House", followed with the introduction of coffeehouses, in 1645, 1650 and later 1689 respectively (Vega, 2008).

Figure 1

The Arabian Peninsula – Coffee Trade and Cultivation (Britannica, n.d.)

Coffee began being heard of by European visitors coming from near countries in the east, taking interest in this "unusual dark black drink" and ultimately commencing their own coffee consumption in the 17th century (National Coffee Association, n.d.-a). It is said that Venice's pope personally approved the bean's consumption, after religious leaders had initially condemned the ingredient, due to fear and suspicion in 1615, naming it the "bitter invention of Satan". Coffee consumption grew increasingly, as coffee houses multiplied, coffee appeared in universities for a dollar, and was being consumed for breakfast.

Coffee cultivation outside of Arabia began with the Dutch who managed to cultivate coffee beans on the Indonesian Island, Java, in the 1600s. Cultivation was generated by imported coffee plant seeds from Yemen. The Dutch East India Company held the reins. After a failure in India and a success in Java, it expanded its cultivation to other islands near Java (National Coffee Association, n.d.-a; Vega, 2008). Coffee seeds made their way from Java to the Amsterdam Botanical gardens in 1706 (Vega, 2008). Upon receiving a coffee plant from the mayor of Amsterdam in 1714, King Louis XIV of France had it planted in the French Royal Botanical Gardens as well. A French naval officer called Gabriel de Clieu, managed to obtain a seedling in 1720 and, following a tedious voyage to Martinique, planted it on the land with great success. It is said that a seedling is responsible for the spread of most coffee trees across south and central America, and the Caribbean (National Coffee Association, n.d.-a; Vega, 2008). Coffee is, today, the second most-traded commodity worldwide. The first one being petroleum products. Brazil's production is said to originate from Suriname in 1727, a Dutch colony, where Amsterdam sent seeds from its Botanical Gardens to cultivate coffee themselves (Vega, 2008).

The drink made its way to New York, called New Amsterdam in the past, in the mid 1600s (National Coffee Association, n.d.-a). The Boston tea party of 1773, a rebellion of great historic significance during which tea was destroyed in different parts of the city of Boston (Carp, 2010). Provincial taxes introduced on tea, tipped coffee in favour of the historically preferred drink of choice (see Figure 2). These tea destroyers were men disguised as Native Americans, "playing Indian" (reference towards

the East India Company). This rebellion was a significant effort towards the liberty of Americans of all social classes, ultimately leading to the war of independence (Carp, 2010).

Robusta coffee, representing one of two self-pollinating coffee species, has a history of its own (Vega, 2008). Its cultivation origins date back to 1870, in the wild near the Lomami River, now called the Congo River, in Democratic Republic of Congo (Berthaud & Charrier, 1988). It was noticed by the French 10 years later and named C. Canephora by a French botanist called Louis Pierre in 1895. The coffee seeds were distributed on lands of neighbouring countries after the cultivation of Robusta coffee took off in Belgian Congo at that time (Benoit, 1968). Brussels went on to send seeds to Java in Indonesia where coffee cultivation moved on from arabica to Robusta coffee in the mid 20th century, given its higher perseverance to diseases and resistance to heat and humidity (Cramer, 1957). C. Canephora travelled from Java to certain regions of Asia such as India and Latin America (Brazil) in the early and mid-20th century (Campuzano-Duque & Blair, 2022).

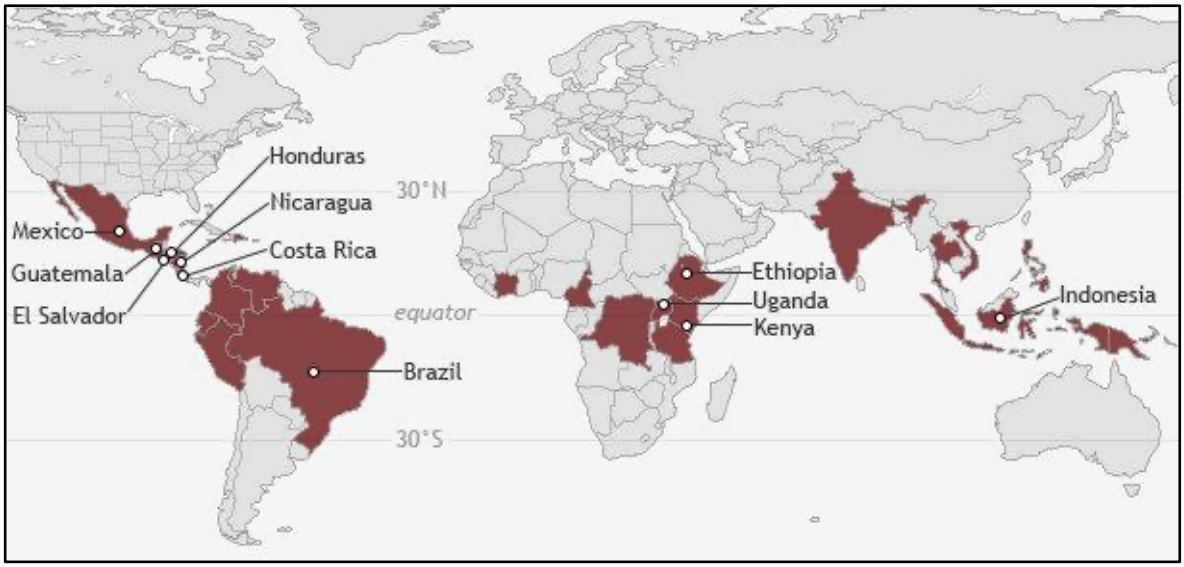
Assessment of the Global Coffee Market (2019-2023)

o Coffee Belt & Privileged Coffee Locations

Coffee cultivation spans over 80 countries worldwide. Its production resides along the equator, mainly in Asia, Africa and Latin America, in tropical and subtropical zones (Rivas, 2020). The current leading coffee producer worldwide is Brazil, Belgium's n°1 supplier (CBI, 2021a; Statista, 2024; World Population Review, 2024). Brazil produced 66 million 60kg bags of coffee in 2023, followed by Vietnam, Colombia, Indonesia and Ethiopia. These five top-producing leaders, Brazil, Vietnam, Colombia, Indonesia and Ethiopia, are responsible for the majority of the coffee output to this day. Honduras, India, Uganda, Mexico and Peru are the runner-up's (CBI, 2021a; World Population Review, 2024; Statista, 2022).

Figure 3

Coffee Producing Countries 2024 - Coffee Bean Belt (Scott, 2015)

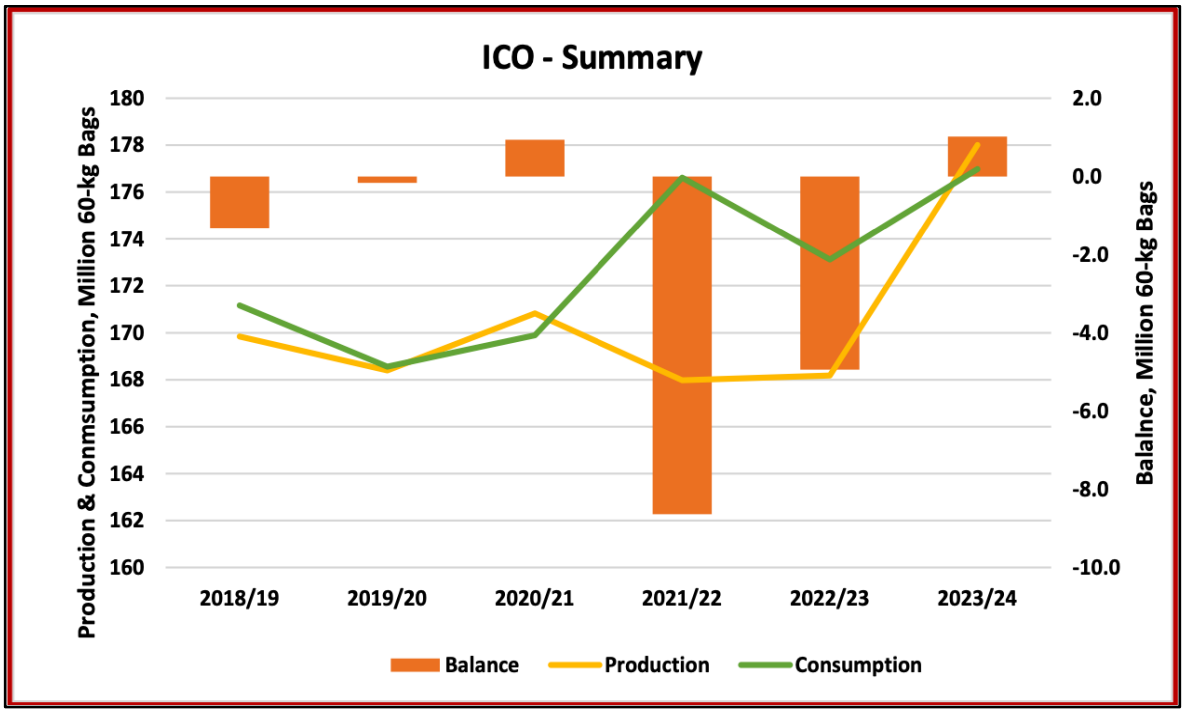


Global coffee production and consumption have been growing since last year, as shown in the figure 4 below (ICO, 2023a). Conservation International (n.d.) expects coffee demand to triple by 2050. Since

2021, the gap between coffee production and consumption, represented by the orange bars in the graph, has been narrowing, indicating a better balance between supply and demand in the market (ICO, 2023a).

Figure 4

World Coffee Supply, demand and gap between supply and demand 2018 - 2024 (ICO, 2023a)



Global coffee production stood at 168 million 60-kg bags of coffee between 2022 and 2023. A rise was established in 2023-2024, reaching 178 million, with 102 million accounting for the arabica variant and 76 million 60-kg bags accounting for the Robusta variant (Vega, 2008; ICO, 2023a). The International Coffee Association shared that the Americas region (Asia, Oceania, Africa) is responsible for this increase, as rest of the global coffee production is declining in this period (ICO, 2023a).

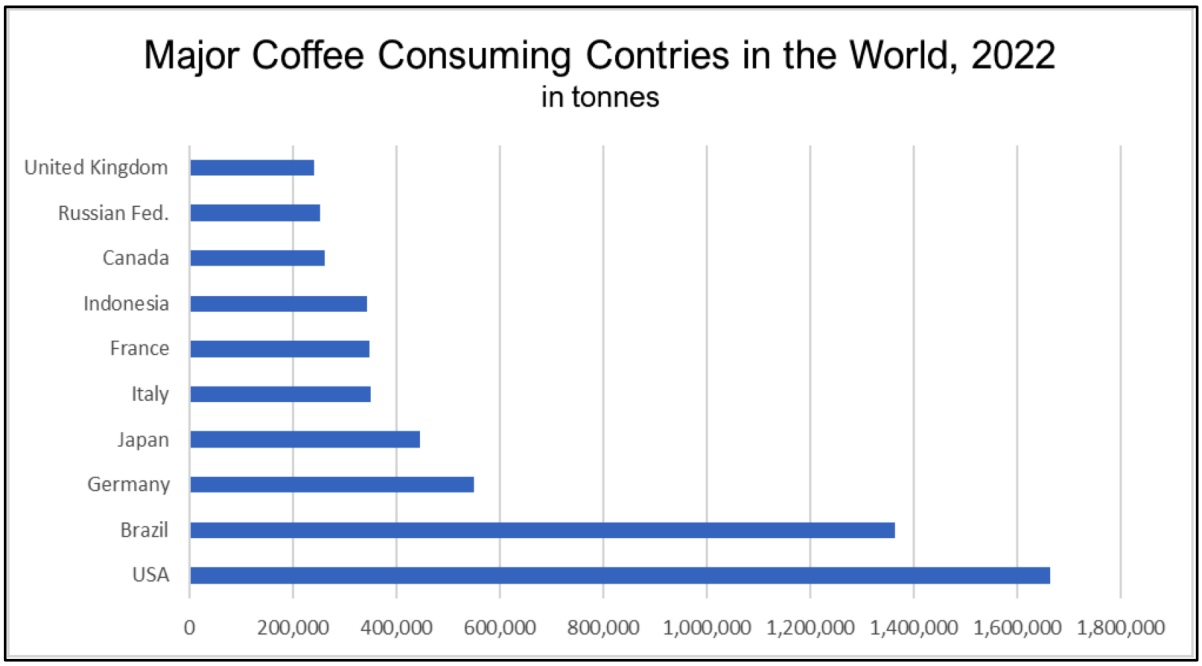
The reasons for the fall in production is primarily due to climate adversities and a challenging global economic environment due to the COVID-19 pandemic in part. Due to this, the Robusta cultivation has experienced growth, in contrast to the arabica coffee production (ICO, 2023a). This variant is trickier to grow and now accounts for a little under 60% of the world's coffee production in 2023, compared to 70% in 2006 (Vega, 2008). The Stockholm Environmental Institute highlighted in 2022 that climate change will be responsible for cutting coffee production. The study stated that the land will become unsuitable for coffee production by 2050, especially impacting the Arabica variant as it is more sensitive to weather conditions (Dzebo & Adams, 2022). Rainfall and rising temperatures are causes of this. Preserving biodiversity, forests and our ecosystem, combined with regenerative practices are of the essence. With coffee cultivation still expanding, forests are at risk of deforestation to coffee cultivation, negatively impacting ecosystems and greenhouse gas emissions (Dzebo & Adams, 2022; Panhuysen & de Vries, 2023).

- Global Coffee Market Share & Growth

Regarding global consumption levels, the European Union, the US and Brazil accounted for a significant portion of worldwide coffee consumption in 2023, with the EU accounting for 24%, the US 16%, and Brazil 13% (see figure 5 below) (ECF, 2023). Within the EU27, the countries with the highest coffee sales in value and volume are Germany, France, Italy, Spain, Poland & the Netherlands (ECF, 2023).

Figure 5

Largest Coffee Consumers Worldwide per Country in 2022 (ECF, 2023)



The highest consumption per capita is found in the European Union, particularly in Luxembourg, the Netherlands, and Nordic countries, with consumption ranging from 6.8 kg to 11 kg per person annually (ECF, 2023; CBI, 2021a).

Almost half of European coffee consumption is sourced from South America, mainly Brazil, followed by imports from Asia Pacific (33%), Africa (13%), and Central America (10%) (Panhuysen & de Vries, 2023).

European coffee imports are primarily concentrated in Germany, Italy, Belgium, and Spain, accounting for 80% of total green coffee imports between 2020 and 2022. Switzerland and Russia are significant non-EU importers (CBI, 2021a; ECF, 2023). One reason for the concentration of import quantities towards these EU countries over these two years is shipping costs and efficiency which have been prioritised. The main ports of Europe are in Germany, Italy, Belgium and the Netherlands (ECF, 2023).

Regarding European coffee imports, almost half of the European coffee consumption derives from coffee exported from South America, mainly from Brazil. 33% was imported from Asia pacific, especially Vietnam, 13% was imported from Africa, from Uganda especially, and 10% was imported from Central America, from Honduras for the most part (Panhuysen & de Vries, 2023).

It's important to note that the coffee market in Europe is considered saturated, with no major increases in consumption expected. However, there is a slight increase in coffee consumption, particularly in higher-quality coffee (CBI, 2021a).

Retail dynamics have shifted post-pandemic, between 2018 and 2022, with consumers showing higher price sensitivity but also a willingness to pay more for unique and convenient options (Panhuysen & de Vries, 2023). Research highlights an increasing interest of consumers in coffee origins and coffee quality and in social, environmental and economic sustainability behind the coffee chain as strong arguments that back this trend, on top of innovations in brewing systems and the development of online channels. The potential health benefits may drive coffee consumption as well (Samoggia & Reidel, 2019).

Since the global pandemic, retail dynamics have been changing. Keeping in mind that consumers may be experiencing a potentially higher price sensitivity, due to inflation caused in part by the global pandemic, the authors add on to say that consumers are willing to pay more for a uniqueness and convenience in 2022 (Hernandez et al., 2020; Panhuysen & de Vries, 2023). This has generated an increase in the single-serve coffee consumption, including capsules and Keurig k-cup capsules, as well as ready-to-drink options. 40% of US households owned a single-serve coffee brewing system in 2020 and capsules represent 40% of value retail sales in the EU27 on average (Panhuysen & de Vries, 2023). The European Coffee Federation states that coffee capsules represented 16% of the EU27 coffee market by volume in 2022. They represent much more in terms of value, being at 40% or retail value sales in 2022 (ECF, 2023). Coffee capsules consumption in Europe increased four times its size in four years (2018 – 2022) (European Bioplastics, 2023).

A report from the European Coffee Federation (2023) states that although soluble coffee presents a small share of the European Union's coffee imports compared to green coffee, it remains relevant in terms of volume, together with ground coffee. While soluble coffee is said to have been decreasing before the Coronavirus, the pandemic, with evolving consumer behaviour, generated a spark in soluble coffee consumption, reaching record levels. The Brexit and the Ukraine conflict had temporarily led to a reduction in soluble coffee imports (ECF, 2023).

In 2020, conventional coffee (non-certified or organic, see section below for detailed explanation) accounted for 70% of global consumption, indicating a limited market for sustainable options (Panhuysen & de Vries, 2023). However, there's growing consumer concern for environmental issues, driving demand for sustainable products (European Commission, 2020; Panhuysen & de Vries, 2023). It has triggered sustainability initiatives throughout the coffee lifecycle, whether it be in the cultivation or purchase stage (Nab & Maslin, 2020).

Despite increasing demand, the market share for sustainable coffee remains limited due to information asymmetry, lack of trust, transparency, and high prices (European Commission, 2020; Panhuysen & de Vries, 2023; Terlau & Hirsch, 2015). Sustainability standards such as Voluntary Sustainability Standards (VSS) have been introduced to address these barriers and promote sustainable coffee production and consumption (Martins et al., 2022). The rainforest alliance, organic certification and fair trade certification are among the most popular examples, which will be developed in this dissertation.

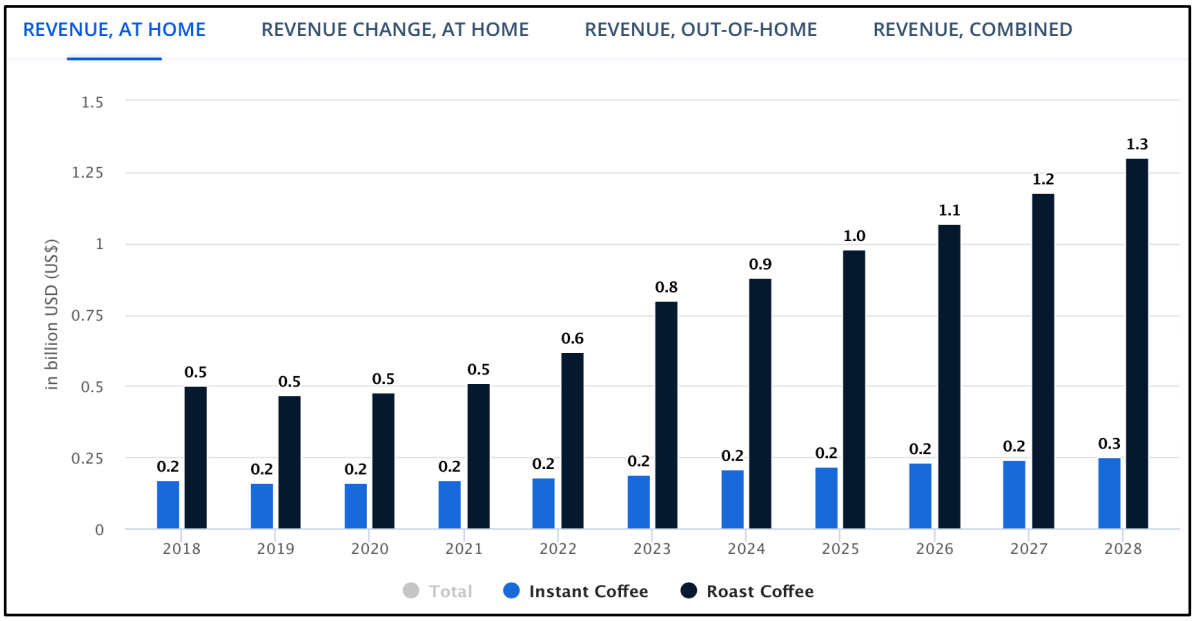
Assessment of Belgium's Coffee Market (2019-2023)

The European Coffee Federation conveyed that Belgium is currently the third largest direct importer of the EU, after Germany and Italy (ECF, 2023; CBI, 2021a). This is mainly due to the stock capacity of the countries' ports, being the continents' main and largest points of entry. Germany and Belgium are among the top countries that supply green coffee (re-export) to other members of the EU (ECF, 2023; CBI, 2021a). Belgium's port, the Port of Antwerp, has the world's largest coffee capacity of 250,000 tons at a time. The majority of Belgium's coffee imports are reexported to its neighbouring countries, mainly the Netherlands, followed by France, Germany and Spain. This number reached 77% in 2020, making Belgium the biggest re-exporter of Europe (CBI, 2021a).

In 2024, Statista's international team of analysts assessed the sales value of the Belgian home coffee market, encompassing retail coffee products such as beans, ground, and soluble, at 1.1 billion (Statista, n.d.). It has increased by 10% compared to 2023 and is expected to rise at a yearly rate of minimum 10% in the next 4 years (see figure 6 below). Please note that it is the Roast Coffee category that has been experiencing growth, in comparison with instant coffee, the former consisting of whole beans and ground coffee used in combination with coffee machines or a French Press (Statista, n.d.). Indeed, the coffee market's value has soared within the European Union, as inflation is on the rise in parallel, driving the value growth (ECF, 2023).

Figure 6

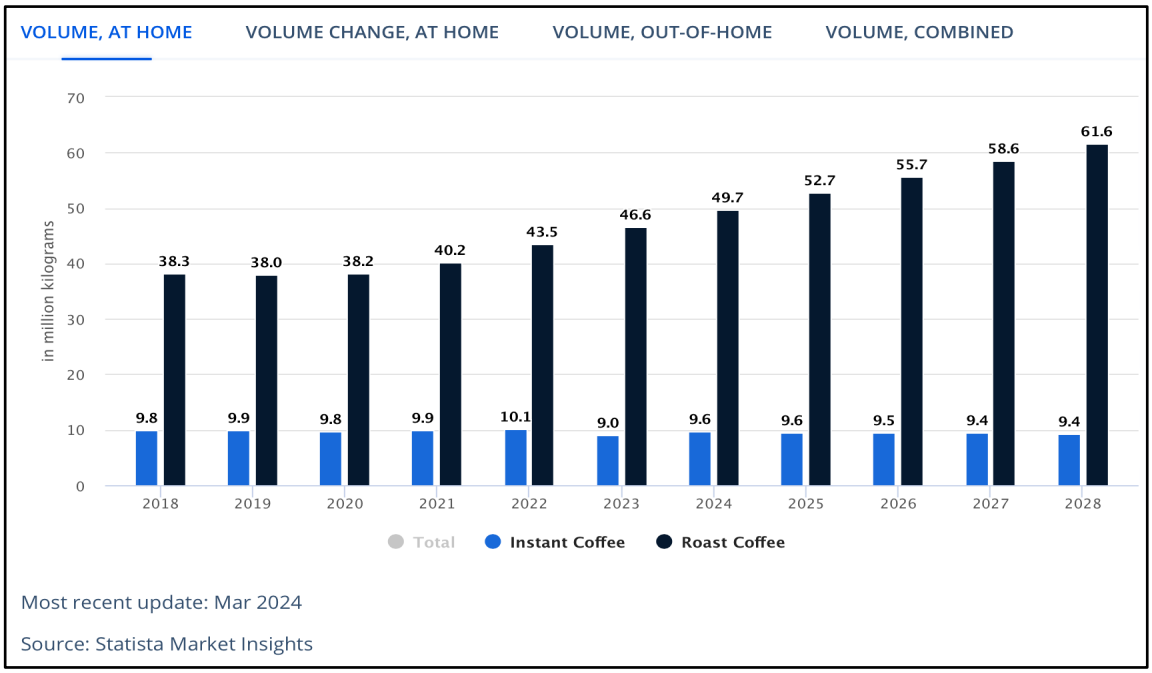
Coffee Sales Value Market Insights – Belgium 2024 (Statista, n.d.)



The sales volume of the Belgian in-home Coffee market on the other hand, has been experiencing modest growth, with its growth gradually decreasing over time, as seen on figure 7 below (Statista, n.d.; ECF, 2023). As the Centre for the Promotion of Imports from Developing Countries states, the European coffee market is saturated (CBI, 2021a). Therefore, only a slight increase in volume is expected, leaning towards stability in the long term (CBI, 2021a; ECF, 2023). The instant (soluble) coffee is expected to experience a volume decrease in the years to come (Statista, n.d.).

Figure 7

Coffee Sales in Volume - Market Insights Belgium 2024 (Statista, n.d.)



A report from 2021 suggests that the Western European coffee markets are saturated when it comes to single-use (portioned) coffee (Marinello et al., 2021). However, reports state that single-use coffee (capsules) and specialty coffee have been experiencing demand and growth in Europe, and Western Europe particularly (CBI, 2021a; CBI, 2021b; CBI, 2024). The authors expect the single-serve coffee format, which is experiencing a strong growth within Western European households, to spread to Asia, China and South Korea particularly, in the coming years as well (Marinello et al., 2021).

○ Trends on the Belgian In-Home Coffee Market

It is safe to say that amidst a saturated market, notable trends and opportunities are emerging. In Belgium, several key trends and opportunities have been identified, including: In 2024, coffee consumers are more knowledgeable and demanding (CBI, 2024). Consumers are willing to pay more for uniqueness and convenience as well (Hernandez et al., 2020; Panhuysen & de Vries, 2023). In addition, a quest for unique flavours and specialty coffee has been growing in interest in the country (Statista, n.d.). As established previously, consumption of specialty coffee and single-serve coffee methods, such as capsules, have seen an increased adoption, as convenience gains importance (CBI, 2021a; CBI, 2024). Furthermore, there is a growing demand for coffee traceability and transparency, driven by the rising interest in ethically-sourced coffee. This aligns with the increasing interest in direct trade (Statista, n.d.; CBI, 2024). Additionally, the trend towards healthy living and concerns for coffee sustainability are gaining traction, impacting consumer preferences (CBI, 2024; Mordor Intelligence, 2024). Lastly, there is a notable increase in coffee consumers' awareness of its social and environmental impact, particularly regarding sustainability labels. This may influence consumers' preferences and willingness to pay more for coffee (Fuller & Grebitus, 2023).

The value market share in terms of single-serve coffee in Belgium has been identified at 46% and 47% in 2021 and 2022. It represents almost half of the market and is increasing. Its presence on the in-home Belgian coffee market is unavoidable. As Baltic and Nordic consumers opt for more traditional coffee formats such as ground coffee and whole beans, and central and eastern countries in Europe have a capsule market share value market share below 10%, western countries in Europe showcase an opposite trend. Coffee beans are experiencing a slow growth on the market, next to the substantial increase of portioned coffee (ECF, 2023).

COVID-19 Pandemic impact

Impact on the Coffee Supply chain

The global coffee market is still recovering from the COVID-19 pandemic (ICO, 2023a). The pandemic impacted all the stages of the coffee supply chain, including on-farm operations, logistics and transport, and demand for coffee (Hernandez et al., 2020). Looking at the downstream side of the supply chain, the devaluation of local currencies in producing countries and the implemented governmental measures in warehouses and ports disrupted and delayed international shipping. The global pandemic generated an increase in trade and transaction costs. Other examples of downstream supply chain impacts are a reduced workforce, social distancing measures in warehouses and ports and landlocked countries (Hernandez et al., 2020).

Post-harvest processing took longer as well, generating delays in export. Delays inevitably affected coffee quality and in consequence their price. It is important to note that climate disruptions affected coffee cultivation as well during this time, leading to delays in the harvest season (Hernandez et al., 2020).

Studies state that stock availability and previous harvest quantities are also to be held accountable for potential decreases in export quantities. A decrease in coffee harvest was recorded as well (Hernandez et al., 2020).

Upstream, at farm level, labour supply was reduced due to sickness and social distancing measures. A large quantity of coffee is still picked by hand. The labour shortage therefore generated delays and a potential rise in wage levels (Hernandez et al., 2020). The Fairtrade (2020) Belgium Annual Report stated that access to the fields was reduced and that costs were higher due to sanitary measures required to be integrated.

Impact on Demand for Coffee

An increase in the demand for coffee was detected at the start of the COVID-19 pandemic, due to panic-buying and stock-piling. Out-of-home coffee consumption saw itself partially replaced by in-home coffee consumption. This global pandemic generated a worldwide economic downturn, affecting coffee consumption patterns as well. While unemployment, inflation and interest rates rose, so did price sensitivity and a greater lookout for more economical products (ICO, 2023a; Hernandez et al., 2020). The authors of the ICO report state that this could lead to a decrease in specialty coffee consumption and in certified coffee consumption (ICO, 2023a). In parallel, the authors go on to state that demand for coffee tends to follow inelasticity, although consumers are adjusting their purchasing behaviour based on their savings and income over time (Hernandez et al., 2020).

Impact on lifestyle-related behaviours

The Coronavirus also affected us psychologically. The Fairtrade Organisation states that this period made consumers more vulnerable and aware of the importance of treating the ones responsible for creating the food we eat more fairly (Fairtrade, 2020). Belgian consumers acknowledged the importance of solidarity in a survey conducted by Fairtrade Belgium (2020). The Coronavirus generated a change in attitudes and behaviours among consumers. The pandemic generated much stress and pressure, whether it be personal or professional, impacting coffee consumption patterns. More consumers drank coffee due to stress and anxiety. In addition to the physiological needs that coffee responds to, its beneficial properties can help improve moods and attentiveness. The latter has been identified as potential reasons for the coffee consumption increase as well (Pintado et al., 2023; Bakaloudi et al., 2022).

Coffee Basics

Types of Coffee Beans – Arabica and Robusta Variants

The name "Coffea" was introduced by a Swedish botanist in 1737, known for standardising the process of giving genus and species names (Vega, 2008). Coffea, the plant, contains over 100 species. It is the seed within the cherry fruit of that coffee plant, that we know as coffee beans (Harvard, 2020). Of these species, 2 are commercially traded; Coffea arabica, known as arabica coffee, and Coffea Canephora, known as Robusta coffee today (Vega, 2008; Everett, 2023; Nab & Maslin, 2020). This is because only they possess the self-pollinating trait required to expand cultivation. Both have different cultivars, which are generally named after their place of origin (Vega, 2008). Arabica coffee currently represents around 70% of the total grown coffee, with Robusta coffee responsible for the other 30% (Nab & Maslin, 2020).

Coffea Arabica, originally from Yemen and first cultivated in Ethiopia, now primarily grows in southeastern Sudan, northern Kenya, and the Ethiopian highlands, regions where coffee is believed to have been discovered (Vega, 2008). Arabica coffee possesses mild and aromatic notes, with higher bursts of flavour (Vega, 2008; IDB, 2019). It asks for a certain level of humidity, shade and mild temperatures ranging from 16 to 24 degrees Celsius on average (Harvard, 2020). In terms of production, 87 million 60-kilogram bags of arabica coffee in 2022-2023.

Robusta coffee, which represents 30% of the world's production as stated earlier (Vega, 2008; IDB, 2019; Nab & Maslin, 2020), originates from Brazil, central and southern Africa, and Southeast Asia (Everett, 2023). This variant contains a higher caffeine content. Regarding its taste palette, Robusta offers higher bitterness and lower levels in acidity to our taste buds, as well as more body and earthiness (Miyanari, 2008; (Uganda Coffee Development Authority, 2019). This smaller coffee bean is more resistant to higher altitudes and harsher weather conditions, whether it be more heat, humidity or rainfall (Ridder, 2024; Goldemberg et al., 2015). Originating from the evergreen forests and gallery forests of western and sub-Saharan Africa, it is able to survive temperatures between 18 and 36 degrees Celsius and withstand diseases better, making it, in essence, less expensive and easier to cultivate (Harvard, 2020; Ridder, 2024). However, it's essential to keep in mind that arabica coffee still remains sensitive to changes in weather conditions and diseases, even though its resistance to leaf rust, coffee berry disease nematodes and stem borer is higher (Vega et al., 2006).

Types of Post-Harvest Treatment Methods – Processing Methods

There are many ways to separate the pulp of the coffee cherry from the green coffee bean (to extract the coffee bean). Two are most common. The washed method includes washing the cherries to remove the pulp and then letting the green coffee bean dry for a month. The unwashed method includes removing the peel mechanically and letting the coffee cherry dry naturally in the sun for typically a month, generating a fermentation process and offering more body and exotic flavours and sweetness to the coffee bean with less acidity (Datov, 2019; Widodo et al., 2023).

