PROMOTING CIRCULAR ECONOMY IN THE COFFEE SECTOR

Education and value creation

Arturo Barina

Politecnico di Torino
Laurea magistrale in Design Sistemico “Aurelio Peccei”
Academic Year 2024/2025

Credits

Politecnico di Torino
Architecture and Design Department
Systemic Design Master Degree
Research Thesis

Candidate: Arturo Barina
Relator: Prof.ssa Silvia Barbero
Co-Relator: Dott.ssa Fabiana Rovera
Degree Session: July 2025

To my family

To my friends

To Cami

Politecnico
di Torino

Abstract

The linear economy can no longer bring benefits and prosperity in a world where resources are scarce and climate change casts increasing doubt on the effectiveness of traditional techniques and processes. To meet these needs, society needs a paradigm shift, a shift it can achieve through the application of the circular economy, a thinking and strategy whereby a waste becomes a resource and the concept of designing from cradle to coffin leaves room for a cradle-to-cradle system.

In light of these concepts, the coffee sector offers great scope for work and improvement. The following thesis, under the brief placed by **C4CEC** (Center for Circular Economy in Coffee), therefore starts with an analysis of coffee and its supply chain, recounting characteristics, production process, key stakeholders, dynamics, and value creation; then going on to analyze how the circular economy can bring best practices aimed at reducing waste and making it more resilient in the face of climate change, while also creating benefits for the actors involved.

But how to bring this thinking where it is not yet present, what are the obstacles and needs to be addressed? **The key is to educate the actors** that make up the supply chain, primarily those at the bottom of the supply chain, the farmers. The research goes on to investigate the state of the art of education in these fields and draws guidelines for developing an educational process that takes into account the various targets and their particularities.

The final output of the thesis is a series of modular educational parts aimed at creating ad hoc **training courses** suitable for both coffee farmers and their trainers. The goal is to instill the specific knowledge and soft skills to operate in the sector according to circular best practices, developing their lifelong learning and learning to learn. This is done through a multidisciplinary and multi-methodological approach that emphasizes practicality, systemic vision, and collaboration of the parties.

Finally, in order to make the course more tangible, specific lessons have been considered and **information and illustrative cards** have been designed, material to facilitate learning and remembrance of best practices in the user.

Index

CHAPTER 1

Introduction

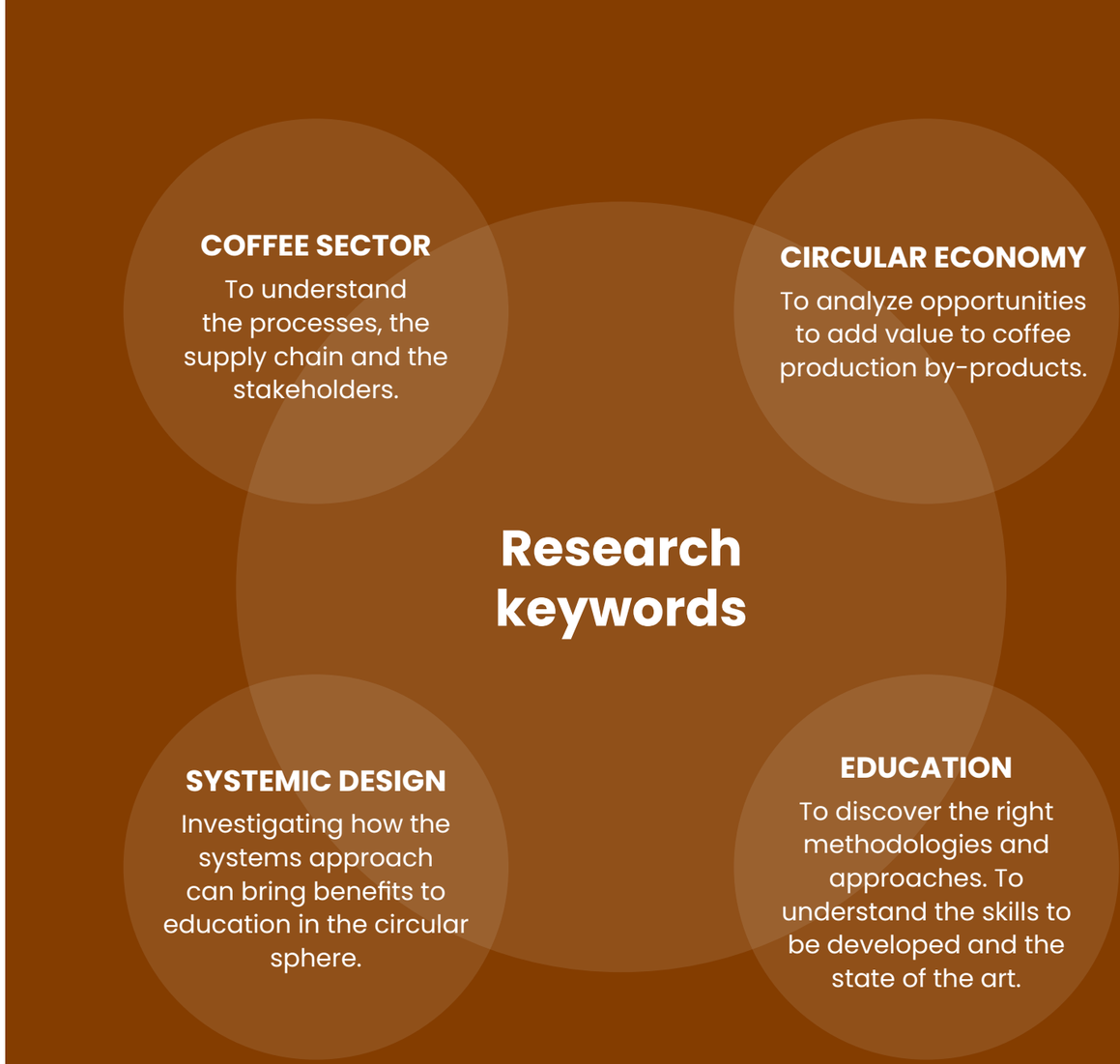
1.1 Investigation domains and keywords

In order to gather all the important information and best understand the essential aspects for carrying out the research and to arrive at the most accurate and coherent output possible, the research desk was conducted on several macro themes identified in keywords. Once papers and studies were collected that complemented the general knowledge regarding the macro themes, the research continued to identify the methodologies, tools, and case studies of these macro themes, which were essential to take note of the state of the art and how to act in practice.

The different areas analyzed specifically are:

• **Coffee sector:** the analysis of this field was focused on understanding the characteristics of the **supply chain**, the raw material and the whole culture behind this world. So the composition of the coffee bean, its **processing** and waste; the **stakeholders** present, their relationships, goals and needs; market regulations and policies; the risks that production encounters with climate change; and the most innovative technologies and practices and projects carried out in this environment.

• **Circular economy:** a twofold research was conducted for this field, material was collected both regarding the circular economy in general, with its **principles, strategies, business models, organizations and case studies**; and specifically regarding



Research questions

1. How can the circular economy help the coffee sector and its stakeholders to combat climate change, waste, and bring prosperity?
2. Can education be the right way to get the circular economy to these actors?
3. Who in the supply chain needs to be educated, how, and why?
4. What characteristics should the educational experience have?

the circular economy in the coffee sector, a field that has additional strategies, methodologies, applications and case studies.

• **Systemic design:** the research aimed to investigate how the methods and principles of systemic design can help in the analysis of other fields, so as to identify the right **challenges and opportunities**. Crucially, it was to discover how a systemic view is important in delineating the needs of the area, the targets, and the sector analyzed and developing the right output.

• **Education:** in this aspect, it was crucial to gather material to better understand the state of the art of education regarding the circular economy in general and the circular economy applied to the coffee sector; the **methodologies** used, **targets** addressed, knowledge disseminated, **educational objectives**, and **skills** developed. An in-depth analysis of **case studies** of courses, workshops, working groups, and action plans offered by both organizations and companies, through both various media and in-person was essential to outline the guidelines and objectives to be achieved through the output of the thesis.

1.2 Scope and research questions

The brief given by the **Center for Circular Economy in Coffee** (C4CEC) set as the objective of the thesis an investigation of how to disseminate the circular economy in the coffee sector: analysis of the state of the art and the right strategies to undertake led to the creation of specific teaching outputs. The research, however, was conducted step by step, building piece by piece the knowledge needed to take action; it all started with the analysis of the circular economy to best understand what was essential to teach, proceeding then with the study of the target audience and how to communicate with these actors, and finally of the educational methods, processes, and objectives; analysis that helped provide the idea of what media and structures, the organizations in the sector, use to implement courses, workshops, and action plans. During the dissertation therefore, several questions were asked that helped guide the work.

• How can the circular economy help the coffee sector and its stakeholders to combat climate change, waste, and bring prosperity?
• Can education be the right way to get the circular economy to these actors?
• Who in the supply chain needs to be educated, how, and why?
• What characteristics should the educational experience have?

1.3 Systemic design methodology

Systemic design with its principles and methodologies, developed by the Politecnico di Torino, have been relevant in this research, helping to better

analyze topics and find the right solutions. But to understand how it has played its part, it is good to clarify what this thinking is about and how it moves. Systemic design is a field of design, born out of the combination of systemic and **holistic thinking** with a humanity-centered approach and sustainability. It is used to address and solve complex situations by proposing solutions that take all aspects into consideration, acting on the **environmental, economic and social spheres**. This is done by analyzing and working on the elements involved in production processes, material, energy, information, and economic flows. Combining them with the system that is created with the stakeholders (suppliers, producers, distributors, consumers), the community and the territory where the reality operates.

Importantly, systemic design and circular economy are strongly interconnected and often share the same methodologies and principles. Both thoughts work on production outputs by transforming them into inputs and trying to create self-regenerating systems that aim at reduced resource exploitation, pollution and a preservation of biodiversity.

As pointed out earlier, however, systemic design goes beyond and is not limited to this; it works with the territory and the realities present, **creating networks and connections** also aimed at social and economic well-being. So here are the key principles that drive this thinking:

"A system is an interconnected set of elements that is coherently organized in a way that achieves something."
(Meadows, 2008)

1. Output>Input: This involves reusing the outputs of one system, normally considered waste, as inputs for another, as normally happens in nature.

2. Relationships: Connections between actors within a system are critical to its development and decrease waste, while increasing its value.

3. Autopoiesis: Eco sustainability and self-re-generation of the system must be ensured. The cyclical dynamics of a system and its ability to evolve with other systems is essential for the perpetuation of innovative practices.

4. Act locally: Giving value to the local area and local communities is important in order to create something that will go mainstream. In addition, acting locally is the first step in creating innovation that over time can expand and create results at larger scales as well.

5. Humanity centered design: Human beings are at the center of any systemic design, their connection with the territory, society, and culture is the key to creating well-being.

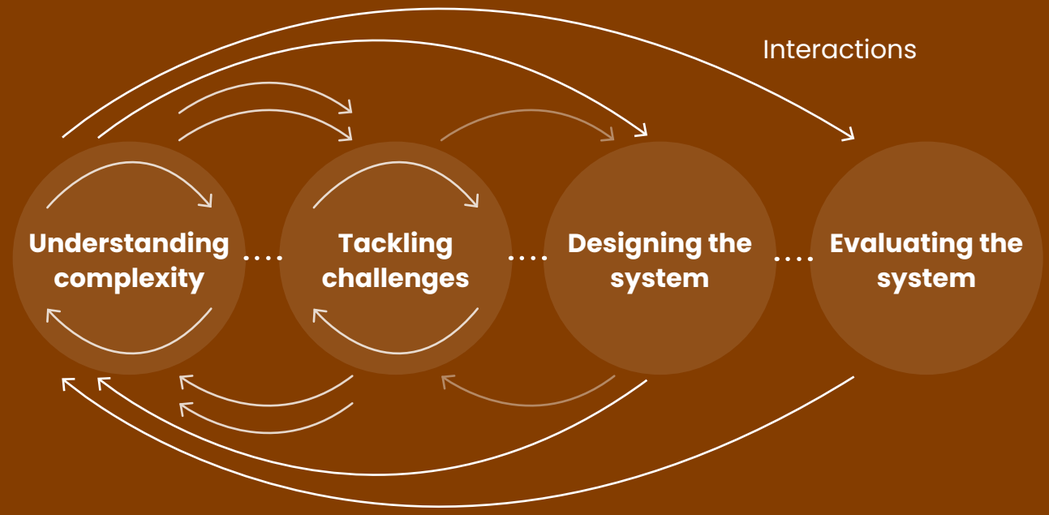
As for systemic design methodologies, on the other hand, the process starts from both desk and on-site analysis of the territory, the system and its context, gathering both quantitative and qualitative information. All aspects are considered: demographics, economics, culture, history, morphology; but also materials, processes, stakeholders and the market,

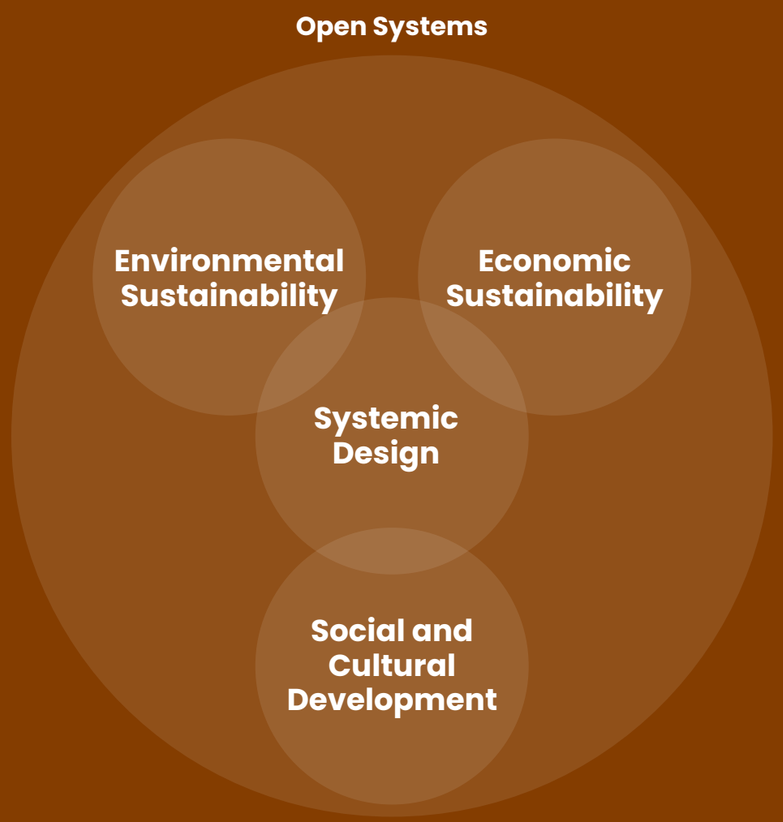
in case one is dealing with a sector or reality specifically.

The next stage of the systemic journey is the identification of the **challenges and opportunities** that the system offers: with the support and research of case studies, different paths and solutions are outlined, covering all aspects of the system, from new relationships and processes to new market strategies and community relations. **Opportunities are then evaluated** against the five pillars to ensure feasibility, coherence and impacts. Once the most important challenges are identified, they are developed as **systemic project outcomes** and analyzed through qualitative and quantitative assessments, at different scales (micro, meso, macro) and considering the related **impacts** over time (short, medium and long term).

These aspects and methodologies can be applied to the research phases of this thesis and to arrive at answers to the design questions posed. First, they advise us to undertake a 360-degree holistic research of the coffee supply chain and its territories to fully understand the current system and networks. Next to carry out the same for how the circular economy applies to the coffee sector and how education of its best practices works, what is already being done and what is missing. Strategies can be developed to optimize and add value to the system through educational interventions that take into account the requirements that systems thinking demands.

Systemic design methodology





Source: Banna A. (2025)

CHAPTER 2

The coffee sector

2.1 Overview

Coffee is a huge and complex commodity. Its record of world trade has grown bigger with each passing year, making it recently something indispensable in every society and economy.
It is omnipresent as a beverage and unites a very big part of society, turning it into a source of passion and an inseparable part of so many cultures; nowadays, some **3 billion cups** of coffee are consumed **every day.** (Fig. 1)(ICO, 2024)

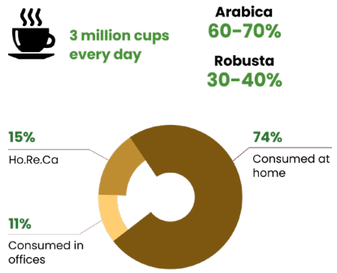


Fig. 1: Coffee consumption

Also in the last decades, the narrative of coffee evolved, crossing four different waves: during the **first wave**, in which coffee turned from a product destined to become daily into something for the everyday, thanks to its energizing properties and the invention of the percolator and instant coffee. The **second wave** began in the 1960s/70s, with the demand for better quality coffee and sociality; hence, the concept of high-quality, specific origin coffee was introduced, new coffee beverages were born, and attention to sustainability is growing. From the 1990s comes the **third wave**: the focus is on quality and origin. Consumers become more sophisticated and more interested in the story behind the cup. Coffee becomes artisanal, with highly skilled baristas and innovative ways of processing. Transparency and sustainability become part of the approach, while direct trade aims to benefit the producers further. Finally, the **fourth wave**, though not defined, seeks to incorporate the quality from the third wave and the accessibility of the second wave. It aims at making quality coffee more available to the mass market while maintaining standards of sustainability and transparency. The focus is on innovations capable of producing business opportunities and greater socioeconomic impact. (ITC, 2021)

Source: Pexels (2025)

2.2 The coffee business

From a business and market perspective, coffee is a considerable sector. From a business point of view, it could be valued at **$131.84 billion by 2024** and **$174.71 billion by the end of the year 2030**. The effects of the coffee economy are immense and provided jobs for an estimate of **125 million people** worldwide. Breaking this figure down, it is estimated that there are around **12.5 million farms** mainly

dedicated to coffee worldwide, **60% of them are smallholder farms** (<5 Hect), 21% large farms or estates (>50h), and finally 19% medium farms or estates (5<50 Hect). (Fig. 2)(Rushton, n.d.)

Among such countries which produce most of the total amount of coffee produced in the world (fig. 3), **Brazil** is the largest exporter of coffee since the 18th century, and now it contributes to around 30-40% of world coffee production. The main producing areas are Minas Gerais, São Paulo, and Espirito Santo, whose volcanic soils and tropical climate create very favorable conditions for producing both Arabica and Robusta quality.

Vietnam ranks second in terms of quantity, contributing about 17% to global production, while the provinces of Dak Lak, Lam Dong, and Gia Lai have proved to be perfect for Robusta quality. This coffee is well-liked due to its robust, bitter, full-bodied taste and its higher concentration of caffeine.

Colombia accounts for almost 8% of global production and is renowned for the high quality of Arabica, rich and sweet in taste, well-balanced, with tastes of fruit and hazelnut. Its main regions include the so-called Coffee Zone, whose departments are: Caldas, Quindío, and Risaralda. (Caffè Roen, 2024)

Indonesia produces 7% of the world's coffee, and its main producing regions are the islands of Sumatra, Java, and Sulawesi. Indonesia is known for Robusta coffee, but also for high-quality Arabica, particularly

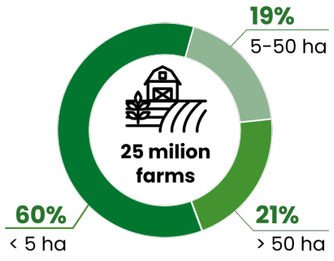


Fig. 2: Coffee farms

from Sumatra, with its rich and earthy flavor. It is also famous for Kopi Luwak coffee, which is produced with coffee beans digested by civets and is noted for its unusual process and high price. (Caffè Roen, 2024)

In Africa, **Ethiopia** is the birthplace of the Arabica variety, and evidence of the coffee plant goes back to the 9th century. Ethiopian coffees are appreciated for their complex and floral notes. Production is often based on small family farms that follow traditional practices. India is the sixth-largest coffee producer in the world, cultivating a large number of varieties in regions such as Malabar, Karnataka, Kerala, and Tamil Nadu. Both Arabica and Robusta are grown, but the latter is more common. The Indian specialty, Monsooned Malabar, has been particularly famous for its peculiar processing, which gives the coffee low acidity and a heavy body with earthy, chocolate, and spice notes. (Caffè Roen, 2024)

Central America holds some of the major coffee producers in the world: Honduras, known for its quality Arabica that grows in mountainous areas like Ocotepeque and Lempira; **Mexico** boasts Arabica from Chiapas and Veracruz, famous respectively for chocolate and nut flavors; **Guatemala** is famous for Arabica coffee, with spices and chocolate notes, while **Costa Rica** produces quality Arabica in the mountainous area of Tarrazú, with a clean and lively aromatic profile, with notes of citrus-fruit. (Caffè Roen, 2024)

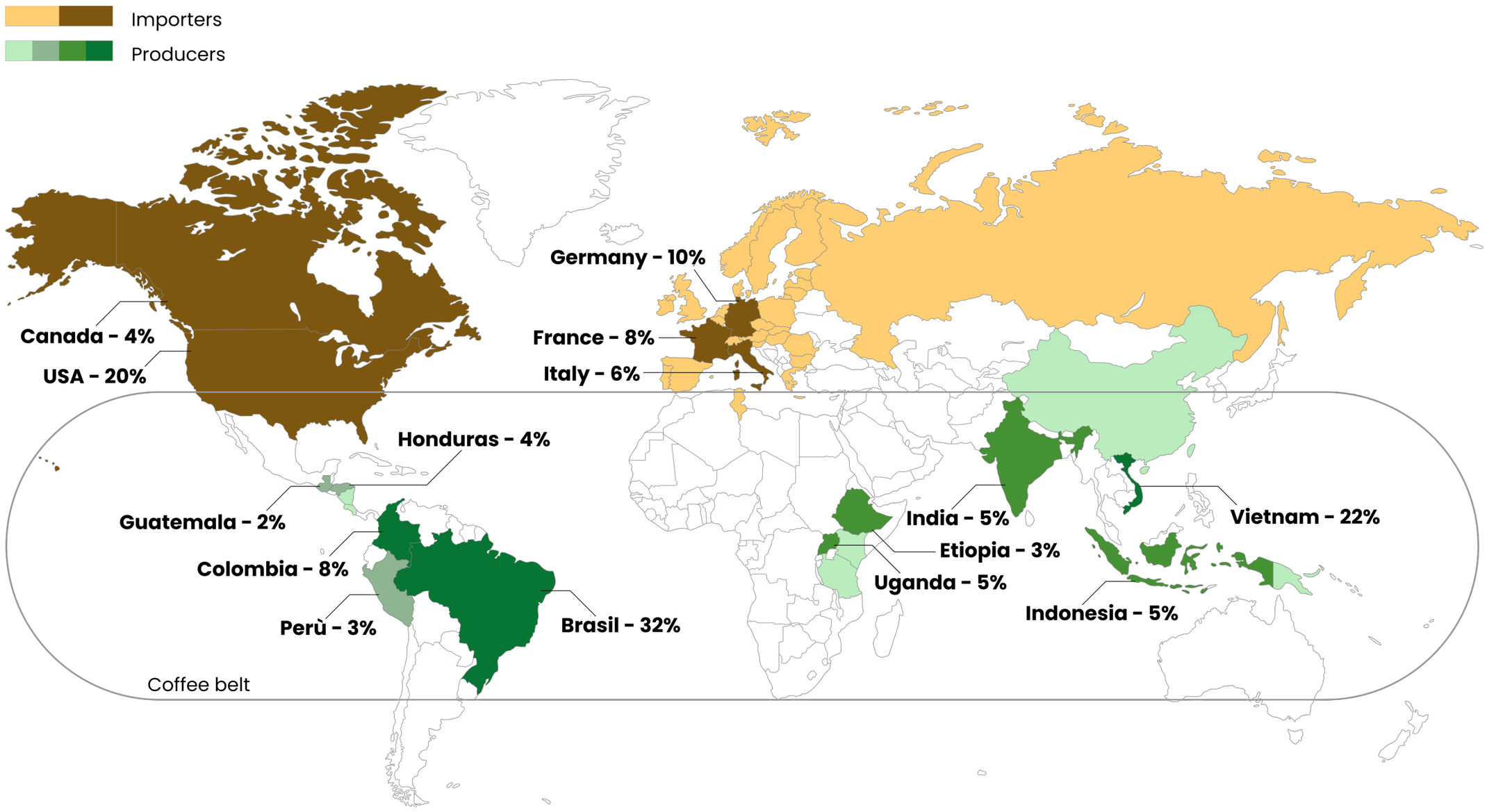


Fig. 3: Coffee producers and importers

The nation that imports coffee (Fig. 3) the most is the **United States of America** at $8.2 billion (18.7 percent of global imports) but, as for the countries that process and import coffee, we find mainly countries of the European Union: in the last ten years, production has increased by 15% and in 2023 each citizen consumed about five kilograms of coffee. Total production, which also includes roasted coffee, decaffeinated coffee, and coffee substitutes, exceeded two million tons, worth €13 billion. With 25% of the total, **Italy** is well ahead of other European countries in roast and ground coffee production, followed by **Germany** with 22%, and then **France** and the **Netherlands** with 6% each. The EU also imports approximately 2.7 million tons every year, or about €10.6 billion. **Germany** is the largest importer, taking 33% of the total, followed by **Italy** with 23%, then **Belgium** with 10%, **Spain** with 9%, and **France** with 7%. (Eurostat, 2024)

FOCUS

2.3 Coffee tour in Quindio

Colombia is the third-largest producer of coffee globally, following Brazil and Vietnam. Colombia is the world's best-known nation for its fine-tasting coffee, pungent aroma, and balanced acidity. Within Colombia's Andes Mountain range, we find the Eje Cafetero. This region offers climatic and topographic conditions favorable to coffee production. Coffee cultivation has served as the pillar of the development of the Eje Cafetero, affecting its cultural and economic identity over history. Although its presence in the industry is not as overwhelming as it was years ago, the area remains a benchmark in the coffee industry due to key contributions towards the modernization of its business and its place within the specialty coffee market. Out of the 53 municipalities that constitute the coffee corridor, 50 are coffee producers. The Eje Cafetero contributes to 15% of the country's national coffee production. The region produces and exports around 2 million 60-kilogram sacks out of the total 14 million sacks harvested in Colombia. Quindío coffee plantations are famous for being located in hilly areas with temperate climates, volcanic ash-rich soils, and high biodiversity. They typically consist of colonial- or rural-style buildings with open gardens and decorated balconies.

The farm that was visited is located in the Salento municipality, Quindío. The farm is an artisanal and bio coffee farm with 5,000 plants of five varieties (Castillo, Tradicional, Cenicafé 1, Geisha, Tabi). The terrain of the finca is very sloping, paths run through the coffee plantations. In addition to the coffee plants, one sees numerous citrus and banana plants, a greenhouse for drying coffee, and a chicken coop.

Source: Barina, A. (2025)

The tour begins with the area where compost is produced: any waste derived from cultivation and animal feces from farming are turned into compost, compost that is given to the plants every two months or so. Near this area we find another compost production site, however, where food scraps are collected.

Source: Barina, A. (2025)

The tour continues with an explanation of the process by which coffee plants are grown. Each coffee cherry usually contains two seeds, if planted we will have a sprout after one month, at the third month a first leaf, at the fifth month already the plant takes on a more identifying form and the leaves get bigger. At the age of one year the plant is pulled out and wrapped with plastic film until it is big enough to be planted with the others. The adult plants are all planted one to two meters apart,

Source: Barina, A. (2025)

Source: Barina, A. (2025)

depending on the Arabica variety, to ensure good water and light distribution. They have an average lifespan of sixteen years; they are not allowed to age longer because the plant would become weak, fragile, more easily attacked by disease, and the quality of the fruit would suffer. As mentioned earlier, there are not only coffee plants, but also many citrus and banana trees, and this is for several reasons: citrus trees are natural insect repellents, while banana plants serve multiple functions. First, they serve to create shade for the coffee plants, which need yes only, but not too much; second, they are plants that absorb a lot of water, so in rainy seasons they absorb all the excess water, removing the risk of the coffee plant absorbing an excessive amount of water; finally, since banana is sweeter and more sugary than coffee, it is preferred by insects, which thus do not destroy the coffee plants. Coffee cultivation presents the use of different techniques, often branches that are now unproductive are cut back to grow new ones; in some cases, usually at the end of a harvest cycle (about every two years), the entire plant is cut back to encourage complete regeneration.

Harvesting is done by a few highly experienced people (there are three workers for 5,000 plants in this finca), all by hand: since it is not an intensive crop and done on a large scale, they pick only the ripe fruit, leaving the still unripe ones attached. To cover the entire size of the plantation they work in zones, each week harvesting only one zone, continuing at this pace until the harvest is complete. The finca also features a small machine to strip the fruit and separate the coffee beans; a mortar to separate the parchment; and drying stations. Then the coffee is sorted by bean quality (color, size, integrity) and stored in burlap bags, about 50 kg each.