Types of Roasts – Light, Medium and Dark

Roasting coffee at high temperatures triggers a chemical reaction that releases the distinct aromas and flavours of the green coffee bean (National Coffee Association, n.d.-b). The darker the roast, the darker the colour, the higher the levels of bitterness and roast flavour, and the lower the acidity of the coffee bean. Studies show that the content of caffeine is higher within lighter roasts (Harvard, 2020). The quality, aromas and flavours therefore depend on the coffee variety (Arabica or Robusta), country and region of origin (climate), coffee roast, and coffee grind (National Coffee Association, n.d.-b).

Types of Grinds – Texture & Taste

Once the roasted beans are cooled and rested, they are ground before brewing. Note that over-or-under extraction will affect the taste of your coffee, from being too bitter to tasting flat if not ground enough (National Coffee Association, n.d.-b). Fine grinds are chosen for deeply-flavoured, highly-bitter coffees such as espresso. Medium grinds are commonly used for drip coffee. Coarser grinds are more common for coffee presses (Harvard, 2020).

Types of Coffee Formats

Coffee can be purchased in a variety of formats for consumption. These include ground coffee, whole beans, instant coffee, coffee capsules and ready-to-drink coffee (Carrefour, n.d.; Fairtrade Belgium, 2020).

Types of Coffee (Brewing) Preparation Methods

The method depends on how the water is being introduced to the coffee. Four brewing methods have been identified by a study; boiling water method – manual - (cowboy brewing method), pressure brewing method (moka pot), gravity brewing method (dripping and filtration brewing methods), pressurised percolation (espresso capsules) and steeping method (French Press) (Ohio State University, n.d.).

The main types of coffee preparation methods which will be developed within this dissertation are the Moka pot (with stove), the French press (with boiler), the manual pour over drip coffee method, the cup for instant coffee, the electric drip-filter coffee machine, the single-serve coffee machine and the automatic espresso machine (Humbert et al., 2009; Phrommarat, 2019; Cibelli et al., 2021).

Please note that the manual pour over drip coffee method is a hands-on approach. It requires hot water to be poured in a particular conical paper filter, sitting on a dripper. Various dripper models exist on the market. The V60, the Chemex and the Kalita Wave have become cult classics and the most common in the world of coffee. The passage of the hot water on the coffee grounds found in the paper

filter allows for a unique extraction of coffee flavours, depth and oils and represents a type of coffee art where keen attention and precision is required to generate consistency (Kushalappa, 2023; Konecny & Vassallo, 2024; (Santanatoglia et al., 2023). The aeropress, a modern innovation created in 2005, works with pressure where the French press relies on immersion (Santanatoglia et al., 2023).

Coffee Grading - Cupping Scores

The Specialty Coffee Association of America (SCAA) introduced the cupping score. It dates back to 1984. This made grading coffee accessible for even the inexperienced and lacking practice, as it is based on science. The cupping score allows for a classification between specialty coffee, the highest-grading coffee, and others (Lingle & Menon, 2017).

A coffee grading methodology and the cupping score (Q-score) methodology is available on the coffee market to distinguish a coffee's uniqueness and quality and most importantly, to classify for export (Lingle & Menon, 2017; SCA, n.d.). However, it is important to note that the global classification for coffee is fragmented. No universal classification currently exists (Datov, 2019). Cupping scores and grading act as a reference point for price determination (SCA, n.d.).

Coffee beans can be graded manually, which is very labour-intensive, or technologically with the help of image processing and an algorithm (Kuruppuarachchi & Amaratunga, 2023). Countries have developed their own standards and grading charts as well, which represent the minimum export requirements (SCA, n.d.). However, grading is based on attributes, which the International Coffee Association has presented a few of: altitude, origin, botanical variety, processing method (washed or unwashed), bean size, presence of defects, cup quality (taste characteristics), roast and bean density (Datov, 2019). Higher altitudes reflect improved flavours (SCA, n.d.). The bean size, the presence of defects and the cupping score (SCA cupping protocol) stand out as the most important characteristics (Trabocca, 2020). These three classifications allow for communication with coffee importers but are, however, open to interpretation and thus not 100 % reliable (Datov, 2019).

The SCA cupping protocol allows for a grading of flavour attributes, aromas, body, sweetness and balance that are present within the coffee bean. The higher the cupping score, the higher the quality and price of the coffee bean.

International Coffee Price Volatility

Studies state that the price of coffee, traded on various stock exchanges, is excessively volatile, experiencing multiple peaks over time (Aduteye et al., 2023; Hernandez et al., 2020). The fluctuation of coffee prices is due to a multitude of factors such as supply and demand, environmental conditions, economic conditions, trade policies, exchange rates, and, in recent years, the coronavirus, which seems to have aggravated poverty, food insecurity, and price volatility due to impacts felt on the supply and demand dynamics (Aduteye et al., 2023; Hernandez et al., 2020). Commodity-dependent developing countries (CDDCs) find themselves increasingly vulnerable to high price fluctuations given that they live on significantly lower incomes (Maurice & Davis, 2011).

Arabica and Robusta coffees are traditionally traded on different markets, with the Arabica variant mainly present on the New York Stock Exchange and Robusta coffees traded on the London Stock Exchange. Coffee is negotiated based on futures prices or current market prices (spot prices) (see

Figure 8). The coffee commodity market is mainly based on purchasing coffee that does not yet exist. Purchasing specific amounts of future coffee at a fixed price when the contract ends sums up a futures contract (Panhuysen & De Vries, 2023). As noticeable in Figure 7 below, Robusta coffee prices are lower than Arabica coffee prices, for reasons explained in the Coffee Basics section above.

Health Properties of Coffee

A large basket of evidence points towards coffee beans offering health virtues to its consumers drinking between three and five cups a day (400 milligrams of caffeine a day on average) (Samoggia & Reidel, 2019; Harvard, 2020). Although characterised as inconclusive, studies have suggested a positive effect of coffee on noncommunicable diseases NCDs, consequentially supporting the World Health Organization's goal to reduce deaths generated by NCDs by 25% by 2025 (Samoggia & Reidel, 2019). Research has shown beneficial effects and a reduction in risk of developing these diseases upon consumption of 3-4 cups a day. Furthermore, the bean was identified as the beverage containing the highest content of biophenols (Samoggia & Reidel, 2019). Also found in olives, this botanical compound has caught scientists' attention as its antioxidative potential reflects virtues towards the preservation of food and especially, the maintenance of human health (Obied, 2013). They may act as an antidepressant for some people as well (Harvard, 2020).

Coffee beans possess biochemical properties and over 100 bioactive compounds. They offer more antioxidants than fruits, vegetables and tea respectively, substantially contributing to daily intake levels. Roasted coffee provides anti-inflammatory and antibrotic effects on top of the antioxidant properties. It contains high amounts of vitamin B3 and magnesium and contains potassium (Samoggia & Reidel, 2019). Vitamin B2, called riboflavin, is also present (Harvard, 2020).

Consumer knowledge regarding health benefits of coffee remains limited and unclear. Different perspectives persist as individuals seem confused about whether coffee bean health effects are negative or positive. A study conducted in 2019 suggests that 49% of European coffee consumers deemed coffee to be detrimental to their health. The decision to avoid coffee consumption is influenced, in part, by the insomnia or anxiety it may generate as it agitates the motor zone or the cerebral cortex and the central nervous system (Samoggia & Reidel, 2019; Lone et al., 2023). Despite this, a small segment of the population does however see the potential health benefits of coffee. On top of those previously enumerated, authors Samoggia and Reidel (2019) noted that coffee is consumed for its therapeutic and energetic effects. Coffee has shown to enhance alertness, concentration and moods (Harvard, 2020). Indeed, according to a survey encompassing 263.923 participants, it appeared that individuals drinking 400mg of caffeine a day or more were 10% less likely to experience depression. A substantial difference in suicide risks was also identified in men and women from the United States. Individuals consuming 3-5 cups of coffee a day are reported to have a 50% lower chance of experiencing depression (Harvard, 2020).

To conclude this section, potential for improving consumers' perceptions on coffee health benefits is present. Coffee consumers in our current decade are emanating curiosity and are becoming increasingly engaged in consuming coffee associated with beneficial health claims (Samoggia & Reidel, 2019).

Single Serve Coffee versus Specialty Coffee Capsules

Coffee Waves

To introduce the distinction between mainstream and specialty coffee, we found it beneficial to examine the different coffee waves that surfaced over the years in Europe. The waves are characteristic of the level of consumer knowledge and preference surrounding coffee over the years. This affects the value granted to coffee attributes over time (ICO, 2023b; CBI, 2024).

The first wave goes back to the popularisation of coffee consumption in the 20th century (CBA, 2024). Instant coffee and vacuumed packaging were the output of the first wave's innovations. The origins of the beans and brewing methods were not a purchase criterion. Mainstream coffee was sought out by consumers as quantity was more valued than quality or coffee origins at the time (ICO, 2023b; CBI, 2024). The second wave, present between 1995 and 2005, is characteristic of the introduction of American coffee chains such as Starbucks, introducing coffee experiences and shifting away from mass production. New terms like espresso and latte emerged. Coffee origins as a consumption criterion were starting to be introduced. The third wave of coffee, 2005-2010, placed greater emphasis on the coffee beans and each step within the supply chain, particularly highlighting the different roasting techniques and flavour profiles of the coffee beans, looking out for artisan coffee. Single origin beans were marketed, and latte art was introduced (ICO, 2023b). Here, specialty coffee started to become sought out after (CBI, 2024). Transparency and sustainability surrounding coffee sourcing was starting to become a subject of conversation. The fourth wave, 2010-2015, regards the subject of quality coffee and the science behind it. A more accurate understanding of the characteristics of coffee and flavours was looked out for. The fifth wave, 2015-2020, represents a shift towards coffee of excellence and the integration of technology and sustainability within coffee. The sixth wave, since 2020, surrounds specialty coffee, where roasters are the star. A true understanding of transparency and sustainability and the growing awareness of consumers is at the core (ICO, 2023b; CBI, 2024). Research suggests that the 4th, 5th and 6th waves are more rippling characteristics than waves. Some market players (CBI, 2024) have incorporated them.

Single-Serve Coffee

Definition

Single-serve coffee, also known as single-use coffee, portioned coffee, single-serving capsules and coffee capsules, falls under the roast coffee market category (not instant coffee), within the broader Hot Drinks category (Statista, n.d.). It is a coffee format made up of a short coned-shaped sealed shell, filled with 5 to 7 grams of ground coffee, which is consumed with a coffee machine (Marinello et al., 2021). The material of the capsule shell can be made of plastic and aluminium, biodegradable materials (bioplastics and paper- based), pure aluminium, polylaminate or tinplate (Marinello et al., 2021; Pinto et al., 2024).

History & Growing Popularity

Capsules originally entered the market through Nespresso® invented by M. Eric Favre in 1975, and commercialised in 1991, as stated by the World Intellectual Property Organization (2010). As head of the packaging department at the company during that period, M. Favre revolutionised the market with

this technology, allowing consumers to prepare high-quality coffee themselves (WIPO, 2010). The market has expanded widely since then (Thoden van Velzen et al., 2023).

Single-serve coffee is renowned for its convenience of use, its coffee extraction benefits and its range of available flavours (Pinto et al., 2024). Researchers state that single-serve coffee reflects a new consumer philosophy, encompassing instant gratification, optimization, comfort and convenience, which is what coffee capsules provide (Marinello et al., 2021). Coffee capsules integrate growing consumer trends, which coffee capsules have integrated into their way of consumption: individualisation, practicality, nutrition, naturalness and sustainability (Marinello et al., 2021).

Trends evolve over time. Especially when accompanied by major events such as a health crisis. The most common capsules found on the coffee market today are plastic and aluminium capsules. A resistance towards these capsule materials is increasingly growing, due to their end-of-life phase and recycling process. While single-serve coffee is experiencing a growing demand in Belgium, in contrast to bulk coffee, its recycling options remain meagre (Marinello et al., 2021; CBI, 2021b).

○ Specialty Coffee Capsules

As demand for quality coffee is on the rise and as the single-serve coffee market is continuously growing, so are specialty coffee capsules (Marinello et al., 2021; CBI, 2021a; CBI, 2021b). This is a means to provide quality single-serve coffee, which is what consumers are asking for. Coffee quality can go hand in hand with sustainability according to Nespresso (2015). Let's determine whether this is the case.

History & Growing Popularity

Specialty coffee has made its way since the 20th century. It grew as the appreciation for coffee and consumer knowledge surrounding it witnessed a rise (Urwin et al., 2019). Specialty coffee, of the Arabica and Robusta variant, has been increasingly growing over the years, with Europe and the United States being its biggest markets (CBI, 2021a). It is seen as an opportunity. Consumption has increased by 140% between 2010 and 2018 in Western Europe alone. Interest in quality coffee is also strong. It is said that European coffee consumers are more demanding on quality. The European specialty coffee demand experienced a reduction in 2020 due to implemented pandemic measures, which resulted in closure or limitation of out of home coffee consumption venues. The influx of clients saw a decline (CBI, 2021a).

Definition

The Specialty Coffee Association has noted that specialty coffee is no easy term to define. This coffee is distinct and unique (special). It can technically be defined as not containing any category 1 defects and not containing more than five category 5 defects. Specialty coffee has been defined as the highest-quality coffee, with an excellent flavour profile, containing social and sustainable initiatives surrounding its trade and cultivation (CBI, 2024).

To better understand the term, the association has defined coffee as a "collection of attributes" (Giuliano et al., 2021, p. 8). The report suggests that the series of attributes can be measured with different methods, revealing the impact of coffee genetics, roasting methods and brewing techniques, on flavour profile and coffee quality (see figure 8 below) (Giuliano et al., 2021).

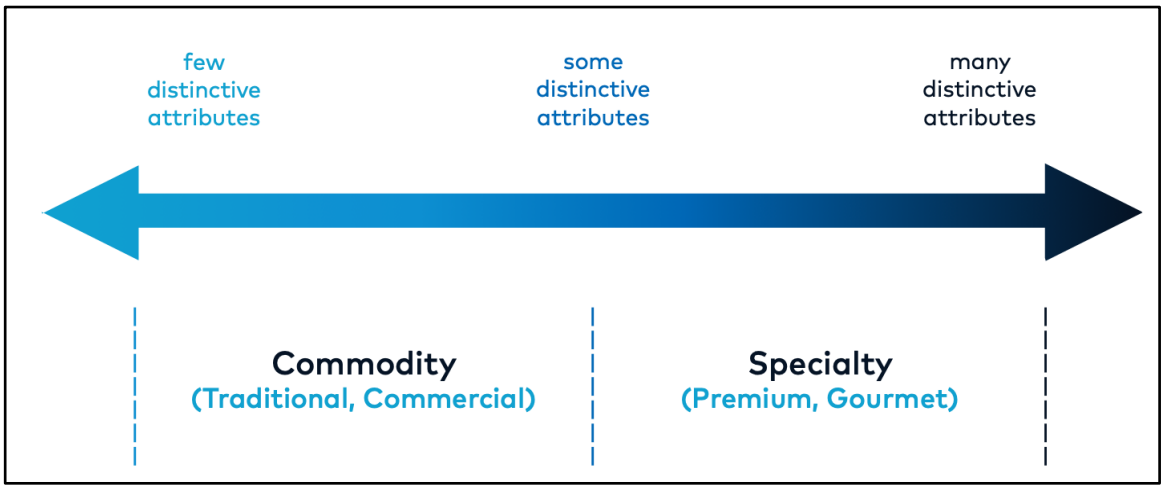
Methods used to measure attributes vary from projective mapping used for chocolate, to sensory descriptive analysis with the coffee taster's flavour wheel, created in collaboration with the SCA, World Coffee Research and the University of California Davis (see appendix 2). A psychological and consumer research approach describing consumer preferences can be used too. The intrinsic and extrinsic attribute method has been defined here as well, as being easier to use, reflecting traceability and transparency. It defines attributes about the coffee bean (intrinsic) and about the coffee's origins (extrinsic) (see appendix 3). Intrinsic, or material attributes, encompass the roast colour, the absence of defects, the cupping score, the physical appearance of the bean, its size and the described profile. Extrinsic attributes take its origin, farm name, brand name and certification into account (Giuliano et al., 2021).

The defined attributes are then valued thanks to economic tools such as coffee scores, coffee prices and certifications, to determine its specialness. Distinctive attributes determine the value of coffee in the market. The antonym of specialty coffee can be defined as standard, or commodity in figure 9 below. This is where mainstream coffee finds its way. It has few attributes that make it stand out and therefore holds less value compared to specialty coffee (CBI, 2024; Giuliano et al., 2021).

Cupping scores and certifications have primarily been used to define specialty coffee. The score defining the quality coffee and thus, its specialty, typically ranges between 80 and 100 points out of 100 (Giuliano et al., 2021). Specialty coffee can be characterised by certifications as well (CBI, 2024).

Figure 8

The specialty/commodity relationship as a continuum



Within the specialty coffee market, niche categories surfaced (CBI, 2024).

Signature blend Coffee Signature blends made their way to the market, sold as coffee beans coming from different origins, that are carefully selected to provide a unique flavour (CBI, 2024).

Single Origin Coffee Coffees emanating from one origin only, due to their high quality and unique taste, make their way on the market as well (CBI, 2024).

Single Farm or Estate Coffee Same goes for coffees cultivated on one single farm (CBI, 2024).

Micro Lots and Nano Lots Micro and nano lots have to do with the quality of a certain coffee bean sold and the direct trade between the producer and smaller buyer that it allows. These beans have been characterised as extremely high-quality and are therefore produced in a smaller quantity and sold at high prices. Micro lots represent 10 to 75 bags on average, compared to an average of 5 60-kilogram bags for an even more exclusive coffee sold in nano lots (CBI, 2024).

Infused Coffees Coffees may be infused, before or after the roasting process, to incorporate flavours and body to the coffee beans. It is usually done while coffee beans are still green. Processing methods are being changed up to allow for different flavours to incorporate the coffee bean. Fermentation in pressurised tanks is one of them, where fruit pulp or aged beans may be infused (CBI, 2024).

Certified Coffee

Definition

As one of the world's most traded commodities worldwide, coffee has had the opportunity of adhering to sustainability standards through certifications in the last three decades (Ssebunya et al., 2019; Jena & Grote, 2022). "Coffee has become a "flagship program" that aims at promoting several Sustainable Development Goals (SDGs) such as decreasing poverty (SDG 1) or sustainable production and consumption (SDG 12)." (Jena & Grote, 2022, para. 1).

Conventional versus Certified Coffee

Conventional coffee has been characterised as non-organic. These coffee cultivators do not follow procedures for fairtrade or organic practices. It has been stated that organic coffee is healthier for the earth and the producers, and not much different for coffee consumers as chemicals are burned off during the roasting process (Wandering Bear Coffee, 2023).

Organic coffee, certified or labelled in other words, is defined by coffee being cultivated with the absence of chemical-based substances, whether it be pesticides, herbicides or fungicides. In addition, cultivators integrate sustainable practices such as conserving raw materials to a maximum and introducing renewable resources as much as possible.

Fair Trade coffee may be organic. However, the coffee bean farm and community is central to the certification. Equity within the coffee cultivation and its supply chain in various fields such as working conditions, fair wages and environment protection practices are integrated.

Certification schemes - Their Importance in Sustainable Coffee Production

To indicate sustainability performance, it is up to consumers to look for sustainability cues (Majer et al., 2022). The main goal of adding standards to coffee is to provide consumers with higher transparency of information regarding sustainable product attributes, for a higher product price (Majer et al., 2022; Jena & Grote, 2022). This could touch upon coffee attributes, coffee cultivation, trading or production (Majer et al., 2022). Producers receive a higher price for coffee and better socio-economic outcomes in theory. While certain scientific reports do confirm the improved welfare of producers when comparing certified and non-certified coffee, other reports have identified no difference in welfare due to the increased production costs and lower productivity that come with the higher price received (Jena & Grote, 2022). Keep in mind that certifications are a means of materialising

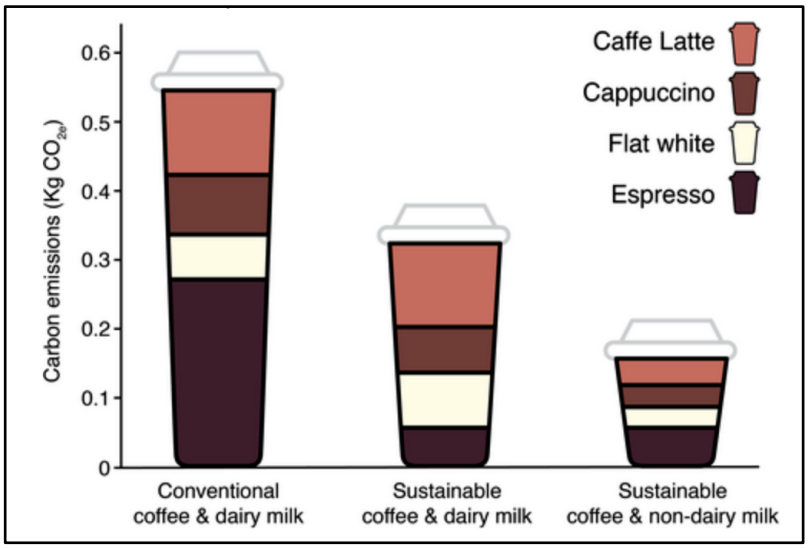
a company's sustainable commitments as well, whether it be environmental or social (CSR – corporate social responsibilities) (Majer et al., 2022). Let's note that certifications have indirect benefits for farmers as well. The number of health issue cases has seen a reduction as the quantity of pesticides used is following a downwards trend (Jena & Grote, 2022).

Recent research has shown that both the fairtrade and organic certifications lead to a more positive environmental impact than conventional coffee. This is evident through reduced water use during the cultivation stage and a lower carbon footprint, especially during transportation of materials (Agguirre et al., 2024).

A case-in-point example of concrete positive environmental impacts of sustainable certifications can be observed in the difference in Co2 emissions of conventional and organic coffee, as illustrated in figure 9 below. Research indicates that conventional coffee production emits between 260 and 670 grams of Co2 during cherry picking, while organic coffee emits between 120 and 520 grams during this stage (Noponen et al., 2012). In another study, Co2 emission levels of the coffee lifecycle as a whole, or the carbon footprint, for both conventional and sustainable arabica coffee were examined. Production countries are Brazil and Vietnam in this study, with the United Kingdom as the consumption destination. The findings revealed that conventional coffee emits 720 grams of Co2, where sustainable coffee emits 130 grams. This represents a substantial difference in carbon emissions of 77%, noticeable on figure 9 below. The main reasons for this gap are the transport of coffee beans with cargo ships instead of freight planes and the optimal utilisation of agrochemicals. The utilisation of renewable energy, efficient use of energy and water and reduced packaging are contributing factors as well (Nab & Maslin, 2020).

Figure 9

Co2 emissions of conventional and sustainable arabica coffee in Kg (Nab & Maslin, 2020)



- Certification Schemes - their Controversy in Sustainable Coffee Production

Sustainability standards are growing in popularity and in contradictions (Majer et al., 2022; Jena & Grote, 2022). A recent report stated that certifications only provide a minor income increase. A debate is present on the benefitting party from such certifications. In general, fair trade and organic coffee

standards have proven to reduce poverty and increase living standards and revenues. However, reports suggest that such certification schemes would benefit wealthier farmers more in comparison to smaller farmers (Jena & Grote, 2022; Dragusanu & Nunn, 2020).

Voluntary Sustainability Standards (VSS)

Voluntary Sustainability Standards, also called Sustainability certificates, eco-labels or private certifications, provide requirements to producers, traders, manufacturers, retailers or service providers (Marx et al., 2022). The United Nations Conference Trade and Development (UNCTAD) defines the Voluntary Sustainability Standards as economic, environmental and social sustainability initiatives and requirements allocated to products, from bean to cup, upstream and downstream along the coffee value chain. Certifications are used to signal its implementation (UNCTAD, 2023).

Commercial sustainability schemes are based on these standards, as concerns for the environment are on the rise. The VSS have generated increased research and influenced policy-making (Martins et al., 2022).

VSS have been implemented with the goal to increase transparency and trust in sustainable products as well as increase sustainable consumer behaviour (Martins et al., 2022). Well known examples of such standards are the rainforest alliance, the Fairtrade certification or the Organic certification (Panhuysen & de Vries, 2023).

Over the years, VSS have successfully led to an increase in certified coffee. The market share for all of the latter have witnessed a rise in Belgium, between 2017 and 2021, except for the 4C certification which experienced a decline. Please note that out of all the coffee produced between 2020 and 2022, 55% of it was certified. However, due to lack of real demand for certified coffee, 74% of this sustainable coffee was sold as conventional coffee, generating a profit reduction for producers. Thus, motivation to produce such coffee is being challenged. Recognition and support for sustainable coffee as well as proper marketing must be ensured (Panhuysen & de Vries, 2023).

Certifications

Existing certifications are: Fair trade, Organic, Rainforest Alliance (UTZ Certified), Global GAP, the Common Code for the Coffee Community (4C), Nespresso AAA and Starbucks C.A.F.E. practices.

Sustainability labels and certifications are increasingly important in purchasing decision factors for Belgian coffee consumers. This is due to the increasing demand for traceability, coffee quality and sustainability by the consumers (CBI, 2021c).

Rainforest Alliance / UTZ Certification

This certification works toward sustainable farming and improving farmers' lives, all the while protecting the environment. The rainforest alliance allows farmers to discover and use better farming methods, allowing for more and better crops. Audits occur independently from the companies (Rainforest Alliance, 2022).

The UTZ certification, an entity within the Rainforest alliance, joined the latter, running in parallel together, in 2018, making way for the new 2020 Certification Program of Rainforest alliance. "Utz" comes from Guatemalan, Mayan, meaning "good". Utz Kapeh, meaning "good coffee", made the day

in 2002 when a Guatemalan farmer and a Dutch grinder came together and created this certification body. Starting out with coffee, the company grew to integrate cocoa, tea and hazelnuts as well, changing its name from UTZ Coffee to UTZ Certified (Rainforest Alliance, 2022).

The rainforest alliance certification is the dominant certification in Belgian supermarkets. Lidl, Aldi and Delhaize range coffees, and the Colruyt Graindor range are rainforest certified (CBI, 2021c).

Fairtrade Certification

Fairtrade certification aims to reduce poverty and promote gender-inclusivity. It offers a certain level of labour standards and offers minimum prices so as to provide a baseline revenue, as prices of this commodity are volatile and at times very low (Jena & Grote, 2022). The overall goal is to improve the socioeconomic status of farmers in developing countries (Dragusanu & Nunn, 2020). Please note prices of fairtrade coffee are regulated (Jena & Grote, 2022). The fairtrade certification is relevant for coffee and other products such as bananas, cocoa, cotton, flowers and sugar cane (Fairtrade Belgium, 2021).

The Fairtrade certification was revised in 2021, in accordance with the updated EUHREDD regulation regarding human rights and environmental due diligence. It is now said to be more rigorous than in the past (Fairtrade Belgium, 2021).

The fairtrade coffee market has been growing rapidly. This growth has been generated by the demand for better social standards by Western Countries, Belgium included (Dragusanu & Nunn, 2020). According to the Fairtrade annual report of 2021, the portion of Belgian consumers buying at least one fairtrade product per year is increasing. The graph below illustrates this trend. In 2021, this penetration rate reached 88%, which was 5% higher than in 2020. In 2019, the fairtrade products portfolio comprised over 100 brands and a total of almost 600 products in Belgium (Fairtrade Belgium, 2021).

Figure 10

Penetration of Fairtrade Products in Belgian households 2013-2021 (Fairtrade Belgium, 2021)

Research defines the Fairtrade coffee segment as a niche market in Belgium (CBI, 2021c). Indeed, although expanding gradually, its market share reached a meagre 3.1% of total retail coffee sales in 2020, growing by 0.7% in one year (Fairtrade Belgium, 2021).

Fairtrade coffee can be found in all coffee formats, be it ground coffee, whole beans, instant coffee or capsules and pads. Please refer to figure 11 below, to observe the very meagre piece of the pie that capsules currently represent in terms of fairtrade coffee sold in Belgium (Fairtrade Belgium, 2020).

Research published that price elasticity is not the same for higher-priced fairtrade coffee, lower-priced fairtrade coffee and conventional coffee. Demand for higher-priced fairtrade coffee was less impacted by a price increase (less price elastic), compared to lower-priced fairtrade coffee (more price elastic). The authors concluded by making a connection between price elasticity and product loyalty, asserting that lower elasticity products align with higher loyalty. Thus, high-priced sustainable coffees generate allow for more loyal consumers (Lee & Bateman, 2021).

Organic Certification

The organic certification is known for its strict regards in terms of the environmental and health responsibilities (Jena & Grote, 2022). This certification focuses its efforts on growing crops in a sustainable manner, including banning synthetic and chemical inputs, such as fertilisers and pesticides for coffee, conserving resources and assuring ecological balance (Lee & Bateman, 2021). Coffee yields are lower in the organic sector and higher labour input is required. Prices of organic-certified coffee are unregulated, unlike fairtrade coffee. Prices are set following negotiations between the buyer and the seller (Jena & Grote, 2022).

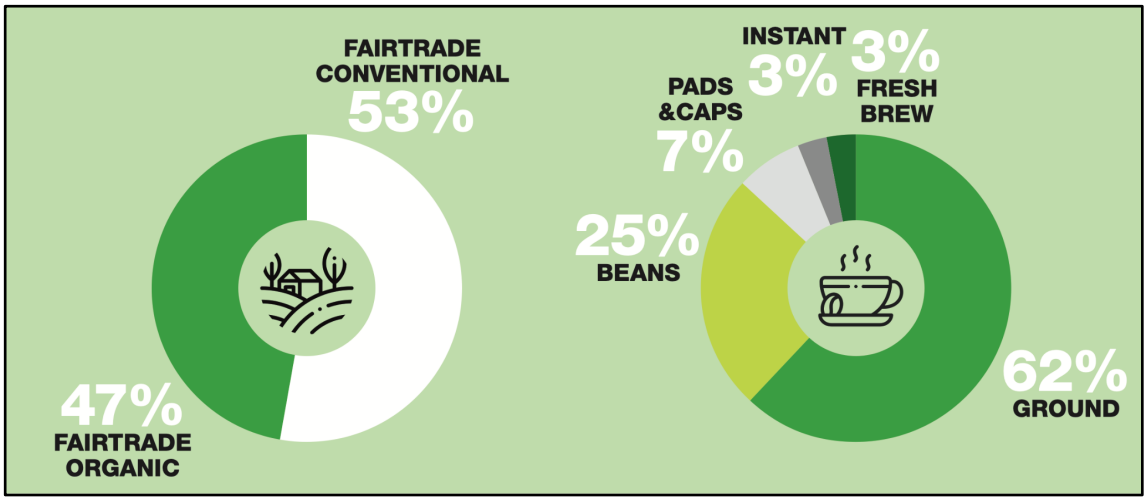
The organic certification is available across more products in the retail coffee market than the fairtrade certification is, representing more than 50% of coffee products in supermarkets. Research published that demand for such organic coffee products is still on the rise (CBI, 2021c; Lee & Bateman, 2021).

Double Certification (Fairtrade-Organic)

The organic and fairtrade certifications can be found separately or together to indicate the economic, environmental and social sustainability of products (Agguirre et al., 2024). As observed in the figure below, out of the total sold fairtrade coffee, a little more than half is labelled fairtrade and a little below half is labelled both fairtrade and organic. The presence of this certification is growing (Fairtrade Belgium, 2020). Please note that although the implementation of fairtrade and organic certification on products is increasing, their independent and combined market share remain meagre, as established above (Fairtrade Belgium, 2021; Lee & Bateman, 2021).

Figure 11

2020 Fairtrade Coffee Sales Distribution in Belgium (Fairtrade Belgium, 2020)



A study shared that demand for fairtrade coffee is significantly higher than it is for conventional coffee (Dragusanu & Nunn, 2020). Research declares the presence of a gap, called the "intention-action" gap, identifying the difference between market demand and real demand. Research further states the limits of survey findings through this data gap. Indeed, a survey does not have the ability to comb through desired or biassed responses and reality-reflective responses (Lee & Bateman, 2021).

AAA Certification

The AAA sustainable quality program incorporates the maximised use of renewable energy, the minimised use of pesticides and fertilisers and responsible management across the coffee life cycle (Quantis, 2019). It was launched by Nespresso in 2003, in partnership with a non-governmental organisation called the Rainforest alliance. Changes are implemented on farm-level, incorporating social, environmental and economic concepts to produce the highest quality coffee (Nespresso, n.d.). A CRECE, Centro de Estudios Regionales de Cafeteros y Empresariales, study was conducted on Nespresso's AAA certified coffee, which aims to analyse how and if these standards generate social, environmental and economic results (CRECE, n.d.). Based on the study, economic output increased by 42%, environmental values increased by 52% and the social impact increased by 23% (CRECE, n.d.; Nespresso, n.d.).

More than 80% of the Nespresso coffee is sourced from these AAA certified farms (Nespresso, n.d.).

C.A.F.E Practices

C.A.F.E. practices stand for Coffee and Farmer Equity practices. Starbucks launched these practices in 2004, with the support of Conservation International. It represents one of the coffee industry's first set of ethical sourcing standards based on four pillars: Economic transparency, social responsibility, environmental leadership and quality. These practices allow for ethically sourced coffee, positively impacting the farmers' lives as well as their communities, through transparent and sustainable coffee practices (Starbucks, 2020).

Please note that these practices are not a one-time certification. It is a verification program requiring continuous verification in order to continuously do better and ensure a long-term supply of high-quality coffee (Starbucks, 2020).

Environmental Responsibility

Environmental responsibility has been defined by the Cambridge dictionary as “the duty that a company has to operate in a way that protects the environment (Cambridge Dictionary, n.d.).

o Corporate Social Responsibility

Corporation Social Responsibility, or CSR, is gaining importance and is increasingly being integrated as a company’s internal framework (Stobierski, 2021). This is the case in Belgium as well (Belgian Federal Government, 2024). Business leaders have come to realise that profitability is not the sole goal that should be worked towards (Stobierski, 2021). They are willing to work towards a responsible way of doing business which includes doing what’s best for third parties, the local community, society at large and the environment (Stobierski, 2021; Shapsugova, 2023). Social and environmental responsibilities are integrated into this model, applied by companies willing to take responsibility towards its society. Examples of such companies carrying such certifications are B-Corporation companies, Social Purpose Corporations (SPCs) and Low-Profit Limited Liability Companies (L3Cs) (Stobierski, 2021).

To generate CSR, companies will implement a form of self-regulation, through initiatives, strategies, goals and reports, to allow them to impact the world positively. Results can be reflected through the Triple Bottom Line concept, integrating the social and environmental impact, sustainability and profitability: Planet, People, Profit – the three Ps.

One can divide CSR into four forms of responsibility: Environmental responsibility, Ethical Responsibility, Philanthropic Responsibility and Economic Responsibility.

Environmental responsibility is one of the most common forms of CSR. It’s about Reducing, regulating and offsetting environmental impact.

To begin, it encompasses minimising one’s harmful environmental practices and energy consumption, by reducing waste, and increasingly relying on renewable, sustainable and recycled resources. Subsequently, it also encompasses implementing beneficial practices for the environment, such as donating, funding research or planting.

The author of this Harvard Business Review states that implementing CSR in a company can generate social change as it has the power to change convictions. Furthermore, this reflection has the power to generate innovative solutions to produce less waste and/or consume less energy, making it more environmentally friendly (Stobierski, 2021).

o Social Responsibility and ESG factors

Environmental considerations, Social aspects and Governance standards, independent from Corporation Social Responsibility, are a means of social, environmental or governance assessment of a company. They guide sustainability and ethical standards within a company (O’Neill, 2023). This is to ensure that the company operates in a “sustainable, socially beneficial and well-governed” way (Shapsugova, 2023, para. 2). CRS and ESG factors may be used hand in hand within a company. Both have generated a renewed focus on social responsibility (Shapsugova, 2023). It is more seen as a quantitative sustainability measure, in comparison to CSR, which takes on the role of an internal framework more so. While CSR defines the company’s goals, concerns and company culture, and

represents its commitments, ESG factors provide metrics and determine measurable goals (Shapsugova, 2023; O'Neill, 2023).

While these principles do not possess a mandatory characteristic for companies, there are international agreements that promote socially responsible initiatives based on these standards. Examples include the United Nations Global Compact, the Principles for Responsible Investment, OECD guidelines (responsible business conduct), the United Nations Sustainable Development Goals (social and environmental challenges) and the 2016 Paris Agreement (to limit global warming) (Shapsugova, 2023).

o Sustainability

"Sustainability takes into consideration environmental concerns along with economic development" (United Nations, n.d., para. 1). The notion of "over time" is what's key within the concept of sustainability, as what is taken into account is the dimension of time. It is about meeting today's needs without compromising the needs of future generations (United Nations, n.d.).

Sustainability has been characterised as a significant factor influencing coffee purchasing decisions. The transparency surrounding environmental sustainability, indicated through certifications in this study, has been identified as a driver for increased sales. Nonetheless, price continues to outweigh sustainability as a primary consideration for consumers. Brand loyalty, quality, taste and quality are other factors that consumers consider pre-purchase (Lee & Bateman, 2021).

Environmental Impact of Coffee Preparation Methods

A recent study asserted that the environmental impact of coffee preparation methods is highly influenced by consumer behaviour during the use and disposal stages, as well as the waste disposal systems that are available per country (Thoden van Velzen et al., 2023). A leading life-cycle environmental footprint assessment firm, Quantis (2019), confirmed this statement, by highlighting consumer behaviour and energy efficiency as the two key parameters impacting environmental performance of coffee preparation methods.

Moreover, when it comes to the coffee market, food packaging waste represents a large contributor to negative environmental impact. It is responsible for a large piece of the global waste burden and often ends up in landfills, waterways or oceans (Pinto et al., 2024).

The environmental impacts of the various coffee preparation methods will for the most part be defined by the life-cycle assessment (LCA). This analysis, using metric tools, is increasingly being used to determine the environmental performance of products within the food or agriculture sectors, from their raw material extraction to their disposal (Marinello et al., 2021; Arzoumanidis et al., 2017; Salomone, 2003).

The environmental impact of the various coffee preparation methods used by Belgian consumers will be analysed below.

o The Moka Pot

Research states that the moka pot, an Italian coffee pressurised-brewing method requiring a stove, produces consequently lower amounts of greenhouse gases compared to single-serve coffee

preparation methods. Even more so when used with an induction hob instead of LPG gas stoves (Cibelli et al., 2021).

On average, producing one cup of coffee, with whichever preparation method, produces between 50 and 100 grams of Co2. The exact amount of emitted Co2 depends on the life cycle assessment (LCA) of each coffee preparation method (Cibelli et al., 2021). To better grasp the environmental impact, consider that a tree absorbs 55 grams of carbon dioxide a day during its first 20 years, although this can vary depending on factors such as temperature, humidity, dryness and type of tree (Bernet, 2023). Thus, it takes approximately one to two trees a day to absorb the Co2 emitted by producing one coffee.

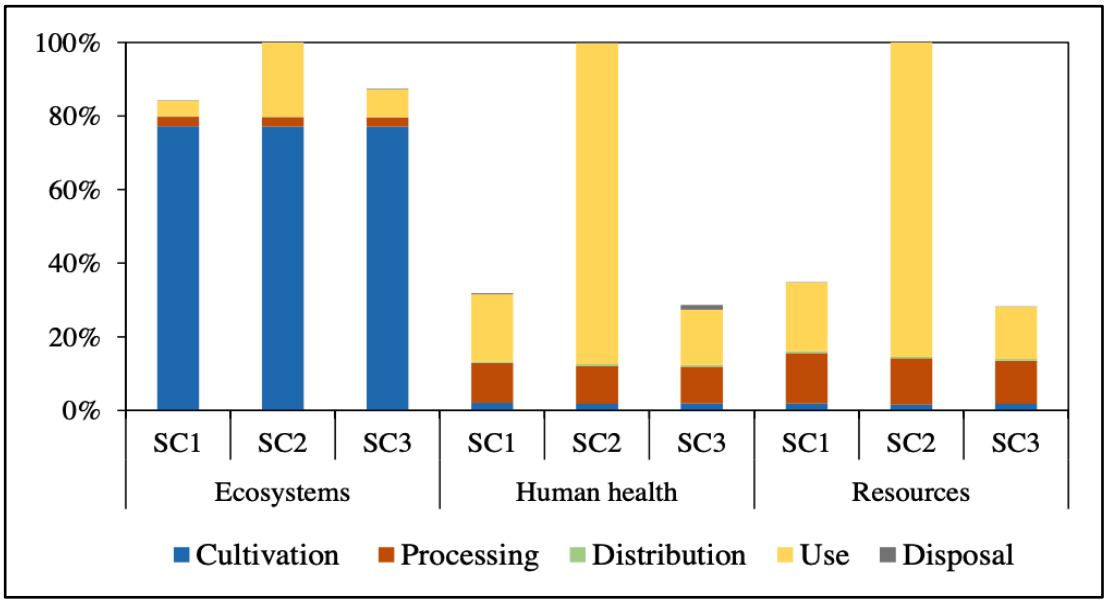
According to researchers, the Moka pot emits the lowest Co2 levels, ranging from 47 to 59 grams of Co2. The espresso capsule machines and automatic espresso machines are said to produce between 57 to 73 grams and 74 to 96 grams respectively. It's important to note that the authors assume that coffee capsules, in the latter option, end up incinerated or in landfills rather than being composted, biodegraded, or recycled. Capsule packaging and machine energy consumption are considered substantial polluters (Cibelli et al., 2021). Additional research completes this data by stating that instant coffee produces the lowest Co2 emissions. However, that research indicates that its Co2 emission levels are at 70 grams of Co2 per portion (Humbert et al., 2009; Quantis, 2019).

Further research compares the Moka pot to electric drip-filter coffee and manual pour-over coffee making use of a boiler (see section on coffee preparation methods for explanation). This research published that the Moka Pot presented the poorest results in terms of environmental performance (Phrommarat, 2019). Author Nowell (2023) affirms this data, suggesting that instant coffee performs best, followed by coffee capsules, the moka pot and lastly electric drip filtered coffee.

With the help of environmental assessment indicators, the following graph shows that the best environmental impact is generated by the manual pour-over coffee with a boiler, followed by the drip-filter coffee machine and ending with the Moka pot (Phrommarat, 2019).

Figure 12

Environmental impact of the drip-filter coffee machine (SC1), the Moka pot with a stove (SC2) and the manual pour-over coffee with a boiler (SC3) based on environmental assessment indicators (Phrommarat, 2019)

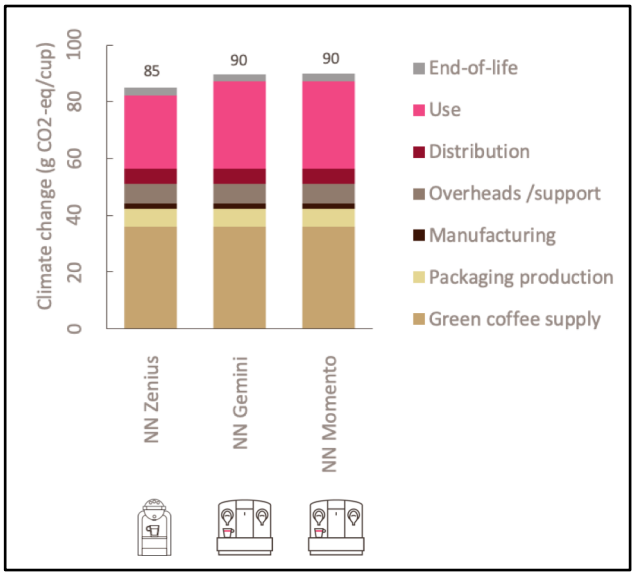


- The Automatic (Espresso) Machine

As the research conducted by Cibelli et al. (2021) states above, an automatic espresso machine consumes between 74 and 96 grams of Co2 per portion. This aligns with the commercial-use Nespresso machines below, ranging at an emission of 90 grams of Co2 during the entire life cycle of the coffee (see figure 13 below). A more traditional at-home capsule machine (NN Zenius) produces 85 grams of Co2, according to Quantis (2019). This is slightly above what the research conducted by Cibelli et al. (2021) in Italy suggests, valuing the Co2 emission at 57 to 73 grams for a capsule machine. Please note that various brands and models exist on the market, with heating and programming functions affecting energy consumption.

Figure 13

Carbon Emissions Assessment throughout the Coffee Life Cycle of the Nestlé Professional System - 1 home use option and 2 commercial use options (Quantis, 2019)



The stage identified as consuming the most greenhouse gas emissions according to Quantis (2019), is the coffee supply stage, encompassing production and cultivation, at 40% on average, followed by the use stage, at around 35%. Please note that the disposal stage of laminated capsules, made up of plastic and aluminium, has been qualified as emitting 2% of the total carbon dioxide emissions, significantly lower compared to its use stage (Quantis, 2019).

○ The French Press

Research stated above has not mentioned the French Press in its sustainable impact comparison (Humbert et al., 2009; Phrommarat, 2019; Cibelli et al., 2021). However, when the moka pot was not included in the analysed range of coffee preparation methods, a study published that the French Press was the most environmentally responsible, followed by the drip filter coffee method and ending with the coffee capsule method characterised as worst-ranking. Again, in this research, the packaging of capsules was not considered as recycled or composted and machines were considered as very energy consuming (Brommer et al., 2011). Authors Marinello et al. (2021) support this research, expressing concerns about waste generation and disposal. The French Press ranks even better if the coffee beans are to be shade-grown and if its coffee grounds are disposed of through composting (Kooduvalli et al., 2020).

○ Drip Brewed Coffee

Studies comparing the environmental impact throughout the life cycle of manual pour-over coffee, instant soluble coffee, the French Press, filtered drip coffee and coffee capsules (extraction, production, distribution, use and disposal), concluded that drip coffee has the most detrimental environmental impact out of these preparation methods. The energy required during the preparation of the coffee itself and the amount of coffee used are its biggest downfall (Chayer & Kicak, 2015; Hicks, 2017; Pinto et al., 2024; Nowell, 2023). Humbert et al. (2009) shares that drip filter coffee has the highest environmental impact, on a per cup basis.

However, not all research and their receptive authors share the same insights when comparing coffee capsules and drip filter coffee. Although Marty et al. (2023) believe drip filter coffee to be the worst in terms of environmental performance, they express their doubts as the coffee capsule preparation method can lead to overuse and its environmental impact can be better. They join authors Thoden van Velzen et al. (2023) and Quantis (2019) in saying that consumer behaviour matters greatly. Leaving the coffee machine on is but one example (Marty et al., 2023).

Authors Brommer et al. (2011) and Marinello et al. (2021) rank coffee capsules as worse for the environment compared to drip coffee in terms. These studies have not included waste disposal systems, recyclability potential and capsule material substitutes, other than plastic and sourced aluminium, in their research.

○ Spray-Dried Soluble Coffee - Instant Coffee

A study analysing the sustainable impact through the coffee life-cycle assessment (environmental impact during extraction, production, distribution, use and disposal) of spray-dried soluble coffee, drip coffee and coffee capsules, based on the ISO standards 140040 and 140044 of 2006, found soluble coffee to have the lowest environmental impact in terms of energy use and environmental footprint.

This is due to the lower amount of energy required during production and preparation of the coffee itself. Spray-dried soluble coffee emits around 70 grams of Co2 and 1MJ of energy per cup, according to the author (Humbert et al., 2009).

Other scientific research supports this statement, confirming that instant soluble coffee, compared to other coffee preparation methods, possesses the lowest carbon footprint when prepared efficiently (Nowell, 2023; Marty et al., 2023).

As Humbert et al. (2009) states, with other authors sharing similar beliefs, over half of the environmental impact of soluble coffee remains in the hands of the consumer, during the use phase (Thoden van Velzen et al., 2023; Quantis, 2019, Marty et al., 2023). Packaging and distribution each represent around 10% of its environmental footprint (Humbert et al., 2009).

Coffee Capsules

Let's dive into waste generation, packaging materials recyclability and energy consumption of the various types of capsules currently on the market in Belgium.

The European Coffee Federation states today that single-serve coffee units (coffee capsules) are not shown to do worse in terms of environmental footprint than brewed coffee (ECF, 2022). The greenhouse-gas emissions do not stand out as higher than any other coffee preparation method as the amount of coffee required is lower, reducing the amount of coffee waste, and higher extraction efficiency is present (ECF, 2022). This supports certain studies developed above (Nowell, 2023; Humbert et al., 2009; Chayer & Kicak, 2015; Hicks, 2017; Pinto et al., 2024). Keeping into account the waste that plastic and aluminium studies are known to generate, a new study stated that the greenhouse gas emissions generated by single-serve coffee are lower than that of an electric filtered coffee machine (Marty et al., 2023). This study also asserts that other research prior to this one has published similar findings. They ascertain the fact that the production of coffee beans is the most greenhouse-gas emitting phase of the coffee lifecycle. Capsules make use of a consequently lower-amount of coffee, about 20% less on average, and of water (50%) as well (Nowell, 2023; Hicks, 2017; Humbert et al., 2009).

Out of the life-cycle assessment study conducted by Humbert (2009), addressed above, coffee capsules are not the poorest performing coffee preparation method, regarding environmental impact, compared to drip coffee, spray-dried soluble coffee and coffee capsules. Indeed, drip coffee comes out the poorest. Energy consumption, water consumption and greenhouse gases are analysed (Humbert et al., 2009). Indeed, when it comes to drip coffee, the consumer controls all inputs and outputs – the amount of water, coffee and energy used (Chayer & Kicak, 2015).

To support this statement even further, the author Hicks (2017), in a second, more recent, study, stated that the coffee capsule generates the best environmental impact when comparing it to the French Press and drip coffee. The author included impact categories to determine the coffee preparation methods' environmental impact. The two most damaging categories, in his eyes, are the amount of dry coffee and energy required for one cup of coffee. Capsules are said to score the best, in comparison to drip coffee, scoring the worst, and the French Press, close second (Hicks, 2017).

Further studies support these findings. The environmental impact of packaging and consumption for 2 coffee preparation methods: ground brick coffee and capsule coffee, has been summarised as the following: coffee capsules once more have a lower environmental impact than ground brick coffee. The reasoning behind this statement boils down to the energy required in the use phase, and the amount of coffee required, which generate a significant environmental impact (Pinto et al., 2024). Single-serve coffee generates more packaging, but the coffee and electricity consumption outweigh the packaging waste, according to this research, making single-serve coffee more environmentally performing throughout its life-cycle (Chayer & Kicak, 2015).

Please note that, when it comes down to single-serve coffee, the machine choice impacts energy consumption and thus environmental impact (Chayer & Kicak, 2015). As analysing machine energy consumption exceeds the realm of analysis of this dissertation, please refer to the following study's findings: water heating properties impact machine energy consumption. Flow-type heaters have been identified as the most energy efficient (Chayer & Kicak, 2015).

Coffee capsules have various beneficial purposes. They contain the ideal amount of coffee powder for one portion of coffee, avoiding over-consumption and reducing waste, they ensure coffee freshness thanks to its moisture-free, oxygen-free and light-free properties, and they offer convenience of use to the coffee consumer (Pinto et al., 2024; Chayer & Kicak, 2015).

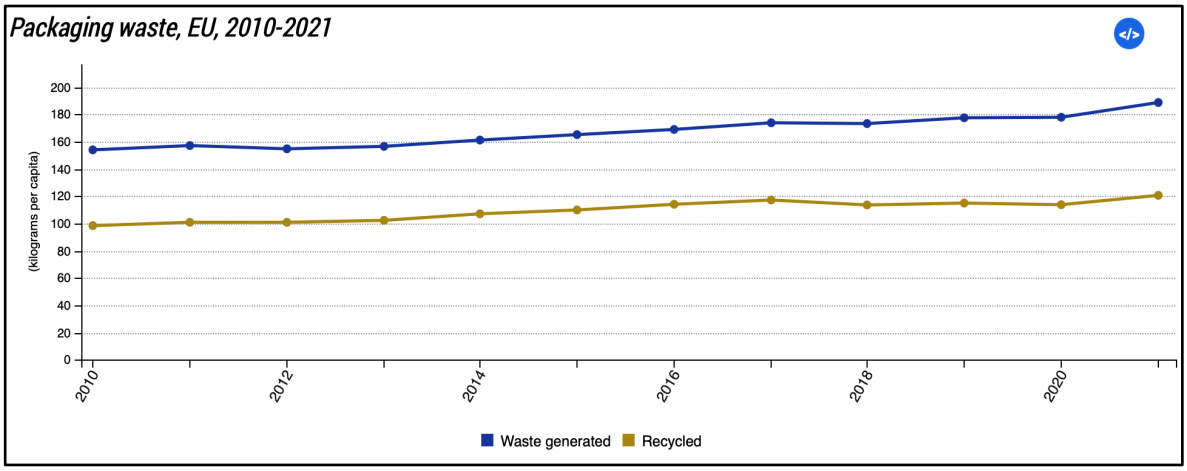
However, coffee capsules also present challenges. Traditional capsules, made up of plastic and aluminium (polylaminate), generate issues for waste treatment facilities as they are unsortable, resulting in their disposal through incineration or in landfills (Pinto et al., 2024).

Environmental Impact of Capsule Packaging

Eurostat publishes the increasing trend of packaging waste that is occurring in the European Union especially, between 2010 and 2021. Together with the waste, packaging recycling is increasing at the same speed (see figure 14 below). No higher increase in waste recycling compared to waste production has been noticed (Eurostat, 2023).

Figure 14

Packaging waste evolution in the European Union 2010-2021 (Eurostat, 2023)



Packaging waste of food and drinks is the most predominant form of waste that is being witnessed. Of them, plastic and metals are said to be the most harmful to the environment (Koons, 2018a). The European Commission shared that only 14% of plastic waste consumed in households ended up in the blue PMD bag for recycling in 2020. The other 86% ended up incinerated, landfilled, exported or littered (European Commission, 2022). Belgium's recycling facility, Fost Plus states, that "As of the 1st of January 2024 sorting food waste is mandatory across Europe. » (Fost Plus, 2024a, para. 9).

Please note that paper and cardboard have been identified as currently producing the most waste, responsible for 34 million tons of waste in 2021. Second and third are plastic, at 16.1 million tons, and aluminium at 15.5 (Eurostat, 2023). Regarding capsule packaging waste, a study suggests that the number of capsules having ended up in landfills in 2014 could circle the earth 12 times (Kooduvalli et al., 2020). Coffee capsules are gaining in popularity and consequently, increasing in consumption (Pinto et al., 2024). Is their recycling following the same trend?

To determine the sustainability impact of capsule packaging, a study carried out in the Netherlands published its results using two sustainability indicators, a material circularity indicator (MCI) and a greenhouse gas emissions calculator (of the coffee lifecycle and of the packaging) (Thoden van Velzen et al., 2023). Aluminium capsules, traditional plastic capsules and compostable plastic capsules have been compared in this study, integrating the end-of-life procedures that are currently implemented in the Netherlands. To determine the circularity of the material (MCI), the recycled content, the biobased content, the recycling rates, the reusability and the average lifespan of the packaging are taken into account.

The end-of-life stage of the coffee capsules are analysed in particular. Whether the capsules are incinerated, sent to landfills, recycled, composted or mono-collected (aluminium capsules whether coffee waste and aluminium waste are separately recycled and composted).

Plastic / Polypropylene (PP)

In Europe, around 26 million tons of plastic are disposed of yearly (ECF, 2022). Of these 26 million tons, plastic capsules account for 0.07%. Around 30% of single-serve coffee units (capsules) are made of plastic. 70% are aluminium-based (ECF, 2022).

Research suggests that around 60% of all the plastic ever produced on the planet has landed beed disposed of and is no longer in use. It has landed in landfills or other surroundings (Cazaudehore et al., 2021).

Plastic packaging comes in different components. Polypropylene (PP) is a very common type of plastic used for single-use products, together with PET and polyethylene (Domingues et al., 2020).

Plastic offers various advantages such as its affordability, water resistance, hassle-free manufacture and strength (Mamun et al., 2023). However, as the European Bioplastics Association (2023) states, the combination of various composites within the plastic capsule material makes for recycling difficult. Indeed, it weighs heavier on costs generated as it requires more technical efforts to recycle. Adding an aluminium lid to the plastic capsule intensifies costs and technicity (European Bioplastics, 2023; Domingues et al., 2020). To provide a clearer understanding of the lack of plastic recycling, please observe that only 12% of used plastics were recycled in 2021. The Belgian recycling treatment facility

did add on to say that this is drastically changing since the 1st of January 2023. This number is expected to rise to 75% in the following years only, thanks to newly implemented infrastructure (Fost Plus, 2024b).

Although plastic food packaging helps preserve products, it ultimately negatively impacts our health and environment as plastic particles are found everywhere. Indeed, plastic is highly resistant to degradation and takes time to decompose - into microplastics nonetheless (between 1-1000 micrometres or 0,001-1 millimetre) (Mamun et al., 2023; Bermúdez & Swarzenski, 2021). This in turn contaminates waterways, the soil, the food chain, ecosystems and ultimately the cells and tissues of our own bodies, negatively impacting our health. The infiltration of plastics in our bodies can consequently cause the development of respiratory problems, gastrointestinal issues, cancer, infertility and alteration in chromosomes. Moreover, the chemicals that plastics release in the water and the soil kill natural microorganisms which are essential for the survival of plants (Koons, 2018a; Mamun et al., 2023). Compared to tin and aluminium, plastic takes 2-4 times more time to degrade, achieving the 400-year mark on average and building up in ecosystems during that time (Koons, 2018a).

Laminated (Plastic-Aluminium) Packaging / Polylaminate

Plastics require fossil fuels to make, generating greenhouse gases. This ranks them poorly when it comes to environmental responsibility. However, its production requires a fraction of the energy required to make metals such as aluminium or tin for example. The following analogy of Co2 kg generated during the production of plastic and aluminium has been presented. To produce 1kk of plastic and aluminium independently, 4 kg of Co2 are emitted when it comes to plastic production, compared to more than 10 kg for aluminium (Koons, 2018a).

Although scientific research has established that plastic generates less greenhouse gas emissions than aluminium does, it scores lower than recycled aluminium in terms of circularity, as coffee remains within the capsule and the plastic of the capsule itself is not recycled. Through the mono-collection process, aluminium can be recycled, together with its coffee content which is composted. Aluminium is recycled up to 40%, not higher, as this would lead to a less pliable material, not suitable for the machines. The issue that is currently on the surface is the efficiency of the capsule collection system and the participation rates of the recycling (Thoden van Velzen et al., 2023).

Plastic-aluminium coffee capsules rank poorly when it comes to its sorting ability. Their low recyclability potential is due to the inability to separate the plastic and aluminium materials found in the capsule, making recycling difficult and often leading to its waste disposed of in landfills (Pinto et al., 2024; Marinello et al., 2021). Although it is a cost-effective solution, it has affected the environment poorly. Please note that such capsules are now recyclable in Belgium since the 1st of January 2023 (see the LCA section, disposal stage). PET, polystyrene, polypropylene and polyethylene, among others, are now all able to be identified, separated and recycled in treatment facilities in Belgium (Fost Plus, 2024b; Fost Plus, 2024c).

Polylaminate consists of three layers: aluminium – polyethylene (most commonly produced plastic) – aluminium. The capsule is covered by a thin layer of aluminium on top once more, to act as closure and permeability. It forms a “tin-like” capsule, the use of which has been forecast to keep on growing,

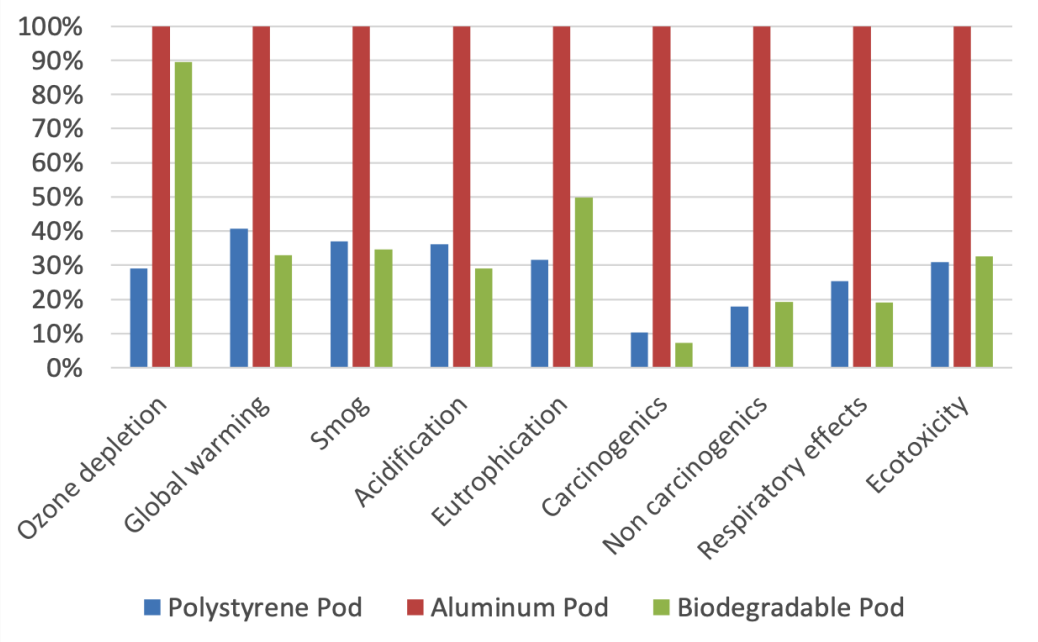
primarily for alcoholic drinks. Belgium is part of the countries selling polylaminate capsules on the market (Data Bridge, 2020).

Aluminium

Aluminium, a lightweight, durable and recyclable metal, is also used to design coffee capsules. It represents 8% of our planet's crust and so therefore is a natural material. However, it does not come naturally in this form. It is originally an ore and must be extracted which requires vast amounts of energy. The extraction of its primary material and its production leave behind a negative effect on the environment (Koons, 2018a). Aluminium is energy intensive to produce (Pinto et al., 2024). Aluminium is one of the metals that generates the most greenhouse gas emissions during its production (Raabe et al., 2022). The aluminium coffee capsule, in comparison to a biodegradable capsule and a plastic one, ranks the worst in regards to environmental impacts, across nine categories throughout the lifecycle, according to this study (see figure 15 below) (Li, 2018). However, when dividing this impact by life cycle stages, material extraction, production, transport and end-of-life, it is the extraction and production which reprepresent more than 80% of this detrimental environmental impact. Regarding end-of-life, aluminium shows slightly more favourable numbers compared to the polystyrene pod. Regarding transport, both show the same effects and represent below 10% of the total environmental impact. Please note that recycled aluminium capsules are not analysed here, but rather virgin aluminium capsules (Li, 2018).

Figure 15

Impact categories throughout the life cycle of three pod formats, with the highest indicator presented as 100% (Li, 2018)



Regarding the end-of-life phase, please observe that aluminium releases few to no chemicals and harmful materials into the environment once used, avoiding harm to microorganisms, plants, animals and the human race. Regarding packaging waste, research states that it ranks better environmentally than plastic does (Koons, 2018a).

Research states that 75% of the aluminium that has been produced over time is still being used today (Raabe et al., 2022). Recycling rates have soared for aluminium and tin, achieving 72% in the European Union in 2009 already (Koons, 2018a). Additional research suggests that recycling rates for aluminium will double in number by 2050 (Raabe et al., 2022).

Recycled Aluminium

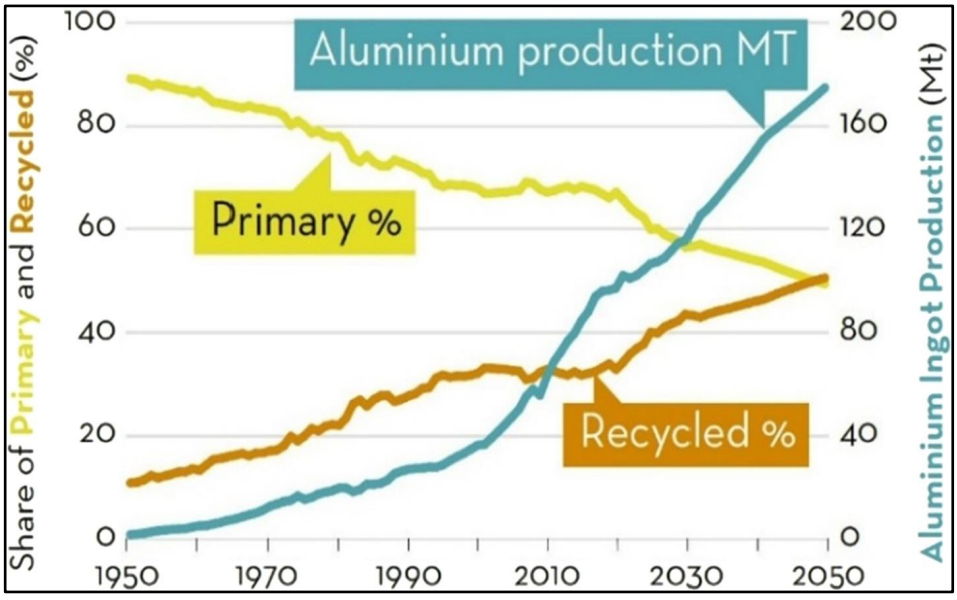
The concept of "green aluminium" has been brought up by a study on sustainable aluminium. It refers to producing aluminium through methods generating lower carbon emissions. Ways of achieving this include recycling aluminium scraps to produce the material.