Source: Barina, A. (2025)

As a small, artisanal operation, the beans are shipped to a local and nearby operation for the roasting stage. The roasted coffee is then shipped back to the finca, which packages and sells it both locally and online. The tour ends with a tasting, then moves on to the grinding stage, where the roasted beans are ground by hand and then the resulting coffee is taken to a space to be cooked. The traditional technique involves 10 g of coffee and 100 ml of water per person. The water is brought to a boil and the coffee placed in a filter, ironically called “la media de la abuela” (grandmother’s sock). The first step is to pour only a little water into a metal pitcher, where you had placed the filter with the coffee in it, so as to remove the bitter and burnt taste that the roasting phase brings; this first water is thrown away. All the water is then poured out according to circular motions. The coffee in this way is served, strictly in hot cups, so as not to alter the aroma of the coffee.

Source: Barina, A. (2025)

To bring this experience to a conclusion, the thesis aims to offer some reflections. First, with this narrative, it is intended to make the point that it is possible to have sustainable coffee cultivation that takes advantage of circular strategies. The small scale and artisanal modus operandi help in this: the larger the plantation, the more there is a need for fertilizers, fungicides and machinery. Secondly, one wants to emphasize how acting locally is useful: relying on local realities for processes that are not carried out in one's own business decreases costs and ensures that the product maintains its quality and very often that it is processed according to techniques that are themselves artisanal. A final thought wants to draw attention, however, to a factor that may not always apply to all plantations: in this area, Eje Cafetero, coffee tourism is very strong. The nature, the typical architecture, and of course the great quality of the coffee brings many tourists, foreign and otherwise, every year, which of course brings additional revenue to the various fincas that offer tours for a fee. These businesses then can rely on this tourism, albeit local, to make a profit and not just have direct coffee sales as their only source of income. Exporting this business model to all areas where coffee is produced is not always possible, arguably making it more difficult to maintain production activity on the local scale.

Source: Barina, A. (2025)

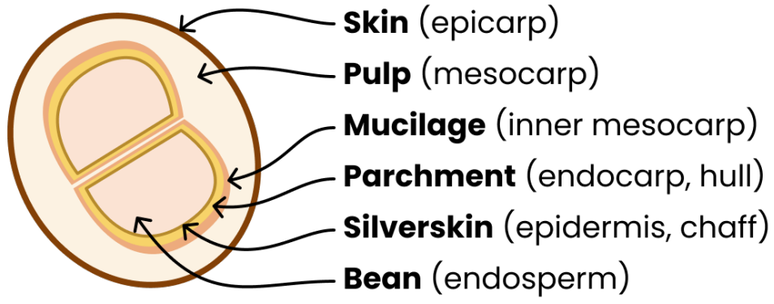
2.4 Coffee's anatomy

In order to have a clear view of the coffee production process and to have the basic foundations aimed at understanding what the circular economy can do in this sector, it is good to lay an initial analysis of the anatomy of the coffee bean. First of all, it should be remembered how the coffee bean is only a part of the fruit, it comes from the cherry or fruit of the coffee tree, and is very small in size compared to the fruit from which it is extracted.

Anatomy of the fruit (Fig. 4):

- **Skin:** Protective outer layer of the fruit.
- **Pulp:** Composed of water and sugar.
- **Mucilage:** Sticky, sweet inner layer of the pulp, also known as "honey."
- **Parchment:** Shell that covers the seed, which then becomes parchment paper.
- **Silverskin:** Innermost protective layer.
- **Bean:** Two coffee seeds.

Fig. 4: Coffee cherry anatomy



The fruit of the coffee plant is not only rich in different elements, but each of them is packed with useful and beneficial nutrients and chemical compounds that should not be left on the back burner. These form the basis of the many applications and best practices for turning process waste into value.

CHEMICAL COMPOUNDS OF BY-PRODUCTS	HUSK	PULP	SILVERSKIN	SPENT COFFEE GROUNDS
ASH	5.4% - 6.2%	7.3%	7.34% - 10.5%	0.47%
CAFFEINE	1%	1.5%	0.6% - 1.1%	0.02%
CARBOHYDRATE	58% - 85%	21% - 32%	0.2% - 6.3%	
CELLULOSE	43%	63%	17.8%	8.6%
CHLOROGENIC ACID	2.5%	2.4%	3%	2.3%
FAT	0.5%	2% - 7%	2.2%	2.3%
HEMICELLULOSE	7%	2.3%	13.1%	36.7%
LIGNIN	9%	14.3% - 17.5%	1%	0.05%
LIPIDS	0.5% - 3%	2%-7%	3%	16%
MINERALS	3% - 7%	9%	8%	0.8%-3.5%
MOISTURE	13% - 15%	82.4%	5% - 7%	74.7%
PROTEIN	8% - 11%	5%-15%	20%	10.3%
TANNINS	5%	3%	0.02%	0.02%
TOTAL FIBRE	24% - 30.8%	60.5%	60%	43%
TOTAL PECTIC SUBSTANCES	1.6%	6.5%	0.02%	0.01%

Source: C4CEC (2024)

Source: Barina, A. (2025)

However, there is not just one species of coffee plant, but several. The main coffee species are Arabica and Robusta, which in turn have multiple varieties. The **Arabica** species is the most widespread, covering 60-70% of world production and is grown especially in Latin America and some parts of Africa. Is known for its aromatic notes and a low caffeine level (about 1.5%), thus being less bitter than the Robusta species; at the same time, however, it is very delicate and more prone to diseases; it usually grows at high altitudes, above 600 meters. The **Robusta** species, on the other hand, covers 30-40% of world production and is grown mainly in Africa and Southeast Asia. It is more bitter, full-bodied, and rich in caffeine (about 2.7%); unlike Arabica, it is more resistant to disease and harsh climates.

Source: Torrefazione Simiele (n.d.)

Source: Caffè Vergnano (2025)

2.5 Supply chain

Similarly to understanding the anatomy of the coffee fruit, to comprehend possible interventions in the field of circular economy, it is important to be clear about the stages of the process that turns the coffee bean into the coffee used in bars and kitchens. This is because it is not composed of a single step, but of multiple stages involving different practices and stakeholders.

Plantation

The supply chain obviously begins with the plantation. Most of them are located in the so-called **"Bean Belt"**, a territorial strip composed of states in the tropical zones of the world. In Latin America, Africa, and East Asia, countries like Colombia, Brazil, Vietnam, Indonesia, India, and Ethiopia stand out. These regions enjoy high temperatures and abundant rainfall throughout the year, with a dry season that can vary but without real winters. However, the various territories, thanks to their specific peculiarities and differences in temperature, humidity, soil type, altitude, and rainfall, strongly influence the taste and quality of the final beverage. (Fig. 5)

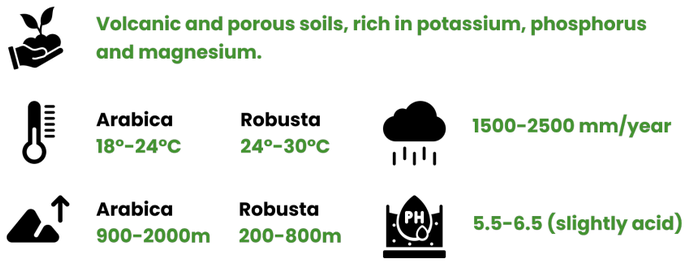
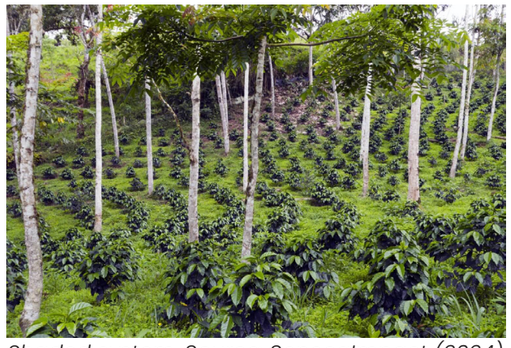


Fig. 5: Caratheristics of the Bean Belt and the coffee coltivation



Shaded system. Source: SenecaImpact (2024)

Sun-exposed system. Source: Britannica (n.d.)

At the plantation management level, we find two different methods: shaded or sun-exposed agricultural systems. **Shaded systems** have the positive aspect of being more compatible with the ecosystem in which they are established, preserving its biodiversity and allowing local species to thrive; however, high humidity can promote mold formation. These systems are particularly suitable for the production of specialty and sustainable coffees, as biodiversity reduces the need for pesticides by consuming insects and pests.

On the other hand, **sun-exposed systems**, more common in Africa and Asia, focus on intensification and production efficiency but often cause loss of biodiversity, extinction of native animal species, and warming of areas due to the lack of thermal regulation. In recent decades, shaded systems have significantly decreased, from 20% in 1996 to lower values, while the growing demand for coffee puts further pressure on farmers and pushes them to switch to a sun-exposed system. (Leahy, 2018)

All the processes of **fertilization, watering, cutting** the plants and **maintaining** them, which is often subject to disease, also take place during cultivation.

Harvesting

Manual harvesting, known as selective harvesting, plays a fundamental role and is currently the most widespread. This is mainly due to the fact that plantations are often located on sloping terrain, where

Manual harvesting. Source: Wikipedia (2012)

Mechanical harvesting. Source: BaristaHustle (n.d.)

the use of machinery is impractical. These machines are indeed rare, bulky, heavy, and expensive. Additionally, coffee crops are often integrated with other plants, making it difficult to exclusively select coffee beans. **Machines** are used only in the case of large-scale plantations, which, however, are only a small percentage.

Among the other reasons why manual harvesting is the most used, we find the greater ease for farmers to better control the ripening of coffee cherries, thus choosing only those ready for processing. Finally, it should be considered that in developing countries, labor costs are low, making the process more competitive and accessible compared to mechanized harvesting. (Guevara, 2017)

Processing

After harvesting, the coffee bean is **pulped**. There are various methods, the most common being the dry or washed process, followed by honey or semi-washed, while anaerobic processes, carbonic maceration, giling basah, or kopi are rarely used. (Peixoto et al. 2022)

In the **natural or dry process**, the cherries are dried in the sun for about 12-14 days, once laid out on brick patios or raised beds that allow air flow, thus reducing humidity to 15%. During this time, the beans are regularly turned to prevent mold and rot. When the pulp is dried, it is removed along with the skin by machines and left to rest. This method is used to obtain a sweet or fruity flavor and is the best option for farms in countries where water is scarce. (Coffee Drying, n.d.)

Natural process.
Source: Barista Parlor (2019)

In the **natural or honey process**, pulping removes only the skin, leaving part of the pulp for the drying phase. This allows the sugars in the cherry to give more sweetness and body to the beans. There are 4 types of honey process: black, red, yellow, and white, depending on the amount of pulp left after pulping. The process has the downside of high cost and considerable water footprint, but the advantage of a balanced flavor and body.

In the **wet process**, the beans are sorted by size and density and pass through pulping machines that, in a continuous flow of water, break the skin and pulp, releasing the seeds. These, still covered with mucilage and parchment, are sent to fermentation tanks for 24-72 hours, depending on the climate. The batch is then washed in small channels to remove residues and then dried in the sun or mechanically for 6-7 days. This method is used for specialty coffee, as it ensures consistency, brightness, acidity, and pleasant flavors. However, it is less sustainable than the dry method; on average, 15-20 liters of water are needed to process each kilogram of coffee beans. The wastewater produced is highly acidic and contains a high concentration of organic matter, which can contaminate local water systems if not treated properly. Countries like Ethiopia are known for the widespread use of the washed technique. (Alemayehu et al., 2019)

Wet process.
Source: Carabello Coffee (n.d.)

In the **semi-washed process**, the coffee cherry is pulped to remove the outer skin, but the mucilage is left intact. The beans are then fermented in water tanks, after which the mucilage is removed, and the beans are dried for 8-9 days. This method, commonly used in Brazil, produces a bright aromatic and sweet profile with reduced acidity. (Chief, 2023)

The less used are the **anaerobic process**, similar to the washed process but with fermentation in oxygen-free tanks; the **carbonic maceration**, which is similar to the anaerobic process but keeping the cherry pulp and giving the beans flavors like wine, whiskey, and banana; finally, the **Giling Basah** process, which resembles the honey process but differs because during drying, the moisture level reaches 35% before the parchment is removed and the beans are completely dried. (Coffee Processing Methods – Drying, Washing or Honey?, n.d.)

Resting

The coffee beans are **stored** in dry tanks for 1-2 months, preventing mold formation thanks to the drying process.

Cupping/Hulling

In this phase, the beans are **inspected** for impurities and **classified** by size and color. Coffee **hulling** is an optional step, which removes the parchment skin from the coffee beans using a machine called a “huller,” making the beans ready for the subsequent stages of cleaning, sorting, and packaging.

Packaging Transport

The coffee is classified for defects and packed in 50-60 kg bags, then shipped in containers to consumer or processing countries, often with long transport times.

Roasting and Milling

To obtain the characteristic flavor and aroma, green beans must be roasted. Once they reach the roasters, they are roasted in special roasting machines according to the desired **blend profile** (light, medium, dark), with temperatures ranging from 210°-220°C. The roasting phase develops through specially studied constant roasting curves:

- **50°C:** start of internal tissue changes
- **60°/70°C:** start of evaporation
- **150°/180°C:** start of “light roast” stage
- **210°/220°C:** optimal roasting degree

(Cellini Caffè, n.d.)

Coffee Bean Roast Levels

	RAW	LIGHT	MEDIUM	DARK
ROAST		Light	Medium	Dark
COLOUR		Tan/Light Brown	Brown	Dark Brown to Black
SURFACE		Dry	Dry	Shiny
ACIDITY		Higher acidity	Lower acidity	Low acidity
FLAVOUR		Keeps all origin characteristics	Some roast flavour with origin characteristics	More bitter, distinct aromas with little original characteristics
SHELF LIFE		Longest	Goldilocks	Shortest
GRIND		Softer	Medium	Brittle
CAFFEINE		Same	Same	Same

Source: Reddit (2024)

Immediately after roasting, the beans undergo **quality checks** (specialty coffee roasters often seek **Q-Grader certifications**, which evaluate coffee quality on a scale from 1 to 100 for Q Arabica and Q Robusta) and are cleaned (Q Graders, n.d.). They are then sorted, stored, and left to rest in silos.

Packaging

Before being distributed to end users, roasted beans are packaged with good preservation systems to ensure long shelf life and no variation in quality. The packaging also communicates

Fig. 6: Coffee supply chain

information about the coffee's attributes, processing methods, and certifications.

Retail
Packaged coffee is distributed, mainly by road transport, to the retail network, including B2B such as coffee shops, bars, restaurants, distribution centers, and B2C such as retail stores, supermarkets, and e-commerce.

Consumption
The final stage of the supply chain is consumption, represented by various people, buyers, and customers who either purchase ground coffee, beans, and preparations (pods, instant coffee, etc.) or directly buy the beverage in establishments.

Source: Juan Valdez (n.d.)

2.6 Stakeholders

Like any market and production process, behind a series of actions, there is a complex network formed by various stakeholders, each with a specific activity and organization depending on their role within the supply chain. These stakeholders ensure that coffee is produced, distributed, and consumed efficiently. The different roles of the actors can be divided into these categories:

- **Coffee production actors**
- **Coffee processing actors**
- **Coffee trade actors**
- **Coffee consumption actors**
- **Support actors**

Growers
Growers are responsible for the fundamental early stages of the process: **planting, cultivating, harvesting, and sometimes processing the beans.** According to Fair Trade, 80% of total coffee production is managed by 25 million growers, with **125 million people** depending on coffee for their livelihood (The Fairtrade Foundation, 2023). It is also important to remember that among these, **60% are smallholder farms (<5 hectares)**, 21% are large farms or estates (>50 hectares), and finally, 19% are medium farms or estates (5-50 hectares). (Rushton, n.d.)

Source: International Coffee Partners (2019)

Strengths and Weaknesses:
- Great knowledge of the territory.

• Poverty and difficulty in supporting families.
• Difficulty managing the economic aspects of the work, such as finding adequate prices, fair contracts, and diversifying income through new businesses.
• Facing environmental issues like climate change, water scarcity, and infestations.
• Finding international buyers and reaching sufficient volumes for direct trade can be challenging.
• Low knowledge of marketing, innovative practices, negotiation, and quality control.
• Often their practices involve the creation and/or destruction of waste.
• Low access to digital technologies, information, and initiatives.
• Limited overall vision.
• Joining cooperatives can help increase revenues and access to new markets.

Cooperatives

Cooperatives are **often non-profit organizations** that act as **intermediaries between growers and other stages** of the supply chain. They support growers by purchasing coffee and distributing it to intermediaries or roasters, also helping in price negotiation. They play a key role in **trade regulation** thanks to their formalities, technical knowledge, market knowledge, and access to dry milling stations, often committing to spreading this knowledge, with an **educational** purpose, to growers.

Strengths and Weaknesses:

• Operating locally, they can easily connect with and support farmers.
• They can form hubs for sharing knowledge and skills, establishing training processes.
• Easier access to specific information and knowledge.
• Platforms like blockchain, databases, and online auctions can help improve productivity and profitability.
• Cooperatives often provide low-interest credits and materials to growers.
• They establish trade networks, negotiate agreements, and create direct trade networks between small producers and third-generation roasters.
• They face challenges like price fluctuations and covering material and administrative costs, making long-term vision difficult.

Source: Barina, A. (2025)

Intermediaries - Traders

Intermediaries connect growers or cooperatives with roasters. They handle **logistics**, managing the transport of coffee shipments and monitoring their journey from producing to consuming countries.

Strengths and Weaknesses:

• Great knowledge of import/export regulations.
• They must deal with hidden costs, loss of confidential data, loss of control, delays, and poor operation management.
• Lack of information and communication with customers and other supply chain actors.
• Supplies can be irregular and of varying quality.
• Effective inventory management, a reliable transport system, real-time information sharing,

strategic structures, and pricing strategies are critical success factors. (Shanker et al., 2021)

Roasters

Roasters own the facilities and machines for roasting green coffee beans, often performing additional processing like grinding, packaging, and distributing through various channels. Some also open their own coffee shops.

Source: Colombian Coffee Roasters (2020)

Strengths and Weaknesses:

- Mastery of techniques and considerable knowledge of coffee quality.
- Non-standardized product quality and unpredictable availability.
- They must respect the freshness of the raw material and maintain its properties, which can also cause storage management difficulties.
- Difficulty tracking the raw material.
- High market competitiveness.
- High energy requirements and technical improvements for equipment.
- Volatile product prices and risk of low-quality products if freshness is lost. (Umaran, T., Perdana, et al 2022)

RETAILERS

Retailers bring coffee directly to customers through physical stores and e-commerce platforms. They handle logistics, inventory, marketing, equipment maintenance, facility management, coffee preparation, and customer service.

Source: Faire (2024)

Strengths and Weaknesses:

- Great knowledge of consumers, leading to excellent customer service and experience.
- High bargaining power thanks to multiple suppliers and marketing channels.
- High ease of creating different revenue streams.
- High fixed costs.
- Difficulty emerging and networking for small and new retailers.
- Attention to packaging and brand communication is crucial (Umaran, 2022).

Consumers

Consumers purchase coffee products for consumption or home preparation. They influence the supply chain through their preferences and behaviors.

Source: CAFP (n.d.)

Strengths and Weaknesses:

- Influenced in purchasing by taste, product design, environment, brand influence, location accessibility, and price.
- Price increases can threaten purchases, despite possibly higher quality offerings.
- Awareness of new products, technologies, innovations, and experiences is important.
- Often tied to habits.
- Increasingly linked to online purchasing and digital channels.
- Limited overall vision of the supply chain.
- Much is wasted in consumption.

Governments

Governments **regulate the sale and production** of coffee through tax management, import duties, and policy creation, although they often do not play an active role in the chain. In some countries, they act as buyers, purchasing coffee directly from producers or cooperatives and selling it at auctions.

Strengths and Weaknesses:

- Great economic availability and diplomatic capacity.
- Wide visibility and an extensive network of relationships with buyers and suppliers.
- Difficulty regulating and monitoring the local industry.
- Territorial disconnection and accessibility challenges.
- Difficulty directing funds and resources.
- Import taxes and poor price regulation can lead to economic imbalance.
- Producing countries are highly dependent on importing countries.

Certifications bodies

Certification organizations play an important, though not central, role within the coffee industry. They **ensure quality, sustainability, and ethics** within the supply chain, certifying that coffee is grown, harvested, and distributed respecting the environment and workers. Over the years, they have become increasingly important for end consumers, who can thus recognize how sustainable the product is. To obtain these certifications, the process must meet

specific standards and practices. The main certification bodies are:

- **Fair Trade:** Focuses on the economic aspect of the supply chain. Ensures that producers receive a fair price and a minimum wage for their coffee, developing fairer pricing policies and promoting sustainable agricultural practices and direct sales relationships. It fights to improve the lives of farming communities and abolishes child exploitation. This model allows growers and cooperatives to have more bargaining power to compete in the market. (CBI, 2021)
- **Rainforest Alliance:** Focuses on environmental, social, and economic sustainability; promoting forest conservation, biodiversity, low-impact practices, and the well-being of farming communities. It also organizes training courses with agronomists, biologists, and sociologists. (CBI, 2021)
- **UTZ:** Merged with Rainforest Alliance in 2018, this certification promotes sustainable agricultural practices and better working conditions for growers. (CBI, 2021)
- **Organic:** Certifies that coffee is grown respecting the soil, nature, and its biodiversity, without the use of chemical pesticides and synthetic fertilizers, promoting ecological agricultural practices. (CBI, 2021)

Strengths and Weaknesses:

- Provide more bargaining power on price to growers.
- Ensure the use of sustainable practices.
- Organize training and education courses.

• Have a strong impact on the end consumer.
• High cost and long time to obtain.
• Not all producers have access to the necessary resources.
• Their effectiveness varies depending on the location.

Universities and Research centres

These actors do not play a primary function along the production chain, but they prove crucial as they take charge of **researching, studying, and disseminating knowledge, best practices, and strategies** needed to make the chain more sustainable, improve relationships among actors, and bring about innovation. Specifically, they can take action on how to improve resource and process management; how to address climate change; how to improve worker conditions and ensure economic equity; and how to make the market more transparent and consumers more aware. To achieve this, universities and research centers often collaborate with strategic stakeholders to reach all supply chain actors and organize courses and workshops.

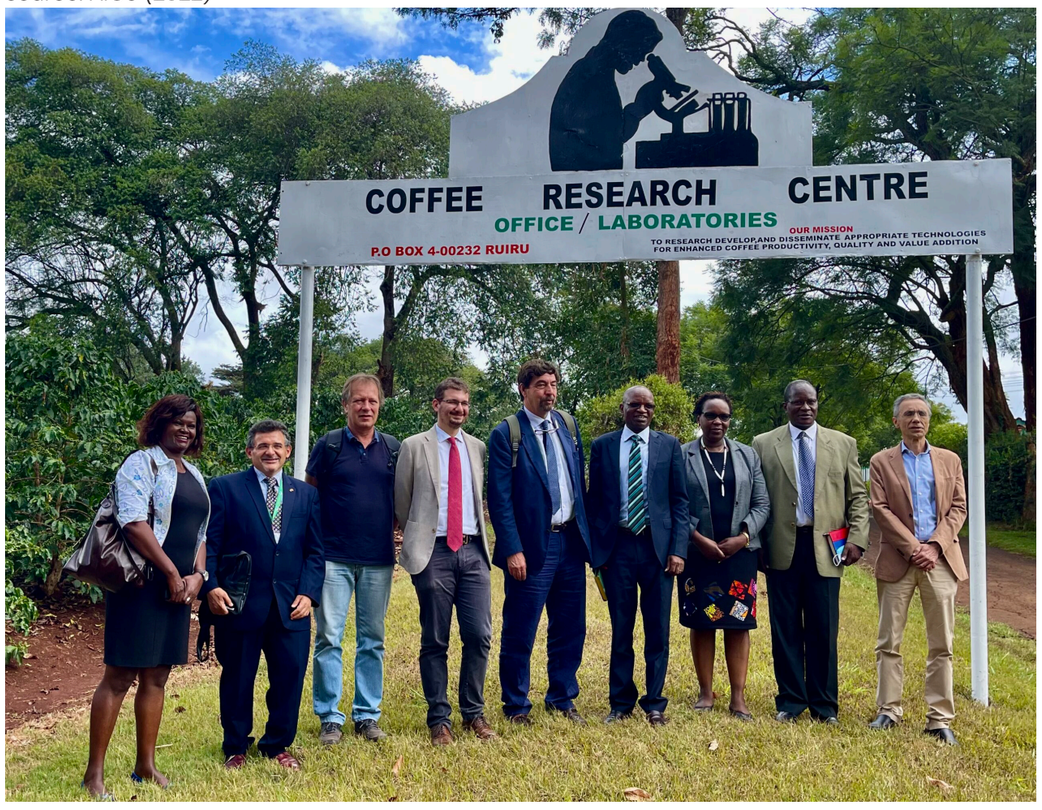
Strengths and Weaknesses:

• Accessibility to knowledge
• Extensive experience in managing and researching know-how and information
• Interdisciplinary approach
• Access to technologies
• Sensitivity to sustainability
• Influence at the policy and political level
• Large network

• Difficulty in reaching and relating to all stakeholders in the supply chain
• Budget and funds often limited
• Gap between theory and practice

Source: AICS (2022)

Source: AICS (2022)



2.7 The problems of the coffee sector

Unfortunately, the coffee industry is not without its problems and impacts towards the environment and society. The industry, through cultivation, transportation, processing, and consumption, brings with it **pollution, waste, and socioeconomic disparities**; in addition, **climate change**, which is now impossible to ignore, causes numerous difficulties that must be addressed. Stakeholders therefore, particularly farmers, face several challenges, affecting all spheres of sustainability: economic, environmental and social.

From an **economic perspective**, one of the biggest challenges is the **volatility of coffee prices**. For example, in 2025, global prices reached €392 per pound, an all-time high (Fig. 7), due to extreme weather conditions in major producing countries such as Brazil and Vietnam. In addition, the **difficulty of obtaining long-term contracts**, and funds means that farmers and cooperatives often face social problems: small coffee farmers are the hardest hit, with 44 percent of them living in **poverty** and 22 percent in extreme poverty. This phenomenon is particularly evident in African countries (Burundi, Uganda, Ethiopia), Indonesia and Papua New Guinea. These countries account for approximately 63% of the world's coffee farmers living in poverty and 71% living in extreme poverty. (Fig. 8) (Rushton, n.d.) Poverty measures are provided by World Bank statistics and indicate consumption thresholds between $1.90 and $3.20 per day.

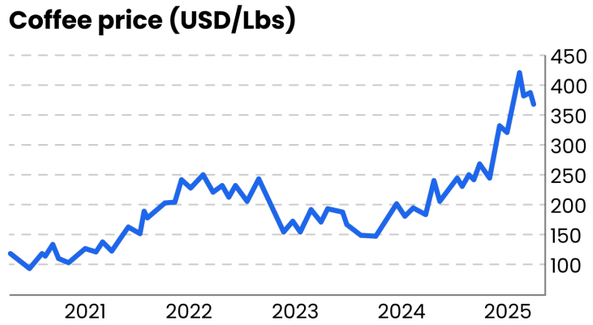


Fig. 7: Coffee price volatility

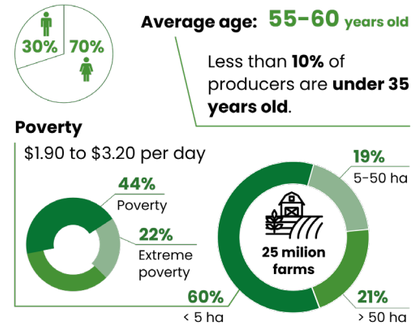


Fig. 8: State of poverty of coffee farmers

Lack of economic resources also impacts the availability by these actors of the resources needed for cultivation and the technologies, innovative or otherwise, that could facilitate the work.

Another **societal-level problem** that impacts workers and entire communities where coffee is grown is found in **health**: labor, pollution and lack of health facilities, make life difficult for the poorest families. **Lack of education** and specific knowledge in agronomy and biology, then, create gaps that slow the spread of sustainable practices that could bring economic and social benefits. It should also be pointed out, how the work of the farmer is increasingly experiencing a labor shortage due to the low attractiveness of the work itself, we are increasingly witnessing a **lack of generational turnover** where the younger generations are more enticed, both because of the hardness of the work and the low pay, to come alongside and then take the place of older workers. In fact, in the coffee world, the average age of farmers is around 55-60 years old; less than 10 percent of producers are under 35 years old (ICO, 2024). Finally, a big problem in the industry is the **gender disparity** in the grower group-70 percent of them are women, but they are often not treated and paid the same as male farmers. All these social problems may as well result in an increasing tendency to migrate to other countries in search of new opportunities.

From the **environmental point of view**, the problems that the sector encounters and seeks a

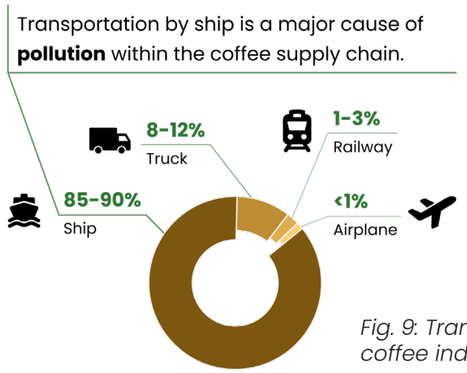
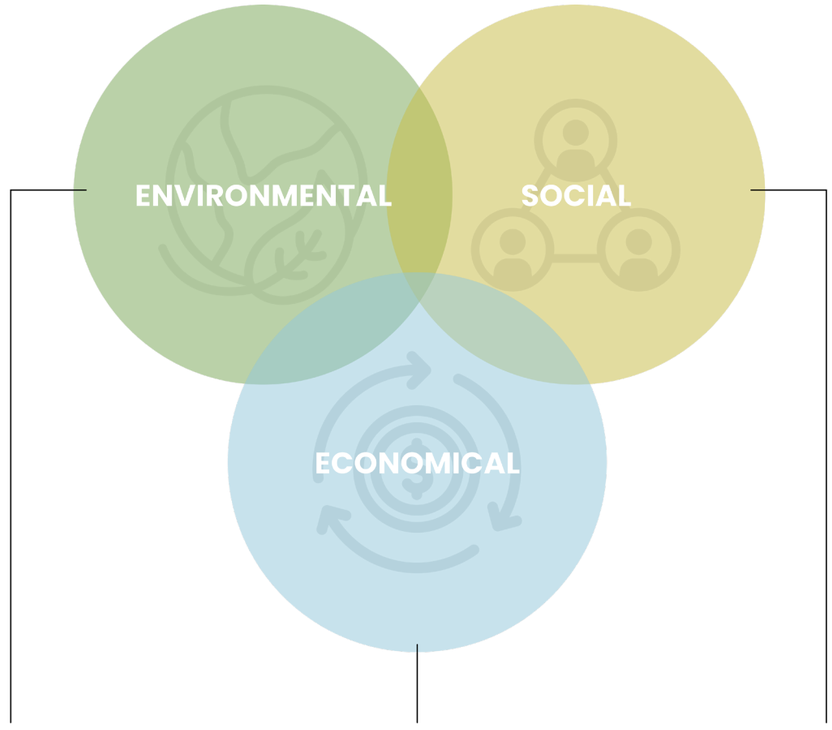


Fig. 9: Transportation in the coffee industry

solution to are mainly related to climate change. **Rising temperatures and water scarcity** pose a serious threat to crops: as time passes, the most suitable and favorable climatic and soil conditions for cultivation are encountered at higher and higher altitudes. This causes, first, a difficulty in maintaining suitable conditions in existing crops; second, there are difficulties in establishing crops in areas at **higher altitudes**, as they are more impervious and restricted. The fact that one needs to go up in altitude to grow coffee will lead to a drastic decrease in the amount of coffee produced and consequently to a significant rise in the prices of the raw material. Controlling **diseases and pests** in the soil and plants is also a challenge for farmers; they often meet it with the use of pesticides harmful to the soil, whose fertility thus continues to decline. In addition to the **loss of fertility**, these harmful practices cause a **loss of biodiversity** in the surrounding environment, which leads to further disease and difficulty in managing the crop. Of course, one must also subtilize the large production of **organic and non-organic waste** during the various steps of the production chain, waste that is often not recovered.

Finally, we also find impacts derived from the **transportation** of the raw material: in 85-90% of cases the ship is the main means by which coffee is brought from the producing countries to those that process it, and this is at the root of considerable pollution. (Fig. 9)

Fig. 10: The problems of the coffee industry

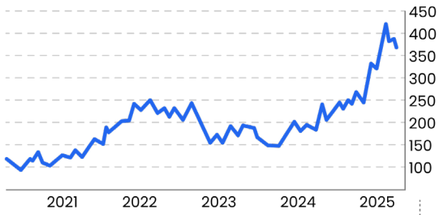


Market

$131.84 billion $ 2024

$174.71 billion $ 2030

Coffee price (USD/Lbs)

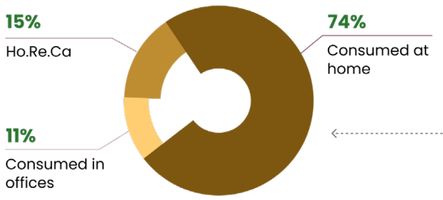


Consumption

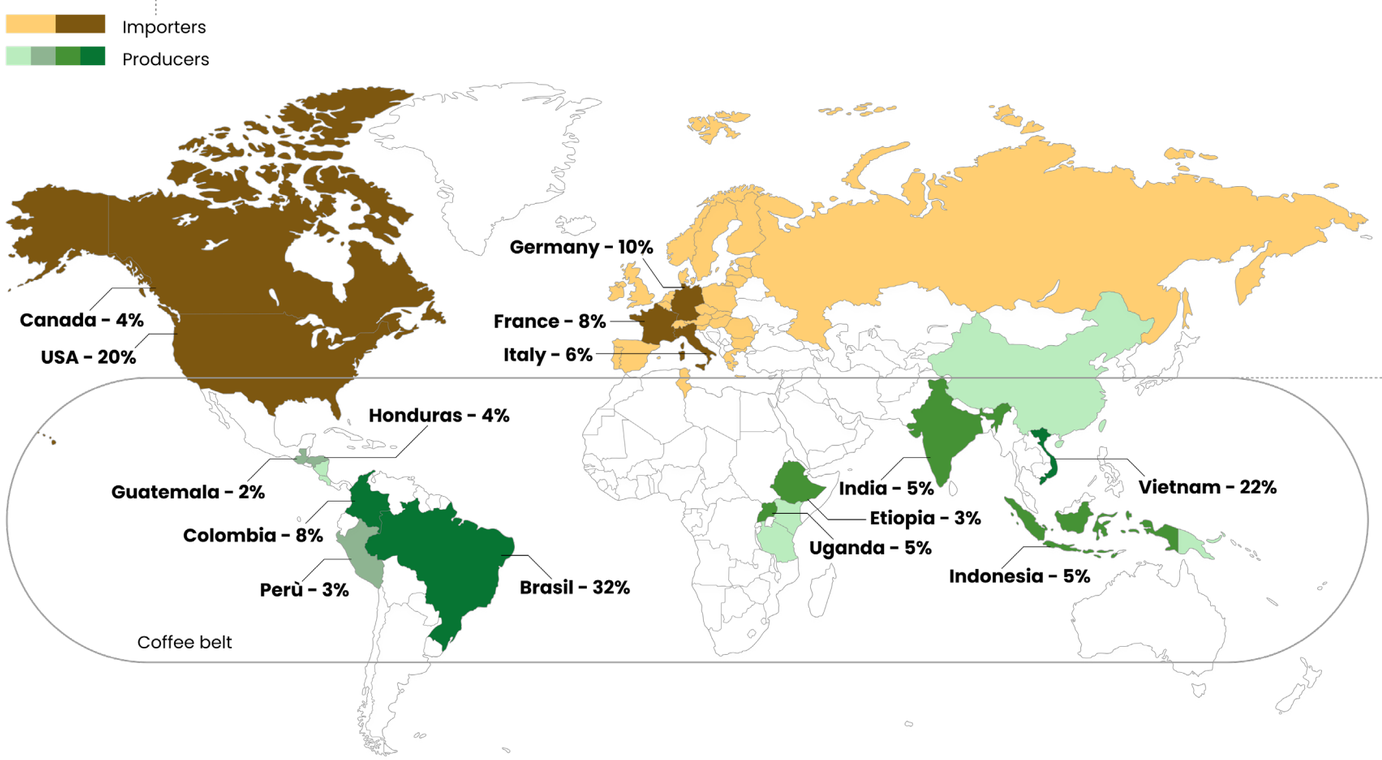
3 million cups every day

Arabica 60-70%

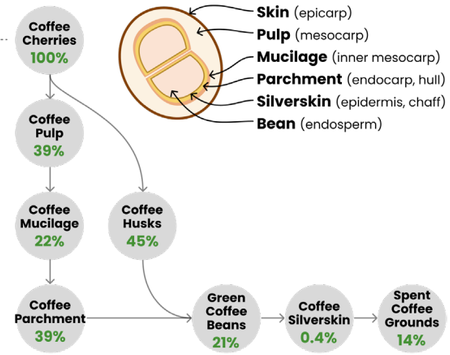
Robusta 30-40%



Coffee sector map



Coffee anathomy



The Coffee Belt

Volcanic and porous soils, rich in potassium, phosphorus and magnesium.

Arabica	Robusta
18°-24°C	24°-30°C
900-2000m	200-800m

1500-2500 mm/year

5.5-6.5 (slightly acid)

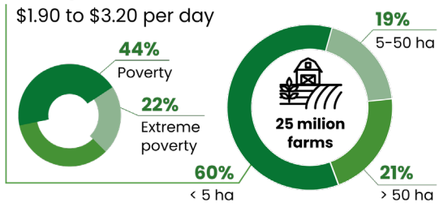
Coffee farmers

Average age: 55-60 years old

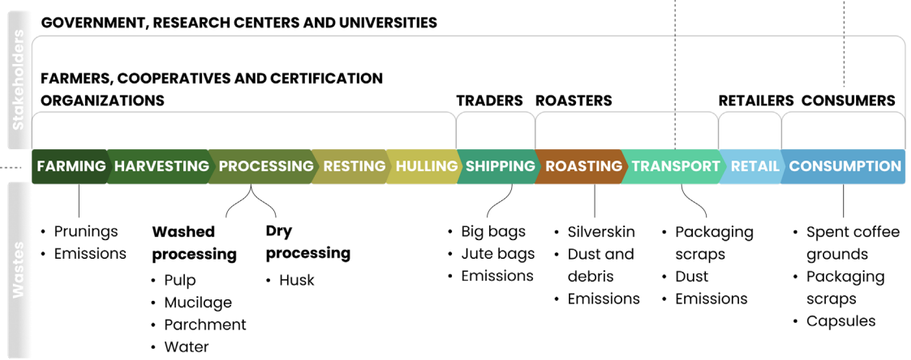
Less than **10%** of producers are **under 35 years old**.

Poverty

$1.90 to $3.20 per day

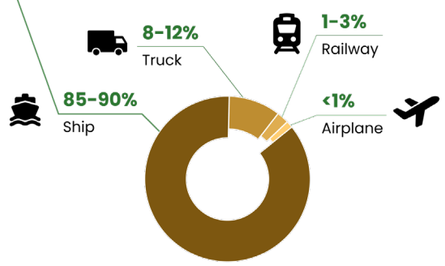


Process and stakeholders



Transport

Transportation by ship is a major cause of **pollution** within the coffee supply chain.



Waste

1 tonne Of cherries → **200 kilos** Of green coffee beans

29 million tonnes Of biomass generated from the process → **40 million tonnes** Of biomass generated globally

To best summarize the analysis carried out on the coffee sector, while at the same time giving a graphic layout to highlight all the important factors and their interconnections, a **complexity map** was drawn. (Fig. 11)

Fig. 11: Complexity map of the coffee sector

Source: Barina, A. (2025)

CHAPTER 3

Circular economy in the coffee sector

3.1 Overview

As climate change increases, coffee production is increasingly threatened and complex, especially when it comes to the Arabica variety, which thrives in cool tropical climates at high altitudes. Combating these problems requires a significant paradigm shift in coffee cultivation: shifting production to higher altitudes can damage forest ecosystems and also become unsustainable from a regulatory perspective. The **United Nations Climate Change Conference** in 2023 (COP 28) highlighted the need to reduce global greenhouse gas emissions by 43 percent by 2030 to limit warming to 1.5˚C compared to 2019. The coffee sector therefore, if it is to adapt to these directives, must invest in regenerative practices, climate-resilient varieties, reorganize farms to improve irrigation, mechanization, and farmers' livelihoods, thus promoting economic, environmental, and social sustainability. The **circular economy**, which focuses on reducing waste, improving resource efficiency, and regenerating natural systems, may be the right way to achieve these goals and create new economic opportunities by fostering job creation, especially in vulnerable farming communities, among young people, and small-scale processors. (ICO, 2024)

Source: European Parlament Research Service (2024)

FOCUS

The **Circularity Gap Report 2024** reveals that only 7.2 percent of the global economy is circular, showing a decline in material reuse and recycling. Despite this, more and more countries around the world are adopting circular economy policies.

- The European Union, with its Circular Economy Action Plan, integrates circular practices into its 2050 climate neutrality goals.
- Brazil, leading the G20 in 2024, has prioritized the circular economy in its presidency and launched a national strategy to transition to circular and sustainable practices.
- India is setting ambitious circularity goals, focusing on renewable energy and rural empowerment.
- Africa is supported by the Africa Circular Economy Facility (ACEF), which helps countries such as Ethiopia, Cameroon, Chad, Ghana, and Uganda develop circular roadmaps.
- Indonesia is advancing a National Roadmap for the Circular Economy.
- A multi-stakeholder program for circularity and sustainability of global coffee value chains was launched at the 2024 G7 Summit under the Italian presidency, including a decision to explore the creation of a global public-private fund to improve sustainability and combat climate change.

(Circle Economy, 2024)

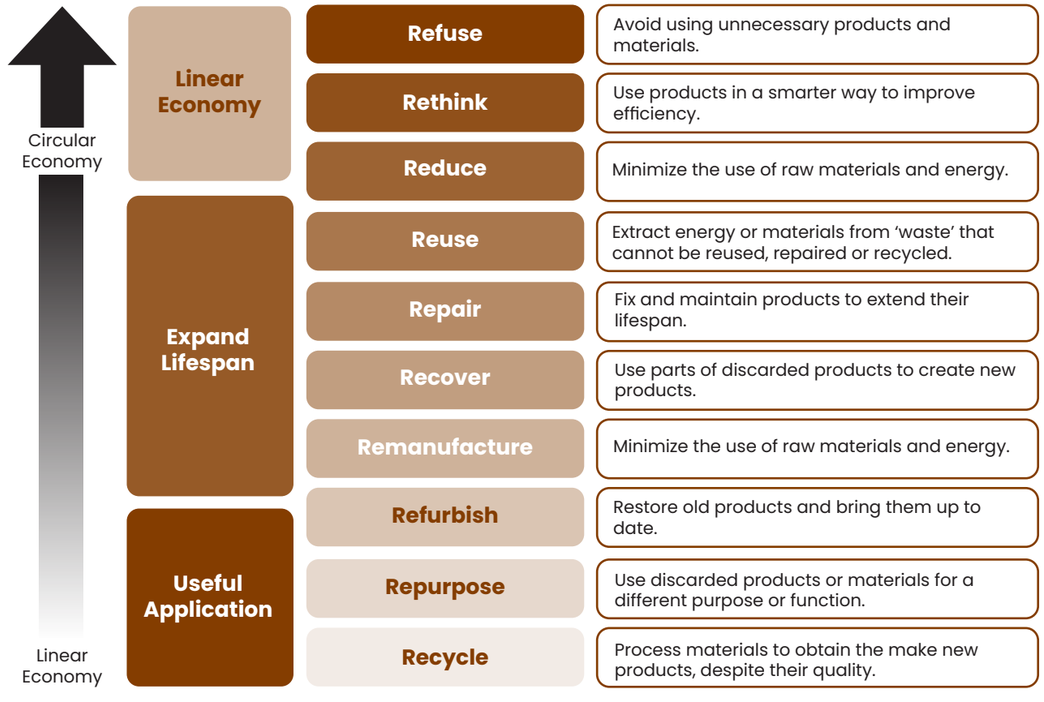
3.2 Principles and schools of thought

The traditional economy is based on linear process and thinking. This **"take, produce, discard"** philosophy, however, will lead in the short to medium term to resource depletion causing in addition, pollution and environmental degradation at all stages of a product's life cycle, from extraction and processing to transportation and disposal. Over time, theories have been formulated that overcome the concept of linearity and theorize a different economy, a **circular economy**. In contrast to the linear economy, the circular economy is based on concepts and principles that aim to create sustainable economic models and closed systems, systems in which there is no waste, only materials that from outputs become inputs to another process, regenerating without losing value, just as happens in natural systems. To achieve a circular system one acts by following many principles and applying different strategies; in the coffee sector not all circular economy strategies can be applied, as they focus on other aspects, but still there is a great set of opportunities that can be considered.

The 9R Framework for the Circular Economy

Specifically, the circular economy stands on nine principles, called the **9 Rs'**. The R's are the actions for circular action and they scale from the least wasteful in terms of energy and materials, thus consequently the most sustainable, to the most

wasteful, which should be used only in case the other strategies cannot be applied. Within a system several of the strategies might be suitable: in order to increase the circularity of it one must apply the strategies starting with the least impactful one, continuing in order then with the others.



Source: Kirchherr et al. (2017)

"Regenerative agriculture is a holistic, outcome-based farming approach that generates agricultural products while measurably having net-positive impacts on soil health, biodiversity, climate, water resources and farming livelihoods at the farm and landscape levels. It aims to simultaneously promote above and below ground carbon sequestration, reduce greenhouse gas (GHG) emissions, protect and enhance biodiversity in and around farms, improve water retention in soil, reduce pesticide risk, improve nutrient-use efficiency and improve farming livelihoods."
(One Planet Business for Biodiversity)

Regenerative agriculture

Sustainability is based on nature's ability to regenerate itself (Illy & Vineis, 2024), and it is on this concept that regenerative agriculture is based. Implementing these practices can help **counteract the impacts of climate change**, resulting in increasingly resilient agricultural systems. This approach is not limited to not creating damage to the ecosystem but aims to regenerate it, bringing benefits not only at the level of environmental sustainability, but also under the economic and social spheres. Regenerative agriculture has mainly five attributes:

- **Soil fertility reconstruction:** through loading with organic matter and establishment of an equilibrated microbiological system, such as bacteria and fungi essential for feeding invertebrates and microbes.
- **Increased carbon absorption:** within the soil through its preservation underground. Soil, filled with carbon-based microbes, is pivotal in carbon sequestration through the presence and maintenance of root systems and crops.
- **Enhancing biodiversity:** by encouraging beneficial insects, pollinators, songbirds, and other wildlife that contribute to making farms more robust and ecologically rich.
- **Valuing the farmer's contribution:** by respecting their expertise and ability and encouraging more diverse and superior quality food and raw materials production.

Source: HFUU (2022)

- **Encouraging ecosystem balance:** through the adoption of farming methods that not only deplete natural resources but also restore and build them up.
(FootPrint Africa)

All of these strategies can prove crucial in achieving various benefits to the communities that apply them. Specifically among the **positive social and economic impacts** can be identified:

- Building **food resilience** by improving farmers' **self-sufficiency and responsiveness**. This is achieved by reducing dependence on external inputs such as chemical fertilizers, rotational crops to add nutrients and fertility to the land, and climate-appropriate species to achieve lower input levels and higher production.
- **Reduced expenditures on agricultural inputs**. Regenerative agriculture increases land productivity and crop diversity while reducing dependence on expensive imported inputs and closing the food trade deficit.
- Contribute to the **food security** of growing populations by providing biodiverse farms that produce denser, healthier diets.
- **Rehabilitate soils** by reversing the processes of erosion, salinization and loss of soil fertility.
- **Prevent climate change** by converting cropland into a net carbon sink. Regenerative strategies reduce emissions from traditional agriculture and sequester carbon in the soil.
- **Relieve the financial burden** on farmers and

governments by decreasing dependence on expensive chemical inputs, money that can be redirected to infrastructure for regenerative agriculture, local organic input production, and new enterprises. (FootPrints Africa)

In the specific case of the coffee sector, regenerative agriculture incorporates aspects of organic farming, permaculture, climate-smart agriculture, holistic farm management, agroecology and indigenous farming. These practices improve coffee quality, increase yields, and improve farmers' livelihoods.

The main goals of regenerative coffee farming are to restore soil fertility, optimize nutrient management, and increase soil productivity while maintaining ecosystem services and farmers' livelihoods. These sustainable approaches ensure long-term coffee production, stabilize incomes, and reduce the effects of climate change. (ICO, 2024)

Best Practices:

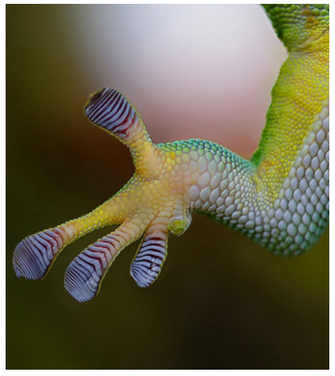
- Agroforestry
- Animal supplementation
- Biochar
- Composting
- Contour planting
- Cover cropping
- Diversified crops or intercropping
- Ecological aquaculture
- Halophilic farming

- No-till
- Pasture cropping
- Perennial plants
- Planting of native species
- Reduction or absence of pesticides or inputs produced by fossil fuels
- Pasture Silvo
- Solar energy

(FootPrints Africa)

Bio Mimesis

Biomimicry is an approach that seeks to solve problems by drawing **inspiration from nature**, thus creating sustainable innovations, lower environmental impacts and greater energy efficiency. The circular economy aims to achieve **closed systems**, and the best source of inspiration are ecosystems: as mentioned earlier, in nature there is no waste, everything produced is reintegrated into a new cycle, from output it becomes input again. However, nature not only teaches this, nature and the animals that inhabit it are a valuable example for form and processes; characteristics that are exploited and imitated for the creation of innovative technologies.



Source: GreenPlanner Magazine (2024)

Eco design and Cradle to cradle design

To meet the demands of the circular economy, the design world has had to adapt and evolve toward

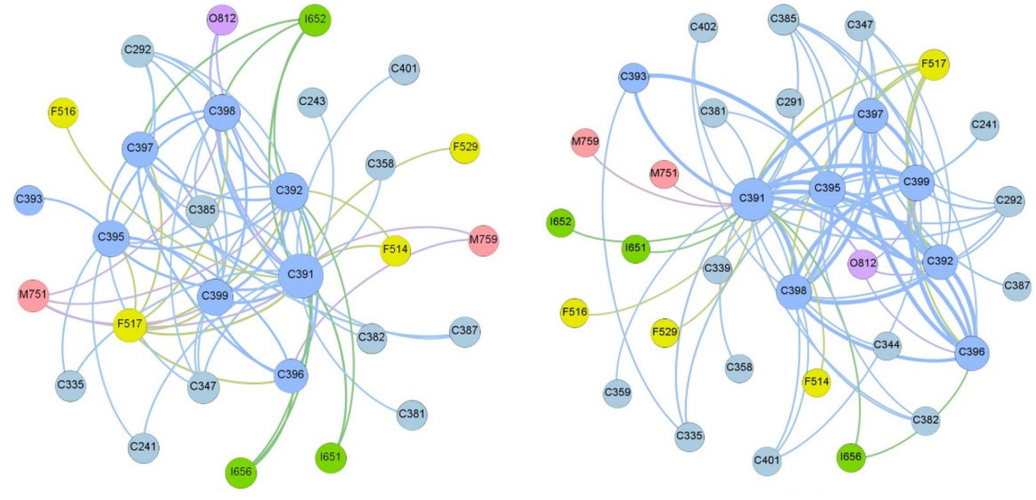
new methodologies and approaches to design and materials. From a design that initially did not take into account the product's end of life and its sustainability, where the main thinking can be summarized as a **"from cradle to grave"** approach, there has been a move to put these concepts in the foreground and theorize the **"from cradle to cradle"** concept, thus ecodesign was born. In the conception and design phase then, an attempt is made to achieve a product that first of all is made from sustainable, recyclable materials that will last as long as possible; secondly, an attempt is made to avoid glues or resins that are harmful to the environment; and finally, the components of the product themselves are designed so that they are easily disassembled and replaceable.

Industrial clusters

Gunter Pauli, with the founding of Zero Emissions Research and Initiatives (ZERI) in the early 1990s, introduced the concept of industrial clustering, which can be identified as a strategy to achieve zero-emission systems. The principle fits within the **Blue Economy**, an economic development model that proposes sustainable business models, exploiting circular economy and biomimicry. Industrial Clustering therefore essentially stands on **collaboration between companies**; they no longer operate in isolation and fueled by market competitiveness, but organize themselves into clusters and also collaborate across sectors to maximize

"There is no unemployment in eco-systems" (Gunter Pauli)

the reuse of resources and by-products. Just as in nature, each output of one company becomes the input of another. Not only does this theory reduce waste and fuel collaboration, but it also optimizes the exploitation of local resources so as not to resort to expensive and often polluting imports. The goal, then, is to create an economic model that is profitable, yet respects the environment and improves the living conditions of local communities.



Source: Tan, Y., et al. (2022)

3.3 Circular economy barriers

One of the main points of criticism toward many perspectives of the circular economy is the **lack of proper balance between the three pillars** of sustainability: economic, environmental and social. This imbalance creates a disconnect between what is sustainable and what is circular. Issues such as intra- and intergenerational equity, equality of social opportunities and diversity are often over-looked. In implementing the circular economy, it is critical that practitioners consider the balance and tensions between these three pillars.
Several studies have examined the implementation of the circular economy in various contexts, providing overviews and comparisons of these initiatives, but have also identified barriers to its implementation. Barriers include **corporate culture, government support, creation of new partnerships, technological developments, product passports, and social awareness**. Other barriers include **consumer awareness, material composition, weak policies, high initial investment, lack of information and technological know-how, and lack of performance monitoring**. (Maarten van Keulen, 2018)

Enablers	Barriers
Cultural	
Progressive company culture	Conservative company culture
Social awareness and education	Lack of public participation and awareness
Shared vision of all stakeholders	Lack shared vision all stakeholders
Regulatory	
Governmental support and policies	No governmental support and policies
Circular procurement	Administrative burden
Market	
Scaling for profitability	Complex material composition
Strong business case	Weak business case
Energy, material and economic savings	Lack of reverse logistics and infrastructure
Product passport and detailed information	Disinterest non-core business practices
Implementation	
Short term aims connected to long term goals	Distance between industries
Systemic and holistic approach	Lack of performance assessment
Co-creation with all actors	Lack of information
Practice based experimenting	Unbalanced power between participants

Source: Maarten van Keulen (2018)

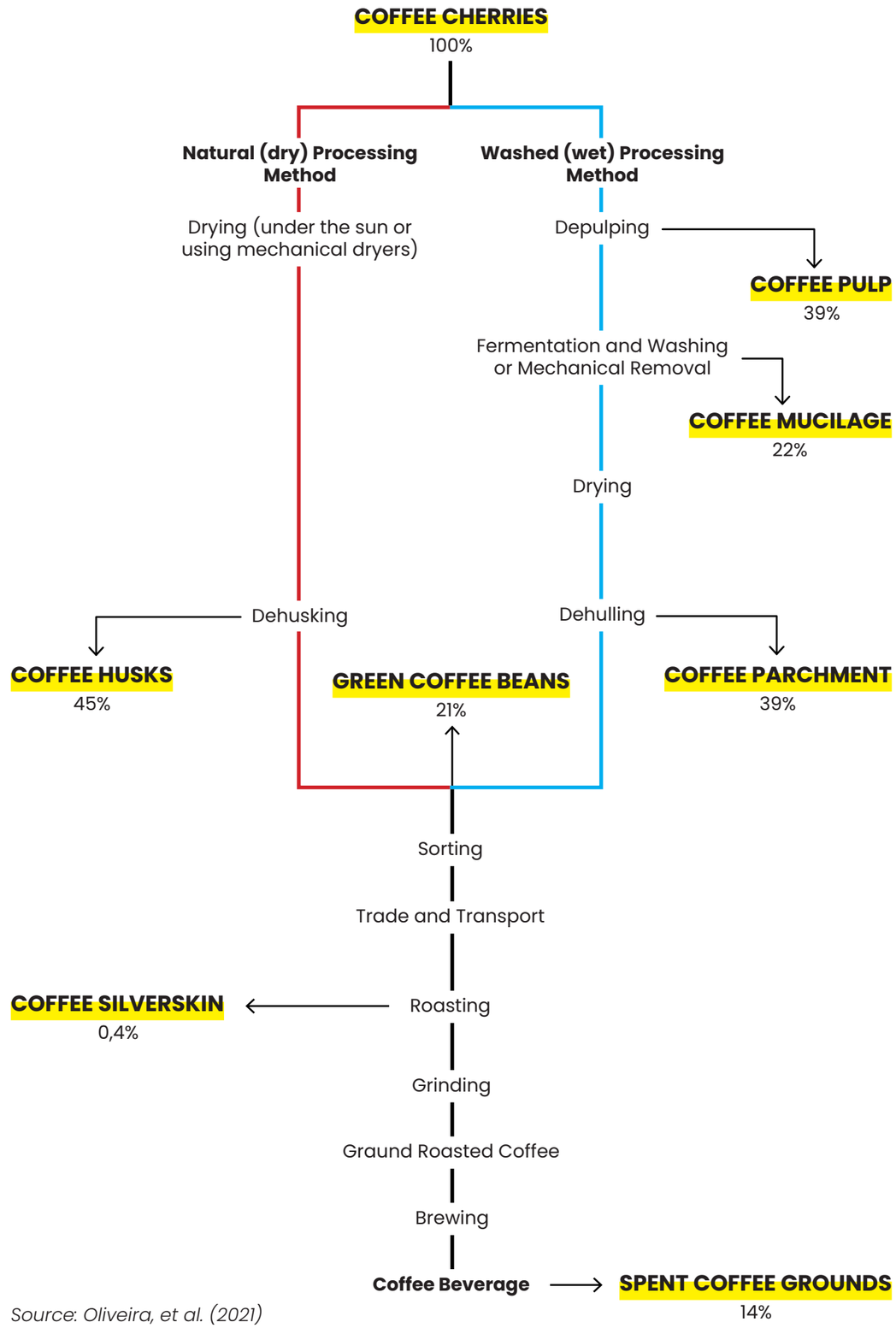
3.4 Coffee by-products and emissions

The coffee production process generates a significant amount of biomass at each stage, from harvest to final consumption. This biomass, instead of becoming environmental waste, can be reduced, reused or transformed into valuable products through circular and regenerative agricultural practices. The entire coffee plant, including the cherry husk, pulp, mucilage, parchment, silver film and spent coffee grounds, contains unique compounds suitable for various industrial applications. Innovative entrepreneurs and researchers are finding ways to reuse these by-products, creating new products and materials that support local economies and generate new sources of income. All these by-products have characteristics and compositions, however, that make them valuable for a second life.