The objective is to recycle aluminium by generating the largest fraction scraps possible as it affects the quality of the recycled aluminium material, and to use the appropriate energy resource. The aluminium scraps are divided into two categories; pre-consumer scraps and post-consumer scraps requiring sorting before the melting process. Post-consumer scraps are primarily generated by packaging and vehicles. Research suggests that melting aluminium, a process which represents the energy required during recycling, utilises a meagre 5% of the total energy required to produce the material in the first place. This data offers an opportunity for a circular economy, as the authors state. Aluminium made from scraps reduces the energy consumption and the amount of greenhouse gases emitted (Raabe et al., 2022).

One third of today's utilised aluminium has been made from recycled aluminium scraps. The International Aluminium Institute (2022) further states that this trend is expected to increase by 50% by 2050 (see figure 16 below) (Raabe et al., 2022).

Figure 16

Mass aluminium production and distribution between aluminium production from scratch (primary) and aluminium production from scraps (recycled) in 2019 (Raabe et al., 2022)



If aluminium and tinplate packaging are to be created with recycled aluminium or tinplate, their Co2 emissions during production, and thus their greenhouse gases and environmental footprint, is

estimated to attain one third of what it would be by using the raw materials from scratch. Thus, producing about 3.33 kg of Co2 per 1 kg of aluminium, compared to plastic's 4 kg Co2 production (Koons, 2018a). Therefore, according to the author Koons (2018a), aluminium and tinplate are considered to have a lower environmental footprint compared to plastic from a cradle-to-grave life cycle standpoint.

Not much energy is required to recycle aluminium, in comparison to other materials such as tinplate. Furthermore, aluminium is infinitely recyclable, unlike plastic (Raabe et al., 2022).

Tinplate

Tinplate is an alloyed (aluminium) steel sheet. It is inexpensive to produce and can tolerate various changes in temperature. This material is highly recycled, especially in Europe where its rate of recyclability in 2018 was recorded at 82.5%. This is in part due to its ferromagnetic property, allowing for sorting to be made easier in facilities (Pinto et al., 2024).

Tinplate is infinitely recyclable, just like aluminium, all the while maintaining its quality and properties over time (Koons, 2018b; APEAL, 2012). Most tinplate is also created with steel scarps, and not the original steel raw materials themselves, which reduces the Co2 emissions generated. Furthermore, please note that in 2012, tinplate was already being recycled at 98% in Belgium, according to the Association of European Producers of Steel for Packaging (APEAL, 2012).

Bioplastics, Biodegradable Plastics & Compostable Plastics

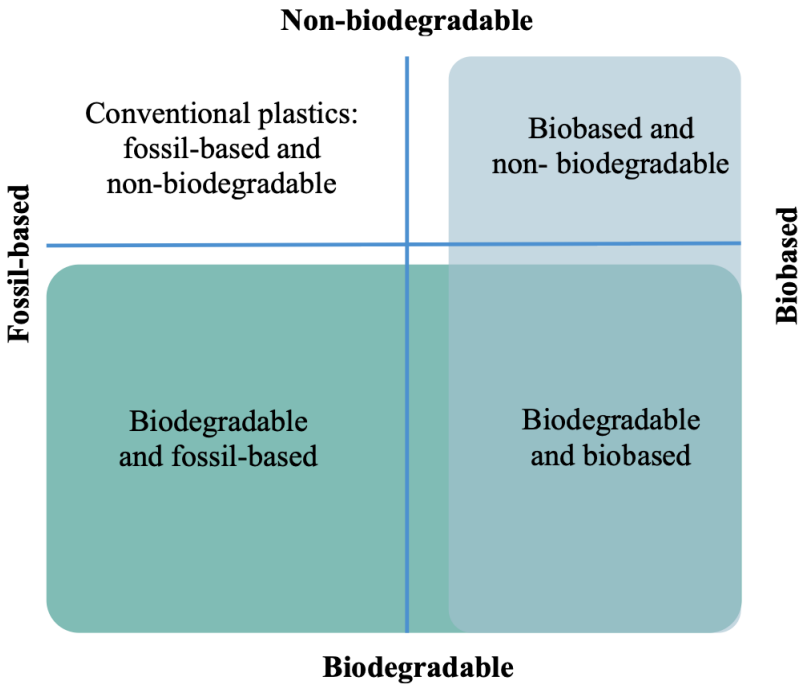
Biopolymers are organic substances, meaning substances that contain carbon, that are found in natural resources. They are increasingly being referred towards for sustainable solutions (Norman, 2023; Baranwal et al., 2022). They can be natural or synthetic. Although natural biopolymers have a lower melting point and are less stable, they are biodegradable, biologically renewable and non-toxic whereas the same cannot be said for synthetic biopolymers. The latter are not biodegradable and may release toxic materials. Examples of biopolymers are rice, wheat, banana, corn and cotton among many others. They are sourced from plants, animals and agricultural waste (Baranwal et al., 2022).

Please retain that bioplastics, biodegradable plastics and compostable plastics are three different concepts which must not be interchanged (European Commission, 2024).

Bioplastics, or bio-based plastics, are a subset of biopolymers, made up of biological resources called biomass. Bioplastics are an emerging industry, only responsible for 1% of the total plastic production in 2022 (European Commission, 2022). Please note that the production of biomass requires water, energy, fertilisers, pesticides and land which affect the environment and its ecosystem negatively (European Commission, 2024). Furthermore, biological resources don't all have the ability to biodegrade or be composted, as we concluded in the paragraph above and as is illustrated in the figure below (European Commission, 2024).

Figure 17

Bioplastics, (non)Biodegradable bioplastics and fossil based or bio based plastics (European Commission, 2024)



Biodegradable plastics, a biodegradable polymer, can be bio-based or fossil-based. They are derived from synthetic or natural sources and have the ability to decompose (break down into simpler compounds) in certain conditions over time (European Commission, 2024). Degradable polymers have a favourable environmental impact as waste and greenhouse gas emissions are reduced, allowing for a clearer path towards a circular economy (Shogren et al., 2019). Mulch films are proposed as a biodegradable plastic to be considered by the European Commission (2024). Cellulose or starch are examples of biodegradable polymers as well (Li, 2018).

Compostable plastics degrade quicker in specific conditions. Consumers (Fost Plus, 2024a; European Commission, 2024) can degrade the latter at home.

Please consult the two examples of bioplastic capsules below.

Charles Liégois - Bioplastic Capsules

Charles Liégois sells 100% organic and fairtrade coffee certified coffee, with a strong commitment to social and environmental responsibility. Compostable, plant-based capsules were introduced in 2021 (Charles Liégois, n.d.-c). The capsule material, bioplastic, is produced by the same company having partnered with Nespresso to make their compostable capsules; Tüv Austria (Charles Liégois, n.d.-c; Nespresso employees & Gammuto, 2022).

Migros - Seaweed-based Bioplastic Capsules

With modern times comes innovation. Coffee capsules now come in the form of coffee balls, protected with a seaweed packaging. Seaweed allows for the layer of biopolymeric film: a bioplastic or bio-based polymer. It is a biodegradable packaging and represents a sustainable solution (Lomartire et al., 2022). Seaweed can improve biopolymer packaging properties by offering a longer shelf-life to the product and providing nutritional value (Carina et al., 2021). A Swiss brand called Migros stated in 2022 that it

would come out with this fully compostable and easily discarded innovation in Switzerland and France, followed by Germany (AP News, 2022).

Only the use of single-use plastics and plastic bags are officially conditioned by EU law (European Commission, 2024; European Commission, 2022). This is not the case for biobased, biodegradable and compostable plastics. A stand-in-point example of lack of regulation surrounding these materials is the fact that no minimum amount of bioplastics is required for a biobased label to be allowed on a plastic product (European Commission, 2022). A policy framework for bioplastics, biodegradable and compostable materials, presented by the European Commission, presents the challenges and benefits that these three materials are facing. Integrating a regulation into the European Green Deal, the circular economy action plan and the EU plastics strategy has been recommended. The goal of the latter three is to reduce, reuse and recycle plastic, in this order (European Commission, 2022).

Please note that the European Commission is working towards updating the legislative framework surrounding packaging and packaging waste reduction, with the revised Packaging and Packaging Waste Directive (PPWD), as it currently is making recyclability and circularity of single-serve coffee units (SSUs) very difficult. At present, the packaging must be fully recyclable or compostable under industrial conditions or its integration on the market is otherwise prohibited. Specific conditions and standards are to be met. However, bio-waste treatment facilities are not yet available throughout the EU (EFC, 2022).

According to scientific research, compostable plastic capsules (bio-based and biodegradable materials) generate 100% material circularity if the compostable capsules end up composted (Thoden van Velzen et al., 2023). Although fossil-based and bio-based plastics are allowed for recycling in the blue PMD bag in Belgium since 01.01.2023, biodegradable and compostable capsules are not (Fost Plus, 2024d; Fost Plus, 2024a). According to Fost Plus, they are referred to as “disturbing” packaging. They present a risk of being identified as other plastics, disturbing the industrial sorting and recycling stream (Fost Plus, 2024). These materials have been stated to reduce the quality of the recycled plastic output as well (Fost Plus, 2024a; Fost Plus, n.d.). Biodegradable and bio-based capsules are not accepted in organic waste either (Fost Plus, 2024a). Scientific research suggests that such compostable capsules should be accepted in organic waste, as tea bags and coffee pads are already accepted in organic waste in the Netherlands. No changes are required within the waste facility for this to take place, according to the authors (Thoden van Velzen et al., 2023).

Biodegradable & Compostable Materials

Compostable coffee capsules have made their way throughout Europe in the last 10 years. Their presence is increasing in volume and in material variety. Six thousand tonnes of compostable materials were used in the conception of compostable capsules in 2022. This represents 3,6% of total capsule materials in 2022, including aluminium and plastics. This number is expected to surpass 10% by 2027 (European Bioplastics, 2023).

Coffee capsules made of biodegradable materials, in comparison to fossil-fuelled plastic materials which degrade over hundreds of years, have shown to generate a lower environmental impact (Kooduvalli et al., 2020; Koons, 2018a). This is mainly thanks to the waste disposal stage, with biobased

products being compostable in a large-scale facility. The capsules take less time to decompose and generate less costs. The study shows that costs related to the waste process were 21% lower than that of traditional coffee capsules, that total degradation of the material occurred within 46 days and that a value-added product was generated: nutrient-rich compost (Kooduvalli et al., 2020).

Issues have been identified with such materials, however. Compostable materials, such as bioplastics, have shown to demonstrate less oxygen-permeability, leading to taste and quality alteration, and do require composting facilities which remain limited (Kooduvalli et al., 2020).

More companies are now starting to turn themselves towards the production of bioplastics and compostable materials (Kooduvalli et al., 2020).

Compostable capsules, according to the EN13432 certification, go hand in hand with circularity. Coffee content is not wasted and, quite the opposite, brings added value to the environment. The compostable capsule disintegrates into compost through industrial composting facilities (European Bioplastics, 2023). When not composted, the organic coffee content in traditional capsules is lost, which goes against circularity as a concept (European Bioplastics, 2023).

Let's keep in mind that recycling and composting are two different means of waste disposal, with a different impact on the environment as well (Kooduvalli et al., 2020).

Paper

Paper-based capsules have been announced to enter the market by Nespresso, a Nestlé B-corp certified company, in late 2022, starting on the French market (Reuters, 2022; Ludmir, 2023; Nespresso employees & Gammuto, 2022). The Swiss market followed in spring 2023, complementing the already existing aluminium capsules (Huhtamaki, 2022; Reuters, 2022). This paper-pulp option is compostable and took three years to come up with, in partnership with a company called Huhtamaki (Reuters, 2022; Mohan, 2023). Huhtamaki aims to be the world leader in terms of sustainable packaging solutions.

The company is offering consumers the choice between recyclable aluminium capsules or compostable paper capsules, as it strives to achieve a 100% recyclable or compostable capsules portfolio by 2025 (Nespresso, 2024; Mohan, 2023). The capsule has been certified home compostable and waste collection compostable by the German certification company Tüv (Mohan, 2023; Nespresso employees & Gammuto, 2022).

Challenges such as preserving the oxygen barrier of the capsule, to assure coffee quality, freshness and aroma were achieved with the help of innovative technology. A new, extremely thin, compostable biopolymer film, made up of responsibly-sourced wood pulp fibres, allows for the oxygen permeability within the capsule (Mohan, 2023; Huhtamaki, 2022). The wood fibres, accounting for 82% of the capsule, are said to be responsibly sourced from European forests managed sustainably (Kurz, 2022). Furthermore, cutting-edge technology from the Huhtamaki company allows for an extremely high level of moulding precision for the paper-pulp capsule's shape (Mohan, 2023; Huhtamaki, 2022). This paper capsule is a substitute for fossil-based (plastic)or aluminium capsules currently on the market today.

Paper offers various advantages. It is non-toxic, biocompatible and lightweight. However, the paper and pulp industry (PPI), derived from wood and wood residues, remains intensive in energy, water and natural resources. It generates forest degradation, impacts the fauna and flora, and generates waste.

Please note that the PPI has managed to make strides regarding emission reduction, energy reduction and energy efficiency over the years, as well as switching to renewable energy resources. Indeed, the Confederation of European Paper Industries reported that the Paper and Pulp Industry is the largest user and producer of renewable energy on an industrial scale in the European Union. 55% of its annual energy consumption is said to be biobased and carbon neutral (Del Rio et al., 2022).

Responsible pulp and paper creation is said to bring benefits to local economies, people and nature (WWF, 2024).

Life Cycle Assessment (LCA) of the Environmental Impact for Single-Serve Coffee

The life-cycle of coffee, from cultivation and production to transport, distribution, use and disposal, impacts the environment in various ways, whether it be generating greenhouse gas emissions, consuming energy and water, deforestation, water pollution due to fertilisers and pesticides, labour exploitation, waste generation, biodiversity degradation and natural resource exploitation (Marinello et al., 2021). Please consult appendix 4 to visualise the steps which are included in the assessment of coffee's life cycle (Phrommarat, 2019).

o Cultivation Stage

Research has shown that the cultivation of coffee is responsible for 55% of its total emissions (Brommer et al., 2011). Quantis (2019) values the cultivation stage's carbon dioxide emissions at 40%, using the Nespresso capsule as case study, which is slightly lower than the findings of authors Brommer et al. (2011). According to Marty, Viana, Boucher and Dessureault (2023), the production stage is the most greenhouse-gas emitting stage, accounting for between 40 and 80% of the total life-cycle's emissions.

Additionally, multiple studies have confirmed that cultivation, followed by the use stage, are the primary contributors to the environmental impact that the coffee life-cycle generates, for all coffee preparation methods (Phrommarat, 2019; Marinello et al., 2021; Marty et al., 2023; Quantis, 2019).

This is mainly due to intense irrigation practices, accompanied by an intensive use of fertilisers and pesticides (Marty et al., 2023).

Please see figure 12 in the "The Moka Pot" section to visualise the extent of harm that the cultivation stage causes (yellow bars). It is the most significant contributor to damage to our ecosystem (Phrommarat, 2019). Hassard et al. (2014), identify the cultivation and packaging production stages as most harmful, carbon footprint and energy consumption-wise.

o Transport and Distribution Stage

Fuel consumption and emissions must be integrated when thinking about environmental impact during this stage. The transport of fertilisers for cultivation, of the coffee cherries, of the green coffee for roasting, of the roasted coffee for packaging, and of the final product to retailers must be considered (Phrommarat, 2019).

Use stage

Researchers having studied the environmental impact of packaging production and disposal, as well as machine production and usage, have identified the use of coffee machines as being the most environmentally harmful (Marinello et al., 2021; Quantis, 2019). Further research identifies the "use" stage as the second most Co2 emitting phase within the coffee life-cycle, after the cultivation phase (Marty et al., 2023). Authors Brommer, Stratmann and Quack (2011) state that the coffee preparation stage represents 30% of the total emissions of the coffee life cycle. This percentage does however vary, depending on the coffee preparation method used and the amount of energy and type of packaging used specifically (Brommer et al., 2011; Thoden van Velzen et al., 2023; Marty et al., 2023).

The use stage remains, a significant contributor to the total environmental impact when assessing the coffee life cycle, due to its energy consumption (Phrommarat, 2019; Hassard et al., 2014). Please see the figure above in section "The Moka Pot" to visualise the extent of harm caused by the use stage, as it is the most significant contributor to damage to our human health as well as our resources (Phrommarat, 2019).

Disposal - End-Of-Life Stage

The disposal stage has been identified as being comparably less harmful to the environment in comparison to the other stages (Phrommarat, 2019; Humbert et al., 2009).

In its March 2023 report, the European Bioplastics Association named organic recycling as the most "environmentally-sound option", among all end-of-life options available for coffee capsules. Indeed, the association states that compostable coffee capsules are a much more environmental option when compared to aluminium capsules or conventional plastic capsules (European Bioplastics, 2023).

A report shares that the end-of-life stage for plastic and aluminium capsules often results in incineration or disposal in landfills (Thoden van Velzen et al., 2023; Marinello et al., 2021). Quantis (2019) states that the disposal of laminated capsules, made up of plastic and aluminium as seen above, is responsible for an estimated 3 grams of Co2 out of the total 85 grams on average per individual portion of coffee. The report carries on to state that if the capsules were made up of 100% recycled aluminium, the carbon footprint related to the disposal of the packaging would experience a reduction of 1.5 grams, about 50% of its emissions (Quantis, 2019).

Disposal of capsules in treatment facilities is currently being invested towards (Fost Plus, 2024b; Domingues et al., 2020). Since the 1st of January 2023, 100,000 tons of additional packaging is now able to be recycled in Belgium. New innovations, technologies, installations and investments as well as partnerships with waste treatment companies have been worked on, creating new projects and opening up more recycling capabilities of various plastic, paper and aluminium packaging (Fost Plus, 2024b).

Industrial recycling consists of sorting, selecting, screening, grinding and washing, drying and reprocessing. A heating process is included, which reduces the property quality of the recycled materials. Having a combination of plastic and aluminium added a level of difficulty and excluded a lot of capsules from being recycled. This is now not the case anymore in Belgium (Domingues et al., 2020).

Practical Review

Methodology

Research Question

Additional data has been gathered in the practical review in order to better respond to the research question. To refresh the mind of the reader, please find the research question below:

"How has the shift in Coffee (Capsule) Consumption Patterns in Belgian Households impacted the Environment? A comparative analysis from 2019 to 2023."

Methodological framework

Explanation of Adopted Methodological Approach

As established in the introduction, secondary data in the shape of scientific literature and reports make up the literature review. The practical review provides an analysis of primary qualitative data as well as secondary quantitative data. Semi-structured interviews have been conducted in order to provide added value, insights and data to this dissertation and contrast said information to externally-conducted surveys on Belgian consumers' consumption patterns and sustainable consumption perception, to internal documents containing externally sourced data, provided by the internship-company Nestlé Belgilux, and lastly to the scientific research collected in the literature review.

Description of Data Collection Methods

The interviews have been conducted with professional experts in their fields. The four Nestlé employees have developed years of experience in the field of retail coffee and have conducted much research on the market and its happenings, especially since the Coronavirus. The first interview has been conducted with the Brand Business Lead of two renowned Nestlé coffee brands in Belgium. The topic of conversation revolved around the evolution of the in-home coffee market since 2019 in terms of volume and value as well as the factors affecting this evolution (Gomez, 2023). The second interview has been conducted with a Business Executive officer in Belgium, around the history of coffee, its current evolution and especially the reasons for the evolution which took place, touching on sustainability as well as on the Coronavirus and macroeconomic factors (Grèze, 2023). It is important to note that, as these are semi-structured interviews, a frame was built and provided. However, each interview varies based on the unique knowledge of the interviewee.

The third interview has been conducted around company accountability and investment surrounding sustainability with the Nespresso Marketing Direction, who develops environmental responsibilities surrounding sustainability certifications and programs (Hermans, 2023). This is especially interesting in today's world as a trust crisis between consumers and companies is growing, together with sustainable certifications (Agguirre et al., 2024; Tebini, 2023, session 1; Kantar, 2023b, p. 19; Terlau & Hirsch, 2015).

The fourth interview has been conducted around digitalisation. This was conducted with a brand manager for a substantial Nestlé coffee brand. Although it was extremely interesting, digitalisation was not in the scope of this dissertation. The decision was therefore made not to incorporate the interview.

However, if the reader wishes to consult the interview transcript, the reader may request the transcript from the author, subject to approval.

Analysis

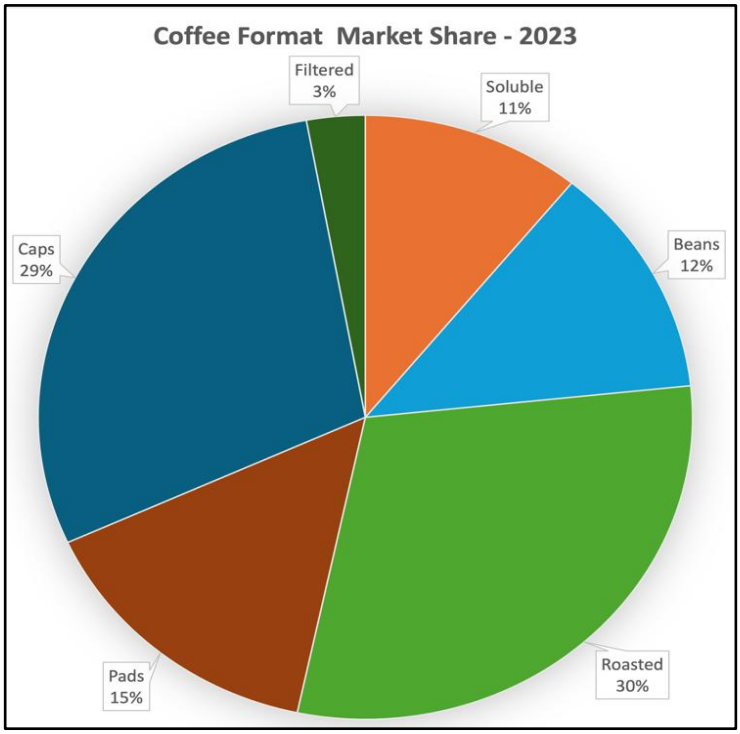
Throughout the practical review, gathered data from documents and interviews with professionals of the field at Nestlé Belgilux will be juxtaposed with the literature review above.

Consumption Patterns and Market Dynamics of the Belgian In-Home Coffee Market: 2019-2023

The roast and ground category remains the largest segment on the Belgian in-home coffee market, accounting for 30.1% in 2023. However, capsules, second in line, are swiftly catching up with the ground coffee powder alternative, reaching 29.0% the same year (see figure 17) (Gomez, 2023). As the figure 18 below attests, filtered coffee represents the smallest category, around 2%, followed by soluble coffee and beans, at slightly above the 10% mark. It's worth noting that these category distributions are consistent for Nestlé Belgilux and Belgium as a whole.

Figure 18

Belgian Retail Coffee Market Sales - Category Distributions from 2022 to 2023 (Nestlé Belgilux, 2022a)



Retrieved data affirms that coffee capsules are generating significant growth. Together with pads, they form the portions category. Gabriela Gomez (2023a), FMCG expert and the Brand Business Lead for Starbucks and Nescafé Farmers Origins at Nestlé Belgilux, attests during our interview that pads are declining. The portions category is expanding, making room for the expansion of the market in terms of value. While the ECF (2023) primarily attributes the rise in value to inflation, FMCG expert Ms. Gomez (2023a) suggests that the growth is driven by a higher interest, and thus purchase, in coffee formats which generate a higher price per cup, such as coffee capsules. Additionally, whole beans,

which also yield a higher price per cup, have experienced a surge in interest as well, confirming the growth of the format on the Belgian market. Whole beans are a part of the expanding Roast Coffee category, as defined by Statista (n.d.) and affirmed by the European Coffee Federation (ECF, 2023).

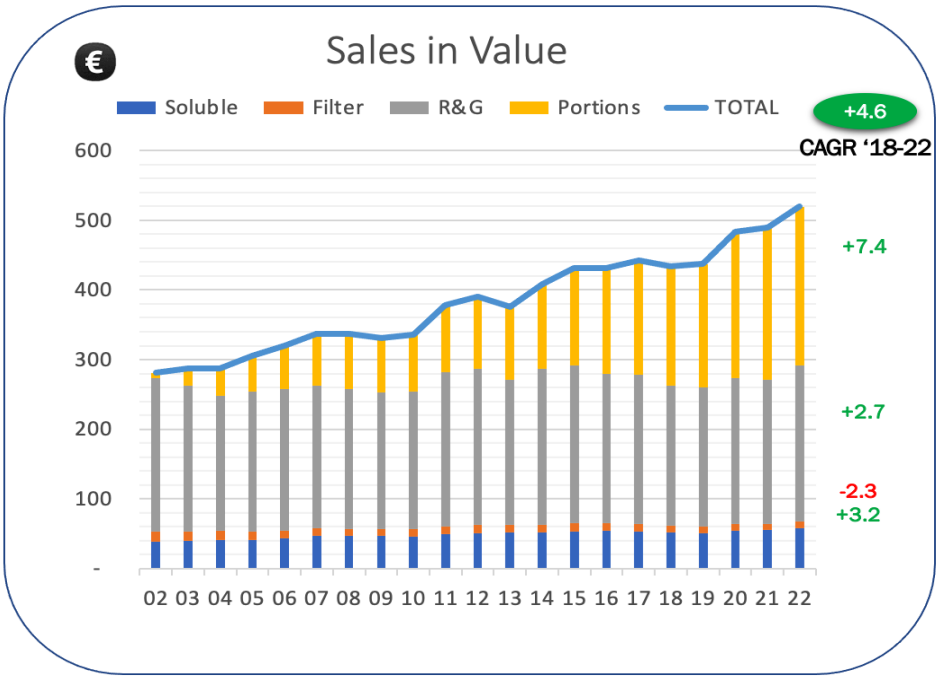
The in-home coffee consumption is determined based on the sales generated by retailers, which can be quantified in value or volume. In Belgium, the market value of total sales has been increasing, as noticeable on the figure below, and is expected to keep on increasing by 10% yearly in the next few years, due to higher prices (Statista, n.d.: ECF, 2023). In contrast, the market sales in terms of volume, reflecting the number of cups purchased and thus consumed by Belgian consumers, has been characterised as vastly stable since 2018. It is expected to rise only very slightly by 2028 (Statista, n.d.: ECF, 2023). This may be explained due to the European coffee market being considered as saturated. Therefore, no high volume increase is to be expected (CBI, 2021a; ECF, 2023). However, researchers have published that the consumption of coffee is expected to increase by 50% by 2050 (Grèze, 2023). Indeed, when looking at the production-levels of coffee, a decrease was established in 2020, with the evolution gaining stability in 2021-2022, all due to the economic environment and climate adversities. Coffee production however soared in 2022-2023 (ICO, 2023a; Vega, 2008).

Inflation is driving value growth, according to the European Coffee Federation (ECF, 2023). Indeed, Nestlé Belgilux business insights affirms this statement, conveying that higher prices harm volumes, further being impacted over time (Nestlé, 2023c, p. 4).

Between 2019 and 2023, the CAGR of retail sales value for single-serve coffee, soluble coffee, roast and ground (whole beans and ground coffee) and filtered coffee (coffee using filters) in Belgium was +7.7%, +4.2, +3.9% and -1.1% respectively (see figure 19 below). So, each year between 2019 and 2023, the coffee formats experienced this evolution on average. Single-serve capsules experienced substantial growth, followed by whole beans and ground coffee, then by soluble coffee. Filtered coffee, seen to produce negative environmental results, experienced a decline which is beneficial to the environment (Nowell, 2023; Humbert et al., 2009; Hicks, 2017; Pinto et al., 2024).

Figure 19

Nestlé Belgian Retail Coffee Sales in Value from 2002 to 2023 (Nestlé Belgilux, 2022b)

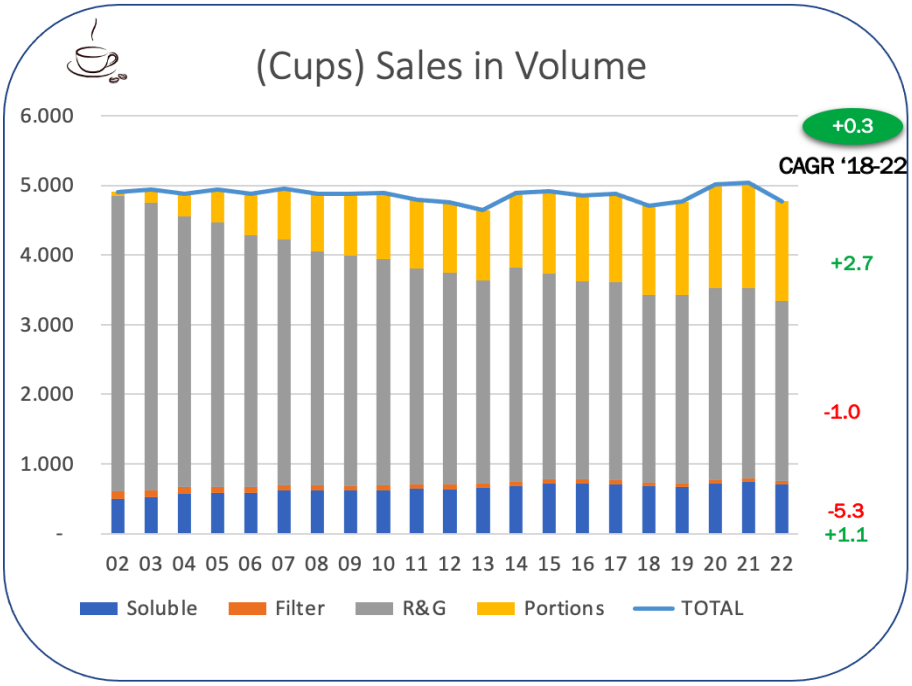


In terms of volume, the European coffee markets, with western European coffee markets in particular and the Belgian Coffee market without a doubt, have been described as saturated by various authors, generating only a slight increase with the years (CBI, 2021a; Marinello et al., 2021; ECF, 2023).

When looking at the coffee evolution in terms of volume as a whole, the Brand Business lead and FMCG expert, has described the coffee category's evolution as a whole as quite flat, if not to say in decline. Between 2019 and 2023, the CAGR of retail sales volume (number of cups sold) for single-serve coffee, soluble coffee, roast and ground (whole beans and ground coffee) and filtered coffee (coffee using filters) in Belgium was +1.6%, +1.1%, -1.4% and -5.1% respectively. As the figure below attests, on average, single-serve coffee and soluble coffee saw an increase of 1.6% and 1.1% per year between 2019 and 2023, with ground coffee, whole beans and filtered coffee experiencing a decline in the amount of coffee cups consumed. The Coronavirus generated change in this evolution, bringing about slight growth in coffee categories, especially in coffee cup sales of portioned coffee (capsules) and soluble coffee, as noticeable on figure 20 (Gomez, 2023; Nestlé Belgilux, 2022c). The European coffee federation publishes that soluble coffee volumes rose (ECF, 2023). Indeed, Statista (n.d.) reflects this increase between 2019 and 2023, generated by the pandemic.

Figure 20

Nestlé Belgian Retail Coffee Sales in Volume from 2002 to 2023 (Nestlé Belgilux, 2022c)



Although the market is saturated, demand for coffee is still present and evolving. The new trends and opportunities are geared towards specialty coffee and single-use coffee in particular (CBI, 2021a; CBI, 2021b; CBI, 2024). Coffee user profiling (CUP) data gathered for Nestlé Belgilux, on behalf of Nielsen affirms that coffee consumption habits are ever-evolving. This is not only due to changing lifestyles, but also due to innovative products and new café concepts making their way on the market (Nielsen, 2023a, slide 2). Consumers value price, sustainability, quality and taste as consumption attributes (see section V. below). A notable shift towards higher quality and less quantity as sustainable, ethical and unique products has been observed (Dynata, 2020; Nestlé, 2023b, slides 2 & 3; Hernandez et al., 2020; Panhuysen & de Vries, 2023; Statista, n.d.; CBI, 2024). This presents opportunities for multiple parties along the supply chain, such as for producers, roasters, exporters or retailers (Panhuisen & de Vries, 2023).