From the **washed process** we obtain :

• **Coffee pulp:** can be useful as it is rich in carbohydrates, proteins, minerals, and bioactive compounds such as tannins and caffeine. However, the presence of these bioactive compounds makes further research necessary to ensure the safety and toxicity of coffee pulp. However, being rich in organic matter and nutrients, coffee pulp is suitable to become fertilizer or be added in animal feed formulations.

Source: Nutral Ingredients (2023)



Source: Oliveira, et al. (2021)

• **Mucilage:** is the sticky substance that adheres to the beans after pulping and is composed of 39% pectic substances and antioxidants. Since it has no bioactive compounds, it is a safer by-product for various applications, such as pectin production.

• **Coffee parchment:** is the fibrous material that remains after hulling and consists mainly of cellulose and lignin. It can be used in bioenergy production and other industrial applications.

From **dry processing**, on the other hand, they are found as waste materials:

• **Coffee husks:** comprising the layers of dried skin, pulp and parchment, they make up about 45 percent of the weight of the coffee cherry, but are usually disposed of in landfills or burned or composted. However, like coffee pulp, they can be used as cascara or nutrient-rich compost. In addition, their high lignocellulose content allows the production of biofuels, through processes such as pyrolysis, and various industrial applications: composite building materials, biodegradable packaging, and biosorbents to filter contaminants from water.

Source: Smart Farming (n.d.)

• **Leaves and branches from pruning**: cover crops and fruit trees, can be regeneratively integrated and processed into value-added products.

During the **roasting stage**, the following is created:

• **Silverskin:** is a thin, paper-like layer that lies

between the coffee cherry and the green bean and tends to fragment during handling. It is rich in bioactive compounds, including antioxidants, fiber, and lipids. Its high cellulose content gives it fibrous and brittle characteristics, while its nutritional profile includes protein, lipids, antioxidants, fiber, and essential minerals such as potassium and magnesium. It also contains phenolic compounds and flavonoids, known for their anti-inflammatory and anti-aging properties, making it valuable for several sectors.

Finally at the **product consumption stage**, the following are created:

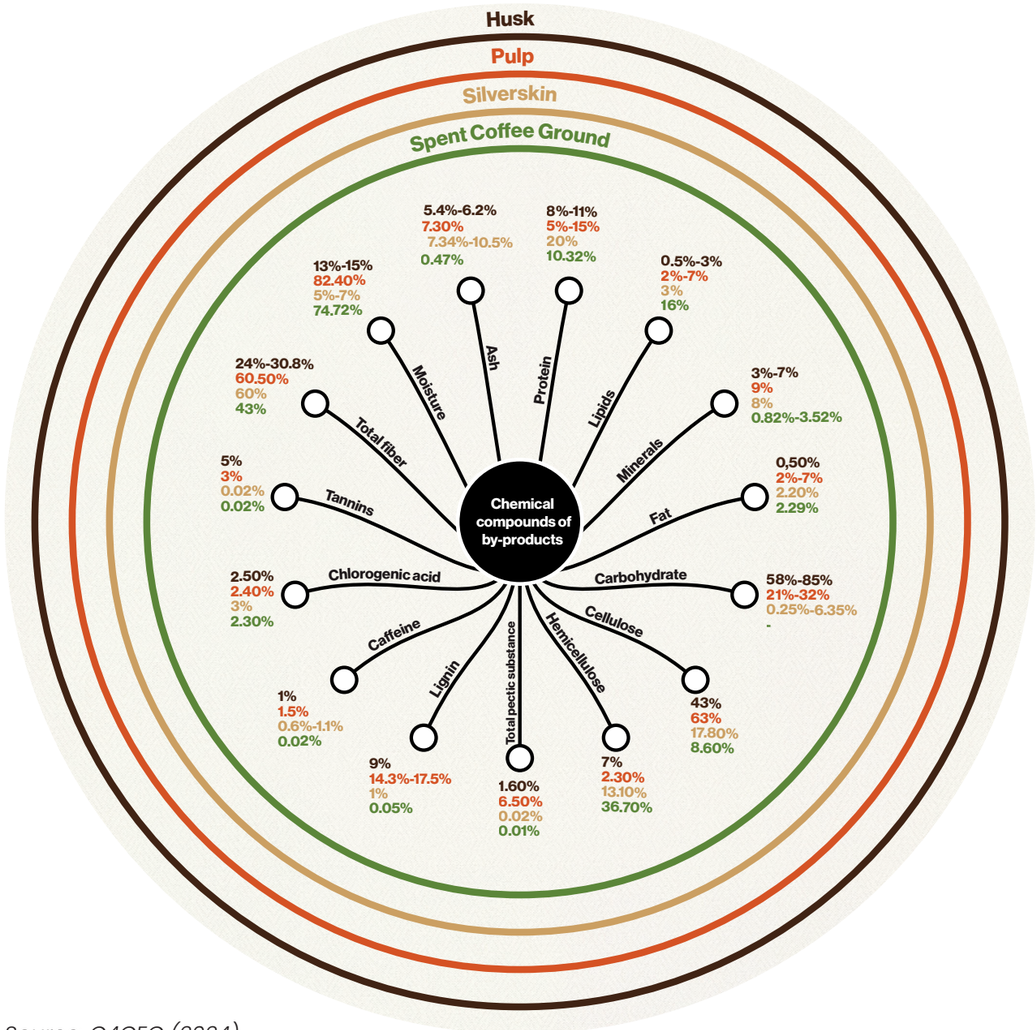
• **Spent coffee grounds:** Normally disposed of in landfills, where they decompose anaerobically, releasing methane, a potent greenhouse gas that contributes to climate change. This is why there is a need for better waste management solutions. Spent coffee grounds are rich in organic compounds, nutrients, and their high carbon and nitrogen content makes them a valuable source of organic matter for agriculture, as they contain fiber, protein, lipids, small amounts of caffeine, and bioactive compounds with antioxidant properties. (ICO, 2024)

Source: New Scientist (2023)

Finally, the environmental impact of coffee cultivation in terms of **carbon emissions** should also be considered. Coffee cultivation and processing are the most critical steps in the supply chain and contribute between 40% and 70% of carbon emissions. For example, the carbon footprint for

producing 1 kg of fresh coffee cherries ranges from 0.26 to 0.67 kgCO2e in conventional systems and 0.12 to 0.52 kgCO2e in organic systems, with the main source of emissions being the use of nitrogen inputs (ICO, 2024). The environmental impact of the coffee industry is not limited to carbon emissions, however; another factor that plays an important role is the consumption of significant amounts of **water and fertilizer**, the mismanagement of which can lead to water scarcity, soil contamination and loss of biodiversity. The average water footprint of a 125 milliliter cup of coffee is 132 liters from production to consumption (ICO, 2024). Monoculture and deforestation further exacerbate these problems, making it urgent to adopt circular practices for the overall sustainability of the sector.

Source: Daily Coffee News (2018)



Source: C4CEC (2024)

3.5 Circular economy best practices

As has been illustrated in previous chapters, many problems and as many challenges need to be addressed in the coffee sector; a large amount of by-products are produced in production, but these are rich in untapped potential. These opportunities can be realized through the strategies and principles of the circular economy that have been stated in a general way. Already, good circular practices that address both by-products have been listed; this chapter will outline additional good circular practices that can be applied throughout the coffee production chain.

At the **growing stage**, regenerative agriculture strategies can be applied, focusing on regenerating soil fertility, biodiversity, water management, and reducing harmful inputs such as pesticides and polluting fertilizers. In addition, there is the possibility of using by-products by re-introducing them into the soil, and by intercropping, soil fertility and farmers' proceeds are increased.

Then continuing to the **processing stage**, which can be washed or dry, one can work with the by-products created and, in the case of the washed process, one can better manage water resources. (ICO, 2024)

C-GVC stage and by-product	By-product characteristics and properties	Circular practice examples
Regenerative agricultural practices	Organic materials Locally available inputs Carbon sequestration Soil improvements Water retention	Regenerative agriculture practices • Promoting the well-being of animals, humans, and environment • Cover crops • Crop rotation • Animal husbandry • Composting • Mulching • Carbon insetting • Conservation of wild forest land
Intercropping and agroforestry: Shade trees Wood production Fruit Vegetables Honey	Creates shade for coffee Multipurpose woods Nutrition and income sources	• Shade crops and canopies • Intercropping bamboo • Intercropping fruit trees • Intercropping fruit and vegetables • Beekeeping • Carbon insetting
Coffee tree pruning: branches and leaves	Hardwood Organic material Leaves: caffeine, polyphenols, antioxidants Renewable and plentiful Local material	• Furniture (hardwood) • Coffee prunings for on-farm lumber (drying beds, posts) • Compost additive • Mulch • Biochar • Beverages and extracts from coffee leaves
Coffee drying	GHG emissions Materials used for drying beds or polyethylene tunnels	• Solar drying beds utilizing natural materials found near farm • Reuse of materials; i.e. polyethylene tunnels • Use biochar or biobricks as fuel • Renewable and bio-based energy sources
Natural (dry) post-harvest processing: Dried coffee husks (coffee cherry skin, pulp, and husk)	Fruity or floral aroma with sweet berry flavour High in fibre (cellulose) Nutrients including proteins, lipids, and minerals Residual nutrients including carbon, phosphorus, potassium, and nitrogen	• *Cascara* products for human consumption • Compost additive • Soil amendment • Spread on coffee farms as a mulch and slow compost • Biochar and biobricks • Biochar for soil amendment • Biosorbent for wastewater treatment and caffeine removal • Polymer composite • Biogas
Washed (wet) post-harvest processing: Coffee pulp (coffee cherry skin and pulp)	Nutritionally dense Sweet smell and taste Bioactive compounds such as tannins, caffeine, and melanonids Pectin, moisture Residual nutrients including phosphorus, potassium, and nitrogen	• *Cascara* products for human consumption (fruit infusion, *Qishr* sweet tea in Ethiopia, distilled alcohol, ready to drink beverages) • Gluten-free flour alternative • Animal feed • Substrate for mushroom cultivation • Compost and fertilizer • Paper product ingredient (cellulose) • Dyes

Post-harvest washed (wet) post-harvest processing: Wastewater (Honey water)	Organic matter Toxic chemicals including tannins, phenolics, and alkaloids Depletion of oxygen levels in water	• Aerobic and anaerobic lagoons • Constructed wetlands • Vetiver grass cultivation • Membrane bioreactors • Composting and biofertilizers with treated wastewater • Water recycling after treatment • Rainwater capture
Post-harvest Washed (wet) post-harvest processing: Coffee mucilage	Sweet and sticky High in pectin High in antioxidants	• Human consumption as beverage or baked good ingredient • Organic fertilizer sprays • Natural food preservative
Milling (washed processed coffee): Coffee parchment	Fibrous material Lignin and cellulose	• Biofuels • Biochar component • Bio brick or cement component • Polymer composite • Paper, textiles, biodegradable packing materials • Biobricks (building material) • Compost ingredient • Mulch • Soil amendment

Source: ICO (2024)

Regarding **logistics and shipping**, one strategy is to make operational warehouses more efficient and consolidate them, reducing their number; also opting for multimodal transport (sea-rail-road) can reduce emissions and fuel use.

The **packaging** side can also be implemented by introducing innovative and environmentally friendly materials, creating packaging that is flexible, durable and can maintain product quality and freshness. (ICO, 2024)

Source: ICO

C-GVC stage and by-product	By-product characteristics and properties	Circular practice examples
Trade and transport: Packing materials	Biodegradable natural fibres (jute) Plastic "big bags" Polyethylene hermetic liners for jute bags Container liners Shrink wrap Pallets Plastic sample bags	• Jute bags • Recycling or reuse of plastic hermetic liners • Compostable sample bags

Trade and transport: Ocean freight Ground transportation Airline travel	GHG emissions	• Consolidated shipments • Multi-modal transport (road, rail, and sea) • Limit on corporate travel • Carbon insetting and carbon credits • Renewable energy and biofuels
Warehousing	GHG emissions Large, climate-controlled facilities	• Consolidated warehouses • Decreasing number of warehouses used
Consumer packaging	Plastics Aluminium Bio-based materials with polymers Recycled materials Single-serve units (SSU) are often a blend of aluminium and plastic and combine with organic waste, limiting material separation for recycling and composting	• Single-serve capsule materials allowing for recycling • Coffee pod return scheme with major brands • Designing for reuse • Designing for recycling with mono-material packaging • Design for compostability • End-of-life product recyclability • Reduced and post-consumer recycled materials use

Source: ICO (2024)

The **roasting stage** is strongly related to the production of silverskin, a by-product that has enormous potential in areas such as cosmetics and, thanks to its nutritional characteristics, also in the production of natural fertilizers.

Finally, numerous opportunities are also found in the final stage of the supply chain, **consumption**. In fact, the coffee that is drunk represents only a small fraction of the material produced along the coffee value chain: only 1 to 5 percent of the original coffee cherry mass makes it to the last stage of the process, but about 11.4 million tons of spent coffee grounds are produced each year.

There are then, depending on the various preparation techniques, other wastes, from capsules to paper filters, materials that are difficult to recycle and often end up in landfills. Coffee grounds, however, are rich in organic compounds and nutrients and can be reused to improve soil constitution, produce biochar, or in biocosmetics, textiles and food. (ICO, 2024) Their high carbon and nitrogen

content makes them a valuable source of organic matter for agriculture, as they contain fiber, protein, lipids, small amounts of caffeine, and bioactive compounds with antioxidant properties. To best reuse used capsules, on the other hand, it is necessary to invest in collection systems, recycling facilities, and compostable or recyclable capsules. Keeping in mind, however, that the fragmented nature of recycling systems, waste management, and the frequent lack, especially in poor countries, of suitable infrastructure makes it difficult to implement these strategies. (ICO, 2024)

Source: The Indipendent (2021)

C-GVC stage and by-product	By-product characteristics and properties	Circular practice examples
Roasting: Silverskin (chaff)	Contains high value cellulose, hemicellulose, lignin, lipids, and some phenolic compounds	• Cosmetics • Nutraceuticals • Paper production • Agriculture fertilizers • Vegan leather fibre • Biopolymer additive
Coffee brewing: Spent coffee grounds (remain after brewing)	Rich in organic matter including carbon and nitrogen Fibre Residual caffeine Nutrients including protein and lipids Polyphenol Bioactive compounds with antioxidant properties	• Coffee flour for human consumption (baked goods) • Oil extracts for skincare products • Extracts for nutraceuticals and functional foods • Substrate for mushroom cultivation • Organic fertilizers or compost additive • Vermiculture • Biofuels • Feedstock component • Biobrick component • Biosorbents to remove dyes, oils, and metal ions from aqueous solutions • Paper products material component including coffee cups • Fabric and textile component • Natural dyes
Coffee shops: Single-serve coffee cups	Often lined with polyethylene plastic that is difficult to recycle	• Reusable coffee mugs • Integrated reuse programmes • Recycling with in-store recycling facilities • Industrial compostable cups

Source: ICO (2024)

3.6 Challenges & opportunities

As seen above, there are a variety of barriers that hold back the implementation of the circular economy. The circular economy in the coffee sector is not exempt from these difficulties, so it is good to outline the problems in detail to understand what opportunities could be developed through the right approach that takes into consideration the needs of the various stakeholders.

The main **challenges** identified by the International Coffee Organization include:

Coordination and knowledge sharing: Along the coffee supply chain, there is often a lack of effective coordination between the various actors involved in research and dissemination of best practices (research centers, R&D initiatives, local solutions) and industry stakeholders. Knowledge of circular economy practices is often isolated and fragmented, hindering the adoption of innovative models. There is a need to improve dialogue and coordination, create standards for guidelines and practices, and develop and scale up pilot projects, but without neglecting indigenous traditional knowledge that is compatible with sustainability: we need to strengthen the culture not forget it.

Energy and resource management: In various steps of production, especially cultivation and processing, good resource management is essential to lower costs and emissions.

Inconsistent policies and regulations: Policies and regulations governing circular practices and manufacturing byproducts are often fragmented and inconsistent. In the various areas of the industry, from food safety and labeling to export/import codes there are differences in regulations that complicate global trade and traceability, making it difficult for micro, small, and medium-sized enterprises to navigate.

Remoteness of government agencies: Government agencies have the power to regulate the market and labor through the right legislation and policies; however, this often does not happen because they are far from the realities where these measures take effect. There is a need to bridge this gap to avoid unintended effects and speed up the achievement of sustainability goals.

Funding and R&D: Bringing about innovation and the circular economy requires significant funding and resources, expenses that are often prohibitive for MPMIs, manufacturers. The cost of developing new products from coffee by-products such as biochar or coffee mucilage concentrate is high, especially at the industrial level. Therefore, more efficient R&D investment plans need to be developed to reduce costs and improve scalability.

Financial access and equity: Access to opportunities is limited for MPMIs and farmers in developing countries. There is a need to bridge the gap between small innovators and financial support, as many

good ideas are hampered by lack of funding.

Access to certifications: Having a certified product gives value to the farmer who can get better contracts and a fair price when selling; but also to the consumer who is assured that that product is sustainable. Obtaining certifications, however, is not easy and accessible to everyone.

Logistics and matchmaking: Without efficient logistics behind the collection and processing of coffee by-products, they are disposed of. With better coordination between pickers and producers and standards for collection and storage, discrepancies in product demand and availability can be resolved, along with the high risk and cost of new product development, major barriers to market entry.

Market fragmentation and transparency: The coffee by-product market, while growing, is fragmented, and the absence of standard practices for quality, harvesting, packaging, and pricing makes it difficult for farmers and producers to navigate and capitalize on niche markets.

Market Development: To enter or develop markets for coffee by-products there is a need for new B2B relationships and networks outside the coffee industry as well. Many producers lack the connections and knowledge to access these new supply chains, hindering market development.

Source: Ringtons Business (2023)

Consumer Awareness: The average consumer knows neither the complex system behind coffee nor the value that the circular economy brings; this results in a lack of interest in these products and a low incentive to buy them. Consumer education and mindset change are critical for products from circular practices to be appreciated and demand to increase.

Distribution of value: Circular practices and initiatives should benefit all stakeholders in the supply chain, but this often does not happen due to problems at the raw material clearing, collection, and distribution stages. Economic benefits must reach the entire value chain, including farmers. Environmental degradation: Problems related to climate change, deforestation and land degradation are major threats to the sustainability of coffee production. The shift to higher altitudes for coffee cultivation is changing the balance of forest ecosystems and amplifying the damage caused by climate change. This shift is also not compatible with the present regulatory system, making it even more of a priority to find a solution.

Economic inequalities: In the production chain, there are numerous inequalities in income, income and economic power. Farmers are the majority of workers within the chain, but they are also the ones who suffer the most from poverty, price fluctuation and lack of weight in economic decisions.

Balancing economic viability with the broader goals of the circular economy: Sustainability often requires investment and effort, so one of the biggest challenges is trying to achieve circular goals, but with business models and strategies that can bring economic returns.

Poor level of coordination between research centers and private sector organizations: Achieving optimal dissemination of knowledge and standards requires collaboration and coordination among actors working on research, a coordination that is complicated to achieve.

Pressures on sustainability: Coffee producers are subject to the will of the market and the will of consumers, customers, regulators, and government agencies that have increasing demands to improve sustainability, increase productivity, and maintain high quality standards. Coping with and meeting these demands requires resources, investment, technology, and adaptation; elements that are most often difficult for small farmers to achieve . Waste management: One of the biggest problems is the management of waste created during processes. Being able to reduce and manage this waste and turn it into resources is important to move toward a more sustainable supply chain.

Once the challenges have been analyzed, one needs to dwell on what a circular culture could bring about positively within the production chain and in communities.

The International Coffee Organization and the research posed by the thesis have identified these **opportunities**:

Adopt waste reduction and reuse approaches: The circular economy with its best practices offer numerous avenues for first, reducing the production of waste and second, sustainable solutions to bring value to these byproducts by putting them back into a new process.

Creating a market for coffee by-products: Reducing and reusing waste is not enough, the next step is to create a market, make it economically viable to sell and buy waste.

Circular solutions beyond coffee to reduce the vital income gap: To address a poverty that increasingly plagues coffee farming families , where the sale of their products does not cover the costs of primary services (health, food, education) and labor (input materials and tools). Intercropping is a solution to income diversification, and circular and regenerative solutions can also increase income and reduce input costs, bringing greater well-being to communities.

Developing regenerative agriculture: Regenerative agriculture strategies bring significant benefits to the land and product quality; it can also lead to additional revenue, lower costs and better health for farmers.

Source: Barina, A. (2025)

Resource efficiency: By implementing circular practices, resource problems can be solved. Acting systemically can reduce inputs, derive them locally, and increase their sustainability. Also by optimizing the process, one can reduce the use of resources and consequently the cost of production.

Regeneration and value creation: The circular economy model goes beyond minimizing negative impacts, but aims for system regeneration and new value creation. Sustainable business models, innovative products can lead to additional income streams for coffee producers.

Sustainability and improved quality of life: Improving sustainability means bringing about improvements for the environment, economy, and society. It means reducing the use of nonrenewable resources, increasing the health of ecosystems, and consequently increasing the quality of life for communities.

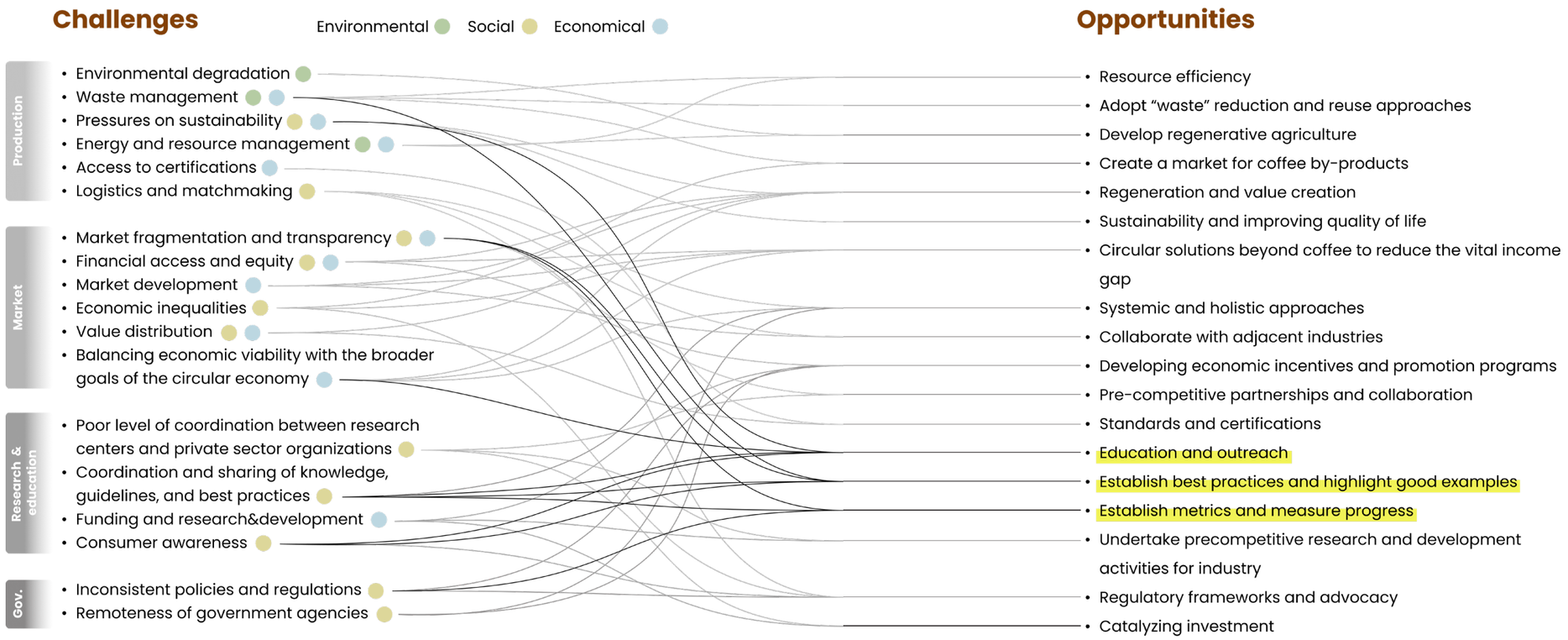
Systemic and holistic approaches: Taking a systemic and holistic approach enables a more comprehensive understanding of the coffee sector, consisting of a complex network of stakeholders and processes. This approach increases resilience and adaptability, helping to address sustainability challenges more effectively. Ensuring that changes in one part of the system do not lead to unintended consequences elsewhere benefits all stakeholders.

Collaborate with adjacent industries: Creating a collaborative system is key in systems thinking; if leased industries worked with each other, waste could be reduced and input material impacts decreased. In addition, exchange of know-how and machinery could lead to industry cluster growth.

Develop economic incentives and promotion programs: The economic aspect is crucial; the right funding and promotion are needed to start circular solutions. Industry workers often have the will but lack the support to undertake these innovative business models.

Undertake pre-competitive research and development activities for industry: If left to their own devices, industry stakeholders will always find it difficult to pursue research into new technologies or innovative solutions; precompetitive activities need to be developed to support industries to accelerate the research and development process.

Pre-competitive partnerships and collaborations: To reduce research and development costs, accelerate innovation and establish common standards, without compromising commercial competition, it is necessary to create pre-competitive collaborations and partnerships. Thanks to these, more research centers, companies and other actors can work together to develop technologies, standards and good practices useful to the sector.



Standards and certifications: Certifications and in general the delineation of standards are important as they ensure the quality, origin and economic, environmental and social sustainability of the product and its production process. This benefits all stakeholders in the chain and end consumers. Making certifications more accessible is the first step towards becoming a constant in the market.

Training and awareness: To achieve greater sustainability one of the most effective ways is education and awareness: knowledge must be spread throughout the chain and to all actors. By acting at the root of the problem, continuity in sustainable thinking can be ensured, ensuring that it is passed down from generation to generation.

Establishing best practices and highlighting good examples: The first step in taking action at the educational level is to define sustainable good practices and make them accessible to all. Establishing metrics and measuring progress: To facilitate the level of progress in the implementation of good practices or levels of education, it is important to introduce systems for measuring progress. Regulatory frameworks and advocacy: Improving regulatory frameworks is essential to attract investment and make work within the sector easier, safer and more organised.

Catalysing investment: Stimulating, incentivising or accelerating the flow of capital to a given sector, project or economic initiative can improve the system itself. Sustainable innovation needs a supportive economy. Offering tax incentives, simplifying bureaucracy, providing subsidised financing and creating new regulations can play a catalytic role in attracting private capital.