These opportunities impact the market as well as the share of the Belgian market's players (Lee & Bateman, 2021). Belgian consumers are increasingly purchasing private label (PL) coffee, in comparison to brand-name products. The private label's coffee market share in Belgium is said to have hit a new record in 2022 at 39.1%, gradually expanding (Nestlé, 2023b, slide 3). A clear correlation is said to be present between price increase and share gain for PL, according to this market analysis. Price is cited as the most important criterion for a consumer in this context. Please note that PL market share is increasing, although its prices are rising faster than those of brand-name products, currently costing double the price on average of the former (Nestlé, 2023b, slides 3 & 7). According to market research in Belgium, a decreasing interest in brand-name products and an increasing interest in private label brands has been identified across all social classes. Private labels are no longer only being chosen by social classes with lower incomes (Nestlé, 2023b, slides 9). Please note, this change in the Belgian coffee market shares has not been said to impact the present evolutions regarding sustainability, quality, traceability or taste.

In-home Coffee Market Share in Belgium - Main Players

The coffee consumption in households on the Belgian market refers to sales generated by the retail channel (ECF, 2023). Within the retail channel, the most powerful coffee players have been identified to be Douwe Egberts, Nespresso, Nescafé Dolce Gusto, Senseo, Starbucks at home and lastly Nescafé. These five master brands score the highest when it comes to quickly coming to the minds of consumers, standing out as a brand and thirdly, consumers feeling that the brand meets their needs, generating affinity (Kantar, 2023a, slide 20).

Douwe Egberts, the dominant player in the Belgian in-home coffee market, is known for its traditions and stands out strongest when it comes down to top-of-mind coffee brands of the Belgian in-home coffee market (Gomez, 2023; Kantar, 2023a, slide 20). Starbucks and Nespresso stand out as a brand the most (Kantar, 2023a, slide 20).

Belgian Consumers

Penetration rates

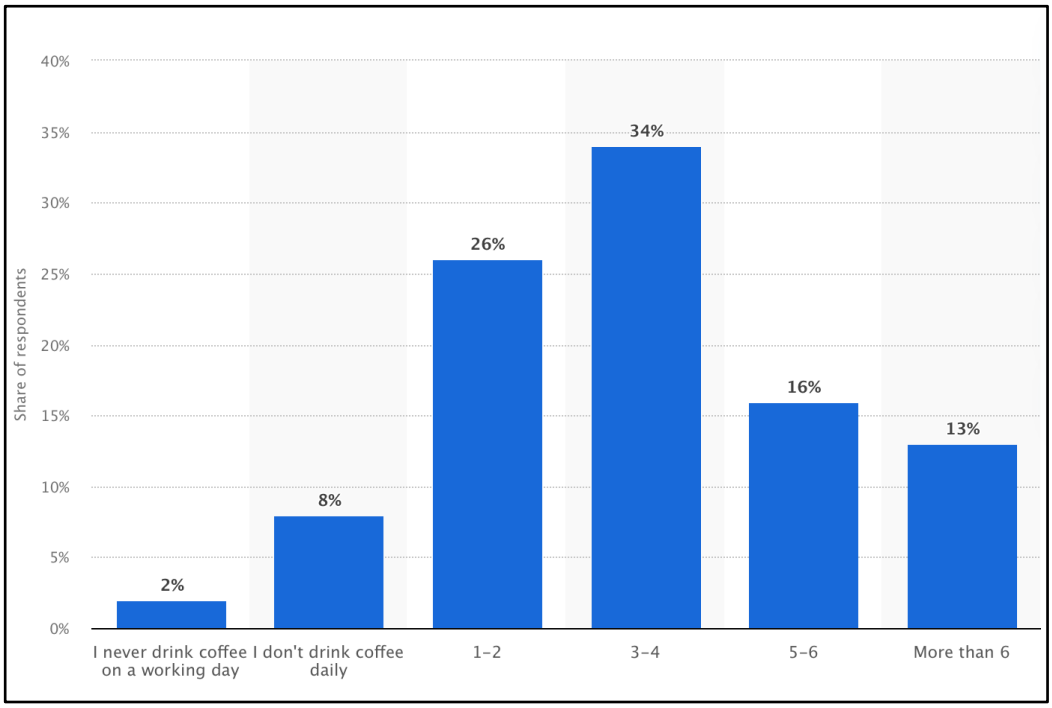
Belgium is a coffee loving country. The perception of Belgian consumers towards coffee is highly positive, as noted by Brand Business Lead and FMCG expert Ms. Gomez. Indeed, there's a lot of benefits that coffee provides to consumers, as developed in the "Health Benefits" section of the literature review, whether it be water intake, antioxidants, proteins, although many consumers are not aware of them (Gomez, 2023).

Eighty five percent of Belgian households drink coffee. When keeping all Belgium's consumers in mind, including all beverages available, this number attains the two-cup mark (Belgian coffee consumers are mild coffee lovers. They appreciate a sweet cup of coffee. A little more than half of Belgian coffee consumers drink their coffee black (Gomez, 2023).

Out of all the consumed beverages, coffee represents more than half (Gomez, 2023; Nielsen, 2023b, slide 5). Belgian hot beverage consumers drink a little under four cups of coffee per day (Gomez, 2023). This coincides with 2019 consumer data retrieved from Statista. As noticeable on figure 21 below, an average Belgian coffee consumer drinks between three and four cups per day (van Gelder, 2020). Based on a survey short of 2,500 interviews with Belgian coffee consumers from across the country, aged 18 to 55+, 28% of consumers drink two to three cups of coffee a day and 38% drink 1 to 2 cups of coffee (Kantar, 2023a, slide 9).

Figure 21

Average number of coffee cups consumed daily in Belgium in 2019 (van Gelder, 2020)



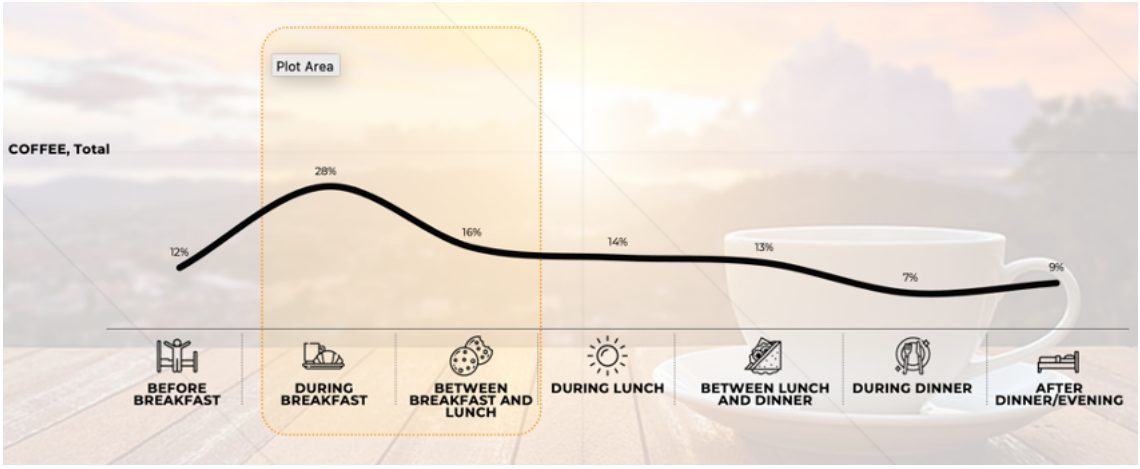
Belgian consumers are not drinking less coffee; they're switching the type of coffee they drink (Gomez, 2023). Indeed, a survey on Belgian coffee consumers established that 11% of Belgian adults reported an increase in coffee consumption post-COVID, with 83% still drinking as much (Dynata, 2020). Belgian Coffee market data confirms this increase in coffee consumption, stating that it is the population between 16 and 34 years old that has led this trend, increasing by 23% in one year (Nielsen, 2023b, slide 15).

Belgian Consumer Profiles & Consumption Dynamics

Belgian coffee consumers have been observed to drink the most coffee during their quick breakfast and mostly while recharging at home later in the day, across all profile categories, as a gentle start (see figure 22 for illustration) (Nielsen, 2023a, slide 11).

Figure 22

Coffee Consumption Moments in Belgium in 2022 (Nielsen, 2023b, slide 26)



The following data emanates from a survey conducted in 2023 to extract data on Belgian nationals having consumed coffee in the last 24 hours, to determine Belgian coffee user profiles and coffee consumption dynamics in the country (Nielsen, 2023a, slide 2). Nielsen offers one way of segmentation Belgian coffee consumers, through six typologies. Belgian in-home coffee consumers have also been categorised into two dimensions by the data insights consumption company. Firstly, the older, more conservative and grounded consumer or rather the younger, more driven consumer, allocating importance to its external image. The consumption reason for the coffee is the second dimension: whether the coffee is consumed for functional purposes or whether it is more about enjoying the moment (Nielsen, 2023a, slides 6 & 7).

Around 45% of today's Belgian coffee consumers are labelled to be rather conservative and more grounded when it comes to coffee consumption. The other 55% of coffee consumers fall under the more dynamic, young and driven consumer profile. Around 35% of Belgian coffee consumers drink coffee for its functional properties, with an average of 65% of Belgian consumers drinking coffee for the emotional connection (Nielsen, 2023a, slide 7).

The best performing coffee profile, at 30%, are consumers that find enjoyment in family and small indulgences. They couldn't live without the coffee they know. They make choices based on taste rather than nutrition or healthy lifestyles.

The second largest profile, at 20%, are more organised and responsible consumers, striving for balance and control in their lives. Proactive in leading a healthy lifestyle, they don't over-indulge in coffee but enjoy drinking fresh, quality coffee.

Thirdly, 16% of Belgian at-home coffee consumers are said to lead their lives around their home and family. They do not have a vaste outlook on life and advance day-to-day. This functional coffee consumer tends to drink coffee out of habit, often in the mornings. Taste is the key driver of coffee consumption here as health does not come into play as a consumption factor.

The fourth category, at 13%, are very optimistic consumers, driven to succeed and get the most out of life. This consumer type appreciates a good quality coffee and will pay for the best, all the while making healthy choices for a balanced lifestyle.

The fifth category, at 12%, slightly health aware, represents coffee novices. This profile drinks coffee for the social and image aspects rather than for taste.

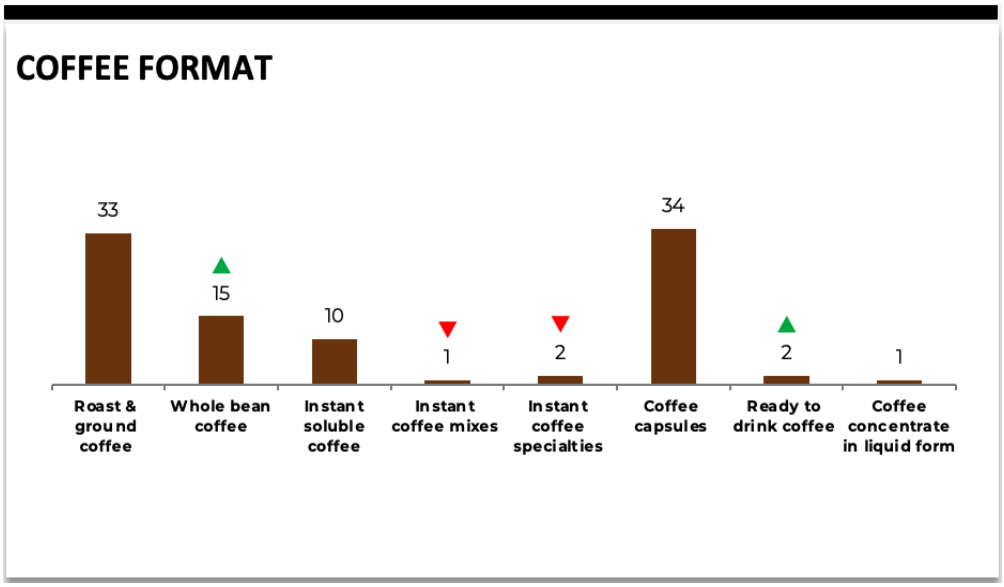
Lastly, 9% of Belgian in-home coffee consumers are responsible, reserved, cautious and health conscious. They drink coffee for the caffeine, not for the taste which they dislike (Nielsen, 2023a, slide 9).

Nielsen data shows that capsules, followed by whole beans, are the preferred coffee formats of the first four profiles, representing the highest coffee shares out of all Belgian consumer profiles. The first three allocate importance to coffee freshness, the organic-natural attributes and authentic taste. The two largest profiles like to prepare their coffee just how they like it, in their own way, whether it be capsules or whole beans (Nielsen, 2023a, slide 10).

An additional survey, conducted by the data and insights consulting company Nielsen, has shared data which aligns with these statements. Roast & Ground and Portioned Coffee are the most popular coffee formats among Belgian consumers. Capsules represent the largest piece of the pie at 34%, followed by ground coffee at 33% and, one third place, whole beans at 15%, aligning with market dynamics identified above (see figure 23 below) (Nielsen, 2023a, slide 13; Nielsen, 2023b, slide 7 & 13).

Figure 23

Percentage of Consumed Coffee Formats in Belgium in 2022 vs 2021 (Nielsen, 2023b, slide 7)

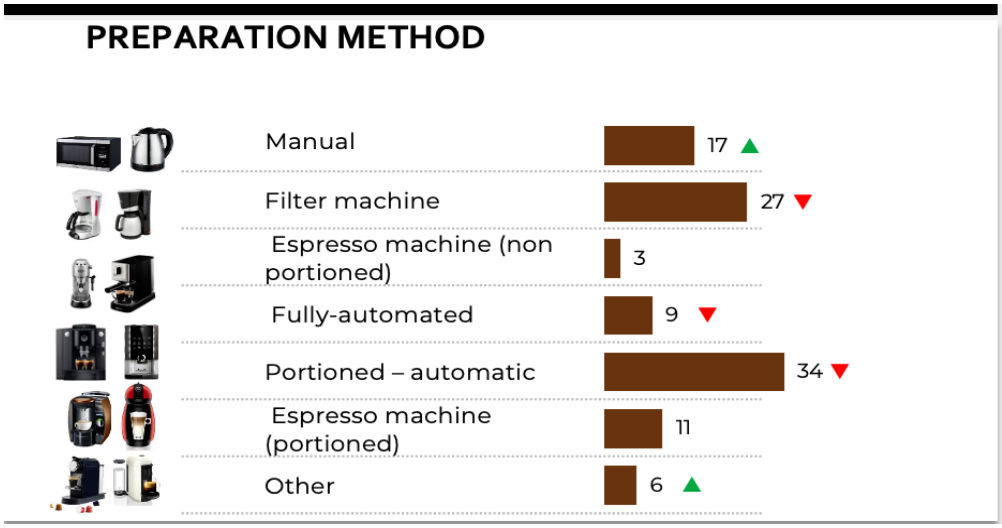


Coffee Preparation Methods Used by Belgian Consumers - Environmental Impact

Aligned with data above are insights on preparation methods used by Belgian consumers. As seen on the figure below, Nielsen identifies Portioned-Automatic machines as the most-used coffee preparation method in Belgium in 2022, at 34%, followed by the filter machine at 27%, the boiler (manual preparation methods) and the espresso capsule machine at 17% and 11% respectively. What's interesting to note is that coffee preparation methods used in Belgium, which have been identified by scientific research as generating an undeniable environmental impact, are experiencing a decline in usage.

Figure 24

Percentage of Consumed Coffee Formats in Belgium in 2022 vs 2021 (Nielsen, 2023b, slide 7)



New innovative preparation methods as well as manual preparation methods, such as the boiler used for the French Press and other new upcoming coffee preparation methods or stove used for the Moka pot, are not experiencing this decline. On the contrary, their utilisation has increased in 2022 vs 2021 (Nielsen, 2023b, slide 7).

Scientific research has shown conflicting results with regards to the environmental impact ranking of the various coffee preparation methods present in Belgian households. Parameters such as energy usage in MJ, Co2 emissions generated in grams or materials used have enabled the quantification and assessment of the environmental impact within the life cycle assessment (LCA) of coffee to a certain extent (Humbert et al., 2009; Phrommarat, 2019; Marinello et al., 2021). When cross-referencing the various authors' contributions, two generally favourable methods appear to be soluble coffee first, followed by the French Press and the Drip-Filter coffee method (no machine required), although energy use varies greatly depending on the machine's efficiency (Humbert et al., 2009; Brommer et al., 2011; Marty et al., 2023; Phrommarat, 2019; Marinello et al., 2021; Hicks, 2017; Pinto et al., 2024).

Single-serve Espresso (Capsule) machines and the Moka pot are a controversial subject (Humbert et al., 2009; Brommer et al., 2011; Marty et al., 2023; Marinello et al., 2021; Cibelli et al., 2021; Hicks, 2017; Pinto et al., 2024). The former frequently ranks poorly, largely due to the environmental cost of the capsule packaging and power consumption. Phrommarat (2019) has called out the latter to be energy-intensive during the manufacturing and consumption stages, although Cibelli (2021), supported by Nowell (2023), remains adamant that the Moka pot contributes to lower greenhouse gas emissions than its counterpart. As noticeable on the figure above, the portioned espresso machine, however, is not experiencing a decline. This may be due to the growing demand and interest, market expansion in sales value, recycling innovation and developments in Belgium and evolving consumer behaviour and trends identified on the market. The change in consumer behaviour is mirrored by evolving consumer consumption patterns, particularly evident in the evolution of adopted coffee preparation methods.

The coffee preparation method, identified as most detrimental to the environment, is the automatic espresso machine. It consumes the most energy and water and generates the most Co2 emissions (Brommer et al., 2011; Cibelli et al., 2021). It is experiencing a decline, as noticeable on the figure above. The electric filter coffee machine follows this trend as well, showcasing the evolving consumer

behaviour and the contradictory scientific research, one side of which has identified filtered coffee machines to be more detrimental to the environment than espresso capsule machines, when taking revised energy efficiency, newly introduced capsule recycling methods and innovative capsule material evolutions into account (Chayer & Kicak, 2015; Marty et al., 2023; Marinello et al., 2021; Hicks, 2017; Nowell, 2023; Pinto et al., 2024).

Belgian Consumer Behaviour

Based on consumer market intelligence, 64% of the Belgian consumers are price sensitive. Belgian consumers monitor their spendings carefully and tend to focus on saving money (Nestlé, 2023b, slides 2 & 3). Indeed, 40% of Belgians used money from their savings to complete their current budget (Nestlé, 2023b, slide 5). They are therefore defined as not confident, spending in moderation. The pandemic exacerbated the market share of coffee private labels, also called store-brand products, at 39% in 2022, in Belgium (Quelch & Harding, 1996; Nestlé, 2023b, slide 2). Belgian coffee consumers have been characterised as "shop-hoppers", as a consumer data consulting agency, Nielsen, states that price is the number one concern for shoppers in 2023 (Nestlé, 2023b, slide 2). A correlation is present between the shift towards private labels and inflation. Indeed, brand-name products cost on average twice the price as private label substitutes (Nestlé, 2023b, slide 3).

As Belgian shoppers become increasingly price-conscious, shopping behaviours have been identified to better respond to consumer needs and catch onto new innovation opportunities. Consumers look for better value, a smart deal, want to make an informed choice or look out for trusted brands.

On the other hand, Belgian consumers are increasingly interested in authenticity, representing coffee origins (Nestlé, 2023c, p. 4). This consumer interest aligns with the identified interests for coffee traceability and transparency and ultimately a growing demand for ethically-sourced coffee (Statista, n.d.; CBI, 2024). Therefore, organic and ethically grown coffee make up a growth opportunity (Nestlé, 2023c, p. 5). A data insights consulting company shares that the consumption of organic and sustainable coffee increased between 2021 and 2022 in Belgium, which confirms this interest and demand for ethical coffee through the recent increase of organic coffee on the Belgian market (Nielsen, 2023b, slide 12).

All six consumer segments (see section III.) have been classified in three sustainability commitment levels: high, medium and low commitment. Nearly all six profiles are said to show medium commitment (Nielsen, 2023b, slide 18). This supports the issue reflected by the intention-action gap theory, observing a disparity between market demand and real demand (consult section VI.) (Lee & Bateman, 2021; Kantar, 2023b). The largest consumer profile, representing 30% of the consumer base, consists of highly committed consumers to sustainability, reflecting the highest level of engagement, and has shown an increase in 2022 compared to the previous year (Nielsen, 2023b, slide 18).

Besides an interest in origins, traceability and transparency, a demand for quality coffee by Belgian consumers has also been established. A quest for unique flavours and specialty coffee to be exact (Statista, n.d.).

In parallel to coffee taste and quality, health has been a point of interest for consumers and thus, a growth opportunity not to be ignored (CBI, 2024; Mordor Intelligence, 2024; (Nestlé, 2023c, p. 4).

The trends outlined here have a significant impact on Belgian consumer profiles. The two largest consumer profiles, making up 50% of Belgian coffee consumers together, who prize quality, may start seeking out more affordable options within their preferred formats. The fourth and fifth profiles, at 16% and 12%, already price-conscious, may become more susceptible to less expensive coffee. This shift towards affordability could see a decrease in ethical coffee purchases unless retailers find ways to maintain the perception of value while addressing price sensitivity.

o Impact of the Coronavirus on Consumer Behaviour

Consumer perception has been impacted by the Coronavirus. Indeed, a 2020 survey on Belgian consumption patterns conducted by Fairtrade Belgium inquired about sustainable consumption following the Coronavirus. The pool of respondents consists of more than one thousand adults from the Belgian population, who were asked to answer questions from a scale of "don't agree at all", "rather not agree" and "no opinion" to "rather agree" and "completely agree" (Dynata, 2020). A total of 70% of respondents realised the importance of solidarity post-COVID more than ever. More than half realised how vulnerable the Belgian food chain is, as well as the important role of farmers in the food chain. 50% of the respondents now allocate more importance to the source of the coffee than before 2019 (Dynata, 2020).

It has been established that Belgian consumers are looking to buy more locally, more fairtrade and more organic, following the pandemic (Dynata, 2020). Indeed, increasing importance is being allocated by consumers towards healthy living. Concerns for coffee sustainability are gaining traction, impacting consumer preferences (CBI, 2024; Mordor Intelligence, 2024). When asked about their personal ways of consumption, whether buying in bulk, local, biological or fairtrade was considered by Belgian adults, around 20% said to be consuming in bulk, fairtrade and organic. A whopping 42% declared to be consuming locally post-COVID. Thirty three percent of Belgian consumers will buy directly at the farm itself more often, or in a local open air market (21%), rather than going to hard discount stores (9%) or to the supermarket (5%) (Dynata, 2020).

Data suggests that the levels of financial prudence exerted by Belgian consumers are increasing as a result of the Coronavirus. According to a survey conducted by Dynata (2020), 71% of respondents fully agreed with this statement (Dynata, 2020). Indeed, scientific research has identified a higher price sensitivity experienced by consumers, primarily led by inflation, as developed in the sections I. and III. above. The global pandemic exacerbates this trend (Hernandez et al., 2020; Panhuysen & de Vries, 2023).

Although inflation and the pandemic exacerbate price sensitivity, a consequential purchasing factor for Belgian consumers, as established, coffee consumption is increasing in Belgium, among the younger age group (16 to 34 years old). These have been identified to be less price sensitive than older generations (35 to 54 and 55+). Furthermore, the largest consumer profiles in Belgium out of the six identified above, prize quality over affordability. Sustainability is increasingly gaining importance as a purchasing attribute as well (CBI, 2021c). Its growing interest may influence their willingness to pay more for coffee, thus justifying the higher price point for sustainable coffee (Kantar, 2023b; Fuller & Grebitus, 2023; Lee & Bateman, 2021).

Consumer Purchasing Attributes - Embracing Sustainable Coffee Practices

A report, published in partnership with conservation international, states that the coffee market is vague when it comes to transparency of information throughout the supply chain. Most consumers are said to be in the dark when it comes to knowing their consumed coffee's origins, producer or if fair pricing was implemented (Panhuisen & de Vries, 2023).

The strength of a brand is reflected by the interests of the consumers of that country, and thus vary from one country to another. In Belgium, a powerful brand is one that offers high-quality coffee, and an enjoyable coffee moment, especially a morning moment, based on analytics retrieved by the Kantar data insights consulting company. Convenience, morning and indulgence are driving coffee consumption factors for Belgian coffee consumers. Coffee innovation and authority generate uniqueness and distinction (Kantar, 2023a, slide 31). Coffee authority is said to refer to superior coffee quality, taste, blends and origin (Kantar, 2023a, slide 44).

Data retrieved from Nestlé Belgilux and harvested by Kantar states that sustainability is not yet a driving force for Belgian consumers, regarding brand strength and product choice. However, it has been said to contribute towards it (Kantar, 2023a, slide 31). Data retrieved from the "Sustainability" section, Environmental Responsibility division of the literature review, affirms this by naming price as the primary decision attribute, outweighing sustainability. The latter has, however, been characterised as significant when it comes to purchasing decisions, thanks to the transparency it conveys (Lee & Bateman, 2021). Additional literature, tracing back to the Certified Coffee division, "Certifications" section above, contributes to this statement by suggesting that the importance allocated towards sustainability labels and certifications in Belgium within purchasing decisions is growing. This goes hand in hand with the increased demand for traceability, coffee quality and sustainability emanating from the consumers (CBI, 2021c). Indeed, an increasing number of Belgian brands now sell compostable capsules as part of their product portfolio. Or Coffee, Màsalto, Koffie Kàn, de Koffiejongens, Charles Liégeois and Lavazza are all brands which have introduced industrially compostable, home-biodegradable and/or zero-emission capsules (Or Coffee Roasters, n.d.; Màsalto, 2024; Koffie Kàn, 2024; de Koffiejongens, 2022; Charles Liégeois, n.d.-d; Lavazza, 2022). Nespresso is currently piloting compostable capsules as well (see the "paper" division of the "Environmental Impact of Capsule Packaging" section) (Nespresso, 2024; Reuters, 2022).

Brand loyalty, quality, taste and quality are factors which consumers take into account pre-purchase as well, in addition to sustainability and price (Lee & Bateman, 2021). Published research states that fairtrade coffee, improving the socioeconomic status of farmers, and organic coffee, more widespread, improving the health and environment of farmers, are gaining market share in Belgium and still in demand with penetration rates increasing (Dragusanu & Nunn, 2020; Lee & Bateman, 2021; Fairtrade Belgium, 2021; CBI, 2021c). Please note that brand loyalty for fairtrade coffee increases in parallel with brand quality and price (Lee & Bateman, 2021).

The Value-Action Gap - Sustainable Coffee Consumption

The value-action gap, also called the intention-action gap, is defined by people acting in a way that's inconsistent with their values (Lee & Bateman, 2021; Kantar, 2023b). It highlights the difference between market demand and real demand, as established in the literature review above (Lee &

Bateman, 2021). What people claim to hold true as their values is seen to counter their actions regarding sustainability and ethical consumption patterns (Kantar, 2023b). Please refer to appendix 5 for an illustration of the concept.

Theoretical material from the Consumer Behaviour course of HEC Montréal, given by M. Nepomuceno, states that these objections between actions and intentions generate an unpleasant emotional state, in other words a feeling of guilt, among consumers (Solomon et al., 2017).

A sustainability report conducted by Kantar (2023b) suggests that this is a very real topic of conversation. Surveyed data in more than 1000 consumers in Belgium suggests that many are concerned, but few take action. Learnings from this survey are said to make it easier for brands to see where consumers hold friction and provide solutions to facilitate an easier transition to adopting more sustainable practices (Kantar, 2023b).

30% say that they are willing to invest time and money to support companies that do good. However, more than 70% buy something without checking if it's Fairtrade or produced locally and around 80% of Belgian consumers opt for new products instead of purchasing pre-loved (Kantar, 2023b).

This source shares that while people may care about sustainability issues, barriers exist that prevent sustainable consumption from being an easy, frictionless choice. The cited barriers are knowledge and awareness, price and quality, convenience, accountability, impact and fulfilment and lastly, availability (Kantar, 2023b).

Regarding knowledge and awareness, 67% of respondents share their struggle in differentiating which products are good or bad ethically, for the environment or for sustainability as a whole, stating that they don't have enough information.

Regarding price, 81% of consumers' minds are on price more than on sustainability, with 73% sharing that sustainable and ethical products are always pricier.

When it comes to convenience, almost 70% admitted to not thinking about sustainable products while shopping. These issues are apparently not on their radar.

More than half of consumers (65%) do not take accountability. They feel it's up to businesses and producers to take action, or the governments and NGOs. More than half of respondents feel businesses don't seem to be trying hard enough.

Regarding Impact and fulfilment, the majority of Belgian consumers (70%) feel that they are not making much difference alone. Less than half believe that it's too late to make a difference (45%).

Lastly, about availability, slightly more than half of Belgian consumers feel that their preferred brands do not offer sustainable versions of their products. 46% do not know where to find ethical or sustainable products (Kantar, 2023b).

Interestingly enough, out of three age groups, 18-34, 35-54 and 55+, it is the younger generation which renounces responsibility, accountability and interest the most. They follow group trends the most (Kantar, 2023b). As seen in the consumer behaviour course at HEC Montreal, given by professor x, social influence can be reflected in many forms. One of which is reference groups, defined as having significant relevance upon an individual's evaluations, aspirations, or behaviour. Normative group

influence is what's at play here, based on this course, as the youngest age group is looking towards others to know what to do (Nepomuceno, 2023, Session 6, slide 7). Social pressure has the power to influence consumer behaviour. Research on consumer behaviour suggests that people's public attitudes and purchase decisions may be different from their private ones. This effect is called the "subjective norm", which should be taken into account when surveying consumer intentions (Solomon et al., 2017).

Please note that convenience, knowledge barriers and price priority have been noticed to increase with age, as the percentage is higher within the second and third age groups (Kantar, 2023b).

Consumers are looking to brands to address these barriers and make sustainable consumption an easy, frictionless choice, as will be affirmed below by an additional survey conducted by Fairtrade Belgium (Kantar, 2023b).

A study on environmental issues and marketing activities found that consumers with greater conviction show greater consistency between actions and intentions. In addition, it states that past behaviour has shown to be a better predictor of future behaviour, than consumers' behavioural intentions may be (Solomon et al., 2017).

Kantar (2023b) proposes innovation, communication and activation interventions as solution enablers in closing this intention-action gap.

To bridge the gap between attitudes and behavioural intentions, the HEC Montréal Consumer Behaviour professor, M. Nepomuceno, introduces Volkswagen's Fun Theory, a case-in-point example of innovation and activation interventions which are presented as solution enablers by Kantar above (Solomon et al., 2017). The brand Volkswagen launched a campaign in 2009, encouraging the use of stairs by turning it into a piano (see illustration below), showing that consumer behaviour can be heavily impacted when turned into a fun activity. The number of staircase users increased by 66% thanks to the integration of the piano (Lan, 2013).

Figure 25

Volkswagen Fun Theory Campaign (Lan, 2013)

o Consumer Awareness & Perception on Sustainability - Emerging Behaviours

The global data insights consulting company Kantar (2023b, p. 10) sifted through the concerns of Belgian nationals regarding sustainability. The survey conducted by the latter establishes that sustainability issues are top of mind for Belgian consumers (Kantar, 2023b, p. 18).

The data is derived from a survey sampling over 1000 respondents from the country aged between 18 and 55+. Indeed, out of 32 topics linked to the 17 United Nations Sustainable Development Goals (UN SDGs), key concerns are overwhelmingly linked to the environment. The UN has highlighted the importance of acting locally, per country, and has identified the food and drinks consumption as being a critical player affecting behaviours which in turn generate detrimental climate changes (Kantar, 2023b, p. 10 & 12).

This same survey on how sustainability is perceived by Belgians revealed that 44% of Belgian consumers pay a lot of attention towards social and environmental issues in the news. 30% are prepared to invest time and money to support companies trying to do good and 42% currently buy sustainable products to reflect their image and values (Kantar, 2023b, p. 20).