CENTER FOR CIRCULAR ECONOMY IN COFFEE

3.7 Center for Circular Economy in Coffee

The Center for Circular Economy in Coffee (**C4CEC**) is an important collaborator in this thesis as it is for the center and its members that this research and the outputs that will follow have been developed; the thesis aims to propose to the center a project suitable to complement the work already present. Furthermore, it is also necessary to tell it in relation to its goals and what it is doing to promote the circular economy in the coffee sector: the project wants to help achieve the goal of spreading knowledge of the circular economy where it is needed. The center is a global pre-competitive and non-profit initiative founded in **Turin** and launched in September 2023 during the 5th ICO World Coffee Conference in Bangalore. The purpose it supports is the promotion and application of the principles and good practices of the circular economy in the coffee sector, focusing on research and sharing systemic innovation and the Slow Food philosophy. Through a **collaborative approach**, the aim is to achieve environmental, social, cultural and economic sustainability and assist stakeholders through knowledge transfer, resource mobilization for adaptation and implementation of **circular solutions**. The Center has as founding members the **Lavazza Foundation**, the **Politecnico di Torino** and the **University of Gastronomic Sciences of Pollenzo** and as strategic partners the International Coffee Organization, the International Trade Centre and UNIDO. But it is open to all stakeholders in the coffee sector: farmers and cooperatives who want to have access to **educational resources** and experiment with circular innovations; companies that want to implement initiatives with the support of a scientific network and its global connections; and the public and academic sector, for entities that want to collaborate in sharing knowledge, proposing initiatives and carrying out research.

To achieve these results, the C4CEC has developed a useful **platform** thanks to which stakeholders can view the strategies and principles of the circular economy applied to the coffee sector and view all related good practices. Sharing allows you to have a first contact with what can be implemented and what are the procedures to implement these strategies, thanks also to the presence of case studies and explanatory videos.

Source: UNIDO (2023)

Source: AirX Carbon (2023)

CHAPTER 4

Educating the circular economy in the coffee sector

4.1 Overview

Among all the challenges and opportunities identified in the circular economy sector in coffee, the thesis wants to focus on the opportunities that concern education and the sharing of good circular practices, identified as one of the first steps to improve the resilience of the coffee sector towards climate change and safeguard the well-being of the actors involved.

Education is a cornerstone of society and represents a fundamental part of life for the citizens who make it up, education and **knowledge** are the basis of people's behaviors and habits. (Fig. 12)
With the right behaviors, communities can develop in a sustainable way, not only from a social point of view, but also from an environmental and economic point of view. The first step to achieve a sustainable community that passes down good practices, passion for work and culture **from generation to generation**, we must act on education, both of those who already operate and work in the sector, and of the new generation, making them passionate in the right way about this reality.

The aim of this chapter is to understand how to act at an educational level, what are the strategies and the state of the art. The process begins with the analysis of **educational methodologies**, then goes on to investigate the **skills** required by today's professional world, concluding with the collection of numerous **case studies** to see how the courses are conducted, how the methodologies and materials used are applied. From here, **opportunities** to be implemented with the project have been outlined.

Fig. 12: The inseparability of education, society and culture

4.2 Methodologies

In the field of education, there are numerous methodologies applied to teaching. Most of them differ based on the **target** and the **area** in which they are applied (university, professional, open access course, etc.), but each one has its own peculiarities, pros and cons; therefore, the analysis of these methodologies is essential to understand which one or which ones to apply in the case of the output that this thesis intends to propose.

Learning by doing
"Learning By Doing" is a method in which knowledge is taken by direct **experience**. It's applicable to all fields and is used more and more in schools. It joins the link of theory and practice. This method, unlike the previous traditional teaching methods, gives importance to experience. Experience is a very important part in human life both logically and subconsciously. The child, therefore, is by nature born to be an **active learner**, and learning by doing includes reflection and development of knowledge.

Self learning
Self Learning Self-Directed Learning: People take the **initiative to learn** without relying on the teacher or formal program in this learning style.

Source: Rival Design (n.d.)

Here, the learners determine their own objectives, locate materials, and manage their own process of learning. The key ingredients of this are **autonomy**, or learners taking responsibility for what they want to study, how, and when; intrinsic **motivation by curiosity and personal interest**; variability in resources, such as books, online courses, videos, forums, and other materials; **self-assessment**, understood as the activity of monitoring one's progress and assessing one's learning; **adaptability**, entailing the learning path can be adapted to needs and learning styles.

Problem based learning

Problem-Based Learning (PBL) is a **student-centered** teaching approach, used in fields such as engineering, medicine and education, in which students **develop practical and critical skills** through solving **complex, real-world problems**. Instead of receiving information passively, students are actively involved in the learning process, **working in groups** to find solutions to specific problems.
To develop this type of approach, one must ensure that these elements are present:

- **Real problems:** Students tackle problems that reflect real-world situations.
- **Collaboration:** Teamwork is critical, promoting the development of collaboration and communication skills.
- **Autonomy:** Students are encouraged to take initiative and manage their own learning.
- **Active Learning:** Students research, discuss and apply knowledge to solve problems.

Vocational Education Training (VET)

Vocational Education and Training is education that prepares individuals to acquire practical skills and specific knowledge for technical professions. Most of the time, this kind of training is focused on labor market needs and often developed in close cooperation with industry to ensure its relevance. It stresses practical learning through direct experiences, such as internships and apprenticeships. VET is available for individuals of all ages and backgrounds, offering flexible pathways for those who work or have special needs. It allows individuals to keep themselves abreast with continuous development in response to technological and labor market change. VET significantly contributes to the economic and social development by decreasing unemployment and enhancing productivity. It is learner-centered, affording one opportunity for career development either into further study or a vocationally specific course of learning.
(Circle Econonomy)

Source: OECD (2023)

Learner-centered

The pedagogy focuses on the learner and his/her process of learning. Learners are more **active**, **gaining knowledge autonomously and consciously**. Learning here becomes an active process where knowledge is constructed through **investigation, reflection, and application**. The teacher's role thus changes from being a knowledge transmitter who has structured knowledge

to that of a facilitator and mentor, providing an environment where **intellectual curiosity** flourishes. The educators facilitate the learner in keeping track of progress and developing **metacognition**, or the ability of reflecting upon and refining one's learning process. This approach fosters deeper, more durable learning and equips learners to manage complex situations and **adapt to changes**.

Action-oriented

This method is based on **action and experimentation**; learning is achieved by **cognitive, emotional, or sensory means**. Learners acquire the capability to deal with uncertainty and handle emotions. The name of this process is Experiential Learning, and it involves what is called **Kolb's Cycle**, comprising Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. The job of the teacher is to provide an environment which promotes or fosters students to experience and acquire reflective thinking as highlighted by Dewey.

Source: Plays in Busines (2015)

Transfonrmative learning

The approach aims to help students develop a **critical awareness** of implicit assumptions and expectations and evaluate their adequacy in forming their worldview (Mezirow, 2000). The teacher's task is to challenge students to form or revise their perspectives, acting as **facilitators** and **promoters** of knowledge to support students in their educational journey.

"***Una competenza in materia di sostenibilità mette in grado i discenti di incarnare i valori della sostenibilità e di accettare i sistemi complessi, al fine di agire o richiedere azioni che ripristinino e mantengano la salute dell'ecosistema e aumentino la giustizia, ideando futuri sostenibili.***"
(Joint Research Centre)

4.3 Skills and competence to develop

The worker is that figure who possesses the knowledge and skills necessary to carry out the required activities. Obviously, to have a competitive worker, all that specific knowledge is necessary that differentiates him from workers who move in other fields. This specific knowledge, characterizing and closely linked to the work that is going to be carried out, is called **hard-skills**. In the field of the circular economy in the coffee sector, these skills are made up of the notions analyzed and reported in the previous chapter, "the circular economy in the coffee sector" and require knowledge regarding processing techniques, coffee by-products, quality controls and all the good practices that can be carried out to add value to the chain.

Hard-skills are necessary for the correct training of the worker, but they are often not sufficient.
In today's market, in view of an ever-increasing need for collaboration and adaptation to complex and changing challenges, in work and in job training, a series of qualities that in the past were less relevant are increasingly seen as necessary and useful. To best develop an educational output that improves the user as a whole, it is necessary to take into consideration the so-called **soft-skills**, that is, the non-vertical skills on the specific knowledge that the job requires, therefore qualities more linked to the person, his attitude and his way of thinking. Good training will work on these skills trying to make them blossom in the user, so as to make

him dynamic and competitive with respect to the changes that a circular and sustainable transition requires.

Below are the soft skills that the analysis carried out found to be important and relevant:

• **Leadership:** creating figures with leadership skills is essential to enable them to be able to manage a group of people, to be able to assert their own ideas and those of others and to be able to interface with important stakeholders. Furthermore, a good leader sets an example for others in times of need, instilling in turn the necessary qualities and skills and motivating their teammates as best as possible.

• **Systemic thinking:** having a systemic thinking allows the worker to analyze complex systems and have a total vision of the actors and their relationships; the flows of energy and materials; and the economic, environmental and social impacts of the system in question

• **Learning to learn:** is the ability to learn methods and tools to independently develop further knowledge

• **Lifelong learning:** related to learning to learn, this approach induces in the user the ability and aptitude to learn continuously.

• **Collaboration:** knowing how to work in a group and knowing how to relate to other people is essential to act together in solving challenges. Knowing how to collaborate means knowing how to deal with unexpected events and difficulties, acting with the

same objectives and helping each other.

• **Regulatory:** having a clear vision of the policies and regulations that govern systems is essential to understand what can and cannot be done, and how to move to change things.

• **Anticipatory:** knowing how to grasp the clues to understand the changes that will occur in the near future is useful not only to avoid being caught unprepared, but it even allows you to find applicable solutions to solve problems even before they occur, thus saving time and resources.

• **Empathy:** this personal attitude has a double importance if developed in the worker. First of all, it facilitates group work, an empathetic person understands how to behave towards others and knows what to say and do in emotionally complicated situations. Secondly, empathy is useful in the design phases to better understand the target in question. Understanding what the target feels and thinks will help develop a targeted and suitable project.

• **Time management:** knowing how to organize activities and allocating the right amount of time is important to avoid delays and consequent losses of resources. Acting in time helps prevent unforeseen events.

• **Communication:** knowing how to best carry out an activity or project is of little importance if you are not able to communicate it in the end. Communication is significant to bring out the relevant things and to better understand the results obtained. This is true both towards colleagues and towards the most important stakeholders.

• **Self-awareness:** having the ability to know how to position yourself in a system helps to understand your strengths and weaknesses. It also means having more confidence in what you do, without losing sight of the overall situation.

• **Problem solving:** managing unforeseen events is essential if you want to solve a complex problem. Having a strong mental agility and good logical and creative reasoning allows you to deal with the difficulties that arise along the way.

• **Critical thinking:** knowing how to critically analyze a problem or situation in its entirety allows you to outline the right solutions, acting without losing sight of the positive and negative sides.

• **Autonomy:** as previously mentioned, knowing how to work in a group is essential, but it is equally important to know how to manage tasks independently, with the awareness of what you are capable of doing.

• **Planning:** the ability to organize activities, actors, times and costs is important if you want to best develop and implement a project, outlining its steps, Milestones and impacts.

Source: JRC (2022)

FOCUS

For further reference, the GreenComp, or the European framework of competences in sustainability from the Joint Research Centre, is composed of 12 competences organized in the following four objectives.

Embodying the values of sustainability:
• attributing value to sustainability
• defending equity
• promoting nature

Embracing complexity in sustainability:
• systemic thinking
• critical thinking
• problem definition

Imagining sustainable futures:
• sense of the future
• adaptability
• exploratory thinking

Acting for sustainability:
• political agency
• collective action
• individual initiative

As can be seen, in many arguments the research process of the thesis and the document published by the Joint Research Centre (JRC), the European Commission's service for science and knowledge, reach common and shared conclusions and objectives.

4.4 Case studies

To better understand the state of the art of circular economy education, with a greater concentration imprinted on the coffee sector, desk research was conducted and case studies were identified. The first set of case studies reported are a selection of varied educational outputs, so as to get an overview of the content, modes of delivery, and approaches used. Then case studies of projects done by companies in the coffee sector are recounted to understand how they apply these methodologies in their realities and system.
The most relevant case studies will be given in the next few pages; others will be given in the appendices of the thesis.

Case studies typologies:

- **Programs**
- **Courses**
- **Workshops, webinars and working groups**
- **Hubs and communities**
- **Products and platforms**
- **Toolkits**

Source: IDH (2022)

PROGRAMS

Coffee Farmer Income Resilience Program

Idh
2021-2025
Uganda and Kenya

Approach: Systemic
Target: Coffee farmers
Main topic: Intercropping

Coffee Farmer Income Resilience Programme (CFIRP) focuses its attention on enhancing the economic resilience of coffee farmers using diversified services and regenerative farming. CFIRP encourages other sources of income from farm activities, integrated with coffee, for enhanced earning through training, financial support, and end-to-end farm care. CFIRP encourages partnership with private sector companies since it deepens a sustainable system of service and counteracts farmers' mono-dependence on coffee farming for earning a livelihood.

https://www.idhsustainabletrade.com/uploaded/2022/05/2022111-IDH-Baseline-Report-V2-gecomprimeerd.pdf

Source: SAI Platform (2023)

Regenerating Together Programme

SAI Platform
2022-2023
Online

Approach: Systemic
Target: Coffee farmers
Main topic: Regenerative methods and practices.

Regenerating Together adopts an integrated and holistic approach to achieving regenerative outcomes on farms, addressing the impacts of climate change, soil health, biodiversity, and water management, in addition to improving farmers' livelihoods.
It seeks to convert global concepts into local action by providing a systematic framework to prioritization, tracking, and transition planning uniquely tailored to the requirements of every region. With four focus areas of environmental influence, the program promotes quantifiable results and continuous improvement. It brings together farmers, specialists, NGOs, and industry actors to deliver meaningful systemic change at scale.
By participatory consultations and collaborations, the program aims to ease the farmers' burdens, establish strong partnerships, and develop to adapt to the shifting needs of the agriculture sector.

https://saiplatform.org/wp-content/uploads/2023/09/sai-platform_-regenerating-together_september-2023-1.pdf

COURSES

Source: IFOAM (n.d.)

The Organic Academy - The Organic Leadership Course

IFOAM
Worldwide

Approach: Face-to-Face (F2F) sessions, webinars and course assignments (development plan)
Target: Farmers
Main topic: Leadership

The Organic Leadership Course (OLC) is designed to empower the formation of leaders for organic agriculture to allow them the time to learn and acquire the requisite knowledge, skills and attitudes for leading and to aid the organic movement development within a global or local perspective. The course content and methodology is not to create topic experts, i.e. extension or agriculture specialists, certifiers, etc. – but to enable a deepened understanding of all the aspects of organic agriculture and establish a regional and international network of capacitated change agents.

https://www.ifoam.bio/our-work/how/training

Source: IFOAM (n.d.)

The Organic Academy - The Training of Trainers

IFOAM
Worldwide

Approach: Face-to-Face (F2F) sessions, webinars and course assignments (development plan)
Target: Trainers
Main topic: Educational methodologies and organics

The ToT has been designed with the intent to support trainers who will subsequently train trainees as multipliers (rural service providers, lead farmers, extension agents, etc.) for organizational capacity development of organics. Both capacity building and training methodology are focused here for the objective of supporting and guiding the trainers deliver their message and content to the trainees as efficiently and effectively as possible. The ToT has been drawn from participants' needs, the level of comprehension and knowledge, and the specifications therefore. The ToT deals with actual content, curriculums, technical matters and organics inspires the training. The ToT focuses on developing the capacity of the trainers to:

- Train and inspire their target group.
- Improve cross-cutting methodological skills.
- Introducing key aspects of organics.
- Develop and deliver their own training courses

https://www.ifoam.bio/our-work/how/training

Source: Coffee Quality Institute (n.d.)

Post-Harvest Processing

Coffee Quality Institute
Worldwide

Approach: Field-based course with lectures, team activities, applied lessons and a certification at the end (diversified into proposals of progressive difficulty)
Target: Coffee farmers
Main topic: Processing methods, best practice and quality controls

Q Processing Professional is a six-day field-based course where students further their theoretical knowledge of the main processing techniques, best practices, and practical experience with a post-harvest processing quality control system. With this material, students will begin developing the skill sets necessary to develop different flavor profiles through processing. The course takes place in a producing country during the harvest season, includes lectures, group sessions, applied instruction, and cuppings, and is a hands-on and participatory learning experience suited to the practical needs of the producing side of the industry. Students must pass theoretical and practical examinations in order to receive certification.

https://www.coffeeinstitute.org/education/post-harvest-processing

Source: Coffee Quality Institute (n.d.)

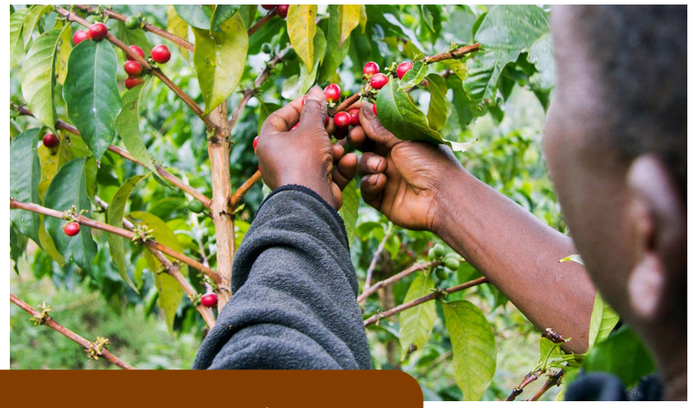
Quality Evaluation

Coffee Quality Institute
Worldwide

Approach: Lectures, applied lessons and a certification at the end (diversified into proposals of progressive difficulty)
Target: From coffee industry workers to normal people interested.
Main topic: Cupping protocols, olfactory senses, gustatory sensory skills, green and roasted grading, organic acid identification, triangulation skills, roasted sample identification, coffee processing evaluation, and general coffee value chain knowledge.

This professional certification provides the skills and principles to perform coffee assessments from farm to import to customer products. The Q Grader training is offered for both arabica and robusta assessment. Q Grader course has two sections, review and exams. The job-related skills are learned through the course like cupping protocols, olfactory sense, gustatory sensory skill, green and roasted grading, identification of organic acid, triangulation skill, identification of roasted samples, evaluation of coffee processing, and coffee value chain general knowledge. CQI also provides various preparatory classes and courses for individuals continuing to Q Grader or who simply want to study the topic of coffee quality.

https://www.coffeeinstitute.org/education/quality-evaluation



Source: TechnoServe (n.d.)

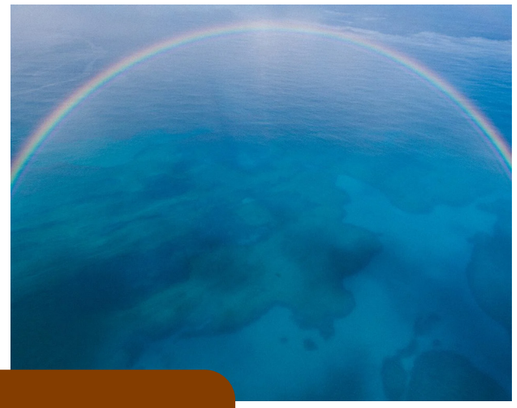
The Coffee Initiative - Farm College training program

TechnoServe
2008-2015
East Africa

Approach: Applied lessons
Target: Coffee farmers
Main topic: Mulching, weeding, pruning, rejuvenation, erosion control, shade management, composting, coffee nutrition, integrated pest and disease management, coffee planting and the safe use of pesticides.

The Coffee Initiative constructed the Farm College training program by hiring farmer trainers who were primarily daughters of local coffee farmers to conduct the training. It assigned each farmer trainer to train between 9 and 13 groups of 30 or more farmers. Each training group also selected a member who volunteered to provide a demonstration plot, which farmers could participate in as hands-on training and see directly how different methods affected the coffee trees in the long term. They were also tuned to the local market and growing conditions—e.g., highlighting the potential for saving on the use of pesticides in Kenya, where they are excessively used, and putting more emphasis on rejuvenation in western Ethiopia, where coffee trees are usually old and rarely properly managed.

https://www.technoserve.org/fight-poverty/projects/coffee-initiative/



Source: Ellen MacArthurFoundation (n.d.)

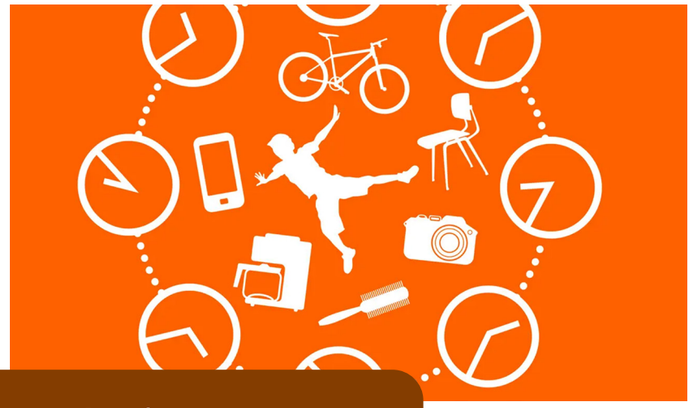
Circular Economy: The Big Idea

Ellen MacArthur Foundation
2024-2025
Online

Approach: E-learning
Target: Massive Open Online Course
Main topic: Circular economy principles, applications and methods.

In this three-week course, you'll learn about the circular economy, which offers a sustainable alternative to the current linear economy that depletes finite resources and generates waste. The course explores the limitations of the linear model and the need for a complete shift rather than simple modifications. You will learn crucial vocabulary, definitions, and the three principles of the circular economy that you may utilize in professional practice or learning. The course also teaches you how to utilize a systems diagram in managing material flows and value, which is vital in circular economy design. With case studies, you'll see how well circular business models function and how policy making helps accelerate the transition to a circular economy. At the end of it all, you'll be in a position to apply the principles of circular economy to actual situations, assess the limitations of linear thinking, and scrutinize policy decisions that facilitate circularity.

https://www.futurelearn.com/courses/circular-economy-the-big-idea



Source: Delf University (n.d.)

Circular Economy: An Introduction

Delf University
2024-2025
Online

Approach: E-learning
Target: Massive Open Online Course
Main topic: Circular economy principles, applications and methods.

The course deals with addressing problems such as waste, global warming, resource scarcity, and loss of diversity; without neglecting the economy and population growth. The theme then is the circular economy: how companies can generate value through recycling and reusing products, how designers can create simply ingenious solutions, and how you can help make the circular economy a reality. Users are taught to rethink the economic system they experience every day and act accordingly by behaving as leaders.

https://www.edx.org/learn/circular-economy/delft-university-of-technology-circular-economy-an-introduction

Source: MIT (n.d.)

Circular Economy: Transition for Future Sustainability

MIT Professional Education
2024-2025
Online

Approach: E-learning
Target: Massive Open Online Course
Main topic: Circular economy principles, applications and methods.

The Circular Economy offers a green approach that considers waste as a design flaw, fostering economic development with resilience and sustainability. The approach offers certainty that materials close the loop into the economy after use, reducing climate change and resource depletion. MIT Professional Education's course explores strategies, policies, and technologies for establishing circularity, including material science, alternative energy, and case studies. Participants become proficient in creating equitable systems, quantifying circularity, and studying sustainable material transportation. Learn more about sustainable economic changes through this comprehensive framework.

https://professionalprograms.mit.edu/online-program-circular-economy/

WORKSHOPS, WEBINARS AND WORKING GROUP

Source: IDH (2024)

Lesson learned and key success factors for African agribusiness working with smallholders farmers

Idh, Technoserve and AgDevCo
2024
Online

Approach: E-learning
Target: Everyone can access, but mainly aimed at workers in the industry.
Main topic: Sustainable smallholder-inclusive business models, value creation in the agribusiness.

Building profitable, smallholder-driven business models can drive profitability and deliver sustainable, long-term impact for farmers and communities. In this webinar are discussed important success determinants and takeaways from experience in engaging smallholders in multiple value chains, including cashew in Côte d'Ivoire, rice in Tanzania, and digital platforms in Ghana. Drawing from their extensive portfolios, our hosts let us know what does and doesn't work while engaging with smallholders. The webinar also shows how three African agribusinesses have successfully applied smallholder-inclusive business models, learning from practical experience how these strategies create value for farmers and companies alike.

https://farmfitinsightshub.org/resources/knowledge-sharing-webinar-lessons-learned-and-key-success-factors-for-african-agribusinesses-working-with-smallholder-farmers

Source: IDH (2015)

FLP Meeting Colombia

Idh, Technoserve and AgDevCo
2015
Colombia

Approach: Problem-based learning and systemic approach
Target: ECOM, FNC, Cafexport, Pur Projet, TechnoServe, Carcafé, IDH, Nespresso, and Solidaridad
Main topic: Technology adoption in the Colombian context, gender equity and youth (coffee farming as a family business), climate change adaptation and mitigation in the coffee sector, technology applied to the coffee sector.

Sustainable Coffee Program is a global, public-private, pre-competitive initiative involving trade and industry stakeholders, governments, NGOs, and standards bodies active in the coffee sector. It aims to expand sustainable coffee production and international buying by bringing together stakeholder investment in producer assistance programs, with an aim to improve livelihoods for farmers, build resilience in an evolving marketplace and increase sustainably grown coffee to respond to growing demand. Sourcing these experiences with all the Implementing Partners offers a window of opportunity to enable them to collaborate in maximizing the impact of the SCP in Colombia.

https://www.idhsustainabletrade.com/uploaded/2017/02/1603_Report_FLPMeeting2015_EN.pdf

Source: Biomimicry 3.8 (n.d.)

Biomimicry Immersion Workshops

Biomimicry 3.8
From 2015
Worldwide

Approach: Learning by doing
Target: Everyone
Main topic: Biomimicry tools and strategies

Biomimicry workshops provide experiential training in applying nature-inspired solutions to business and design challenges from international experts. Trainers receive access to educational materials, online courses, and credit toward obtaining the Biomimicry Specialist certification, such as accredited online courses and immersive workshops. Among these workshops, “Discover Nature’s Genius” explores different ecosystems in search of environmentally friendly methods in nature appropriate for inventors, students, and educators. “Biomimicry Thinking” uses a scientific thinking method that applies the “Challenge-to-Biology” framework to drive sustainable innovation, imagination, and interdisciplinary cooperation. It offers effective tools for embedding biological intelligence in design. Held in nature settings that encourage creativity and nature bonding, the workshops have limited group settings for opportunities in networking and meaningful interactions.

Site: https://biomimicry.net/what-we-do/professional-training/immersion-workshops/

HUBS AND COMMUNITIES

Source: Coffee & Climate (2022)

Community of practice

Coffee & Climate
From 2017
Location: Worldwide

Target: Coffee actors
Main topic: Coffee best practices

The core idea of Communities of Practice (CoPs) is to facilitate systematic sharing of learning and knowledge of coffee and climate projects in areas of projects. These communities bridge individuals with an interest in adaptation to climate change, facilitating working together across organizational boundaries. They are sites of knowledge sharing, learning, and capacity building. CoPs are characterized by their group knowledge and member benefits they confer. They are managed locally to exchange knowledge effectively, influencing decision-making and public policy in support of adaptation and mitigation efforts in the coffee industry.

https://coffeeandclimate.org/communities-of-practice-cop/

Source: This Side Up (2020)

Agroforestry Training Hub

This Side Up
From 2020
Colombia

Approach: Learning by doing
Target: Coffee farmers
Main topic: Circular best practices and methods

This project has been structured with the vision to construct an education center where farmers will be taught sustainable methods, utilization of biofertilizers, and digital tool usage to ensure transparency and traceability in operations to serve the high-quality coffee industry requirements. Apart from training, the project seeks to encourage those who, due to social or political circumstances, have engaged in illicit cultivation or never worked with coffee before by making them knowledgeable about and favorable to the long-term benefits of sustainable agriculture. The other aim is to trigger healthy soil and implement regenerative farm practices, eradicating myths related to biofertilizers, that they are of poor quality or plant toxic. In addition, the center is dedicated to advancing gender equality in the region by ensuring equal training for women. This initiative not only supports sustainable agricultural development but also serves as a catalyst for broader social change, with the possibility of being extended to other regions of Colombia.

https://thissideup.coffee/agroforestrytraininghub

Source: Climate Farmers (n.d.)

Climate Farmers Community

Climate Farmers
From 2020
Worldwide (Most Europe)

Target: Coffee farmers
Main topic: Circular and regenerative best practices and methods, regulations and policy.

Farmer-run, farmer-driven community. With local gatherings, internet meetings, and easy-to-use interface, it's a key facilitator of transition. Overcome access barriers through access to practical knowledge. Facilitate farmer-to-farmer sharing of experience. Framework for large-scale scaling up of regenerative agriculture in Europe by offering farmers, corporates, and regulators a data- and communications platform. Climate Farmers motivates others who must convert to regenerative practices and understands the need for private investment so as to be able to facilitate a transition ultimately bringing benefits for the public good. The company works to foster a learning culture and support by local and global stakeholders. The farmers are connected to a mediated pool of knowledge and peer-support system through its ambassador program to other local producers. Companies are incentivized to support financing the transition to regenerative agriculture through carbon offset credits.

https://www.climatefarmers.org/

PRODUCT AND PLATFORMS

Source: SYKLI (n.d.)