When asked about the most critical concerns that today's Belgian population experienced, respondents identified Poverty & Hunger, Water Pollution and Deforestation to be their highest areas of concern. Kantar observed that preserving biodiversity and ensuring the survival of future generations is a pressing matter which must not slip through the cracks. Consumers accentuate that it must be addressed (Kantar, 2023b, p. 13).

The survey has shown that the younger population (18-34) now addresses more concern towards social issues such as Mental health, Inclusion, Gender inequality and Xenophobia compared to the older age groups 34-54 and 55+ (Kantar, 2023b, p. 14 & 15).

The survey findings have further established the appearance of new behaviours among Belgian consumers towards sustainability such as the avoidance of products with plastic packaging, the increasing purchase of certified, sustainably-sourced and more sustainable products. The survey reflects the trend of purchasing less in quantity and more in quality (Kantar, 2023b, p. 17). The Fairtrade Belgium survey conducted by Dynata (2020), addresses this last idea as well, suggesting that Belgian consumers now focus more on sustainable and quality consumption while cutting back on overall consumption.

The current sustainable action which Belgian consumers are most willing to implement, out of a list of 25 actions provided to them ranging from energy and public transport usage to clothes purchases and becoming vegan for example, was to reduce food waste, followed by taking their own bags when shopping, recycling everything they can, reducing energy at home and using less water. Next was buying items that used less or reusable/refillable packaging (Kantar, 2023b, p. 21).

Based on the survey responses and Kantar's analysis, the latter states that consumers are ready to make conscious choices and acknowledge the role they play in the environment. However, they encourage companies to come up with solutions that are easy, convenient, scientifically proven and rewarding, as people are finding it difficult to identify the most sustainable solutions (Kantar, 2023b, p. 22).

The survey conducted by Dynata (2020) for Fairtrade Belgium affirms these findings. It suggests that half of Belgian consumers now allocate more importance to the environmental impact of their food and drinks. Almost half of the respondents shared that they are now paying more attention to sustainable products and their health benefits compared to before COVID-19 (2019). Notably, 60% of Belgian adults believe that businesses, supermarkets in this case, should do more to promote sustainable consumption (Dynata, 2020).

Among difficulties encountered by Belgian consumers regarding sustainability and product purchases, two stood out. The survey highlighted the challenge of greenwashing and a difficulty in identifying true sustainable products, leaving consumers uncertain about what and who to trust (Kantar, 2023b, p. 19). A CSR professor noted in 2023 that a trust crisis has been brewing over the last years, between companies and clients (Tebini, 2023, session 1). Information asymmetry, transparency issues and a lack of trust by consumers act as roadblocks to sustainable coffee consumption (European Commission, 2020; Panhuysen & de Vries, 2023; Terlau & Hirsch, 2015). The opposite is said for transparency, along with coffee traceability, which have emerged as a driver for increased sales, as discussed in the literature review sections on "Sustainability" and "Assessment of Belgium's Coffee Market" (Statista, n.d.; CBI, 2024; Lee & Bateman, 2021). As the literature review section on certifications suggests, consumers in Belgium are increasingly becoming aware that with coffee comes a certain social and environmental impact and are developing a growing interest and attention regarding the matter (CBI, 2021c; Fuller & Grebitus, 2023).

Literature above states that transparency and sustainability surrounding coffee started being a subject of conversation during the third coffee wave, roughly between 2005 and 2010. The quality of coffee and the science behind it, the integration of technology and sustainability and a true understanding of environmental impacts and awareness characterise the fourth, fifth and sixth waves, from 2010 to 2020 (ICO, 2023b; CBI, 2024). Indeed, coffee consumers are more knowledgeable and demanding in 2024 (CBI, 2024). As professor Tebini (2023, session 1), teaching Corporate Social Responsibility at HEC Montréal, expresses, communication has evolved and parties are now less able to hide what they're doing. Consumers are increasingly aware and transparency is growing (Tebini, 2023, session 1).

These challenges can potentially be addressed by investing towards CSR and integrating Voluntary Sustainability Standards (VSS) and sustainability certifications, which aim to provide consumers with higher transparency of information regarding sustainable product attributes and act as a means of materialising commitments, albeit at a higher product price (Martins et al., 2022; Majer et al., 2022; Jena & Grote, 2022). Corporate social responsibility is gaining importance globally and is increasingly being integrated in Belgium (Stobierski, 2021; Belgian Federal Government, 2024). Ms. Tebini (2023, session 1) shares that globalisation, facilitating free flow of information, and sustainable ecology have contributed to the increasing integration of CSR.

To elaborate further on CSR and add on to the content available in the literature review, a Corporate Social Responsibility professor, Ms. Tebini (2023, session 1) has defined CSR, as a social responsibility that goes beyond the economic responsibility that a company has towards its stakeholders and its environment. CSR is not only implemented in good faith. Although ethical responsibility is one of the four responsibilities that a socially responsible company should carry, it is the sunshine of many critics. It is nowadays implemented to give sense to a company, to ensure the sustainability of a company over time, to maintain or grow its market share through this market opportunity or to build legitimacy

(Tebini, 2023, session 1). However, as professor Tebini (2023, session 1), teaching Corporate Social Responsibility at HEC Montréal, expresses: the goal of a socially responsible company must be to raise awareness and shake up the consumer, which is what the latter seems to be increasingly doing on its own already (see 3 paragraphs above) (CBI, 2021c; Fuller & Grebitus, 2023).

As it has been said in the literature review (see section on Corporate Social Responsibility), through strategies, goals and initiatives, CSR has the power to generate innovative solutions, allowing for reduced waste or energy consumption as an end result and ultimately making companies, activities and products more environmentally friendly (Tebini, 2023, session 1; Stobierski, 2021).

- Life Cycle Assessment of Coffee - Environmental Impact

Production Phase

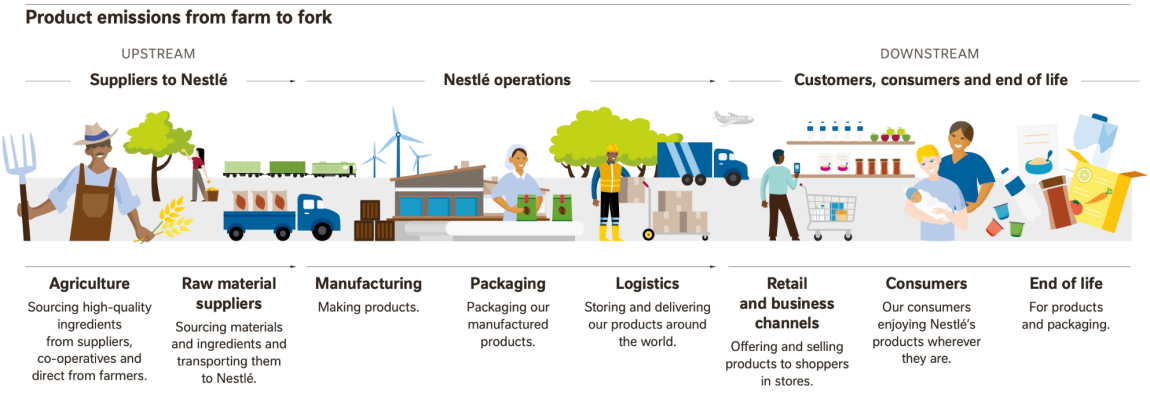
As discussed in the literature review, the production phase is responsible for the majority of the detrimental ecological impact of coffee consumption. This is still the case today, from gathered data and the interview conducted last year with a coffee BEO (Brommer et al., 2011; Dessureault, 2023; Grèze, 2023).

Mr. Grèze (2023) indicates that coffee production represents 60% of the total ecological impact, followed by the use phase in second place. He adds that the correlation between environmental impact and the amount of coffee, energy, and water consumed during the usage phase is finally brought up in scientific research (Grèze, 2023).

Indeed, Nestlé's Net Zero Roadmap establishes that upstream and downstream activities of the value chain are the scope that represent 94.6% of generated GHG emissions in 2018, and where the company will thus most of its efforts to reduce the GHG produced (please refer to the illustration below for reference). The 3.3% and 2.5% represent direct and indirect emissions generated by Nestlé such as fuel for company vehicles and purchased energy respectively (Nestlé, 2021).

Figure 26

Co2 Emissions throughout the Product Life Cycle (Nestlé, 2021)



To support the statement that 60% of coffee's greenhouse emissions are generated by the production phase even more, Nestlé's Net Zero roadmap shares that sourcing its ingredients represents more than

71,4% of its global GHG emissions, next to manufacturing, packaging, logistics and transport (Nestlé, 2021).

Use Phase

The use phase follows in close second place (Thoden van Velzen et al., 2023; Quantis, 2019). Its environmental impact heavily relies on consumer consumption practices. As the choice in preparation methods is changing, so too is the environmental impact of the use phase. The amount of coffee content, energy and water used by the preparation method and by the consumer during preparation and consumption determines environmental impact (Thoden van Velzen et al., 2023; Quantis, 2019). M. Greze (2023) stated in his interview, Belgian consumers waste less coffee today as sustainability is kept in mind, reducing excessive coffee, water and energy production.

Overall

Nestlé has many practices in place to improve its sustainability footprint or environmental impact which will be developed: (Nestlé, 2021)

- It is investing in packaging innovations (packaging materials) and strategies to keep waste from landfills. As mentioned in the literature review, although packaging does not make up the largest share of GHG emissions within the LCA, waste which ends up in landfills or unrecycled and incinerated is very detrimental to the environment (Thoden van Velzen et al., 2023; Marinello et al., 2021). Quantis (2019) shares that its level of impact could significantly be reduced by 50% when using recycled materials for example. More and better solutions are now present to avoid packaging from ending up in landfills and being recycled in Belgium (Fost Plus, 2024b) (see literature review).
- It is moving towards sustainable products and transforming the product portfolio. As seen in the analysis above, more than half of Belgian consumers feel that their preferred brands do not offer sustainable versions of their products (Kantar, 2023b). Regarding coffee, specialty coffee is seen as healthier for the planet, with lower GHG emissions than conventional coffee (CBI, 2021a). It is experiencing a rise in demand and interest as well, as Belgian consumers are searching for quality and sustainability among other factors (ICO, 2023b; CBI, 2024) (see literature review).
- It is investing in cleaner logistics (renewable energy).
- It is sourcing its ingredients more sustainably by working with farmers, enhancing livelihoods and protecting ecosystems (certifications). Certifications are increasingly being integrated by companies and seen as important by consumers (CBI, 2021c). The Fairtrade and Organic certified coffees, for example, are seen to have a more positive environmental impact than conventional coffee, with lower GHG emissions (Agguirre et al., 2024) (see literature review).
- It is using its voice to galvanise action (campaigns). As seen in the analysis above, this is what consumers seem to be asking for and is necessary to break accountability, knowledge and awareness barriers (Kantar, 2023b).

In Practice, to source ingredients more sustainably and reduce GHG emissions, Nestlé avoids deforestation with the goal to eliminate it completely. It also plants hundreds of millions of trees, as

natural ecosystems are under pressure. Improving transparency by working with farmers, to know more on how and where materials are produced (Nestlé, 2021).

The role of packaging is to keep food safe and fresh. It accounts for 12% of Nestlé carbon footprint in 2018. Plastic ending up in the environment has been called out as one of the most pressing global challenges the world faces by Nestlé (2021). Nestlé's goal is to have all of its packaging 100% recyclable or reusable by 2025, by improving recycling infrastructures, helping increase recycling rates and shifting from virgin plastics to recycled plastics among other practices. The company has a first of its kind R&D packaging institute in Lausanne Switzerland Nestlé (2021). From 2030 onwards, the company aims to innovate and invest from bio-based plastics and reusable packaging to net-zero synthetic plastics with renewable energy for example (Nestlé, 2021).

Nestlé affirms in its Net Zero Plan that consumers are demanding low-carbon products such as plant based foods and drinks. It's a shift that is present in the company's core strategy and they plan to engage 1 billion consumers (Nestlé, 2021).

Brands themselves within Nestlé are moving towards carbon neutrality, such as Nespresso by 2022. To be carbon-neutral as a brand, GHG emissions must be assessed, carbon insetting must first be practised, which is removing carbon within the value chain, before offsetting carbon, in other words balancing the carbon emissions, outside of the company's direct value chain (Nestlé, 2021). Nespresso became a B Corp member in that year as well (Hermans, 2023).

The difference between a corporate net zero target and brand carbon neutrality is "Farm to Store", including the end-of-life stage, and "Farm to Fork", including the consumer use and end-of-life stage, respectively. Insetting and offsetting are practised within brand carbon neutrality. However, in a corporate net zero strategy, no offsetting is allowed. All emissions must be balanced by insetting (Nestlé, 2021).

Regarding using its voice to galvanise action, Nestlé will advocate for government policies and leadership within civil societies, to limit global warming to 1.5% (Nestlé, 2021).

- Actions Promoting Environmental Responsibility at Company-level in Belgium: Nestlé

The Net Zero by 2050 Objective

Nestlé Belgilux, like more than one third of the current 2000 largest companies worldwide, is committed to Net zero Greenhouse Gas (GHG) emissions (Nestlé, 2021; Accenture, 2022). Please note that Accenture states that this goal will not be met for most companies if they don't double their efforts to meet a net zero goal by 2030. Please also note that rising energy price inflation and supply insecurity are requiring companies to invest more effort than initially planned to achieve their goals (Accenture, 2022).

Please note that Accenture (2022) and Nestlé Belgilux's BEO for Coffee, M. Patrice Grèze (2023), establish that the war in Ukraine, the Coronavirus, macroeconomic turbulence as well as rising energy prices have acted as drivers for change and catalysts of commitment for companies. The war and the pandemic are the grass roots of inflation, galvanising macroeconomic turbulence as global debts accumulate, generating a risk of economic crisis (Grèze, 2023). Out of the 2000 companies, 84% are

still planning to increase investments in their sustainability initiatives (Accenture, 2022). Nestlé is following the same trend (Nestlé, 2021; Grèze, 2023).

Nestlé has sustainable goals in place on corporate and brand level. It is committed on corporate level to Net zero GHG emissions by 2050 and on brand level, Nespresso is carbon neutral since 2022 (Nestlé, 2021).

The AAA Certification's Role

The Belux Marketing Director of Nespresso, Bob Hermans (2023), shared during an interview that the aim with the AAA certification is to offer quality coffee to consumers in a collaborative way with the farmers, while respecting set quality and sustainability standards. Almost 100% of the Nespresso coffee is sourced from the rainforest alliance today, if not to say all of its coffee (Hermans, 2023). As the literature above states (see section on certifications, AAA certification), the AAA program was put in place by Nespresso, together with the Rainforest Alliance in 2003 (Nespresso, n.d.). These standards are said to produce economic, social and sustainable results (CRECE, n.d.).

The Nescafé Plan's Role

As seen above, the Nescafé Plan is a Brand level goal. It's about helping make the world better, from farm to cup (Nescafé, 2022). The Nescafé Plan is about working with farmers to help enhance resilience to climate change, help improve farmers' lives with higher incomes among other practices and build strong coffee communities. Climate change, import costs, coffee prices and labour have been identified as the main challenges farmers have experienced from 2017 to 2021, followed by irrigation, the fact that other crops are more profitable and the lack of family to take over (Nescafé, 2022). Climate change has indeed been named a strong threat to these commitments (Nescafé, 2022). Patrice Grèze, the Benelux BEO for Coffee at Nestlé, states that the biggest challenge for the future is having enough coffee, keeping global warming in mind which the planet is having to endure (Grèze, 2023).

Collaboration throughout the coffee value chain of companies implementing sustainability initiatives on their own is crucial to generate sustainable change. Engaging in collective actions to accelerate positive, sustainable change is key (Nescafé, 2022).

Nescafé's 2030 vision has 3 pillars: reducing GHG emissions, increasing farmers' incomes and improving social conditions. By 2025, the brand will offer 100% responsibly sourced coffee and will source 20% of its coffee through regenerative agriculture methods. By 2050, the latter number is expected to reach 50% and GHG emissions are expected to decrease by 50%. Regenerative agriculture is at the core of this plan. It allows the achievement of all three goals in theory. It is said to protect and restore natural resources, enhance soil health and biodiversity, and reduce the use (and improve efficiency) of fertilisers and agrochemicals. As seen in the literature review, such materials pollute waters and degrade biodiversity (Panhuysen & De Vries, 2023; Marinello et al., 2021).

As well as a partnership with Nespresso, the Rainforest Alliance has a longstanding partnership with Nescafé (Nespresso, n.d.; Nescafé, 2022). The organisation helps Nescafé guide its programs by providing data collection and analysis. From 2018 to 2022 an increased adoption of regenerative agriculture, higher farmer revenues and high farmer satisfaction rates with the Nescafé Plan were

established. Farmer satisfaction is based on training and technical assistance provided, consistent green coffee volume purchases and competitive prices (Nescafé, 2022).

The C.A.F.E. Practices' Role

The C.A.F.E. practices are present to support and help farmers and their farming activities as well (see literature review, Certifications section). Like the B Corp certification, this certification can be lost if no continuous improvement is established (Starbucks, 2020).

The B Corp Movement's Role

The B Corp movement seems to play a role in promoting environmental responsibility, according to M. Robrecht Herman's observations. As M. Hermans says, "B Corp is a movement, not just a certification" (Hermans, 2023, para. 4). It offers a roadmap, a frame to the company and clarity, in order to implement sustainable change more easily, efficiently, and concretely. This benefits communities, the environment and the people that the B Corp, Nespresso in this case, serves and works with (Hermans, 2023). The B Corp movement is a way of expressing everything that Nespresso does for good and a means of doing even better. As M. Herman repeats: "If we don't want to end up with an empty cup, we need to protect what's inside it" (Hermans, 2023, para. 22). Projects such as giving coffee machines a second life, improving recycling systems for coffee capsules and reviving coffee origins are examples allowing for the achievement of a higher B Corp score. The objective with campaigns is to generate awareness every time. Nespresso is currently in the market of providing reassurance as much as possible (Hermans, 2023).

To become a B Corp, it is necessary to continuously show improvement in benefiting communities, third parties, and the environment. Ambition, drive, and initiative are essential. As a B Corp certified company, it is mandatory to continuously show improvement to avoid losing your certification. Losing the B Corp status is a very real possibility. It's about assessing yourself yearly and incorporating new perspectives. It's about being challenged and about like-minded people thinking together (Hermans, 2023).

The Marketing Director makes a parenthesis on communication in order to generate awareness and have an impact on consumer behaviour. When investing in sustainability campaigns and communication, the risk of losing in brand value must be considered if such values are not part of the core brand from the start. Consumers associate Nespresso with quality coffee, for example. Bob Hermans highlights that Nespresso consumers are first and foremost looking for quality over sustainable coffee. Literature does suggest that sustainability does not rank higher in terms of purchasing decisions compared to price, taste, brand loyalty or quality. However, its importance has been living an increasing trend (Lee & Bateman, 2021).

A strong link between generating an impact and awareness and consumer perception has been established by Robrecth Hermans. He feels that the B Corp movement may be a way of receiving external validation, improving perception, as it encompasses sustainability as a whole, whether it be economic, social or environmental. It allows for the brand to better answer the current consumer demand for ethical, quality coffee and thus improve consumer perception on the brand's sustainability practices and claims (Hermans, 2023).

This is especially relevant to this current day, as a trust crisis between consumers and companies is said to be brewing (see the previous section on Consumer Awareness and Perception on Sustainability for reference). In the current world, consumers are increasingly wary of sustainability claims, uncertain about who and what to trust (see interview transcription and the previous section on Consumer Awareness and Perception on Sustainability for reference). Bob Hermans highlights that greenwashing remains a challenge to overcome (Hermans, 2023; Kantar, 2023b, p. 19). He acknowledges that customers feel inundated with sustainability claims from every corner. These claims are increasingly being used indiscriminately: carelessly and without proper justification. As a company, more caution must be exercised around the utilisation of such "green" and "sustainable" terms and claims. Brands have yet to find the right balance to ensure their stated actions align with their actual implemented actions and carry the appropriate connotation (Hermans, 2023).

Nespresso held a score of 84 in 2023. The AAA sustainability program, launched by Nespresso, has not even been taken into account, when it comes to Nespresso's B Corp score of 84 (Hermans, 2023). But it reflects a piece of Nestlé's DNA which has always been a rooted part of the company: Sustainability. The B Corp certification is the next level in terms of environmental responsibility, in M. Hermans' eyes. If a brand wishes to have a sustainable impact, consumer perception is a substantial factor which must be kept in mind. Understanding how consumers will perceive the impact is a challenge. However, while simultaneously providing reassurance through explanations, the B Corp certification may improve consumer perception on environmental considerations (Hermans, 2023).

Fost-Plus Recycling Movement's Role

Launched with the collaborative efforts of Nestlé, Nespresso, JDE and Fost Plus, the Blue Bag initiative offers recycling potential, lower packaging waste generation and a lower environmental impact (see literature review, Environmental Impact of Capsule Packaging section) (Thoden van Velzen et al., 2023; Fost Plus, 2022; External Survey, 2024). A new survey externally conducted in 2024 shows that 80% of Belgian consumers are aware that coffee capsules can be disposed of in the blue PMD bag. Out of those 80%, 61% always do it. The end goal of this mission is to give capsules a second life, and why not even more (External survey, 2024).

Please note that the EU regulation on packaging recycling is very strict for Belgium. Not any capsule may be recycled in the blue bag or composted (European Commission, 2022). Therefore, compostability claims may not be used although the capsule material itself may be compostable, the facilities or regulations don't allow for it (Gomez, 2023; European Commission, 2022; Fost Plus, 2024d).

Results

To effectively assess the environmental impact of the in-home coffee consumption evolution in Belgium between 2019 and 2023 and address the corresponding research question, five hypotheses were developed.

Research Question: “How has the shift in Coffee (Capsule) Consumption Patterns in Belgian Households impacted the Environment? A comparative analysis from 2019 to 2023.”

Hypothesis 1

The environmental impact of the Belgian in-home consumption of coffee is worse as its consumption increased during 2019 and 2023.

The scientific literature as well as conducted interviews and surveys reveal that many factors come into play when determining the environmental impact of in-home coffee consumption. The sales evolution, the potential evolution of the coffee format consumed, the potential change in the coffee preparation method used, the change in type of coffee consumed, change in cup size and a potential change in behaviour and in implemented actions throughout the supply chain must be taken into account (on farm-level, on consumer-level and on end-of-life level for example).

What can be established is that Belgian coffee consumers are rather spending more on coffee (Nestlé Belgilux, 2022b; (CBI, 2021a; ECF, 2023).). Their volume of coffee consumed remains relatively stable (Nestlé Belgilux, 2022c; (ECF, 2023). Consumption saw an increase not in terms of volume but rather in terms of value.

Throughout the change in total value, shifts in chosen coffee formats and coffee preparation methods have taken place. A vast increase in single-serve coffee consumption has been established as well as of soluble coffee, followed by a slight increase of whole beans consumed (ECF, 2023; Statista, n.d.; Nestlé Belgilux, 2022c). Although various scientific studies touch upon the single-serve capsule market growth, soluble coffee has received less light.

Please note that scientific research has called out instant coffee to be the least GHG emitting coffee preparation method. Also keep in mind that capsules make less use of coffee and water (Thoden van Velzen et al., 2023; Quantis, 2019; Marty et al., 2023). The environmental impact is largely influenced by the quantity of coffee content, water and energy ultimately consumed, as the cultivation stage is said to emit more than 50% of the GHG emitted by the coffee life cycle, followed by the use phase emitting not less than 30% (Brommer et al., 2011; Quantis, 2019, Grèze, 2023). As mentioned earlier, coffee capsules require less coffee compared to other methods of coffee preparation to prepare one cup of coffee, reducing its environmental impact, although convenience plays a role (Thoden van Velzen et al., 2023; Quantis, 2019; Marty at al., 2023).

The type of coffee, whether it be conventional coffee, specialty coffee or certified coffee, plays a role in the environmental impact it generates. Although the Belgian coffee market is saturated, a particular demand for specialty coffee and single-serve coffee has been identified (CBI, 2021a; CBI, 2021b; CBI, 2024). Consumption of certified coffee is on the rise as well (Agguirre et al., 2024; Noponen et al., 2012).

Increasing consumer awareness regarding their social and environmental impacts align with identified trends on the Belgian in-home coffee market. The latter indicate a shift towards more environmentally responsible consumption patterns. Although Belgian coffee consumers are increasingly price sensitive, they are willing to pay more for sustainable and certified coffee as they align better with their values (Statista, n.d.; CBI, 2024; Mordor Intelligence, 2024; Fuller & Grebitus, 2023; CBI, 2021a; CBI, 2024).

The behaviour of all third parties is witnessing an improved sustainable evolution. Consumers are demonstrating higher expectations for sustainable coffee, displaying greater knowledge and interest in coffee traceability and ethical sourcing (Statista, n.d.; CBI, 2024). Companies on the other hand are actively investing in sustainable practices, such as certifying their coffee, while acknowledging the significance of consumer awareness amidst a backdrop of trust challenges and concerns regarding greenwashing (European Commission, 2020; Panhuysen & de Vries, 2023; Terlau & Hirsch, 2015; Hermans, 2023; Tebini, 2023; session 1). Additionally, companies are dedicating resources to innovation, developing sustainable alternatives for capsule packaging, establishing partnerships to facilitate proper disposal systems, and launching initiatives to raise consumer awareness, spread information, and incentivise sustainable behaviours (Hermans, 2023; Raabe et al., 2022; Norman, 2023; Pinto et al., 2024; Baranwal et al., 2022; Reuters, 2022; Mohan, 2023; Lomartire et al., 2022; AP News, 2022).

In conclusion, the hypothesis that the environmental impact of in-home coffee consumption is worsening due to increased consumption cannot be definitively affirmed or denied. Although the volume of consumption remained stable between 2019 and 2023, the scenario is more complex. Factors such as the shift in coffee preparation methods and formats, inflation, evolving market trends, and changing behaviours of brands, consumers and third parties contribute to this complexity. Therefore, determining the environmental impact requires a holistic approach, considering all facets of the coffee life cycle and the various factors that come into play, where providing a straightforward answer proves to be challenging.

o Hypothesis 2

The gap between the perceived environmental impact and the actual environmental impact of coffee consumption in Belgium is smaller compared to 2019 due to increased awareness and education efforts.

As stated in the practical review, lack of knowledge, awareness and accountability act as barriers to this sustainable positive change forwards (Kantar, 2023b). The good news is that consumers have been identified as more demanding, knowledgeable and aware (Statista, n.d.; CBI, 2024; CBI, 2021c; Fuller & Grebitus, 2023; Tebini, 2023, session 1). Communication is evolving (Tebini, 2023, session 1). Indeed, interest in ethical coffee, transparency and coffee traceability is on the rise (Statista, n.d.; CBI, 2024). Demand for certified coffee, shown to produce less Co2 emissions during its life cycle, is increasing (Agguirre et al., 2024; Noponen et al., 2012). Consumers are increasingly concerned surrounding environmental issues and it is said to impact their preferences (European Commission, 2020; Panhuysen & de Vries, 2023; CBI, 2024; Mordor Intelligence, 2024). Consumers are awaiting action from companies (Dynata, 2020).

Sustainability issues have been said to be top of mind for Belgian coffee consumers (Kantar, 2023b, p. 18). Conviction regarding the importance of sustainability is increasing. A study found that greater conviction allows to reduce the gap between actions and intentions (Solomon et al., 2017).

However, while the gap between action and intention relating to ethical and sustainable consumption is reducing, there is still a gap between what the market reflects and what is really occurring, or what consumers believe the environmental impact to be and what it really is (Lee & Bateman, 2021). The proportion of concerned Belgian consumers is much higher than the proportion actually taking action. One reason for this can be that surveys do not always have the ability to fully provide reality-reflective actions at all times, but rather intentions or desired actions (Lee & Bateman, 2021). Please note that more certified coffee was produced than it was sold. The literature review shares that 74% of the produced certified coffee between 2020 and 2022 was sold as conventional coffee due to lack of demand, generating profit loss (Panhuysen & de Vries, 2023). Is this due to the action-intention gap? Many factors come into play. One of them being price which remains the most important purchasing factor for consumers. Sustainability has however been identified as gaining importance as a purchasing attribute among Belgian coffee consumers (Lee & Bateman, 2021).

To further reduce the knowledge, awareness and accountability barriers, the practical review introduces activation interventions, innovation and fun as having the weight and power to impact consumer behaviour (Solomon et al., 2017; Lan, 2013).

The trust crisis which is present between brands and consumers, aside a feeling of information overload generate uncertainty within consumers, allowing for a gap between trusting what they read and see and believing it, impacting perception (Tebini, 2023, session 1; Kantar, 2023b, p. 19; Terlau & Hirsch, 2015). Indeed, as an interview reflects, consumer perception highly impacts consumer behaviour. It's about generating awareness in a manner that reassures the consumer, while staying true to a brand's core values to generate sustainable change (Hermans, 2023).

The actual environmental impact follows the same positive trend as the consumer awareness, interest and demand. A survey on Belgian coffee consumers indeed shows an increased consumption of sustainable and quality coffee while cutting back on overall consumption (Dynata, 2020). More sustainable consumption leads to less Co2 emissions and thus an improved life cycle assessment score for the coffee on an environmental standpoint. However, global coffee consumption is expected to rise globally by 50% in 2050 (Grèze, 2023). Certified coffee, on the rise, produces less Co2 emissions than conventional coffee does. Instant coffee, the coffee preparation method which has been determined to be emitting the least Co2 emissions, together with capsules which seem to be doing better in many instances throughout the LCA compared to drip filter coffee for example, have experienced a compound annual growth rate of 1.1% and 1.6% respectively, compared to a decline in CAGR of 1.4% for roast and ground coffee, which incorporate the second least emitting coffee preparation formats such as manual pour over filter coffee methods and the French Press (Nowell, 2023; Humbert et al., 2009; Marty et al., 2023; Phrommarat, 2019; Hicks, 2017; Pinto et al., 2024; Quantis, 2019). Recycled capsules lead to a lower environmental impact, up to 50% less Co2 emissions, as well, whether it be thanks to their production phase or end-of-life phase (Quantis, 2019).

Hypothesis 3

Each coffee preparation method generates its own unique environmental impact, with coffee capsules generating a better environmental impact compared to 2019 due to substitute packaging and improved disposal options in Belgium.

Scientific literature review affirms that the method of coffee preparation used impacts the environmental impact of the coffee consumed greatly. The choice of coffee preparation method falls under the use phase of the coffee life cycle. Research established that the cultivation phase is the most greenhouse gas emitting phase, followed by the consumer preparation and use phase (Quantis, 2019; Brommer et al., 2011; Grèze, 2023; Nestlé, 2021). Quantis (2019) quantifies the Co2 emissions of both stages at 40% and 35% respectively. Other sources attribute a percentage of above 55% of emissions to the cultivation stage (Brommer et al., 2011; Grèze, 2023).

The environmental impact of the use phase greatly depends on consumer behaviour. The coffee content used as well as the water utilisation and energy consumption as the factors which affect its detrimental environmental impact the most (Thoden van Velzen et al., 2023; Quantis, 2019; Marty et al., 2023). A machine's efficiency, programming, water-heating technology and leaving it on or turning it off take up energy required for the preparation of coffee which must be kept into account as well (Marty et al., 2023).

As mentioned in the hypothesis above, the preparation method for instant coffee has unequivocally been identified as the most environmentally favourable out of all coffee preparation methods (Humbert et al., 2009; Nowell, 2023; Marty et al., 2023). The manual pour over filter coffee methods and the French Press are next (Phrommarat, 2019; Brommer et al., 2011; Marinello et al., 2021). The automatic espresso machine was identified as the worst environmentally-performing option (Cibelli et al., 2021). When it comes down to the electric drip filter coffee machine and the single-serve coffee machine, more factors and perspectives come into play. Scientific research suggests that electric drip filter machines perform better environmentally-wise, as more energy is consumed by capsule machines and as plastic and aluminium packaging represents a burden for the planet (Brommer et al., 2011; Marinello et al., 2021). Marty et al. (2023) does note that convenience of single-serve coffee capsules can lead to overuse, increasing its environmental impact. However, innovations in capsule materials and developed recycling disposal systems are generating a revision of this statement, allowing for a lower environmental footprint. Identified authors in the literature review, in turn, share the belief that single-serve coffee capsules generate less Co2 emissions than filtered drip coffee (Chayer & Kicak, 2015; Hicks, 2017; Pinto et al., 2024; Norman, 2023). Capsule packaging material substitutes and improved disposal and recycling systems, machine efficiency and a lower amount of coffee content required per cup lead to this statement. Research has highlighted that around 20% less coffee is used to make one cup of coffee with a capsule as well as around 50% less water (ECF, 2022; Nowell, 2023; Hicks, 2017; Humbert et al., 2009; Pinto et al., 2024; Chayer & Kicak, 2015). Drip-filter coffee is said to generate more coffee spilling, to consume more energy during dripping and to generate more coffee waste (Chayer & Kicak, 2015). Additionally, although packaging waste is very detrimental to the environment, its disposal only represents 2% of coffee's total life cycle carbon footprint (Quantis, 2019; Cibelli et al., 2021). The lower coffee content used and lower amount of energy utilised with the single-serve preparation method are said to outweigh the packaging waste's impact in terms of GHG emissions generated (Chayer & Kicak, 2015).

Hypothesis 4

Advancements in Belgium are present in terms of coffee capsules material substitutes and recycling and disposal systems which has generated a reduction in the in-home coffee market's environmental-impact

Scientific research has identified a substantial decrease in Co2 emissions when substituting capsule packaging materials and when disposing of capsules through sorting, recycling, biodegradation or composting, instead of incineration, landfills, exports or littering (ECF, 2022; Nowell, 2023; Hicks, 2017; Humbert et al., 2009; Pinto et al., 2024; Chayer & Kicak, 2015; European Commission, 2024).

Scientific research has established that an increasing number of companies are turning towards the production of bioplastics and compostable materials (Kooduvalli et al., 2020). This has been identified on the belgian market as well, as an increasing number of companies offer compostable capsules as part of their product portfolio (Or Coffee Roasters, n.d.; Màsalto, 2024; Koffie Kàn, 2024; de Koffiejongens, 2022; Charles Liégeois, n.d.-d; Lavazza, 2022). The environmental concern is growing, triggering sustainability initiatives (European Commission, 2020; Nab & Maslin, 2020).

Recycling rates for aluminium and tin have been identified as experiencing a substantial increase. They are shown to produce less Co2 emissions than virgin aluminium (Koons, 2018a). The recycling of aluminium is expected to double by 2050 (Raabe et al., 2022). Tinplate offers the same advantage as it is made from scraps and not from scratch (Pinto et al., 2024). Aluminium production from scraps is increasing and aluminium production from scratch is experiencing a decline (Raabe et al., 2022).

Biopolymers, deriving from natural resources, such as the newly-introduced Migros coffee balls made up of seaweed or the newly-introduced the Nespresso paper-pulp capsules, present much potential for an improved environmental impact, opening the doors to biodegradability and compostability (Norman, 2023; Baranwal et al., 2022; Reuters, 2022; Mohan, 2023; Lomartire et al., 2022; AP News, 2022). However, scientific literature suggests that Belgium has strictly regulated disposal and composting regulations in place (European Commission, 2024; European Commission, 2022; Fost Plus, 2024d). This makes it more challenging for companies to bring these products to market as strict conditions and standards must be met. Furthermore, light has been shed on the lack of regulation on compostability labels which may only reflect a minimal amount of bioplastics in the packaging. Furthermore, as compostable and biodegradable capsules are not allowed in the blue PMD bag in Belgium, this makes it difficult for consumers to reuse and recycle. Reducing, reusing and recycling have been highlighted to represent the core of the Green Deal, the circular economy action plan and the EU plastics strategy (Fost Plus, 2024d; European Commission, 2022).

Please note that, with non-biodegradable bioplastics, conventional plastics and aluminium capsules allowed in the blue PMD bag since a little more than a year, thanks to improvements in recycling infrastructure, less capsules now end up incinerated and in landfills and more capsules end up recycled and reused for new capsules (Fost Plus, 2022). Please note that the Fost Plus capsules recycling initiative in Belgium is yielding results. 61% of coffee capsule consumers now dispose of their capsules in the blue PMD bag, with awareness which attained 80% (External survey, 2024). The sorting facility is delivering on its aim to increase plastic recycling from 12% in 2021 to at least 75% in the coming years (Fost Plus, 2024b).

Although not all types of capsule materials are allowed in the blue PMD bag, biodegradable and compostable plastics in this case, the environmental impact of the packaging stage of the coffee life cycle, representing around 2% of the total GHG emitted during the coffee life cycle, has witnessed an improvement compared to 2019 as recycling rates have soared and regulations and concern and awareness are increasing (Fost Plus, n.d.; Fost Plus, 2024a; Quantis, 2019; Cibelli et al., 2021; CBI, 2024; Mordor Intelligence, 2024; Martins et al., 2022). Innovations in substitute materials, more favourable for the environment as seen above, are on the rise as well. Furthermore, a conducted interview establishes that campaigns are now used as a means to educate on sustainable practices and to generate higher and improved awareness (Hermans, 2023). All of the above offers a favourable answer to the fourth hypothesis, claiming that the changes in coffee capsules material substitutes and recycling and disposal systems in the last four years have generated a reduction in the in-home coffee market's environmental-impact.

- Hypothesis 5

The use of sustainability labels has increased on the Belgian in-home coffee market and has generated more sustainable purchasing decisions among consumers and less detrimental consumption to the environment

Literature has established that certifications are increasingly being sought out, as consumer demand for ethical and sustainable coffee grows (CBI, 2021c). The voluntary sustainability standards, encompassing sustainability certifications, have allowed for greater transparency and traceability along the supply chain (Majer et al., 2022; Martins et al., 2022). They have generated an increase in certified coffee and have influenced policy-making (Panhuysen & de Vries, 2023; Martins et al., 2022).

Research regarding the addressed standards, in other words sustainability certifications, lead to a better environmental impact and lower GHG emissions throughout the life cycle (Agguirre et al., 2024; Nab & Maslin, 2020). The difference in transport modes used, the water and energy efficiency, the amount of agrochemicals and packaging used and the type of energy result in this difference (Nab & Maslin, 2020). To give an example, during cherry picking alone, research shows that conventional coffee generates more Co2 emissions than certified coffee (Noponen et al., 2012).

Sustainability certifications such as the Rainforest alliance, the Fair Trade certification and the Organic certification to name a few, generate a higher socio-economic status as well as positively impacting the environment (Dragusanu & Nunn, 2020; Agguirre et al., 2024). Conducted research seems to suggest that farmers' lives improved thanks to higher incomes and better living conditions. They allow for a reduction in poverty as well as more inclusion (Lee & Bateman, 2021; Jena & Grote, 2022). An external study conducted on Nespresso's AAA practices, set up with the Rainforest Alliance, asserts the certification did generate an improved economic output of 42%, social impact of 23% and environmental impact of 52% (Quantis, 2019; Nespresso, n.d.).

Certain certifications require continuous verification and improvement to be maintained, allowing for a more efficient impact (Hermans, 2023; Starbucks, n.d.). In addition, communication allows for an increase in consumer engagement and awareness as well (Hermans, 2023).

As stated in the literature review labels are not always representative of reality. A case-in-point example is the lack of minimum the number of bioplastics legally allowed in a bioplastic labelled

material (European Commission, 2022). Furthermore, with the increased appeal for certifications popularity comes an increase in concerns. On farm-level, research suggests that cultivators only see a slight revenue improvement. To add on to this, research suggests that wealthier farmers benefit more from such certification schemes than less fortunate cultivators (Jena & Grote, 2022; Dragusanu & Nunn, 2020).

Consumer concern and awareness surrounding environmental impact and interest for certified coffee is increasing (CBI, 2024; Mordor Intelligence, 2024). Although consumers are increasingly price-sensitive, sustainability is an increasingly important purchasing factor. Indeed, consumers consume less in quantity and are increasingly choosing to consume more sustainable products (Kantar, 2023b, p. 17). Furthermore, the number of certified coffees consumed is increasing (Panhuysen & de Vries, 2023). The presence of Fair Trade and organic coffees is expanding on the Belgian market (Fairtrade Belgium, 2021; Lee & Bateman, 2021). The certified coffee portfolio on the Belgian retail market is expanding as well, as established above. This leads consumers to increasingly choosing sustainable coffees over conventional ones. However, amid a brewing trust crisis, a risk of information overload and wary consumers must be kept in mind (Tebini, 2023, session 1; Kantar, 2023b, p. 19; Terlau & Hirsch, 2015).

All in all, aside from the growing presence of sustainability labels, an increase in consumer interest for sustainability coffee and an increase in awareness regarding sustainability concerns are present, positively influencing Belgian consumer purchasing behaviours.

Barriers and Recommendations

Barriers

The first barrier identified in the frame of this dissertation is the time gap between the collected primary qualitative data, conducted during the linked internship, and the scientific literature research and dissertation composition. The interviews bake back to mid 2023. This required planning a year in advance and substantial prior reflexion, and conducting interviews prior to writing the literature review, not hand in hand. However, contact was established between the interviewees more recently to affirm that the insights remain relevant.

This dissertation's title presents a large playing field, making it challenging to revert back to the core thread while researching and analysing. The scope of the analysis starts broadly, while focussing on sustainability. However, this makes it all the more interesting, offering a wider net of knowledge which has been incorporated in the dissertation. This does bring added depth during the lecture and leads to more attention required during reflection.

This dissertation presented a few barriers. Firstly, contradictory research made it difficult to arrive at a cohesive conclusion. More precisely, certain literature pieces named the single-serve coffee preparation method to be less harmful to the environment than the electric filtered drip coffee machine and vice versa (Chayer & Kicak, 2015; Hicks, 2017; Pinto et al., 2024; Norman, 2023; Marty et al., 2023; Brommer et al., 2011; Marinello et al., 2021). Same goes for the Moka pot using a stove and the electric drip filtered coffee method (Phrommarat, 2019; Cibelli et al., 2021; Nowell, 2023).

Secondly, a lack of research regarding the newly-innovated paper coffee capsules present on the Belgian coffee market, was identified in comparison to the other capsule materials researched. This represented a barrier towards adding complete market research for the environmental impact of capsule packaging materials (Nespresso, 2024; Mohan, 2023).

A lack of concrete environmental, social and economic results generated by sustainability certifications. Research was found on the certifications themselves, by the organisms as well as by scientific literature and surveys on consumer intentions and actions regarding sustainable coffee (Agguirre et al., 2024; Majer et al., 2022; Jena & Grote, 2022; Kantar, 2023b). However, research on actual change or repercussions on site of cultivation presented a barrier, to determine the actual environmental impact generated by sustainability certifications.

Regarding the environmental footprint and the Co2 levels emitted, it was necessary to combine findings of multiple reports to provide a complete picture as not all the data was to be found in one cohesive report. This was the cafe for coffee preparation methods, where various reports were juxtaposed as no one author compared all of the methods at once (Chayer & Kicak, 2015; Hicks, 2017; Pinto et al., 2024; Norman, 2023; Marty et al., 2023; Brommer et al., 2011; Marinello et al., 2021; (Phrommarat, 2019; Cibelli et al., 2021; Nowell, 2023). This opens the door towards data incongruencies.

As the manual pour-over drip filter coffee method was identified as least environmentally harmful, research was conducted in the most common manual pour-over drip filter coffee types available. The V 60, the Aeropress and the Chemex came to light and are gaining attention (Santanatoglia et al., 2023; Kushalappa, 2023; Konecny & Vassallo, 2024). However, scientific research is the impact of such

manual pour-over methods, being the most environmentally friendly option. This acts as a barrier to incorporating such added value to this dissertation.

Recommendations

Regulation surrounding sustainable solutions is present. However, regulation of such practices, materials and labels is required. As reflected in the dissertation, accountability is essential to generate change. Not only on consumer level, but also on company level and larger entity level to provide efficiency. Accountability, impact, awareness, fulfilment and knowledge have been identified as barriers to sustainable consumption in Belgium (Kantar, 2023b). The European Commission is encouraged to implement regulations to provide action clarity, that are easy to follow, for all parties combined (consumers but also companies) and that allow for the increased implementation of the most sound environmental options. Biodegradable and compostable capsules come into mind particularly (European Bioplastics, 2023)

In line with the increased regulations, efficient waste management solutions that allow for easy and environmentally-wise disposal solutions of compostable and degradable capsules is recommended (Thoden van Velzen et al., 2023). The European Commission named Reducing, Reusing and Recycling as its three core values integrated within the Green deal, the circular economy action plan and the EU plastics strategy (European Commission, 2022). This must set into all of the third party's mindsets. Efforts must be implemented in order to increase the recycling, biodegradation and composting of a maximum of capsules. It is an issue to have biodegradable and compostable capsules, which reflect an improved environmental footprint, but not be able to dispose of them properly, in turn generating an increased environmental footprint.

To allow for this growth in accountability and action, ease and clarity are key, as mentioned above. To make it easier for consumers to identify sustainable solutions and products, and develop their knowledge, apps, scanning barcodes and external sustainability scales are recommended.

Companies putting in efforts to communicate and generate awareness is highly recommended. Brands have the ability to capture attention. Where they choose to focus this attention on is up to them. As determined in the scientific literature, consumers look up to their preferred brands, building loyalty (Lee & Bateman, 2021). Of course, maintaining this loyalty and not generating negative perception among consumers is essential (Hermans, 2023). Therefore, generating awareness must be done carefully and wisely. Empowering communities, promoting circularity and opening the floor to decarbonizing the value chain through clear actions is of the essence.

Raising awareness plays an essential role in the recommendations of this dissertation. It could potentially bridge the action-intention gap which has been identified regarding sustainable coffee demand, by generating a change in mindset which consumers are experiencing and that is acting as a barrier towards action (Lee & Bateman, 2021; Kantar, 2023b). Increasing awareness is key to improving the environmental impact of the Belgian in-home coffee market (Humbert et al., 2009) However, other notions must be raised simultaneously to generate change, the latter being the feeling of impact and fulfilment. An external survey conducted on Belgian coffee consumers concluded that around 70% feel that they are not making much difference alone and also, that it is too late to make change happen. Alongside impact and fulfilment comes accountability. Around 65% of Belgian consumers feel that it is

not up to them but rather up to companies, governments and organisations to take action (Kantar, 2023b). For change to happen, people must have the drive to implement change. This is the same for companies (Hermans, 2023). And for people to want to implement change, they must be aware, knowledgeable and concerned, which is a trend that has been demonstrated to occur regarding sustainability (CBI, 2024; Mordor Intelligence, 2024). For this, fun, activation interventions and communication, as well as innovation have been recommended (Solomon et al., 2017; Lan, 2013). Research states that individual choices matter and that environmental responsibility is shared (Marty et al., 2023). This must be shouted from the rooftops to generate awareness, concern, interest and action.

Raising awareness on the proper ways to improve efficiency during coffee preparation, making up the use phase of the coffee life cycle, makes up a recommendation to generate mindfulness and improve the environmental footprint that consumers generate during the use phase (Marty et al., 2023). The use phase is responsible for at least 35% of the total Co2 emissions of the coffee life cycle (Brommer et al., 2011; Grèze, 2023). Not all consumers are aware of this. Boiling only the necessary quantity of water, using a precise amount of coffee per cup so as not to spill or looking out for the energy consumed during preparation all have the potential to generate positive environmental impact (Humbert et al., 2009). Using renewable energy during the use allows for a smaller environmental footprint as well (Marinello et al., 2021). It is important to remember that water, coffee and energy are finite. Consuming them responsibly is essential to limit the damage done to the environment.

An additional recommendation to shed light on the carbon labels on products, to further reduce the environmental impact of coffee consumption and encourage more environmentally positive purchases (Birkenberg et al., 2021). This study discusses introducing the carbon neutral label specifically. However, a label indicating the Co2 emissions generated by that product, such as the energy efficiency labels implemented in 2021, with the A-G scale, which already exists, would educate the consumer and raise awareness and potentially increase more environmentally sound purchases leading to a reduction in the environmental footprint (European Commission, 2021). This information provided by an external organism has the potential to bridge the trust gap between clients and consumers. As established in research analysis, consumers are unsure what to trust and are increasingly become wary of certifications and claims (European Commission, 2020; Panhuysen & de Vries, 2023; Terlau & Hirsch, 2015; Hermans, 2023; Tebini, 2023; session 1). Its implementation must be seen as a priority. Indeed, carbon labelling is currently being introduced on products in Europe. The carbon trust label is one which has been identified (Carbon Trust, 2024).

Lastly, I recommend embracing the practice for holistic thinking. A call for holistic thinking is necessary to grasp the environmental impact which an individual or a product generates. Often, many underlying or external factors are ignored, affecting outcome.

Conclusion

In conclusion, a call for holistic thinking is necessary to grasp the environmental impact which the Belgian in-home coffee market is generating. Even more so when integrating an evolution over the span of four years. No clear consensus has been determined on the absolute impact which the coffee market generates on the environment. However, clear trends have been identified. Please note that market research shares the word “Sustainability” as being the most discussed critical topic on the web when it comes to capsules, followed by “Price” and “Co2 Neutrality”. Within sustainability, “Waste” followed by “Compostability” are receiving the most significant discussion. One simple answer is not available for such a discussed topic.

Globalisation, the Coronavirus, the Ukraine war and macroeconomic tendencies all have a role to play in the evolving Belgian in-home coffee consumption. Companies are experiencing increased pressure to act in terms of sustainability as their products and services sold have a vast role to play in terms of environmental impact. They are responding. Research has identified improved waste management systems, revised capsule packaging materials, increased availability of certified coffee and increased accountability and communication.

Regarding in-home coffee consumption, while the coffee volume has been relatively stable in Belgium, consumers have been changing the way in which they consume coffee, generating a shift in higher value coffee such as coffee capsules. Consumers have been noticed to develop a preference for quality over quantity. Higher value formats are suggested to use a lower amount of coffee content, water and energy favourably impacting total Co2 emissions and thus generating a lower environmental impact. The cultivation phase of coffee is shown to generate more than half of its total Co2 emissions, followed by the use phase at around 35%.

An increasing number of capsules now generate a lower environmental impact in terms of Co2 emissions, biodegradable and compostable capsules. Sustainable solutions are increasingly being looked into, whether it be by companies or researchers. In addition, improved recycling systems have emerged since 2019 as well, allowing for more recycling of conventional capsules.

The gap between perceived and actual environmental impact is following a favourable trend, as consumers are demonstrating increased awareness, knowledge and concern for the environment. An increasing number of certified coffees is being consumed. Although consumers are increasingly price sensitive, Belgian consumers are increasingly looking for coffee traceability and transparency, with demand for ethically-sourced, certified, quality coffee and soluble coffee, all aligned with a lower environmental footprint, on the rise.

Although consumer trust in company communications is being put to the test, an increasing number of coffees accompanied by sustainability labels has been established. These certifications, with the aim to improve coffee traceability and transparency, may help in resolving these issues. As can increased accountability which has been identified as a barrier to improving the environmental impact.

With these advancements, barriers towards sustainable consumption within the in-home coffee market have been identified as well. Additional regulation, education, awareness and accountability is required. Lack of research on a concrete action plan reflects the weight of this challenge.

Bibliography

Aduteye, E., Sete, T., & Chi, Y. (2023). TIME SERIES ANALYSIS OF GLOBAL PRICES OF COFFEE: INSIGHTS INTO A COMPLEX MARKET. *International Journal of Business & Economics*, *8*(202ba740b-fa90-42d0-91b4-362873e49f2c), 138–151. https://doi.org/10.58885/ijbe.v08i2.138.ea

Aguirre, N., Iturrondobeitia, M., Akizu-Gardoki, O., Lizundia, E., & Mínguez, R. (2024). Comparative analysis of environmental impacts of fair trade organic coffee compared to conventional coffee through life cycle assessment. In Advances in Design Engineering IV (pp. 730–738). https://doi.org/10.1007/978-3-031-51623-8_72

AP News. (2022, September 6). Swiss retailer rolls out "coffee balls" to replace capsules | AP News. Retrieved May 14, 2024, from https://apnews.com/article/switzerland-climate-and-environment-83cc3ee9959e48301b98d68d15693b64

APEAL. (2012). LIFE CYCLE ASSESSMENT ON TINPLATE. In *APEAL - the Association of European Producers of Steel for Packaging*. Retrieved April 28, 2024, from https://www.apeal.org/wp-content/uploads/2012/04/APEAL-LCA_summary_paper11.pdf

Arzoumanidis, I., Salomone, R., Petti, L., Mondello, G., & Raggi, A. (2017). Is there a simplified LCA tool suitable for the agri-food industry? An assessment of selected tools. *Journal of Cleaner Production*, *149*, 406–425. https://doi.org/10.1016/j.jclepro.2017.02.059

Bakaloudi, D. R., Evripidou, K., Jayawardena, R., Breda, J., Dardavessis, T., Poulia, K., & Chourdakis, M. (2022). The impact of lockdowns on caffeine consumption: A Systematic Review of the evidence. *International Journal of Environmental Research and Public Health*, *19*(9), 5255. https://doi.org/10.3390/ijerph19095255

Baranwal, J., Barse, B., Fais, A., Delogu, G., & Kumar, A. (2022). Biopolymer: A Sustainable Material for Food and Medical Applications. Polymers (Basel), 14(5), 983. https://doi.org/10.3390/polym14050983

Belgian Federal Government. (2024). *Corporate social responsibility (responsible business) | Business Belgium*. business.belgium.be. Retrieved April 19, 2024, from https://business.belgium.be/en/managing_your_business/sustainable_business

Benoit P.L.G. 1968. 'Luja (Edouard Pierre)', in : Biographie belge d'Outremer, t. VI, Bruxelles, Académie Royal des Sciences d'Outré-Mer, 1968, col. 676 – 678.

Berkman, E. T. (2018). The Neuroscience of Goals and Behavior Change. *Consulting Psychology Journal: Practice and Research*, *70*(1), 28–44. https://doi.org/10.1037/cpb0000094

Bermúdez, R., & Swarzenski, P. W. (2021). A microplastic size classification scheme aligned with universal plankton survey methods. *MethodsX*, *8*, 101516. https://doi.org/10.1016/j.mex.2021.101516

Bernet, R. (2023, July 25). *How much CO2 does a tree absorb?* One Tree Planted. Retrieved April 25, 2024, from https://onetreeplanted.org/blogs/stories/how-much-co2-does-tree-absorb

Birkenberg, A., Narjes, M. E., Weinmann, B., & Birner, R. (2021). The potential of carbon neutral labeling to engage coffee consumers in climate change mitigation. Journal of Cleaner Production, 278, 123621. https://doi.org/10.1016/j.jclepro.2020.123621

Britannica Kids. (n.d.). *Arabian Peninsula*. https://kids.britannica.com/kids/article/Arabian-Peninsula/346082

Brommer, E., Stratmann, B., & Quack, D. (2011). Environmental impacts of different methods of coffee preparation. *International Journal of Consumer Studies*, *35*(2), Wiley Library. https://doi.org/10.1111/j.1470-6431.2010.00971.x

Cambridge Dictionary. (n.d.-a). Environmental Responsibility. In Cambridge Dictionary. Retrieved May 16, 2024, from https://dictionary.cambridge.org/dictionary/english/environmental-responsibility

Cambridge Dictionary. (n.d.-b). Composting. In Cambridge Dictionary. Retrieved May 15, 2024, from https://dictionary.cambridge.org/dictionary/english/composting

Cambridge Dictionary. (n.d.-c). Recycling. In Cambridge Dictionary. Retrieved May 15, 2024, from https://dictionary.cambridge.org/dictionary/english/recycling

Cambridge dictionary. (n.d.-d). Sustainability. In Cambridge Dictionary. Retrieved May 15, 2024, from https://dictionary.cambridge.org/dictionary/english/sustainability

Cambridge Dictionary. (n.d.-e). Penetration. In Cambridge Dictionary. Retrieved May 15, 2024, from https://dictionary.cambridge.org/dictionary/english/penetration

Campuzano-Duque, L. F., & Blair, M. W. (2022). Strategies for Robusta Coffee (Coffea canephora) Improvement as a New Crop in Colombia. Agriculture, 12(10), 1576. https://doi.org/10.3390/agriculture12101576

Carina, D., Sharma, S., Jaiswal, A. K., & Jaiswal, S. (2021). Seaweeds polysaccharides in active food packaging: A review of recent progress. Trends in Food Science & Technology, 110, 559–572. https://doi.org/10.1016/j.tifs.2021.02.022

Carrefour. (n.d.). Carrefour BE Storefront Catalog | Carrefour Belgique. Retrieved April 30, 2024, from https://www.carrefour.be/fr/search?q=caf%C3%A9

Cazaudehore, G., Monlau, F., Gassie, C., Lallement, A., & Guyoneaud, R. (2021). Methane production and active microbial communities during anaerobic digestion of three commercial biodegradable coffee capsules under mesophilic and thermophilic conditions. Science of the Total Environment, 784, 146972. https://doi.org/10.1016/j.scitotenv.2021.146972

CBI. (2021a). Statistiques et perspectives du marché. In *cbi.eu*. Retrieved March 5, 2024, from https://www.cbi.eu/sites/default/files/market_information/researches/2021%20Coffee%20Statistics%20and%20Outlook%20FR.pdf

CBI. (2021b, October 12). Exporting coffee to Belgium | CBI. Retrieved March 19, 2024, from https://www.cbi.eu/market-information/coffee/belgium-0

CBI. (2021c, October 12). The Belgian market potential for coffee | CBI. Retrieved April 30, 2024, from https://www.cbi.eu/market-information/coffee/belgium/market-potential

CBI. (2024, February 13). *Which trends offer opportunities or pose threats in the European coffee market? | CBI*. CBI Ministry of Foreign Affairs. Retrieved February 17, 2024, from https://www.cbi.eu/market-information/coffee/trends

Charles Liégeois. (n.d.-a). Sustainable development. Retrieved May 2, 2024, from https://charles-liegeois.com/en/sustainable-development

Charles Liégeois. (n.d.-b). Introducing our new identity! Retrieved May 2, 2024, from https://charles-liegeois.com/en/blog/introducing-our-new-identity

Charles Liégeois. (n.d.-c). "Generous to the planet". . . Easier said than done! Retrieved May 2, 2024, from https://charles-liegeois.com/en/blog/generous-planet-easier-said-done

Charles Liégeois. (n.d.-c). Mano mano puissant. Retrieved May 6, 2024, from https://charles-liegeois.com/en/shop/coffee-pods-nespresso-mano-puissant

Chayer, J.-A., & Kicak, K. (2015). Life Cycle Assessment of coffee consumption: comparison of single-serve coffee and bulk coffee brewing. In *Quantis*. Retrieved April 22, 2024, from https://lyonspc2019.files.wordpress.com/2019/03/pac0680-full-lca.pdf

Cibelli, M., Cimini, A., Cerchiara, G., & Moresi, M. (2021). Carbon footprint of different methods of coffee preparation. *Sustainable Production and Consumption*, *27*, 1614–1625. https://doi.org/10.1016/j.spc.2021.04.004

Conservation International. (n.d.). Sustainable Coffee Challenge. Retrieved May 3, 2024, from https://www.sustaincoffee.org/

Cramer, P. (1957). A review of literature of coffee research in Indonesia. In *Interamerican Institute of Agricultural Sciences*. SIC Editorial. Retrieved February 14, 2024, from https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwj5ssehsreEAxXoi_0HHba7DvQQFnoECA4QAQ&url=http%3A%2F%2Frepositorio.iica.int%2Fbitstream%2Fhandle%2F11324%2F14860%2FCDCR21030663i.pdf%3Fsequence%3D1%26isAllowed%3Dy&usg=AOvVaw0lW2Sk1QSdMY-eTz32wiGm&opi=89978449

CRECE. (n.d.). CRECE's monitoring & evaluation study on the Nespresso AAA Sustainable Quality Program in Colombia. In CRECE. Retrieved April 30, 2024, from https://www.nestle.com/sites/default/files/asset-library/documents/media/news-and-features/2013-may/crece%20nespresso%20study%20executive%20summary.pdf

Data Bridge. (2020). Polylaminate Capsule Market – Global industry trends and forecast to 2028 | Data Bridge Market Research. In *Data Bridge Market Research*. Retrieved April 28, 2024, from https://www.databridgemarketresearch.com/reports/global-polylaminate-capsule-market

Datov, A. (2019, June 18). *Classification and grading of green coffee beans in Asia*. FFTC Agricultural Policy Platform (FFTC-AP). Retrieved February 27, 2024, from https://ap.fftc.org.tw/article/1405

De Koffiejongens. (2024, April 18). Koffiesmaken van De Koffiejongens. Retrieved May 6, 2024, from https://dekoffiejongens.nl/koffiesmaken/

Del Rio, D. D. F., Sovacool, B. K., Griffiths, S., Bazilian, M., Kim, J., Foley, A., & Rooney, D. (2022). Decarbonizing the pulp and paper industry: A critical and systematic review of sociotechnical developments and policy options. Renewable & Sustainable Energy Reviews, 167, 112706. https://doi.org/10.1016/j.rser.2022.112706

Domingues, M. L. B., Bocca, J. R., Fávaro, S. L., & Radovanovic, E. (2020). Disposable coffee capsules as a source of recycled polypropylene. *Polímeros*, *30*(1). https://doi.org/10.1590/0104-1428.05518

Dragusanu, R., & Nunn, N. (2020). *The effects of fair trade certification: Evidence from coffee producers in Costa Rica* [Journal-article]. Retrieved April 11, 2024, from https://scholar.harvard.edu/files/nunn/files/fair_trade_draft_january_2019.pdf

Dynata. (2020). De Belgen en Duurzame Voeding na de COVIDcrisis. In Fairtrade Belgium. Retrieved April 30, 2024, from https://www.fairtradebelgium.be/fileadmin/fairtrade/user_upload/PDF_s/DE_BELGEN_EN_DUURZAME_VOEDING_NA_DE_CORONACRISIS.pdf

Dzebo, A. and Adams, K. M. (2022). *The coffee supply chain illustrates transboundary climate risks: Insights on governance pathways*. Policy brief. Stockholm Environment Institute, Stockholm. http://doi.org/10.51414/sei2022.002

ECF. (2022). ECF position on the draft Regulation proposal for packaging and packaging waste (PPWR). In *EFC EUROPEAN COFFEE FEDERATION*. Retrieved April 22, 2024, from https://www.ecf-coffee.org/wp-content/uploads/2023/02/ECF-position-PPWR-proposal_07.02.23.pdf

ECF. (2023). European Coffee Report 2022/2023. In *European Coffee Federation*. Retrieved March 4, 2024, from https://www.ecf-coffee.org/wp-content/uploads/2023/05/European-Coffee-Report-2022-2023.pdf

European Bioplastics. (2023). COFFEE CAPSULES SHOULD MANDATORILY BE COMPOSTABLE – WHY THE EUROPEAN COMMISSION GOT IT RIGHT IN THE REVISED RULES ON PACKAGING AND PACKAGING WASTE (PPWR). In *European Bioplastics*. Retrieved April 22, 2024, from https://docs.european-bioplastics.org/publications/pp/EUBP_PP_Compostable_Coffee_Capsules.pdf

European Commission. (2020, March 3). *New Eurobarometer survey: Protecting the environment and climate is important for over 90% of European citizens* [Press release]. Retrieved March 4, 2024, from https://ec.europa.eu/commission/presscorner/detail/en/ip_20_331

European Commission. (2021, March 1). New EU energy labels applicable from 1 March 2021. Retrieved May 18, 2024, from https://ec.europa.eu/commission/presscorner/detail/en/ip_21_818

European Commission. (2022). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS EU policy framework on biobased, biodegradable and compostable plastics. In European Commission. Retrieved April 22, 2024, from

https://environment.ec.europa.eu/document/download/14b709eb-178c-40ea-9787-6a40f5f25948_en?filename=COM_2022_682_1_EN_ACT_part1_v4.pdf

European Commission. (2024, April 19). *Biobased, biodegradable and compostable plastics*. Retrieved April 22, 2024, from https://environment.ec.europa.eu/topics/plastics/biobased-biodegradable-and-compostable-plastics_en

European Parliament. (2020). Sustainable consumption - Helping consumers make eco-friendly choices. In *European Parliament*. Retrieved February 8, 2024, from https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/659295/EPRS_BRI(2020)659295_EN.pdf

Eurostat. (2023). Packaging waste statistics. *Eurostat*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging_waste_statistics

Everett, H. (2023). Coffee History, Benefits & Drawbacks. *Study.com*. https://study.com/academy/lesson/history-of-coffee-facts-timeline.html

External Survey (2024). Results on Belgian Coffee Consumer Recycling Practices [PNG image]. Retrieved May 2024 from Nestlé Belgilux.