Circula

SYKLI Environmental School of Finland
2017
Finland

Approach: Gamification
Target: Students and workers
Main topic: Circular economy

The Circula® Game is an innovative educational tool that is designed to introduce students to the circular economy idea founded upon active learning and collaboration. The game does not merely attempt to explore sustainable practices alone but also the cultivation of creativity, self-knowledge, and responsible business model innovation. The game endeavors to instill hope of a sustainable future through wellbeing that is not founded on the excessive use of natural resources. Appropriate for a wide range of learners, from adolescents to adults, Circula® is readily integrated into diverse learning contexts such as secondary school, vocational school, and universities of applied sciences. Its flexibility also makes it simple for incorporation into extracurricular courses, organizational development programs within companies, and environmental consultancy services. Combining education and inspiration, the game is a versatile instrument for the development of sustainable lifestyles and creative thinking in various environments.

https://circula.fi/en/

Source: Coffee & Climate (n.d.)

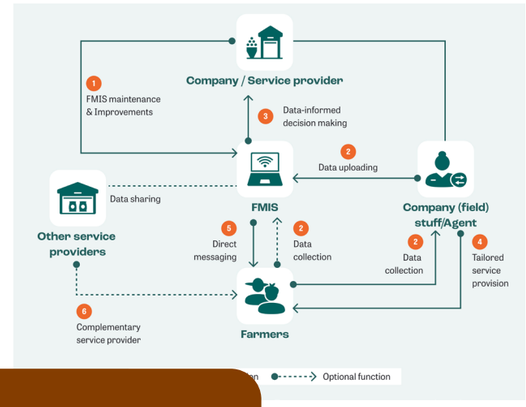
C&C Toolbox

Coffee & Climate
2017
Online

Approach: E-learning
Target: Farmers
Main topic: Climate resilient farming techniques.

As a reaction to the needs of coffee farming communities worldwide, the c&c toolbox was created as an open online platform in a multi-stakeholder initiative to fight climate change effectively. The c&c toolbox is a compilation of field-tested tools, case studies, guidelines and training materials. The c&c toolbox offers farmers and farming communities valuable information on farming practices and techniques that are climate resilient.
The c&c toolbox is an excellent forum to share knowledge on established and novel climate-smart agriculture practices. The tools are selected and piloted together with farmers, extension workers and some of the world's top climate experts. The visitors are encouraged to utilize the toolbox as an interactive forum and also contribute their own experiences on useful tools.

https://coffeeandclimate.org/cc-toolbox/



Source: IDH (n.d.)

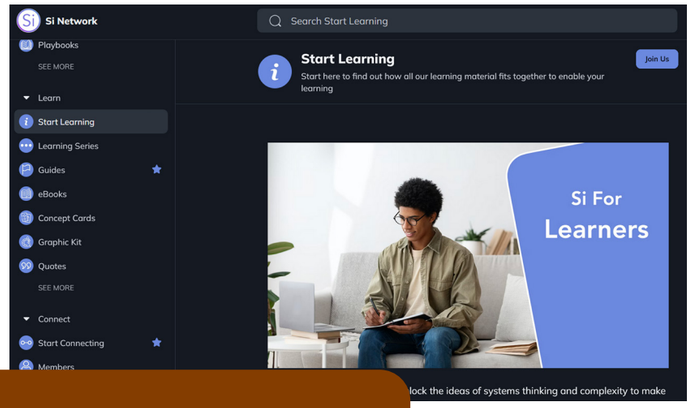
FarmFit Insights Hub

Idh
From 2015
Online

Approach: E-learning
Target: Farmers
Main topic: Smallholder-inclusive business models.

The FarmFit Insights Hub is a data-driven and supportive platform for smallholder-inclusive business models that aims to balance business profitability with farmer benefits. It draws on over 100 models globally and stringent data collection, offering insights into sustainable investment, scalability, and efficiency. It targets the private sector's role in smallholder market financing and promotes data-driven decision-making. Supported by important international institutions, the Hub aims to support innovation and partnership in order to turn smallholder farming around sustainably.

https://farmfitinsightshub.org/



Source: Systems Innovation (n.d.)

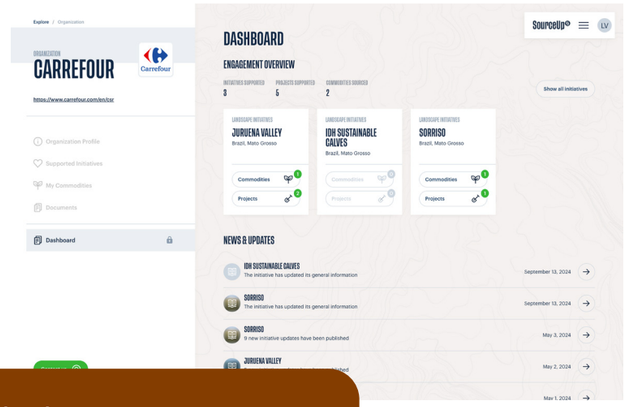
SiNetwork

Systems Innovation
Online

Approach: E-learning
Target: Everyone
Main topic: Education

We are building a network of individuals and organizations co-creating and co-learning systems innovation across geographies and sectors. This network is supported by our online platform providing learning material, toolkits, managing projects and events and providing various support services for organizations. The Si Network is an online platform connecting people worldwide to learn and apply the ideas and methods of systems innovation to address intricate issues.

https://www.systemsinnovation.network/spaces/13504261/page



Source: IDH (n.d.)

SourceUp - Landscape Initiatives

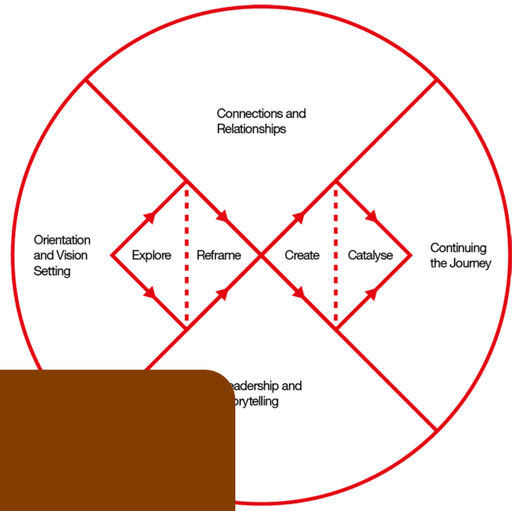
Idh
Online

Approach: E-learning
Target: Farmers
Main topic: Smallholder-inclusive business models.

SourceUp is an online platform connecting buyers and stakeholders of global agricultural supply chains with sustainable projects in production landscapes. It enables landscape-level engagement for green, inclusive, and climate-smart development. The platform raises visibility, transparency, and credibility of landscape projects, enhancing collaboration and access to sustainability impact information. It promotes landscapes that produce commodities like palm oil, coffee, soy, and others, giving early-stage projects visibility and enhancing their impact.

https://sourceup.org/

TOOLKITS



Source: Systems Innovation (n.d.)

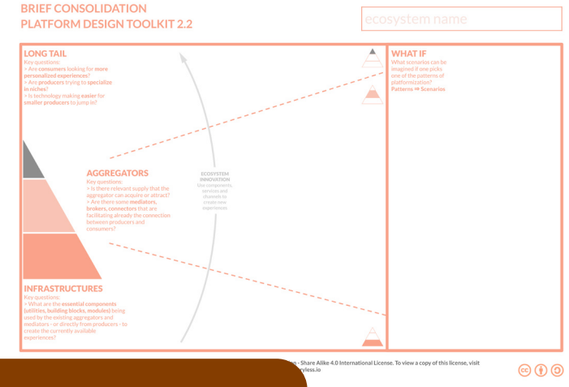
Systemic Design Toolkit

Systemic Design Toolkit
2017
Online

Approach: Learning by doing
Target: Research centres, companies
Main topic: Understanding and improving a system.

This framework is intended to tackle societal and organizational challenges by a mechanism of systemic improvement driven by a systematic approach involving seven canvases.
A process designed for use in co-design sessions without a facilitator, it is step-by-step with a guide and printable canvases. The tools help partici-pants: define the context of the system, analyze its dynamics, gain better understanding, envision a preferred future, explore possible solutions, design an intervention model, and facilitate the transition to change.

https://www.systemicdesigntoolkit.org/



Source: Boundaryless (n.d.)

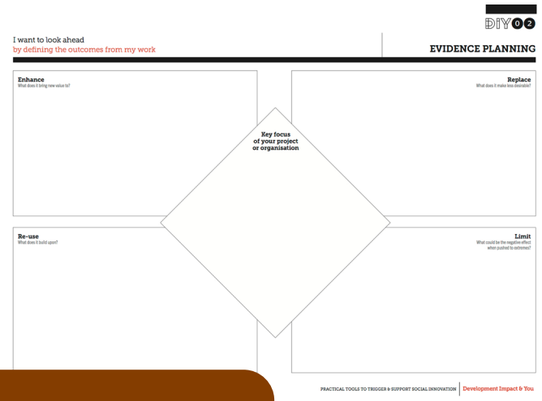
Platform Design Toolkit

Boundaryless
2021
Online

Approach: Learning by doing
Target: Companies
Main topic: Service design e business modeling.

This model is designed to track entities within an ecosystem, analyze their relationship and integrate them into a business model that can be prototyped and validated.
Developed for co-designing without the need for a facilitator, it has a step-by-step process and practice tips. It is structured in eight canvases, each with a main concern: ecosystem mapping, defining entity roles, evaluating value exchange potential, deciding on key operations, designing the “learning engine,” defining the system, constructing platform experiences, and designing the minimum viable platform.

https://www.boundaryless.io/ pdt-toolkit/



Source: Diy (n.d.)

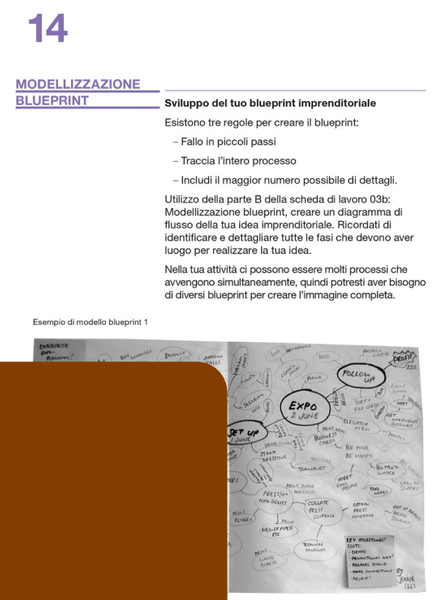
Development Impact & You Toolkit

Diy
2018-2021
Online

Approach: Learning by doing
Target: Companies
Main topic: Social innovation

Created for business practitioners to innovate or come up with ideas for improved outcomes. Depending on the chosen canvas, there are three usage levels: self-management, need for dialogue, and advanced tools. It is made up of 30 canvases that are based on established theories and practices in innovation, design, and business development. These canvases guide users through: envisioning future outcomes, developing a clear strategy for collaboration on a shared vision, building on past work, and prioritizing by breaking down complex issues and setting goals and directions to achieve them.

https://diy-toolkit.org/


14

MODELLIZZAZIONE BLUEPRINT

Sviluppo del tuo blueprint imprenditoriale

Esistono tre regole per creare il blueprint:

– Fallo in piccoli passi
– Traccia l'intero processo
– Includi il maggior numero possibile di dettagli.

Utilizzo della parte B della scheda di lavoro 03b: Modellizzazione blueprint, creare un diagramma di flusso della tua idea imprenditoriale. Ricordati di identificare e dettagliare tutte le fasi che devono aver luogo per realizzare la tua idea.

Nella tua attività ci possono essere molti processi che avvengono simultaneamente, quindi potresti aver bisogno di diversi blueprint per creare l'immagine completa.

Esempio di modello blueprint 1

Source: Nesta (n.d.)

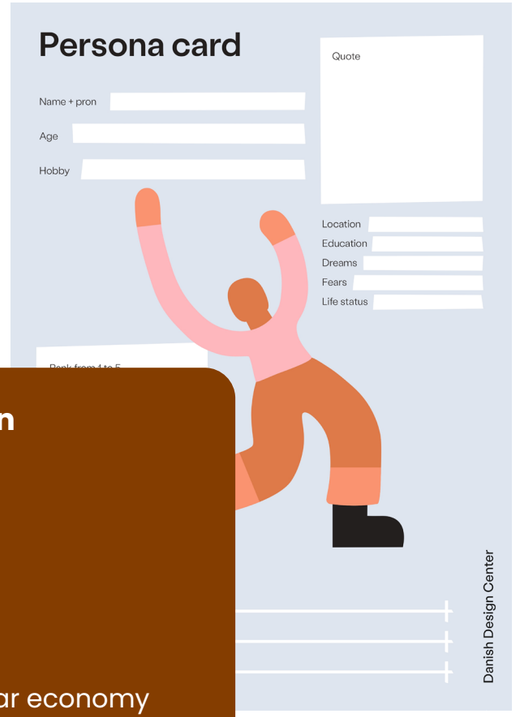
Creative Enterprise Toolkit

Nesta
2013
Online

Approach: Learning by doing
Target: Companies
Main topic: Sustainable entrepreneurship

It is a facilitation guide to creating a business plan that helps the analysis of the ideas of the user and creates a business model to suit their motives and objectives. The guide is accessible, using real examples to refer to, so no facilitator is needed. It consists of seven different canvases, which can be used through the guide and extra tips, all of them on the internet.

https://www.nesta.org.uk/toolkit/creative-enterprise-toolkit/



Source: Danish Design Center (n.d.)

Designing Your Circular Transition

Danish Design Center
Online

Typology: Open source toolkit
Approach: Learning by doing
Target: Companies
Main topic: Social innovation and circular economy

Designed to allow companies and organizations to collaborate creatively and in a cooperative way in a circular innovation process. Each canvas has an introductory video, a tools list, and a detailed guide to use. The toolkit deals with eight core subjects, in printable and digital formats on miro.com. Some of these topics are: an overview of circular approaches to identify potentials, a manual for generating new circular concepts, and a manual for creating and visualizing circular solutions for clear communication and tracking of networks.

https://ddc.dk/tools/designing-your-circular-transition/

Source: Medium (n.d.)

Leading coffee companies

In order to better understand how companies in turn use the methodologies, tools and educational offerings that were partly reported in the case studies, further research was conducted of projects carried out by two leading companies in the industry. This was used to ascertain whether they were developing additional strategies and objectives to the educational processes or merely applying the same solutions as entities and associations that are not properly part of the production chain and do not work directly with coffee.

Source: Nestlè (n.d.)

NESTLÈ

Nescafé Plan

2010
Worldwide

Typology: Action plan
Approach: Systemic
Target: Coffee farmers
Main topic: Sustainable agriculture

The Nescafé Plan is Nestlé's global movement towards sustainability that makes a future for coffee by empowering farmers, communities, and the environment. The plan promotes regenerative farming practices, reduces greenhouse emissions, and improves the lives of coffee farmers in over 20 countries.The program focuses on educating farmers, distributing millions of disease-free coffee plants, and promoting techniques that increase productivity and protect biodiversity. Scores such as responsible sourcing of coffee, improving the quality of life for farming families, and reducing environmental impacts along the production chain. Women, being central to coffee farming, get particular attention. For instance, in Vietnam, the plan has helped women farmers diversify their crops, improve incomes, and develop sustainable farm management.

https://www.nestle.com/sites/default/files/2021-01/sustainable-journey-ten-years-nescafe-plan-2021-en.pdf

Source: Nestlè (n.d.)

Nespresso AAA Sustainable Quality™ Program

From 2003
Worldwide

Typology: Action plan
Approach: Systemic
Target: Coffee farmers
Main topic: Sustainable agriculture and economy

This initiative, created in partnership with Rainforest Alliance, is aimed at offering sustainability in coffee production through the improvement of product quality, productivity, and farmers' living conditions. The initiative is distinctive due to its customized solution that addresses the environmental and social issues of the sector. Through farmer education on sustainable farming and agronomist technical support, the initiative optimizes crop yield and quality while reducing environmental impacts. Direct economic support is in the form of premium prices for farmers and investments in infrastructure, such as more efficient milling machines that reduce pollution and increase the process of production. Furthermore, initiatives like planting millions of trees and farmers' pension programs ensure the sustainability of agricultural societies. The program also seeks to address issues on a systemic basis through collaborations that promote sustainable resource management and resilient landscapes development.

https://www.sustainability.nespresso.com/communities/aaa-sustainable-quality-program

Source: Nestlè (n.d.)

Nescafé Coffee Academy

Worldwide

Typology: Training lab
Approach: Learning by doing
Target: Horeca workers
Main topic: Coffee processing and quality control

Nestlé Coffee Academy, certified as a specialty coffee association, is a specialist in coffee culture. It offers training activities along the whole coffee value chain from botany, roasting, and extraction to sensory analysis and more. Professional customers visit the academy for the Horeca channel, perform practical courses, and create learning digital content.

https://www.nestleprofessional.it/a-proposito-di-noi/coffee-academy

Source: Nestlè (n.d.)

Nescafé Professional Lab

Worldwide

Typology: Training lab
Approach: Learning by doing
Target: B2B workers
Main topic: Coffee processing and quality control

The Nestlé Professional Lab is an advanced, technology-enabled lab facility for B2B professionals. It offers creative services and technical support to serve customer needs, with high-qualified professionals making high-quality products, new recipes, and blending flavors. Apart from technical counseling, the Lab also offers training courses and workshops to enhance the skills of the operators. It is a source of innovation and excellence for the food and beverage sector, and it inspires innovation and teamwork.

https://www.nestleprofessional.it/a-proposito-di-noi/nestle-professional-lab

Source: Fondazione Lavazza (n.d.)

FONDAZIONE LAVAZZA

Meta

2015
Colombia

Typology: Project
Approach: Systemic
Target: Coffee farmers
Main topic: Sustainable agriculture, social and economic development.

Meta is a distant rural area that is well-known for coffee production. The area has experienced the brunt of war and cultivation of crops for drugs. However, the area is now unlocking new economic growth opportunities with the production of high-quality coffee. Efforts have been made to encourage local farmers towards Rainforest Alliance certification, which has been building better farming techniques and improved profitability. Key goals are the training of farmers in high-quality and sustainable ways, strengthening agriculture infrastructure, and providing access to new technology for enhancing the regional competitiveness level. Furthermore, rural internet penetration and technology increases also aim at updating the coffee industry and stimulating connectivity between producers on the ground and global markets.

https://www.lavazza.it/it/blend-for-better/colombia

Source: Fondazione Lavazza (n.d.)

Cafè Escuela - BioCuba Cafè

2018-2021
Cuba

Typology: Project
Approach: Systemic
Target: Coffee farmers
Main topic: Sustainable agriculture

Cafè Escuela was a collaborative effort between Fondazione Lavazza, Oxfam, Grupo Agroforestal, and HEI to revive coffee cultivation through the promotion of agronomic skills, production effectiveness, and eco-friendly cultivation practices. The project restored plantations through 10 production centers and the cultivation of over 6 million Roya-resistant plants. It involved 170 certified organic farmers with green practices, including organic compost produced by insects and worms. Women and youths were most relevant: 95 women in Guisa and Contramaestre worked manually to grade beans in order to ensure quality. The second phase led to the creation of the joint BioCuba Cafè venture that helps producers and businesses to add value in quality, access, sustainability, and certification by enhancing training and innovation. The ultimate goal is to give a better tomorrow to Cuban farm communities with each cup of coffee being a symbol of unification and progress.

https://www.lavazza.it/it/blend-for-better/progetti-cuba

Source: Fondazione Lavazza (n.d.)

A cup of learning

From 2017
Lavazza Training Centre

Typology: Program
Approach: Learning by doing
Target: Coffee enthusiasts
Main topic: Coffee retail

A Cup of Learning is a coffee training program that was created in collaboration with the experts of the Lavazza Training Center. It is one of the programs through which Blend for Better is dedicated to assisting underprivileged social individuals by providing them with information and competences that are related to the coffee industry. The project offers two distinct training courses, both specifically aiming at young people in search of employment within the sector. The first focuses on green coffee processing techniques, the second on giving participants the training they need to become professional baristas. Through this project, over 380 young adults from 16 countries have been able to turn their passion for coffee into a real professional challenge.

https://www.lavazzagroup.com/it/le-nostre-storie/progetti/sustainability/a-cup-of-learning.html

Source: Fondazione Lavazza (n.d.)

Farmer Field School

2016
Vietnam

Typology: Program
Approach: Learning by doing
Target: Coffee farmers
Main topic: Soil and water management

Along with Olam and ISLA (Initiative for Sustainable Landscapes), the Lavazza Foundation helps small Vietnamese coffee farmers with Farmer Field Schools, which provide technical assistance and training. The program involves soil analysis to identify the right fertilizers, the use of new irrigation systems, and the cultivation of shade trees to protect plantations from excessive sun or sudden rains. The project seeks to enhance water usage efficiency, lower greenhouse gas emissions from coffee production, and adopt sustainable solutions to mitigate the impacts of climate change.

https://www.lavazza.it/it/blend-for-better/innovazione-contro-il-cambiamento-climatico

Source: Fondazione Lavazza (n.d.)

¡Tierra!

From 2002
Worldwide

Typology: Project
Approach: Systemic
Target: Coffee farmers
Main topic: Sustainable agriculture, social and economic development.

¡Tierra! is a global initiative by Lavazza that began in 2002 aimed at creating social and economic advancement in communities by supporting sustainable methods of farming coffee plantations. Initial focus being on small rural farming communities of Colombia, Honduras, and Peru, ¡Tierra! enlarged its ambit of work to benefit 19 more countries, active in engaging with farmers and their families. The project in certain regions facilitated quality coffee production for the ¡Tierra! washed Arabica blend, sourced from full-fledged, sustainably practicing agriculture certified by Rainforest Alliance, promoting environmentally responsible farm practice and decent living standards of farmers. ¡Tierra! has assisted over a hundred farm families in these regions to restore plantations using sustainable methods for enhanced economic autonomy and stability in the communities.

https://www.lavazzagroup.com/it/come-lavoriamo/le-comunita.html

Source: Fondazione Lavazza (n.d.)

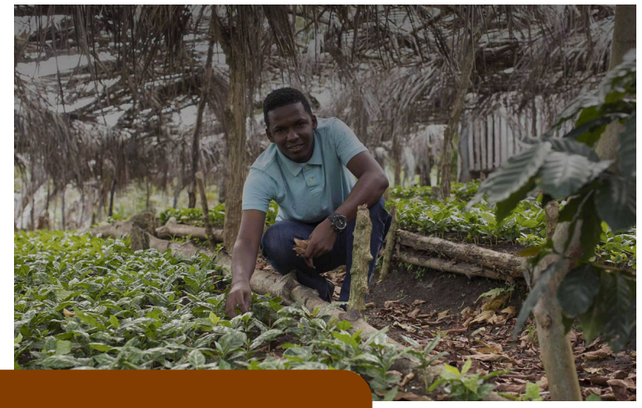
Coffee to be Reborn

From 2016
Guatemala

Typology: Project
Approach: Systemic
Target: Coffee farmers
Main topic: Sustainable agriculture, social and economic development.

The project began to finance the coffee production and marketing activities of an initial group of 20 Maya Pop'omchì women, between the ages of 16 and 55, in San Lucas Chiacal. It now includes over 175 women who have been able to successfully re-initiate the production and sale of high-quality coffee, with access to a market of over 1,000 people. Its core goal is to provide training in production techniques and sale strategies, make the Verdad y Vida association stronger, and forge partnerships with other regional and local organizations. Verdad y Vida, which began in 2012, is active in sites like San Cristòbal Verapaz and Santa Lucia Cotzumalguapa among Maya Pop'omchì women subjected to violence or placed in risk conditions. It equips them with solutions to improve education, health, and economic independence. Through the project, the Lavazza Foundation seeks to enhance the quality of Guatemalan coffee and social and economic growth among indigenous populations and give them access to opportunities for development.

https://www.lavazza.it/it/blend-for-better/a-coffee-to-be-reborn



Source: Fondazione Lavazza (n.d.)

Ujana Coffee

From 2016
Uganda

Typology: Project
Approach: Systemic
Target: Young coffee farmers
Main topic: Sustainable agriculture, social and economic development.

In Uganda, where 85% of the coffee is produced by local farmers, climate change is pushing many families into cities in search of better opportunities. In a bid to support such farmers, the Lavazza Foundation, together with International Coffee Partners and Sawa World, established the Ujana Coffee project, targeting young people on small coffee farms. The project aims at diversifying and expanding local incomes through provision of inputs, innovations, and training. Seven young people between the ages of 15 to 35 years were chosen to set up businesses and were endowed with money support as well as marketing and business administration training. They produced study-by-themselves learning tools in the formats of videos and books to impart their expertise and motivate other youth. The "local solution hubs" will serve to engage up to 10,000 and 30,000 youth to propagate positive reforms in local societies.

https://www.lavazza.it/it/blend-for-better/uganda

4.5 Case studies conclusions

From the analyzed cases, conclusions were drawn to understand what works in the present proposals and what needs to be taken into consideration to develop an educational output in the circular economy.

• **The course must have both a theoretical and practical part:** theoretical and applied knowledge must be given, providing the know-how to develop circular practices in practice.

• **The course must be a sum of various modalities (lectures, workshops, working groups, etc.):** this is essential both to provide methodologies to the trainers to then spread the knowledge, and to make the course more dynamic and comprehensive.

• **To really act for the well-being of farmers and territories, one must act not only on education, but also on families and the local economy:** according to systemic principles a good solution must take into account all aspects of sustainability, so if possible act both environmentally, economically, and socially; spreading value on all stakeholders.

• **In addition to knowledge specific to the circular economy, the course must also develop soft skills:** in today's market, soft skills are becoming increasingly important. The worker must possess these skills to engage with other stakeholders and move toward innovative practices.

• **To get to educate growers, one has to go through local educators or growers who have already done the training and who can be educators in turn:** this is crucial to gain the trust of the growers and to create knowledge sharing that lasts even after the course.

• **Having a platform, book or toolkits to support the course can help:** it is important to share tools that remain with the user and that they can use in their work and facilitate. They are also useful to help follow the lessons and facilitate learning.

• **The participation of government stakeholders, public agencies, relevant companies, institutes and organizations** is essential to bring a comprehensive view of the system and get to implement the initiatives in the practical.

• **The course should aim to create collaboration and a group of like-minded people:** networking, improving relationships and spreading a team spirit is key to creating a cohesive and aligned community.

• **Making the course light through games and group activities is key to educating users who are not used to learning:** the targets considered often have no education or at any rate cannot invest too much time, making the course light through different and specially designed methods is the key to creating interest and encouraging learning.

4.6 Challenges & opportunities

In the specific area of education, therefore, specific opportunities for improving the coffee supply chain can be outlined, while emphasizing the importance of considering all stakeholders: governments, development partners, NGOs, producer farmers, traders and processors, research and educational institutions.

The International Coffee Organization recognizes for **stakeholder education and awareness** (Economic and Environmental Benefits SDG 12):

• **Implement educational campaigns** to raise awareness among stakeholders in the coffee value chain about the importance and economic opportunities of circular economy practices.

• **Provide training programs** for farmers and coffee retailers on sustainable practices and waste reduction strategies along the value chain.

• **Integrate circular economy and regenerative agriculture training** into existing coffee industry support initiatives.

• **Leverage pre-competitive platforms, local institutions and regional coffee associations** to spread knowledge about circular practices and their benefits.

• **Develop "Train the Trainers" programs** to empower local coffee support organizations, institutions, and associations by promoting local ownership and combining global insights with local expertise.

• **Promote continuous learning** by documenting and sharing lessons learned, fostering collaborative action among value chain actors beyond individual projects.

• **To create online learning modules** with case studies for higher education students and professionals, supporting knowledge building for future leaders in the coffee industry.

To establish best practices and highlight good examples (Environmental and socio-economic benefits SDGs 2, 8, 12, 17):

• **Develop and share open-source databases** showcasing global best practices.

• **Provide access to technologies, business models, step-by-step guides** for farmers, specifications, datasets and other practical resources, enabling others to adopt effective solutions.

• **Build local capacity by co-creating training** packages with farmers, ensuring that resources are accessible in various formats (e.g., videos, photos, and multilingual guides).

• **Highlight the potential of small and local solutions** by showing their innovation, scalability, and value to the broader community.