Fairtrade Belgium. (2020). FAIR TRADE BELGIUM ANNUAL REPORT 2020. In Fairtrade. Retrieved April 30, 2024, from https://www.fairtradebelgium.be/fileadmin/fairtrade/user_upload/PDF_s/FTB-AnnualReport-_2020-web-optimized.pdf

FAIRTRADE BELGIUM. (2021). FAIRTRADE BELGIUM ANNUAL REPORT 2021. In Fairtrade Belgium. Retrieved April 30, 2024, from https://www.fairtradebelgium.be/fileadmin/fairtrade/user_upload/PDF_s/FTB-AnnualReport-_2021-Final.pdf

Fairtrade International. (n.d.). *Fairtrade producers overview*. Retrieved April 11, 2024, from https://www.fairtrade.net/impact/fairtrade-producers-overview

Fost Plus. (2022, December 23). *Les capsules de café et d'autres boissons désormais dans les PMC*. Retrieved April 22, 2024, from https://www.fostplus.be/fr/blog/les-capsules-de-cafe-et-d-autres-boissons-desormais-dans-les-pmc

Fost Plus. (2024a, April 8). *FAQ Bio-based/sourced plastics, bio-degradable and compostable plastics*. Retrieved April 22, 2024, from https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.fostplus.be/en/media/1031/download%23:~:text%3DFor%2520now%252C%2520bio%252Ddegradable%2520and,please%2520refer%2520to%2520your%2520region.&ved=2ahUKEwiI_tGustWFAxUs_rsIHXEjA7sQFnoECA4QAw&usg=AOvVaw3lqrKUQgDAcE7jda9haUaR

Fost Plus. (2024b). *Plateforme belge du recyclage*. Retrieved April 26, 2024, from https://www.fostplus.be/fr/projets/plateforme-belge-du-recyclage

Fost Plus. (2024c). Les emballages en plastique. Retrieved April 28, 2024, from https://www.fostplus.be/fr/recycler/les-emballages-en-plastique

Fost Plus. (2024d, April 8). FAQ Bio-based/sourced plastics, bio-degradable and compostable plastics. Retrieved May 5, 2024, from https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.fostplus.be/en/media/1031/download&ved=2ahUKEwif9buXrZ6GAxWTgP0HHZ9qDLUQFnoECBIQAQ&usg=AOvVaw3lqrKUQgDAcE7jda9haUaR

Fost Plus. (n.d.). About Fost Plus. Retrieved April 22, 2024, from https://www.fostplus.be/en/about-fost-plus

Frimousse, S., & Peretti, J.-M. (2020). Les changements organisationnels induits par la crise de la COVID-19. *Questions De Management*, *29*, 105–149. https://doi.org/10.3917/qdm.203.0105

Fuller, K., & Grebitus, C. (2023). Consumers' preferences and willingness to pay for coffee sustainability labels. *Agribusiness*, *39*(4), 1007–1025. https://doi.org/10.1002/agr.21810

Giuliano, P., von der Lieth, J., Fernández-Alduenda, R., Apostolopoulos, Y., Ionescu, E. & Rugolo, J. (2021). Towards a Definition of Specialty Coffee: Building an Understanding Based on Attributes. In *Specialty Coffee Association*. Retrieved February 17, 2024, from https://static1.squarespace.com/static/584f6bbef5e23149e5522201/t/61656536b3ef6570d80794cc/1634035009273/Attributes+Framework+Whitepaper+2021+-+Release+1.2+Reduced.pdf

Goldemberg, D. C., Antonio, A. G., Farah, A., & Maia, L. C. (2015). Coffea canephora: A promising natural anticariogenic product. In Coffee in health and disease prevention (pp. 615 – 625). Academic Press.

Gomez, G. (2023). Interview with Gabriela Gomez [Interview]. Z. Matthys. Researcher.

Grandville, J.-J. (1867). *The rise of coffee*. American Scientist. Courtesy of Fernando E. Vega. https://www.americanscientist.org/article/the-rise-of-coffee

Grèze, P. (2023). Interview with Patrice Grèze [Interview]. Z. Matthys. Researcher.

Hajer, T. (2023). Responsabilité sociale des entreprises [Course]. HEC Montréal.

Hamago, M., Santos, M., Grote, U., Sustineo, Mainlevel Consulting AG, Front. Sustain. Food Syst, GlobeScan, Fairtrade International, Fairtrade Australia and New Zealand, Fairtrade Germany, Scio Network and Athena Infonomics, & CLAC. (2022). *Fairtrade Coffee Impact Study* [Report]. Retrieved April 11, 2024, from https://files.fairtrade.net/Fairtrade-Coffee-Impact-at-a-glance.pdf

Harvard. (2020, July). *Coffee - The nutrition source*. Retrieved February 11, 2024, from https://www.hsph.harvard.edu/nutritionsource/food-features/coffee/

Hassard, H., Couch, M. H., Techa-Erawan, T., & Mclellan, B. C. (2014). Product carbon footprint and energy analysis of alternative coffee products in Japan. *Journal of Cleaner Production*, *73*, 310–321. https://doi.org/10.1016/j.jclepro.2014.02.006

Hermans, B. (2023). Interview with Bob Hermans [Interview]. Z. Matthys. Researcher.

Hernandez, M., Pandolph, R., Sänger, C., & Vos, R. (2020). VOLATILE COFFEE PRICES: COVID-19 AND MARKET FUNDAMENTALS. In *International Coffee Organisation*. ICO & IFPRI. Retrieved February 28, 2024, from https://www.ico.org/news/coffee-break-series-2e.pdf

Hicks, A. (2017). Environmental Implications of Consumer convenience: Coffee as a case study. *Journal of Industrial Ecology*, *22*(1), 79–91. https://doi.org/10.1111/jiec.12487

Huhtamaki. (2022). Huhtamaki's proprietary breakthrough high-precision technology delivers home compostable paper-based coffee capsules for Nespresso and millions of coffee lovers. Retrieved April 29, 2024, from https://www.huhtamaki.com/en/media/media/press-release/2022/huhtamakis-proprietary-breakthrough-high-precision-technology-delivers-home-compostable-paper-based-coffee-capsules-for-nespresso-and-millions-of-coffee-lovers/

Humbert, S., Loerincik, Y., Rossi, V., Margni, M., & Jolliet, O. (2009). Life cycle assessment of spray dried soluble coffee and comparison with alternatives (drip filter and capsule espresso). *Journal of Cleaner Production*, *17*(15), 1351–1358. https://doi.org/10.1016/j.jclepro.2009.04.011

ICO. (2023a). *COFFEE REPORT AND OUTLOOK - December 2023*. International Coffee Association. Retrieved February 14, 2024, from https://icocoffee.org/documents/cy2023-24/Coffee_Report_and_Outlook_December_2023_ICO.pdf

ICO. (2023b). *Delivery Modalities - Paths to consumption*. International Coffee Organization. Retrieved February 16, 2024, from https://icocoffee.org/market-development-toolkit/page/index/4

IDB. (2019, July 22). *The most unexpected effect of climate change*. IDB Inter-American Development Bank. Retrieved February 11, 2024, from https://www.iadb.org/en/story/most-unexpected-effect-climate-change

Jena, P. R., & Grote, U. (2022). Do certification schemes enhance coffee yields and household income? Lessons learned across continents. *Frontiers in Sustainable Food Systems*, *5*. https://doi.org/10.3389/fsufs.2021.716904

Kantar (2023a). Cocacem Report Coffee Yearly review 2023 for Nestlé Belgilux [PowerPoint slides].Retrieved July 2023 from Nestlé Belgilux offices.

Kantar (2023b). Kantar Sustainability Report 2021 for Nestlé Belgilux - Identifying Sustainability opportunities [PDF]. Retrieved July 2023 from Nestlé Belgilux offices.

Koffie Kàn. (2024). Coffee capsules and coffee pads full of tasty coffee. Retrieved May 6, 2024, from https://www.koffiekan.be/en/coffee/coffee-pods-capsules/

Konecny, T., & Vassallo, J. (2024, May 14). The Best Pour-Over Coffee makers. Wirecutter: Reviews for the Real World. Retrieved May 17, 2024, from https://www.nytimes.com/wirecutter/reviews/gear-for-making-great-coffee/

Kooduvalli, K., Vaidya, U., & Ozcan, S. (2020). Life cycle assessment of compostable coffee pods: a US university based case study. *Scientific Reports*, *10*(1). https://doi.org/10.1038/s41598-020-65058-1

Koons, E. S. K. (2018a, June 27). *Environmental Impacts of Plastics vs. Metals: Which is better?* Desjardins. Retrieved April 28, 2024, from https://www.desjardin.fr/en/blog/environmental-impacts-of-plastics-vs.-metals-which-is-better

Koons, E. S. K. (2018b, September 27). *How Aluminium and Tinplate are Better Than Plastic Packages*. Desjardin. Retrieved April 28, 2024, from https://www.desjardin.fr/en/blog/how-aluminium-and-tinplate-are-better-than-plastic-packages

Kurz, L. (2022, December 8). The story behind Huhtamaki's compostable paper-based coffee capsules for Nespresso. Packaging Europe. Retrieved April 29, 2024, from https://packagingeurope.com/comment/the-story-behind-huhtamakis-compostable-paper-based-coffee-capsules-for-nespresso/9173.article

Kushalappa, H. (2023). THE DIFFERENCE BETWEEN MANUAL BREWING AND MECHANICAL BREWING IN POUR OVER V60. EPRA International Journal of Multidisciplinary Research (IJMR), 9(11). https://doi.org/10.36713/epra14932

L. Carp, B. (2010). Defiance of the Patriots: The Boston Tea Party and The Making of America on JSTOR. *www.jstor.org*, 1–233. https://www.jstor.org/stable/j.ctt5vm65p

Lan. (2013, February 4). The fun theory. Land8. Retrieved May 10, 2024, from https://land8.com/the-fun-theory/

Lavazza. (2022). Italiaanse perfectie, met zero CO_2 impact. Retrieved May 6, 2024, from https://www.lavazzaofficial.be/nl/zero-co2-impact?referrer=https://www.google.com/

Lee, Y., & Bateman, A. H. (2021). The competitiveness of fair trade and organic versus conventional coffee based on consumer panel data. Ecological Economics, 184, 106986. https://doi.org/10.1016/j.ecolecon.2021.106986

Li, J. (2018, January 15). *Comparative Life cycle Assessment of Single-Serve coffee packaging in Ontario*. UWSPACE. Retrieved April 19, 2024, from https://uwspace.uwaterloo.ca/handle/10012/12860

Lingle, T. R., & Menon, S. N. (2017). Cupping and Grading—Discovering character and quality. In *The Craft and Science of Coffee* (pp. 181–203). Academic Press. https://doi.org/10.1016/b978-0-12-803520-7.00008-6

Lomartire, S., Marques, J., & Gonçalves, A. (2022). An Overview of the Alternative Use of Seaweeds to Produce Safe and Sustainable Bio-Packaging. Applied Sciences, 12(6), 3123. https://doi.org/10.3390/app12063123

Ludmir, C. (2023, September 14). Nespresso launches its first Paper-Based Compostable capsules. Forbes. Retrieved April 29, 2024, from https://www.forbes.com/sites/claraludmir/2023/09/13/nespresso-launches-its-pilot-of-home-compostable-capsules/?sh=5e66951a2240

Majer, J. M., Henscher, H. A., Reuber, P., Fischer-Kreer, D., & Fischer, D. (2022). The effects of visual sustainability labels on consumer perception and behavior: A systematic review of the empirical

literature. *Sustainable Production and Consumption*, *33*, 1–14. https://doi.org/10.1016/j.spc.2022.06.012

Mamun, A. A., Prasetya, T. a. E., Dewi, I. R., & Ahmad, M. (2023). Microplastics in human food chains: Food becoming a threat to health safety. *Science of the Total Environment*, *858*, 159834. https://doi.org/10.1016/j.scitotenv.2022.159834

Marinello, S., Balugani, E., & Gamberini, R. (2021). Coffee capsule impacts and recovery techniques: A literature review. *Packaging Technology & Science (Print)*, *34*(11–12), 665–682. https://doi.org/10.1002/pts.2606

Martins, K. F., Teixeira, D., & De Oliveira Corrêa, R. (2022). Gains in sustainability using Voluntary Sustainability Standards: A systematic review. *Cleaner Logistics and Supply Chain*, *5*, 100084. https://doi.org/10.1016/j.clscn.2022.100084

Martins, K. F., Teixeira, D., & De Oliveira Corrêa, R. (2022). Gains in sustainability using Voluntary Sustainability Standards: A systematic review. Cleaner Logistics and Supply Chain, 5, 100084. https://doi.org/10.1016/j.clscn.2022.100084

Marty, C., Boucher, J., Viana, L. R., & Dessureault, P. (2023, January 3). Here's how your cup of coffee contributes to climate change. The Conversation. Retrieved April 30, 2024, from https://theconversation.com/heres-how-your-cup-of-coffee-contributes-to-climate-change-196648

Marx, A., Depoorter, C., & Vanhaecht, R. (2022). Voluntary Sustainability Standards: state of the art and future research. Standards, 2(1), 14–31. https://doi.org/10.3390/standards2010002

Másalto. (2024, May 5). Másalto Capsules Lungo. https://masalto.be/produit/masalto-capsules-compatibles-lungo/

Maurice, N. E., & Davis, J. (2011). Unraveling the underlying causes of price volatility in world coffee and cocoa commodity markets. In *UNCTAD*. https://unctad.org/system/files/official-document/suc-miscDP01_en.pdf

Mayo Clinic. (2018, September 12). *Anti-fibrotic therapy in the treatment of IPF: Ongoing concerns and current practices - Mayo Clinic*. mayoclinic.org. Retrieved February 12, 2024, from https://www.mayoclinic.org/medical-professionals/pulmonary-medicine/news/anti-fibrotic-therapy-in-the-treatment-of-ipf-ongoing-concerns-and-current-practices/mac-20438808

Miyanari, W. (2013). Aloha From Coffee Island. Savant Books and Publications.

Mohan, A. M. (2023, June 1). Nestlé Pilots Paper-Based Nespresso Capsules. Packaging World. https://www.packworld.com/design/materials-containers/article/22862504/nestl-pilots-paperbased-nespresso-capsules

Mordor Intelligence. (2024). Coffee Pods and Capsules Market Insights. In *Mordor Intelligence*. Retrieved January 26, 2024, from https://www.mordorintelligence.com/industry-reports/coffee-pods-and-capsules-market

Nab, C., & Maslin, M. (2020). Life cycle assessment synthesis of the carbon footprint of Arabica coffee: Case study of Brazil and Vietnam conventional and sustainable coffee production and export to the United Kingdom. Royal Geographical Society, 7(2). https://doi.org/10.1002/geo2.96

National Coffee Association USA. (n.d.-a). *The history of coffee*. Retrieved February 10, 2024, from https://www.ncausa.org/about-coffee/history-of-coffee

National Coffee Association. (n.d.-b). *How to brew coffee*. National Coffee Association of USA. Retrieved February 15, 2024, from https://www.ncausa.org/about-coffee/how-to-brew-coffee

Nepomuceno, M. V. (2023). Consumer Behaviour [Course]. HEC Montréal.

Nescafé (2022). Nescafé Plan 2030 Progress Report 2022 [PowerPoint slides]. Retrieved July 2023 from Nestlé Belgilux offices.

Nespresso employees, & Gammuto, W. (2022). THE POSITIVE CUP – 2022 PROGRESS REPORT. In Nespresso. Retrieved April 30, 2024, from https://nestle-nespresso.com/sites/site.prod.nestle-nespresso.com/files/Nespresso_Global_ESG_Progress_Report_ThePositiveCup_2022_Progress_report.pdf

Nespresso. (2015, July 16). NESPRESSO HEAD OF COFFEE EXPLAINS WHY COFFEE QUALITY AND SUSTAINABILITY GO HAND IN HAND. Retrieved April 8, 2024, from https://nestle-nespresso.com/news/Nespresso-Head-of-Coffee-explains-why-coffee-quality-and-sustainability-go-hand-in-hand

Nespresso. (2024). Home compostable capsule | Nespresso. Retrieved April 28, 2024, from https://www.nespresso.com/ch/en/paper

Nespresso. (n.d.). THE NESPRESSO AAA SUSTAINABLE QUALITY™PROGRAM. Retrieved April 30, 2024, from https://www.nespresso.com/ncp/positive/cz/en#!/sustainability/aaa-sustainable-quality

Nestlé (2023b, March). Consumer Market Intelligence (CMI) Belgilux Private Labels Analysis [PowerPoint slides]. Retrieved July 2023 from Nestlé Belgilux offices.

Nestlé (2023c, March). Business Intelligence Report - Competition, Retail, Insights. [PDF]. Retrieved July 2023 from Nestlé Belgilux offices.

Nestlé (2023d, May 17). Search Engine Positioning - Capsules. [PowerPoint slides]. Retrieved July 2023 from Nestlé Belgilux offices.

Nestlé Belgilux. (2022a). Belgian Retail Coffee Market Sales - Category Distributions from 2022 to 2023 [Graph]. Retrieved July 2023 from Nestlé Belgilux offices.

Nestlé Belgilux. (2022b). Nestlé Belgian Retail Coffee Sales in Value from 2002 to 2023 [Graph]. Retrieved July 2023 from Nestlé Belgilux offices.

Nestlé Belgilux. (2022c). Nestlé Belgian Retail Coffee Sales in Volume from 2002 to 2023 [Graph]. Retrieved July 2023 from Nestlé Belgilux offices

Nestlé. (2021). Nestlé's Net Zero Roadmap. In Nestlé. [Report]. Retrieved July 2023 from Nestlé Belgilux offices.

Nestlé. (2023a, June 6). *Nescafé Plan 2030 shows progress on farmers' transition to regenerative agricultural practices*. Nestlé Global. Retrieved February 5, 2024, from https://www.nestle.com/media/news/nescafe-plan-2030-progress-regenerative-agriculture

Nestlé. (n.d.). *Coffee sourcing*. Nestlé Global. Retrieved February 5, 2024, from https://www.nestle.com/sustainability/sustainable-sourcing/coffee

Nielsen (2023a, March). Coffee Usage Profiler Global Typologies Belgium Report. [PowerPoint slides]. Retrieved July 2023 from Nestlé Belgilux offices.

Nielsen (2023b, March). Coffee Usage Profiler Belgium 5Ws Report. [PowerPoint slides]. Retrieved July 2023 from Nestlé Belgilux offices.

Noponen, M., Jones, G. E., & Haggar, J. P. (2012). Greenhouse gas emissions in coffee grown with differing input levels under conventional and organic management. Agriculture Ecosystems and Environment, 151, 6–15. https://doi.org/10.1016/j.agee.2012.01.019

Norman, R. O., Usselman, M. C., & Noller, C. R. (2023, December 7). Organic compound | Definition & Examples. Encyclopedia Britannica. Retrieved April 29, 2024, from https://www.britannica.com/science/organic-compound

Nowell, C. (2023, December 7). Are coffee pods really eco-friendly? The truth behind the surprising findings. The Guardian. Retrieved April 30, 2024, from https://www.theguardian.com/environment/2023/feb/10/single-use-coffee-pod-environment-impact-better#:~:text=Just%20because%20capsules%20produce%20fewer,circle%20the%20earth%2012%20times.

O'Neill, S. (2023, September 25). *What is the difference between CSR and ESG?* The Corporate Governance Institute. Retrieved April 19, 2024, from https://www.thecorporategovernanceinstitute.com/insights/lexicon/what-is-the-difference-between-csr-and-esg/

Obied, H. K. (2013). Biography of biophenols: past, present and future. *Functional Foods in Health and Disease*, *3*(6), 230–241. https://doi.org/10.31989/ffhd.v3i6.51

Ohio State University. (n.d.). *Other methods of making coffee*. osu.edu. Retrieved April 22, 2024, from https://u.osu.edu/568202team3/pod-style-coffee-making/methods-of-making-coffee/

OR Coffee Roasters. (n.d.). Specialty coffee capsules. https://www.orcoffee.be/collections/specialty-coffee-capsules

Pan American Health Organization. (n.d.). *Noncommunicable diseases*. PAHO/WHO | Pan American Health Organization. Retrieved February 12, 2024, from https://www.paho.org/en/topics/noncommunicable-

diseases#:~:text=These%20conditions%20include%20cancers%2C%20cardiovascular,inactivity%20and%20eating%20unhealthy%20diets.

Panhuysen, S., & De Vries, F. (2023). Coffee Barometer 2023. In *Coffee Barometer*. Conservation International & Solidaridad. Retrieved February 28, 2024, from https://coffeebarometer.org/documents_resources/coffee_barometer_2023.pdf

Phrommarat, B. (2019). Life cycle assessment of ground coffee and comparison of different brewing methods: A case study of organic arabica coffee in Northern Thailand: DOI: 10.32526/ENNRJ.17.2.2019.16. *Environment and Natural Resources Journal*, *17*(2). https://doi.org/10.32526/ennrj.17.2.2019.16

Pinto, S. M., Gouveia, J. R., De Sousa, M. V., Rodrigues, B., Oliveira, J., Pinto, C., & Baptista, A. P. (2024). Improving coffee capsules recyclability - A combined assessment of circularity and environmental performance of a novel design. *Sustainable Production and Consumption*. https://doi.org/10.1016/j.spc.2024.02.025

Quantis. (2019). LIFE CYCLE ASSESSMENT (LCA) OF AN ESPRESSO CUP OF COFFEE MADE FROM a NESPRESSO PROFESSIONAL CAPSULE COMPARED WITH OTHER COFFEE SYSTEMS IN FRANCE. In Nespresso [Report]. Retrieved April 30, 2024, from https://www.nespresso.com/agit/app/uploads/2021/05/ACV-comparative-des-diffrentes-fa%C3%A7ons-de-pr%C3%A9parer-un-caf%C3%A9-B2B-Quantis-France-Avril-2021.pdf

Quelch, J., & Harding, D. (1996). Brands versus private labels: Fighting to win. Harvard Business Review. Retrieved May 8, 2024, from https://hbr.org/1996/01/brands-versus-private-labels-fighting-to-win

Raabe, D., Ponge, D., Uggowitzer, P. J., Roscher, M., Paolantonio, M., Liu, C., Antrekowitsch, H., Kozeschnik, E., Seidman, D. N., Gault, B., De Geuser, F., Dechamps, A., Hutchinson, C., Liu, C., Li, Z. M., Prangnell, P., Robson, J., Shanthraj, P., Vakili, S., . . . Pogatscher, S. (2022). Making sustainable aluminium by recycling scrap: The science of “dirty” alloys. *Progress in Materials Science/Progress in Materials Science*, *128*, 100947. https://doi.org/10.1016/j.pmatsci.2022.100947

Rainforest Alliance. (2022, November 21). UTZ Certification (Now part of the Rainforest Alliance) | Rainforest Alliance. Retrieved April 30, 2024, from https://www.rainforest-alliance.org/utz/

Reuters. (2022, November 21). Nestle’s Nespresso to sell paper-based compostable coffee pods. Reuters. Retrieved April 28, 2024, from https://www.reuters.com/business/retail-consumer/nestles-nespresso-sell-paper-based-compostable-coffee-pods-2022-11-21/

Ridder, M. (2024, January 4). *World Arabica coffee production 2023/24 | Statista*. Statista. Retrieved February 14, 2024, from https://www.statista.com/statistics/225400/world-arabica-coffee-production/

Rivas, D. Z. (2020, April). *Figure 2. Global location of tropical and subtropical areas.* ResearchGate. Retrieved February 15, 2024, from https://www.researchgate.net/figure/Global-location-of-tropical-and-subtropical-areas_fig2_341314036

S, R. (2020, November 9). *Coffee: history, art, science, humanity, magic*. https://www.linkedin.com/pulse/coffee-history-art-science-humanity-magic-ramy-shaalan/

Salomone, R. (2003). Life cycle assessment applied to coffee production: investigating environmental impacts to aid decision making for improvements at company level. *Food, Agriculture & Environment*, *1*(2), 295–300. https://www.researchgate.net/profile/Roberta-Salomone/publication/234591049_Life_Cycle_Assessment_applied_to_coffee_production_investigating_environmental_impacts_to_aid_decision_making_for_improvements_at_company_level/links/5710d72e08ae19b18694f93c/Life-Cycle-Assessment-applied-to-coffee-production-investigating-environmental-impacts-to-aid-decision-making-for-improvements-at-company-level.pdf

Samoggia, A., & Riedel, B. (2018). Coffee consumption and purchasing behavior review: Insights for further research. *Appetite*, *129*, 70–81. https://doi.org/10.1016/j.appet.2018.07.002

Samoggia, A., & Riedel, B. (2019). Consumers' perceptions of coffee health benefits and motives for coffee consumption and purchasing. *National Library of Medicine*, *11*(3), 653. https://doi.org/10.3390/nu11030653

Santanatoglia, A., Caprioli, G., Cespi, M., Ciarlantini, D., Cognigni, L., Fioretti, L., Maggi, F., Mustafa, A. M., Nzekoue, F., & Vittori, S. (2023). A comprehensive comparative study among the newly developed Pure Brew method and classical ones for filter coffee production. Lebensmittel-Wissenschaft + Technologie/Food Science & Technology, 175, 114471. https://doi.org/10.1016/j.lwt.2023.114471

SCA. (n.d.). Grading and Classification of Green Coffee. In *SCA*. Retrieved February 27, 2024, from https://www.ico.org/projects/Good-Hygiene-Practices/cnt/cnt_en/sec_3/docs_3.3/Grading%20&%20class.pdf

Shapsugova, M. (2023). ESG principles and social responsibility. *E3S Web of Conferences*, *420*(5), 06040. https://doi.org/10.1051/e3sconf/202342006040

Shogren, R. L., Wood, D. F., Orts, W. J., & Glenn, G. M. (2019). Plant-based materials and transitioning to a circular economy. Sustainable Production and Consumption, 19, 194–215. https://doi.org/10.1016/j.spc.2019.04.007

Solomon, M., White, K., & Dahl, D. W. (2017). Consumer Behaviour (7th ed.). Pearson Toronto.

Ssebunya, B., Schader, C., Baumgart, L., Landert, J., Altenbuchner, C., Schmid, E., & Stolze, M. (2019). Sustainability performance of certified and non-certified smallholder coffee farms in Uganda. *Ecological Economics (Amsterdam)*, *156*, 35–47. https://doi.org/10.1016/j.ecolecon.2018.09.004

Starbucks. (2020, February 28). C.A.F.E. Practices: Starbucks Approach to Ethically Sourcing Coffee. Retrieved May 16, 2024, from https://stories.starbucks.com/press/2020/cafe-practices-starbucks-approach-to-ethically-sourcing-coffee/

StarbucksAtHome. (n.d.). *C.A.F.E - praktijken*. Retrieved February 5, 2024, from https://www.starbucksathome.com/be/nl-be/artikelen/cafe-praktijken/

Statista. (2021, May 19). *Number of employees of Nestlé Belgilux, by type of employment 2010-2018 | Statista*. Retrieved February 2, 2024, from https://www.statista.com/statistics/680035/average-number-of-employees-of-nestle-belgilux-by-type-of-employment/

Statista. (2022, February). *World coffee production leading countries 2020 | Statista*. Retrieved February 14, 2024, from https://www.statista.com/statistics/277137/world-coffee-production-by-leading-countries/

Statista. (2024, March 18). *Biggest coffee exporters worldwide 2023 2023 | Statista*. Retrieved April 2, 2024, from https://www.statista.com/statistics/1096413/main-export-countries-for-coffee-worldwide/

Statista. (n.d.). *Coffee - Belgium | Statista market forecast*. Retrieved January 26, 2024, from https://fr.statista.com/outlook/cmo/hot-drinks/coffee/belgium

Stobierski, T. (2021, April 8). *What is corporate social responsibility? 4 types*. Harvard Business School Online. Retrieved April 19, 2024, from https://online.hbs.edu/blog/post/types-of-corporate-social-responsibility

Syed, O. H. (2018). Biophenols: Impacts and Prospects in Anti-Alzheimer Drug Discovery. *Elsevier eBooks*, 103–148. https://doi.org/10.1016/b978-0-12-809593-5.00004-5

Terlau, W., & Hirsch, D. (2015, May 1). *Sustainable Consumption and the Attitude-Behaviour-Gap Phenomenon - Causes and Measurements towards a Sustainable Development*. EconPapers. Retrieved March 4, 2024, from https://econpapers.repec.org/paper/agsiefi15/206233.htm

The Carbon Trust. (2024, March 5). Organisations we have worked with. Retrieved May 15, 2024, from https://www.carbontrust.com/what-we-do/product-carbon-footprint-labelling/organisations-we-have-worked-with

Thoden Van Velzen, U., Goyal, B., & Barouta, D. (2023). Sustainability assessment of different types of coffee capsules. In *Research Gate* (No. 2450). https://doi.org/10.18174/641509

Trabocca. (2020, October 6). *Coffee Grades: Understanding the Basics - Trabocca*. Retrieved February 27, 2024, from https://www.trabocca.com/coffee-knowledge/quality/coffee-grades-understanding-the-basics/

Trespeuch, L., Robinot, É., Botti, L., Bousquet, J., Corne, A., De Ferran, F., Durif, F., Ertz, M., Fontan, J.-M., Giannelloni, J.-L., Hallegatte, D., Kreziak, D., Lalancette, M., Lajante, M., Michel, H., Parguel, B., & Peypoch, N. (2021). Allons-nous vers une société plus responsable grâce à la pandémie de COVID-19 ? *Natures Sciences Sociétés*, *29*, 479–486. https://www.cairn.info/revue-natures-sciences-societes-2021-4-page-479.htm

Uganda Coffee Development Authority. (2019). Robusta Coffee Handbook: A Sustainable Coffee Industry with High Stakeholder Value for Social Economic Transformation. Retrieved February 14, 2024, from https://www.ugandacoffee.go.ug/node/52.

UNCTAD. (2023, November 2). Voluntary sustainability standards. Retrieved May 16, 2024, from https://unctad.org/topic/trade-analysis/voluntary-sustainability-standards

United Nations. (2023, October 20). *Sustainable consumption and production patterns*. United Nations Sustainable Development. Retrieved February 8, 2024, from https://www.un.org/sustainabledevelopment/sustainable-consumption-production/

United Nations. (n.d.). *Sustainability | United Nations*. Retrieved April 19, 2024, from https://www.un.org/en/academic-impact/sustainability

Urwin, R., Kesa, H., & Joao, E. S. (2019). The rise of specialty coffee : An investigation into the consumers of specialty coffee in Gauteng. *African Journal of Hospitality Tourism and Leisure*, *8*(5). https://www.researchgate.net/publication/343473263_The_rise_of_specialty_coffee_An_investigation_into_the_consumers_of_specialty_coffee_in_Gauteng

Van Gelder, K. (2020, August 7). Average number of coffee cups consumed daily in Belgium 2019. Statista. Retrieved May 7, 2024, from https://www.statista.com/statistics/1073526/number-of-coffee-cups-consumed-daily-in-belgium/

Vega, F. E. (2008, April). *The rise of coffee*. American Scientist. Retrieved February 11, 2024, from https://www.americanscientist.org/article/the-rise-of-coffee

Vega, Fernando & Posada-Florez, Francisco & Infante, Francisco. (2006). Coffee Insects: Ecology and Control. 10.1081/E-EPM-120042132.

Vogt, M. A. B. (2019, December). *Variance in Approach Toward a 'Sustainable' Coffee Industry in Costa Rica*. Research Gate. https://www.researchgate.net/publication/338031026_Variance_in_Approach_Toward_a_%27Sustainable%27_Coffee_Industry_in_Costa_Rica

Wandering Bear Coffee. (2023, August 4). *ORGANIC VS CONVENTIONAL COFFEE AND COLD BREW*. Retrieved March 4, 2024, from https://www.linkedin.com/pulse/organic-vs-conventional-coffee-cold-brew-wandering-bear-coffee-co-/

Widodo, P. B., Yulianto, M. E., Ariyanto, H. D., & Paramita, V. (2023). Efficacy of natural and full washed post-harvest processing variations on arabica coffee characteristics. Materials Today: Proceedings, 87, 79–85. https://doi.org/10.1016/j.matpr.2023.02.376

WIPO. (2010, September). *Anyone for coffee? The story behind the coffee capsule*. Retrieved April 11, 2024, from https://www.wipo.int/wipo_magazine/en/2010/05/article_0007.html

World Population Review. (2024). *Coffee Producing Countries 2024*. Retrieved February 16, 2024, from https://worldpopulationreview.com/country-rankings/coffee-producing-countries

WWF. (2024). Pulp and paper. World Wildlife Fund. Retrieved April 29, 2024, from https://www.worldwildlife.org/industries/pulp-and-paper

Wynn, T. A., & Ramalingam, T. R. (2012). Mechanisms of fibrosis: therapeutic translation for fibrotic disease. *Nature Medicine*, *18*(7), 1028–1040. https://doi.org/10.1038/nm.2807