• **Create hubs and places** to develop case studies and best practices at scale.
(ICO, 2024)

Case studies conclusions

- The course must have both a **theoretical and practical part**
- The course must be a sum of **various modalities** (lectures, workshops, working groups, etc.)
- To really act for the welfare of farmers and territories, one must act not only on education, but also on families and the local economy
- The course must develop not only specific knowledge in the circular economy but also **soft skills**
- To get to educating growers, one must go through **local educators** or **growers who have already done the training** and can be educators themselves
- Having a **platform or book to support** the course can help
- The course should aim to create **collaboration** and a group of people with the same goals
- Making the course light through **games and group activities** is key to educating users who are not used to learning

Opportunities

- Implement educational campaigns to raise awareness among stakeholders in the chain
- Provide training programs for farmers and coffee retailers on sustainable practices and waste reduction strategies along the value chain
- Integrate training on the circular economy and regenerative agriculture
- Leverage **pre-competitive platforms**, **local institutions** and **regional coffee associations**
- Develop **“Train the Trainers”** programs.
- Promote **continuous learning** by documenting and sharing lessons learned, fostering collaborative action among value chain actors beyond individual projects
- Create online learning modules with case studies for higher education students and professionals
- Develop and share **open-source databases** showcasing global best practices
- Provide **access to technologies, business models, step-by-step guides** for farmers, specifications and datasets
- **Build local capacity** by co-creating training packages with farmers, ensuring that resources are accessible in **various formats** (e.g., videos, photos, and multilingual guides)
- Highlight the potential of small and **local solutions** by showing their innovation, scalability, and value to the broader community
- Create hubs and places to develop case studies and best practices at scale

FOCUS

4.7 Interview

During the course of the thesis, through personal contacts, the opportunity arose to speak with a professional who has studied and works in the agricultural sector. Specifically, the interviewee had experience in educational projects regarding regenerative agriculture, sustainable farming practices, and circular economy in countries not yet aware of the benefits of these practices. The proposed thesis shares a strong interest in these topics, and receiving feedback, views, and opinions proved invaluable in better understanding the context, challenges, and opportunities for bringing a project consistent with the identified goals. Together, reasoning was carried out, which is summarized and reported here in interview form.

A. Introduce yourself, tell about your background, vision and experience.

F. Hi A.., sorry I am only responding now. I am a bit busy these days. So, first of all, let me introduce myself, my name is Francesco; I have a background in agriculture, agronomy: I did my bachelor's degree in Padua in Agricultural Science, and then I did my master's degree in the Netherlands, in Ground Science, so let's say I'm quite passionate about agriculture, and precisely I had the pleasure this year to do this volunteer experience in Africa, in Tanzania, an experience that allowed me to discover a new world there and get in touch with

the local people, also through the local language. In the sense, the intention of this volunteer experience was precisely to give support to the community with agricultural practices, and then work in the field with them. And yes, in theory we were also supposed to support them, giving them advice on how to practice certain practices, but as I was telling you, unfortunately in the end our role was mainly just supportive and so that didn't allow me to make a real difference.

A. Speaking of agriculture and sustainability, perhaps specifically circular economy, what are the main challenges and critical issues in applying sustainable practices?

F. The main critical issue in applying sustainable practices is that, precisely, very often they are unorthodox. For example, they adopt monoculture, or they burn the fields, which, I told you, is not even a practice-it's just something very wrong to do. By burning the surface layer of the soil, you burn the most nutrient-rich layer and the crop residues from the previous crop, which, if buried, will give nutrients back. They also do other things wrong, like sowing tomatoes or other crops that should not be grown during the rainy season, resulting in fungal diseases, or sometimes not letting the soil rest. They are very dependent on chemical fertilizers, seeds from multinational corporations (which are sometimes sterile), and this makes them vulnerable economically and agronomically. Or, another example, the soil becomes acidic and prone to erosion because

they use too much water and the soil can no longer retain it. These are all practices that go against the principles of sustainable agriculture.

A. Casting this topic in the context of farmers in less developed countries where you had the opportunity to work, what are the issues that you find most, both in farming practices and in social/ educational relations?

F. In terms of social/educational relations, as I mentioned, at least there where I was, then I don't know if it's always like that, especially in the beginning they were very distrustful, indifferent towards us, towards us coming from another country. They were very skeptical. The biggest difficulty for me was at the social, cultural level: these cultural barriers made things very complicated. Often local people are skeptical, distrustful and do not listen to advice. Even in cultivation practices: they sow with wrong densities, they don't plan the harvest, they don't organize the sale on time. They do not do crop rotation, they cultivate during the wrong seasons, they use too much fertilizer and seeds that cannot be replanted. They lack tools and resources, so they work everything by hand, with greater difficulty. What, on the other hand, are the strengths of the practices and methods they use and the strengths of the farmers themselves (special skills, competencies, attitudes, thoughts, ...) Certainly one strength is that they do not need to irrigate some crops, such as corn, which in Italy requires summer irrigation instead.

In some regions they do not burn fields, so they conserve soil better. Some people know good agronomic practices (such as crop rotation, mulching, proper seeding densities), however, they do not always apply them. There is the theoretical awareness, but not always the will or the practical possibility. The potential would be there.

A. In your opinion, to educate these farmers about sustainability, what needs to be considered? What are the opportunities and risks? Feel free to give your opinion and maybe even some advice!

F. I think a local agent should educate other farmers. Just because of a cultural issue: they trust more those who are like them. A local elder, for example, has more authority than a young person from outside. Or you would need figures who come from outside, but from serious, reputable institutions that inspire trust. The risk is that if you don't win their trust, they won't listen to you. The opportunity is great: with trust and the right tools, you can make a big difference.

A. What do you think has priority in sustainability education in these places? What is important to teach?

F. In my opinion we need to raise awareness, first of all. Soil fertility, for example, is not seen, but it makes a huge difference on the crop. You have to teach the importance of crop rotation, mulching,

proper use of fertilizers, planting densities, pest and disease management. These are all things that can improve yields and reduce costs.
Also: planning. Plan harvest and sales, not improvise. The priority is to give concrete tools, but also to make people understand why they are needed.

A. What methodologies could be used to educate? Who should be involved?

F. I think you need local authority figures who are already listened to by the community. Trusted entities, local cooperatives, and experienced local people should be involved. The approach needs to be practical: let people see the positive effects of certain techniques on the ground. It is not enough to just say it; they have to see it for themselves. Using concrete examples, such as the yield of corn if sown well, or the reduction of weeds can also be successful, let them see and touch local realities that have succeeded in practicing these strategies to the fullest and grasp the results. In conclusion, I believe there is a need to work on trust, culture and practicality.

Source: Seed.Uno (2021)

CHAPTER 5

The course: “Circular economy in the coffee sector”

5.1 Overview

In light of the challenges and opportunities outlined at the end of the chapter “circular economy education in the coffee sector,” the thesis proposes to go out and create an educational output that goes as far as possible to fill the gaps in the proposals already in place and best carry out specific training with respect to the targets and situations that may be encountered. The proposed solution is that of a **training course**.

This precise output was chosen because it was compatible with the actions of the actors in the chain; **to connect companies, growers, cooperatives, institutions and universities there was a need to create something that would include them and facilitate an exchange of knowledge and skills**. A training course can be seen as a meeting between different realities aimed at collaboration, even better if it is mutual. Moreover, the format adapts to different goals and resources, without losing the ability to best convey both more general and more specific knowledge. Crucially, it is important to emphasize how the proposed course seeks to be adaptable to any context, without actually lowering itself into a specific place or context. The output will therefore not be designed on the needs of an area, but that does not mean that this is not possible in the future, **the course in its structure can be easily shaped to best respond to the peculiarities of an area.**

To design the course and be able to best define it, strategies and several steps were followed. The design process followed for this phase was: the identification of the targets and their analysis, the outlining of the **guidelines and objectives** of the course, the selection of the content to be taught, the educational objectives, the ways in which to develop the course, the **educational figures and/or partners needed**, the **duration** and the materials needed to carry it out. Finally, a space in the thesis was devoted to the creation of **outputs/materials** that support the course and go to give a more tangible idea of how it can take shape in its parts. Initially an excel file was written where the course is seen structured in all its aspects, then diagrams and schematics were developed to summarize it and present it graphically; finally, again to graphically communicate the course as a whole a **complexity map** was drawn with all the data.

5.2 Who to educate and why

In order to have a real impact on the coffee industry, it is necessary to act from the **earliest stage of production**, in the growing, harvesting and processing stages. This is for a number of reasons: it is precisely at these stages that **most organic waste and emissions** are created; the territories where coffee is grown are the **most fragile** and those where most of the damage caused by **climate change** is found; the actors at these stages, moreover, are those most subject to **poverty and price fluctuations**; and finally, farmers are also those who have the most difficulty in accessing the education and knowledge needed to adopt circular and innovative practices.

The output that will be developed therefore primarily targets **growers**, but it also aims to go further: in order to create an ongoing educational base and to be able to communicate better with growers, **local educators** will be worked with and trained. In many cases, it is **growers and cooperative** members who can learn how to educate and **disseminate knowledge to others**. In planning, therefore, this dual vision will always be kept in mind; it is necessary to create an educational interaction suitable for the two targets. Only through **local partners and educators** will it be possible to have the trust of growers and create long-term benefits in communities.

In addition, taking into account that the thesis project was carried out with an eye toward **C4CEC**, the proposal will be outlined to be compatible with online training and to be implemented in short lectures and materials that conform to their **online use.**

Source: Pax & Beneficia (2023)

5.2 Guidelines and goals

In order to go about designing a course that is as comprehensive, timely and suitable for the identified target audience as possible, guidelines have been drafted to keep in mind during the design process.

Guidelines

• **Scalable:** The training and resulting outputs must be able to be applied, in different settings and systems.

• **Practical Eye:** The framework, or in general the output, should yes provide theoretical skills but also practical ones, making the topics covered seen and touched.

• **Accessible:** The topic is complex, but the output should be easy to understand and apply

• **Traceability:** Participants should be aware of the goals achieved, skills developed, and knowledge gained.

• **Systemic:** Outputs should consider the whole system and not be limited to the particular

• **Participatory:** Allow space for users to have their say, reason about the problem, and create interventions aligned with their goals. Learning from each other and building on experiences.

• **Leveled:** Updating teaching and training according to technological and material advances.

• **Supported:** Need to always come alongside users. The educational model must be based on ongoing assistance.

• **Modular:** To create a course suitable for all targets and environments, making it modular and composable is essential

Guidelines for training in the farmer’s local land

To bring reflections even if there is the future willingness to apply the course in a specific context and territory, guidelines have been identified to start an educational path that takes into account the context and needs.

Cultural adaptation and contextualization

All training course content must be adapted to the needs, realities and peculiarities of the place of operation, thus taking into account culture, language and values. One should not put the culture and traditions of a place on the back burner, but on the contrary value them; very often there can be solutions that arise from these peculiarities.

Use approaches that are participatory and centered on learners

The trainer will internalize the content much better and will be able to apply it more in his work by using active learning methodologies like “learning by doing” and “peer learning.” Involving trainers in the decision-making processes can raise their sense of ownership and responsibility toward the training received.

Continuous training systems and mentoring
The mentoring programs and field support enable the trainers to solidify their skills gained and practice them in the guidance of experts. Their feedback and review sessions enhance their capabilities and enable them to continually learn from their approaches.

Technical and digital support to sevelopment
Many developing countries face challenges in accessing digital skills and technology. Investment in training on the basic tools and open-source educational resources equips the trainers with all the potential from technology. It is also beneficial to offer devices or guarantee access to online learning platforms in some cases.

Respecting local skills
Identification and valuing of local resources and knowledge are important in creating trainers who can give a better response to the needs at the community level. Utilizing local experts as co-trainers or facilitators allows for effective adaptation of training content.

Creating a Network of Trainers and Sharing Best Practices
This will be of utmost help in building local, regional, and international networks that encourage the sharing of experiences, challenges, and innovative solutions. CoPs can strengthen these bonds between and among the trainers and thus create a place for collective learning and mutual support.

Sustainability and Local Ownership
Any training program should have the objective of developing skills which resident trainers can continue to use autonomously. That is, developing trainers who would be independent and be able to disseminate their expertise, thus making training sustainable over a period.

Monitoring and Evaluating Impact
Continuous evaluation of the process and outcomes would help identify improvements. Evaluation tools should be very simple and available to allow the trainers to trace their progress, as well as that of the trainees, in the field.

Guidelines for conducting the course

Reasoning has been done to understand how they will have to behave and what the educational figures who will carry out the course should pay attention to.

Keep it simple
Projects that aim to regenerate, bring value and business regeneration can have a profound impact in the place and society where they are developed, but often it is complex operations. Simplifying the message, content, objectives and impact is important. You need to communicate why this path is being taken. A further reflection must be placed in the methodologies and approaches used; it is necessary to ensure constant support during

activities and facilitate learning through methodologies such as learning by doing and action oriented. Focusing learning on practical activities is key to making processes and results tangible.

Change leadership
Good leaders inspire people to act, rather than force them to do. Taking the right time and implementing in the right ways, exalting the peculiarities and skills of users increases the chances of creating a more fertile environment from an educational and innovation point of view. On the contrary, an environment where people act with haste and superficiality leaves little room for innovation and learning. Sometimes it can also be useful to put the user in a leadership position and make him understand the dynamics that a good leader must learn to manage and understand, so as to train the leaders of tomorrow.

Understand the place
We must remember the importance of involving stakeholders and local realities; we must adapt to culture and ways, not vice versa. Understanding the intrinsic value of the place where you act is essential to create real systemic change, acting with respect, curiosity and understanding in the system people, activities and local centres win users' trust and once confidence is created, the learning process will be easier.

Goals

• **Collaboration:** The project should aim to involve as many stakeholders as possible, not just the obvious ones, in order to create a real system. It must also create a spirit of collaboration.

• **Continuity:** The project should aim to implement lifelong learning and learning to learn, enabling workers to retrain and update themselves throughout their working lives. Acorn-thinking is based on the indigenous principle of "seventh generation". An acorn seed planted today will grow into a flowering tree that will provide oxygen, shade and food for people seven generations later. Similarly, the innovations created today will have an impact on future lives. Therefore, regenerative companies should consider future generations as stakeholders in decision-making and innovation processes.

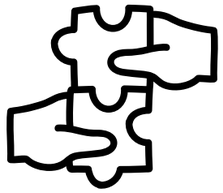
• **Systemic vision:** The project should raise overall and system-level awareness among users and consider all levels: farmers, farmers' organizations, community academics and governments. Both individuals and organisations should recognise their role as critical and connected actors in a wider system, responsible for more than themselves. Regenerative innovation is designed to embrace collaborative rather than competitive or hierarchical solutions and companies should direct this innovation towards strengthening network relationships and creating common value

between the actors of an ecosystem. More people and ecosystems benefit from a company when more stakeholders are considered, especially those outside the “meeting room”. The value created goes beyond financial value: a company should carefully consider the impact its activities have on the wider network of stakeholders; the best way to ensure that business activities do good is to collaborate with a broader network.

• **Community resilience:** The project must act to safeguard local communities and partners by improving their quality of life and work. Regenerative innovation prioritises human and planetary well-being over financial profit. At a human level, the well-being of employees should be seen as an imperative for a thriving company. Regenerative enterprises employ innovative and inclusive approaches to governance and leadership that enable employees to act as leaders and argue that employee prosperity leads to company prosperity. In addition, regenerative companies recognise our dependence on the environment and use innovation as a tool to restore natural systems and address current challenges such as climate change, loss of biodiversity and all its negative consequences. In a regenerative future, companies operate with the awareness that human health is equal to the health of the planet and focus on restoring the balance of both systems.

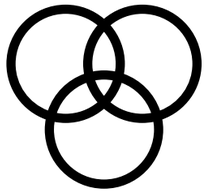
• **Anticipating:** The project should aim to anticipate and adapt to future needs and requirements.

Goals



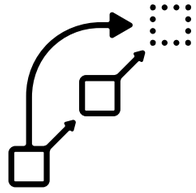
Collaboration

Continuity



Systemic vision

Community resilience

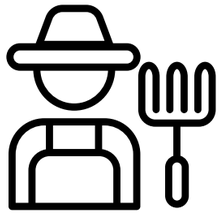


Anticipating

Skills to develop

For the trainers:

Leadership
Systemic thinking
Learning to learn
Lifelong learning
Collaboration
Legislation
Anticipatory
Empathy
Time management
Communication
Self-awareness
Problem solving
Critical thinking



For the farmers:

Systemic thinking
Learning to learn
Lifelong learning
Collaboration
Autonomy
Legislation
Anticipatory
Communication
Self-awareness
Problem solving
Critical thinking
Planning

5.3 Course

Modules e contents

The course was developed trying to take into account all the notions considered fundamental and useful to develop a complete knowledge on sustainability in the coffee sector. Three main macro areas can be noted in the development of modules: one is the **circular economy in the coffee sector**, the second is **systemic thinking** and the last is the **sharing the knowledge**.

The modules are therefore designed to provide both general and specific knowledge regarding good practices of the circular economy in the coffee sector, But the course also aims to provide systemic design knowledge to give the user a **holistic and multidisciplinary view** of the sector, so as to make them more aware of all aspects that influence the market, relationships and sustainability. By itself, the circular economy module already provides the necessary skills for the user to act in a sustainable way, but the circular economy aims at creating a closed system. By proposing a module on systemic thinking the course aims to provide the user with valuable knowledge that can support the circular economy, moving from creating a necessary **closed circular system**, to creating an **innovative open system** that creates a wider and more conscious well-being. Finally, in order to also offer a **“trainers to trainers”** education, a module on education, the sharing the knowledge and the creation of educational outputs was proposed.

Each module is organized into various **sub-modules** which in turn consist of specific lessons. These sub-modules are of three types: first there are **theoretical lessons, practical and the stages of quizzes and feedbacks** to assess whether the knowledge has been incorporated; Second, there are **visits to sustainable sites** that have implemented good practices so that users can see the concepts they are learning implemented; Finally, to obtain a debate and the transition from the course to the implementation of good practices in reality, **working groups** are proposed among users and strategic partners.

As the course was designed in **modular parts**, a more general proposal was initially presented, encompassing all the subjects necessary to achieve the required skills, even for those starting from scratch. (Fig. 13)

As regards the course for more specific target groups, the proposal presented focuses only on some modules, eliminating others or removing some specific lessons, in order to obtain a precise and calibrated output for the chosen target group. In the case of **farmers**, the module on the circular economy in the coffee sector and the module on systemic thinking applied to the coffee sector were included in the course. (Fig. 14)

Fig. 13: The complete course with all modules

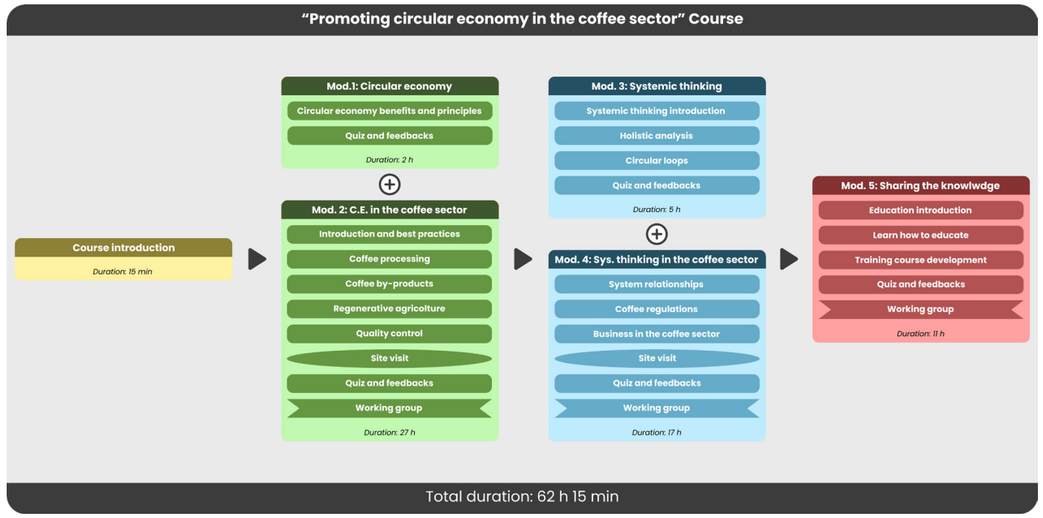
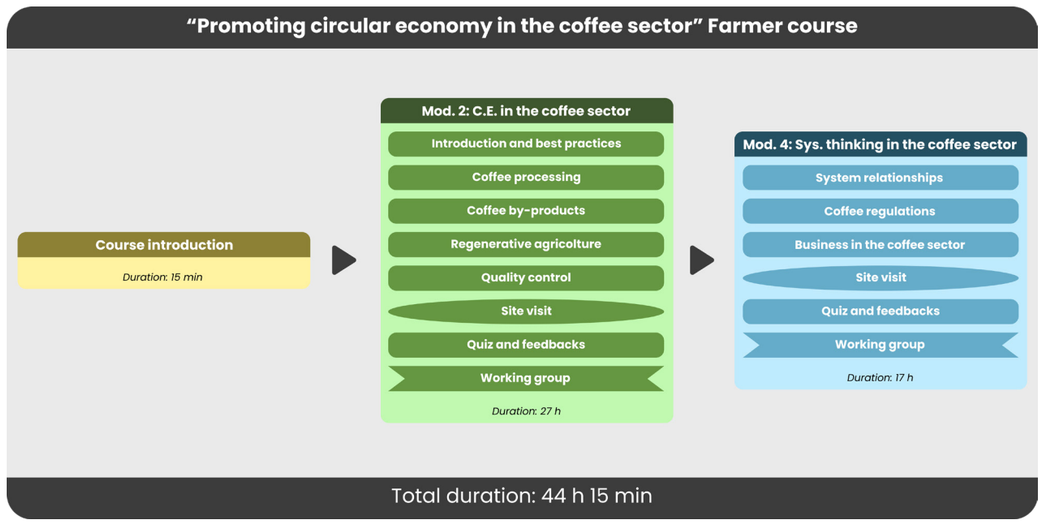
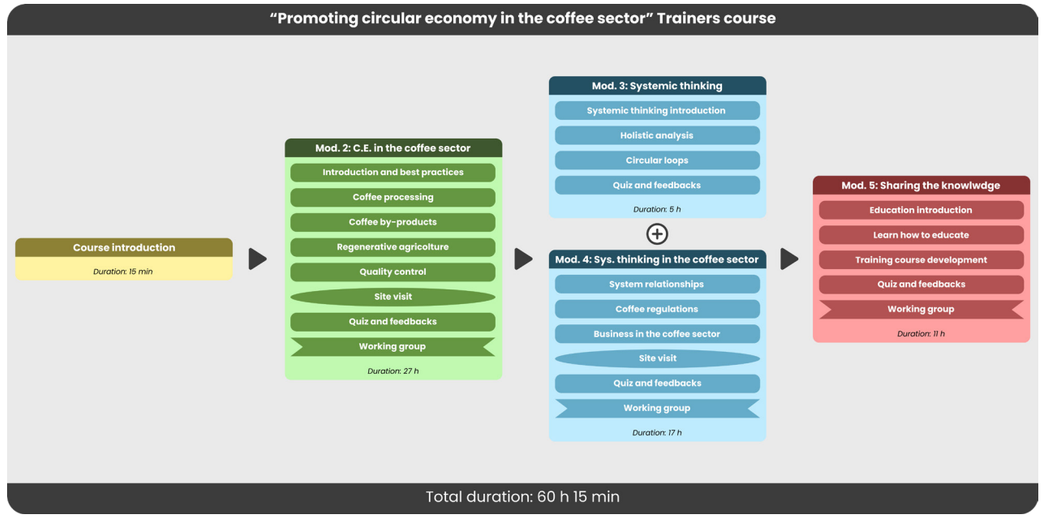


Fig. 14: The course dedicated to farmers



In the case of the course for **trainers**, educators or farmers who want to deepen and in turn become disseminators of knowledge we find the module of the circular economy in the coffee sector, the modules for systemic thinking and the module of the dissemination of knowledge. (Fig. 15)

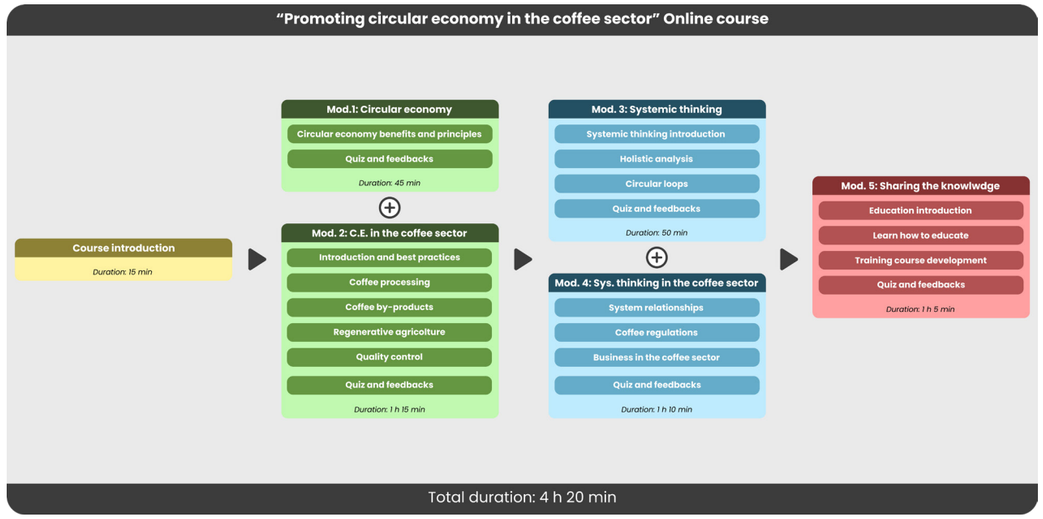
Fig. 15: The course dedicated to trainers



The last case proposed is dedicated to **online** use. All modules have been entered here, but the visits to sustainable realities and working groups have not been inserted. (Fig. 16)

Course diagrams will also be shown for better readability in the appendices of the thesis.

Fig. 16: The online course



Partners and educators

Given the desire of the course to **create relationships between the stakeholders** of the supply chain and to provide all the knowledge to better understand it, the lessons were theorized including the possibility of having **strategic partners to support.** This helps to provide the actor's point of view, his direct experiences, his specific knowledge and to create bases for future collaborations. Within the course there are therefore several partners and educators, some of which could be defined as main, such as systemic design mentors or the company that may be the one who launches the project.

• **Systemic design mentors:** For the conduct of many of the lessons these figures are essential as they are able to infuse knowledge and skills necessary **to create multidisciplinary relationships and between stakeholders**, At the same time giving an **overview of the system and providing practical tools** useful for the definition of the most coherent path to achieve the objectives.

• **Government agencies:** These actors come into play in lessons dealing with **policies and regulations** to give a point of view and in-depth. As policies and regulations are an issue that often affects and has repercussions on both exporting and importing coffee countries, it is hypothesized that the course may be present both local government bodies in relation to the place where the course takes place and entities of other states

that may have relations with the nation where the course takes place.

• **Certification bodies, NGOs and organisations in the coffee sector:** These partners are included in the course as holders of specific knowledge. It may be useful to consider **certifying bodies** for lessons dealing with certification in the coffee sector and how it can be obtained; involving NGOs can give further insight as regards **social and economic aspects**, or the organizations that already deal with circular economy in territory that grow coffee for further deeper knowledge and to establish **useful collaborations to increase the resilience of the system**.

• **Coffee companies:** Coffee companies are key and main partners of the course as they often also carry out projects to increase the sustainability of their processes and supply chain. The course is also designed to be compatible with the outputs that these companies, leading or not in the sector, conduct in the countries where the coffee they process and distribute is grown. In the practical they can bring within the course the **total vision of the process and participate for the creation of a more equal and sustainable collaboration with farmers**, trying to benefit on all stages of the supply chain.

• **Facilitators:** These figures are needed to **support group activities, practical activities and working groups**. They will help educators to better manage spaces, times and users themselves, directing them to the correct course of the lesson. They may be **university assistants, students, workers or people from local communities**; Only in the case of practical activities concerning the good practices of the circular economy for coffee is it necessary that these figures have specific skills in the field of cultivation and biology.

• **Local cooperatives:** In order to create a real relationship of trust with the local communities and the target groups of the course, it is necessary to involve the local cooperatives that already act as a **bridge between the various realities of the production chain**. They are able to help educators and users to **better dialogue, creating a participatory course and encouraging the mutual exchange of skills and knowledge**.

• **Universities and local schools:** Local educational bodies can bring added value to the course as they can bring **local knowledge and foster user learning through proximity and trust.** In addition, their **knowledge of the territory, culture and traditions are valuable** to have a total vision and understand the right methodologies and activities to propose.

Materials

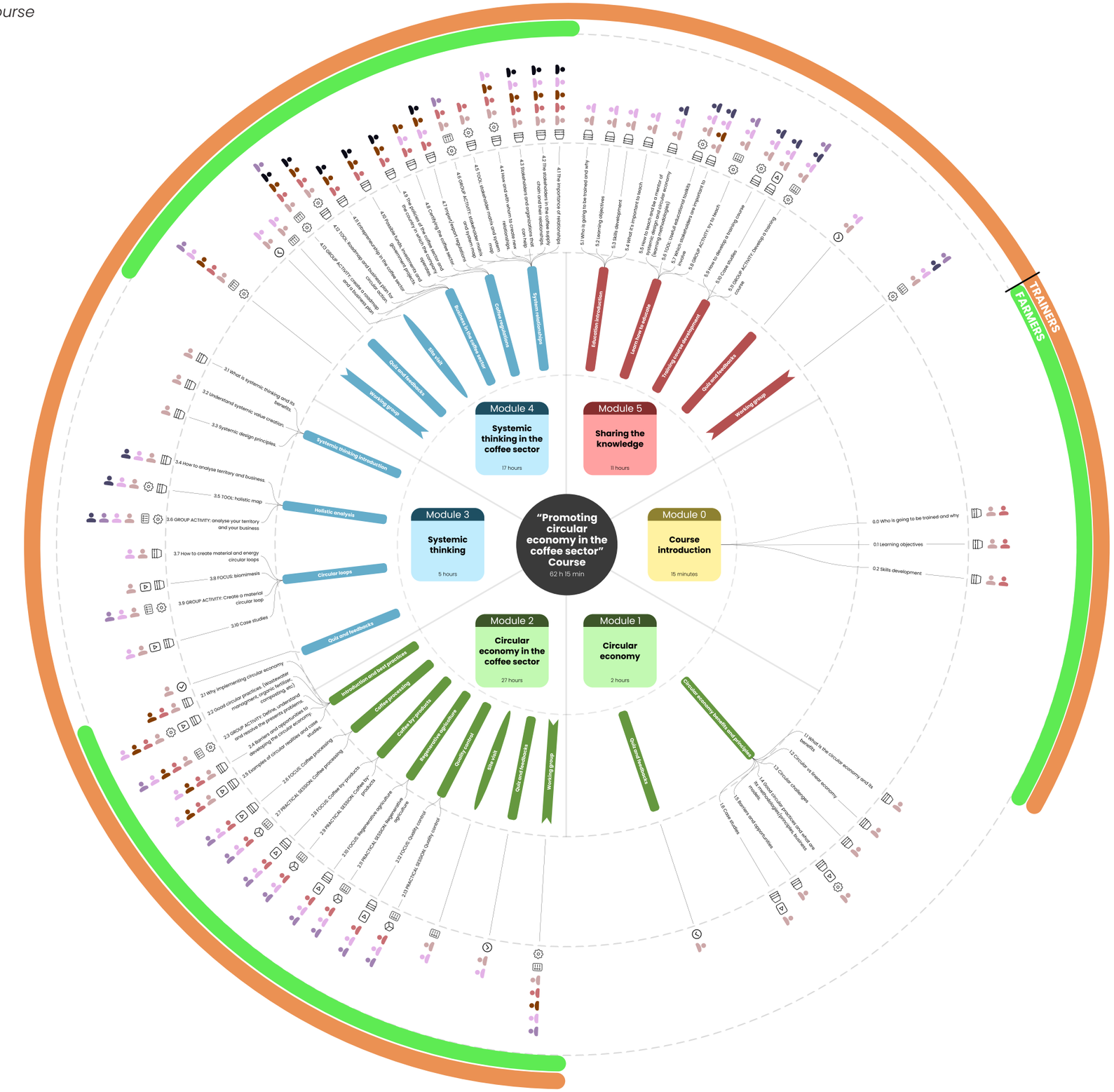
For the correct realization of the course were theorized materials to support the activities and lessons proposed. These materials are needed to facilitate teaching, learning and the proper conduct of activities in accordance with objectives and timing. In many of the activities, both theoretical and practical, it is essential that the material provided for the course is also left to the users so that they can benefit from the content and results even after the end of the course, Also increasing their opportunities to further disseminate this knowledge.

- **Slides:** A classic tool to support theoretical lectures and explain case studies and knowledge. Most lessons include slides to support.
- **Video:** Many lectures, both theoretical and practical, may need supporting videos to best describe the actions required and details of case studies, processes and methodologies.
- **Toolkits:** These types of materials are used in group activities to teach specific strategies and methodologies, while facilitating collaboration between users and soft skills. Materials that need to be carefully designed and may include maps, schematics and games. They need facilitators to help educators through the realization.
- **Activity Programme:** Having a schedule organized with the times and activities specifically is necessary to act in time and not forget important steps.
- **Test:** To ensure proper learning, correct the course with the right feedback and ensure free exchange of information at the end of the module a test has been inserted.
- **Materials:** Some activities in the circular economy module in the coffee sector involve the use of raw materials such as coffee, plants, water, agricultural tools and machinery.

Final representation

To have a complete view of the course with all its details a complexity map has been drawn. To optimise reading and space, it has been chosen to develop from a core, from which the contents branch. The closer you get to the circumference, the more detailed it is. (Fig. 17)

Fig. 17: Complexity map of the course



5.4 Examples of course outputs

In support of the course proposal, the thesis aims to propose a more concrete and tangible output to give an idea of how materials, methodologies, objectives and dialogue between educators and users can be, It was therefore decided to create informative and illustrative material aimed at providing all the elements necessary to support the lessons of the module and facilitate users' learning, Leaving the material to the users even after the course has taken place aims at increasing lifelong learning.

Choosing the output

Before going on to develop the output in detail, an analysis was carried out to choose which module and then lesson to work on. This analysis was carried out by proposing an evaluation according to **four criteria**:

• **Relevance in the course:** The thesis deals with the circular economy in the coffee sector and the need to give an education about it. In the proposed course, to provide a wider spectrum of knowledge so that the user reaches a complete and systemic degree of competence. So during the course there are more vertical lessons on the circular economy in the coffee sector, its education and introductory lessons, general or they could be said secondary, however dealing with important aspects, but

concerning the system that is around the circular economy.

• **Relevance in the thesis:** You should also consider how important the modules and lessons are to achieve the goals of the course. There are fundamental modules/lessons and others of secondary importance, which are proposed to the user for a more complete knowledge, but without which he would still come to know how to face the challenges of the circular economy.

• **Possibility to create an output:** Not all modules and lessons lend themselves to having support materials, some are lectures and theory, where you do not need toolkits, practical activities or exercises.

• **Level of innovation:** The proposed is not the first and will not be the last course that deals with circular economy, so many topics, methodologies and dynamics are already found in some offers already present. However, some modules and lessons are more distinctive and unique; they deal with topics and use approaches that are not yet fully taught and addressed in courses that have been identified in the research phase, can therefore bring a small degree of innovation and evolution in the field of education to the circular economy.

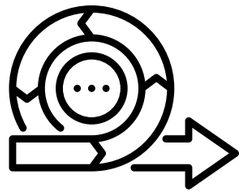
Module	Relevance in the course	Relevance in the thesis	Posibility to create an output	Level of innovation
Course introduction	●○○○○	●○○○○	●○○○○	●○○○○
Circular economy	●●○○○	●●○○○	●●○○○	●●○○○
Circular economy in the coffee sector	●●●●●	●●●●●	●●●●●	●●●○○
Systemic thinking	●●●○○	●●●○○	●●●○○	●●●●○
Systemic thinking in the coffee sector	●●●●○	●●●○○	●●●●○	●●●●○
Sharing the knowledge	●●●●○	●●●●○	●●●●○	●●●●●

Fig. 18: Module selection

All course modules were **rated from one to five** to bring out the module(s) most suitable for output creation. (Fig. 18) The operation brought out the modules of Circular economy in the coffee sector and that of Sharing the knowledge as outputs. Subsequently, the individual module lessons were supervised in detail, and after due reasoning, the lessons of Coffee by-products with regard to the Circular economy in the coffee sector module and Learn how to teach with regard to the Sharing the knowledge module were identified. From these two proposals, the lesson on **Coffee by-products** was chosen as the final case for the production of the output, as it was considered most relevant to the theme of the thesis and the will expressed during a meeting held with Lavazza's C4CEC contact person, Dr. Dario Toso.

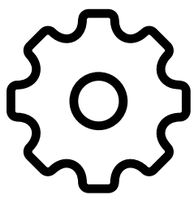
Once the lesson on which to go and develop the project output was chosen, what could be created was evaluated. There are several aspects that it would be useful to go into more depth to clarify how the proposed course operates and functions, some of these being the **relationships**, relationships and dialogue that goes on between educators and users and between users and users; it is also fair to go into the **methodologies** used during the course. Finally, **activity schedules** can be developed, how they are carried out, **toolkits** used, teaching materials and the **exercises** used to test the knowledge gained.

Relationship and dialogue between eduators and users

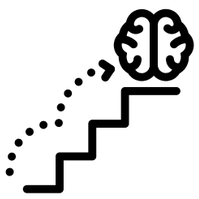


Methodologies

Activities programme



Toolkits



Exercices and tests

The output development

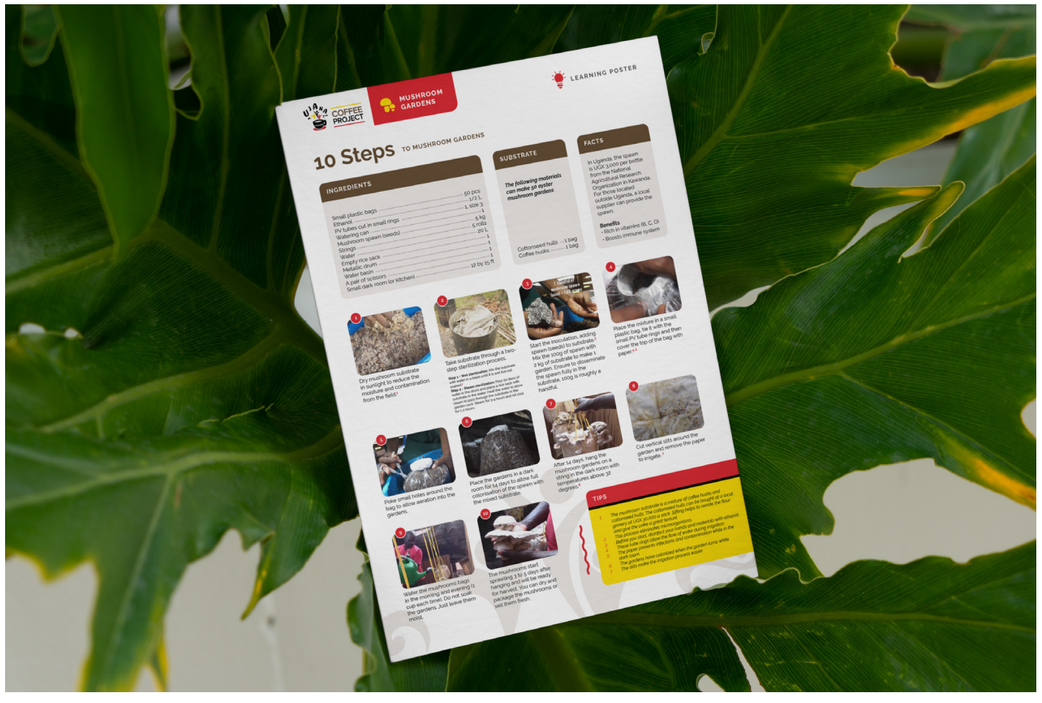
In light of these considerations and the lessons chosen, it was decided to design informational and illustrative cards dealing with the possible uses of waste derived from coffee production; to be given and left with the users for two main reasons: first, to create materials to **support them during the practical activities** included in the lessons; second, leaving the cards with the users even after the end of the course **facilitates the remembrance** of the circular practices and **helps the dissemination** of them; the fact that they are physical cards also makes it easier to use them, in case of lack of internet or devices.

Before going on to design the cards, an analysis of a very relevant **case study** was carried out to understand the state of the art and to go on to draft useful **guidelines** to best realize the output. The case study in question is the work done by **Sawa World**, an entity that is based in Uganda, but has implemented programs in numerous countries where young people live in poverty (less than 5 USD per day) and that works to find solutions at the local level that go to solve poverty and finally share and teach them to people through workshops, webinars, video tutorials and posters. It is precisely the posters made by Sawa World that are the references for the cards that this thesis proposes.

What is striking at first glance is the c**ommunication and graphic style** used in these posters: a

lively, colorful style that aims, in its **simplicity**, to attract attention and make the content as clear as possible. The presence of **explanatory images, box containers and practical tips** make the poster easy to read and compatible to a target audience that is not used to reading complex infographics. From these features it can be deduced that in order to speak to a target audience that is so far removed from the dynamics of graphic communication, one must aim for simplicity, but without falling into the trivial: a lively and appealing style invites and facilitates comprehension.

Source: from Sawa World (n.d.)



Having ascertained the style to be maintained in designing the cards, a reflection was posed at the content level: what can the proposed cards offer that is more than the case study or other offerings that can be found? Certainly it is important to provide, as in the case study, all the materials, processes, and tips for creating a new product by making the best use of coffee waste and not wasting it. The next step, proposed in the thesis, is to **provide further valuable information** to the user, both introductory and general, such as what kind of waste we are talking about, where it comes from and when it is produced, and more specific, such as a summary of all the various **chemical-nutritive characteristics** of the waste and how these underlie multiple **applications**, not just the one that is explored in more detail later.

Applications are then ranked according to the time and resources required to perform the activity, so as to provide an assessment of the ease of implementation and its **priority**. Indeed, it is this that will go into defining which applications are explained in depth in the card. A further step forward that one wants to bring and take into account in the creation of the cards is **systemic** in nature: one wants to propose useful advice to the user to go to work with the system around him, such as with whom to form relationships, where to find certain resources, or how to best use and sell the product created. (Fig. 19-20)

A few clarifications about this should be noted, however. The first is that, although there was the opportunity to see and touch the world of coffee cultivation in Quindio, a Colombian region famous for its coffee, and to receive an account of an experience lived in Africa, in close contact with the farmers; **the cards created are not intended to focus on any particular geographic area, but rather seek to be applicable and useful in any context they are proposed.**

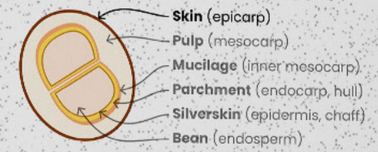
The second concerns the **criteria for evaluating the applications** (priority, ease, time, resources): it should be specified that the evaluation was made based on personal reasoning, video tutorials, research, and estimations and therefore cannot be considered totally objective, but the result also of a sensibility achieved through the practice of the discipline of systemic design.

Fig. 19: Coffee husk cards

Coffee Husk

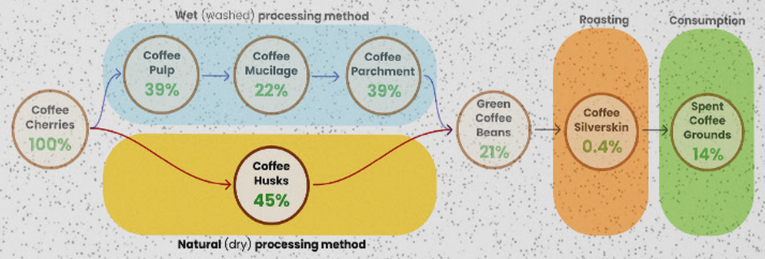
What is it?

Coffee husk is the skin of the coffee bean after it is dried.



When is it produced?

Coffee husk is produced during the natural (dry) processing method, and rapresent the 45% of the initial mass of the coffee cherry.



Characteristics

- Antioxidant
- Fermentable sugars and organic acids
- High fiber and complex carbohydrate content
- Rich in lignin and cellulose
- Biodegradable organic matter
- Natural pigments

Legend

P Priority **T** Time
E Ease **R** Resources

Good Medium Bad

Case studies

N.B. All applications are feasible with the right time and resources. With this classification we do NOT want to discourage making the most complex applications, but simply to highlight which ones are the most accessible.

Applications

- Cascara products for human consumption (fruit infusion, Qishr sweet tea in Ethiopia, distilled alcohol, ready to drink beverages) *Nossa Familia, Nestlè, Caskai* P E T R
- Gluten-free flour alternative *The Coffee Cherry, Sawa World* P E T R
- Animal feed *HKN EXIM Co.* P E T R
- Substrate for mushroom cultivation *Sawa World* P E T R
- Compost and fertilizer *Jacobs Douwe Egberts & Solidaridad, Melitta* P E T R
- Paper production *Kofi-Remix El Barrio, Conifer Handmades, Bluecat Paper, The Urban Nordic* P E T R
- Dyes *Batik Aksara Karo* P E T R

Animal feed

Natural food intended for feeding farm animals, formulated to provide the nutrients necessary for their growth, health and productivity.

From Coffee Husks produced during the dry processing method.

Materials & resources

To produce 100kg of feed:

- 30-40 kg of clean, dry coffee husk (from dry processing or parchment)
- Water
- 10-15 kg of molasses or fruit scraps (to reduce bitterness)
- Max 1 kg of urea (optional, as a nitrogen source)
- 40-50 kg of hay, straw, dried grass (for blending)
- Containers for mixing and fermenting (bins, plastic bags)

Warnings

1. Coffee husk by itself is not a complete food. It should be processed and mixed with other ingredients to reduce antinutritional compounds (such as caffeine and tannins) and make it digestible.
2. Do not feed to monogastrics (chickens, pigs) without more advanced industrial processing.
3. It is important to monitor the response of the animals and consult a local veterinarian/ zootechnician.

Steps

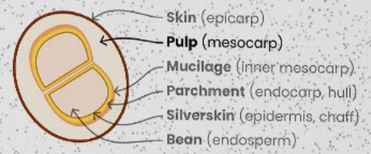
1. Make sure the coffee husk is well dried and clean of contamination. Chop it coarsely if there are too large pieces.
2. Soak the coffee husk in warm water for 24-48 hours, changing the water every 12 hours to remove caffeine and tannins. Finally drain and let drain.
3. Blends processed coffee husk with: Molasses (2-5%) to improve taste and provide energy; hay or straw (50-60%) to balance fiber; urea (1% max) only for adult ruminants to improve protein content; fruit scraps (10-20%) such as bananas and fruit peels to enrich nutritive value.
4. Put the mixture in tightly closed plastic bags or barrels. Let it ferment for 5-7 days in a shady environment. This process is optional ,but recommended to further reduce anti-nutritional compounds and improves digestibility.
5. After fermentation, you can re-dry the feed to keep it longer, or use it fresh within a few days.
6. Administer in small amounts as a supplement to the diet (no more than 15-20% of the total ration). This feed is suitable for cattle, sheep and goats.

Fig. 20: Coffee pulp cards

Coffee Pulp

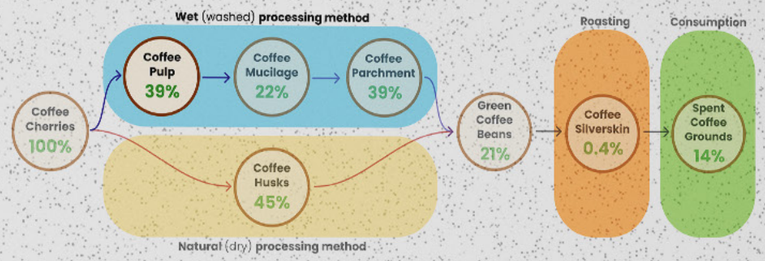
What is it?

Fibrous mucilaginous material obtained during the wet or dry processing.



When is it produced?

Coffee pulp is produced during the wet (washed) processing method, and rapresent the 39% of the initial mass of the coffee cherry.



Characteristics

- Antioxidant
- Antimicrobial
- Anti-inflammatory
- Pigment

Legend

P Priority **T** Time
E Ease **R** Resources

Good Medium Bad

Case studies

N.B. All applications are feasible with the right time and resources. With this classification we do NOT want to discourage making the most complex applications, but simply to highlight which ones are the most accessible.

Applications

- Cascara products for human consumption (fruit infusion, Qishr sweet tea in Ethiopia, distilled alcohol, ready to drink beverages)
  Nossa Familia, Nestlé, Caskai P E T R
- Cosmetics
  Sanam P E T R
- Nutraceuticals
  Pectcof, BioFortune Group, Department of Cauca P E T R
- Food industry
  Coffee Pixels P E T R
- Natural pesticide
  EEET ans RAS journals P E T R
- Paper production
  Kofi-Remix El Barrio, Conifer Handmades, Bluecat Paper, The Urban Nordic P E T R
- Dyes
  Batik Aksara Karo P E T R

Cascara

Dried peel of the coffee fruit that can be used to prepare aromatic infusions with a fruity and slightly sweet flavor.

From Coffee Pulp produced during the wet processing method.

Materials & resources

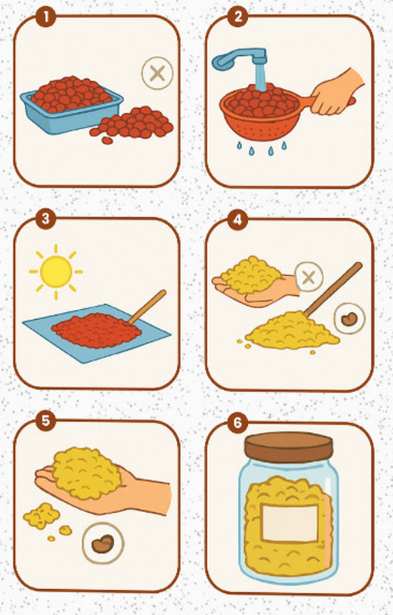
- Fresh coffee pulp (pulp removed from ripe cherries)
- Washing container
- Clean towels or mats for drying
- Sunny, well-ventilated area
- Solar dryer (optional but recommended in case of rain/humidity)
- Airtight containers for storage

Suggestions

- For consumption put 10g of cascara in 200ml hot water for 5-7 minutes, strain and enjoy as a fruity, sweet and slightly tart infusion.
- The cleaner and well-dried the cascara is, the higher its quality.
- It can also be an additional source of income for small growers (sold to stores, local markets, or exported).
- It can be flavored (e.g., with cinnamon, ginger, or orange peel).

Steps

1. Select coffee pulp: use only fresh, good quality pulp from ripe cherries, paper material that is too fermented, mold or dirty scraps.
2. Rinse the pulp thoroughly with clean water. Repeat the washing until excess sugars and impurities are removed. This is to prevent unwanted fermentation and bad odors.
3. Let the pulp drain on a sieve or in a colander for a few hours. The drier it is before drying, the better the process will succeed.
4. Place the pulp in a very thin layer (1-2 cm) on clean sheets or mats. Place it in a sunny but well-ventilated area. Then stir regularly (every 2-3 hours) to avoid mold. Leave the pulp to dry until the material is crisp and crumbly (may take 7-10 days depending on climate).
5. Check that the cascara is well dried, with no fermentation odor. Discard any blackened or moldy pieces.
6. Store cascara in airtight containers, away from light and moisture. Label with date of production.



Impacts and conclusions

Today, the coffee sector and its farmers face increasingly **large and difficult challenges**; coping with climate change, poverty and socio-economic dynamics requires sudden adaptations and paradigm shifts toward more **environmentally, socially and economically sustainable solutions**.

The research carried out by this thesis aims to shed light on these points and provide opportunities to be undertaken if this path is to be pursued. **Systemic design**, the **circular economy** can bring added value to the coffee sector and its stakeholders: during the thesis it was seen, thanks to the focuses and case studies presented, that it is possible to create sustainable realities and projects, improving workers' conditions and product quality, so the path went on to ask how to achieve these goals.

The key identified is **education**: through proper dissemination of the necessary knowledge and skills toward all stakeholders in the supply chain, especially those at the grassroots who suffer the most, the tools can be given that would enable users to improve their business. The search toward the right methodologies, notions and skills to develop resulted in the proposal of a **modular course** dedicated to farmers and those within cooperatives, centers or other stakeholders who are in close contact with farmers and support them.

The project proposal brought with the thesis ends with the creation of materials to support the course; **cards/posters** that tell about coffee by-products and how to use them to create something new, useful and sustainable.

The thesis in general has always tried to set goals and guidelines for itself, but it is certainly only one step toward achieving them; numerous **steps still need to be developed**: looking at a specific location and coordinating the course, stakeholders, and materials based on the analysis of the local context; developing the educational output entirely; and finally, being able to test it with a real user group, following the various lessons, hands-on activities, and feedback is certainly important to reshape the project in the right direction. This in time would begin to bring the first impacts on the local coffee-growing communities.

On the **environmental side**, the adoption of circular and sustainable practices would increase the fertility of the fields and the biodiversity of the environment, factors that would facilitate other types of crops besides coffee in the future. On the **economic side**, thanks to widespread knowledge, new business models can be developed from coffee waste, and thanks to a more comprehensive and conscious view of the system, valuable relationships can be established. Factors that would also go into the **social sphere**, with the possibility of making strides in combating poverty, health problems and social injustice.

In conclusion, the thesis also wants to highlight the power and importance of systemic design and its processes; analyzing the whole as a whole, trying not to leave out anything important, makes it possible to arrive, within the limits of the case, at a coherent and effective output. Certainly, the path is still long, but the tools are there to carry it forward in the best way.

Source: Eurostat (2025)

Bibliography and sitography

Alemayehu, Y. A., Leta, S., & Tirfie, T. A. (2019). Management options for coffee processing wastewater. A review. Journal of Material

Barreto Peixoto, J. A., Silva, J. F., Oliveira, M. B. P., & Alves, R. C. (2022). Sustainability issues along the coffee chain: From the field to the cup. Comprehensive Reviews in Food Science and Food Safety, 22(1), 287–332. https://doi.org/10.1111/1541-4337.13069

Bianchi, G., Pisiotis, U., Cabrera Giraldez, M. (2022). GreenComp – Il quadro europeo delle competenze in materia di sostenibilità. Bacigalupo, M., Pu nie, Y. (a cura di), EUR 30955 IT, Ufficio delle pubblicazioni dell'Unione europea, Lussemburgo; ISBN 978-92-76 53202-6, doi:10.2760/172626, JRC128040.

Bistagnino, L. (2011). Systemic Design: Designing the Productive and Environmental Sustainability. Bra (CN), Italy: Slow Food Editore.

Buster Brew Coffee. (n.d.). Coffee Processing Methods. https://busterbrewcoffee.com/pages/coffee-processing-methods

CBI. (2021, August 11). The European market potential for certified coffee. CBI. https://www.cbi.eu/market-information/coffee/certified-coffee/market-potential

CBI. (2022, December 23). What is the demand for coffee on the European market? CBI. https://www.cbi.eu/market-information/coffee/what-demand

Caffe Roen. (2024, August 14). Paesi produttori di caffè: da dove viene il migliore? https://www.cafferoen.com/it/blog/paesi-produttori-di-caffe-quali-sono

Celli, S. (2017, January 18). Tutte le certificazioni del caffè verde - 1°parte. Il caffè espresso italiano. https://www.ilcaffeespressoitaliano.com/2017/tutte-le-certificazioni-del-caffe-verde-1parte/

Cellini Caffè. (n.d.). Le fasi di tostatura del caffè. https://cellinicaffe.com/blogs/coffee-vibes/le-fasi-di-tostatura-del-caffe

Center for Circular Economy in Coffee (C4CEC). (2024). 2024 Summary Booklet, "The sustainable future of coffee: a year with the Center for Circular Economy in Coffee". https://www.circulareconomyincoffee.org/wp-content/uploads/2024/12/The-Sustainable-Future-of-Coffee-A-Year-with-the-Center-for-Circular-Economy-in-Coffee.pdf

Chief. (2023, November 5). Semi-Washed vs. Fully Washed Coffee, Which One is Better? Coffee Arks. https://coffeearks.com/2023/11/05/semi-washed-vs-fully-washed-coffee- which-one-is-better/

Circle Economy. (2024). The circularity gap report 2024. https://www.circularity-gap.world/2024#download

Coffee drying. (n.d.). http://www.coffeeresearch.org/agriculture/drying.html

Coffee processing methods – drying, washing or honey? (n.d.). Paulig - Barista Institute. https://www.baristainstitute.com/blog/jori-korhonen/january-2020/coffee-processing- methods-drying-washing-or-honey

Dell'Anna, A. (2024, October 14). Quali sono i Paesi dell'Ue che producono e importano più caffè. Euronews. https://it.euronews.com/my-europe/2024/10/14/quali-sono-i-paesi-dellue-che-producono-e-importano-piu-caffe

DRWakefield. (2022, September 16). The difference between Fully Washed, Washed and Semi-Washed Coffees. https://drwakefield.com/news-and-views/the-difference-between-fully-washed-washed-and-semi-washed-coffees/

European Coffee Federation. (2024, May). European Coffee Report 2023/2024. https://www.ecf-coffee.org/wp-content/uploads/2024/07/

European-Coffee-Report-2023-2024.pdf

FootPrint Africa. (n.d.). Roots of the Future The businesses regenerating Africa's soils. FootPrint Africa. https://ifootprintsafrica.co/wp-content/uploads/2025/01/RegenerativeAgricultureReport-131-1.pdf

Guevara, J. (2017, July 6). Hand-Picked vs Mechanized Coffee Harvesting. Perfect Daily Grind. https://perfectdailygrind.com/2017/07/hand-picked-vs-mechanized-coffee-harvesting/

IDH. (2022). IDH Coffee Farmer Income Resilience Program: baseline report. https://www.idhsustainabletrade.com/uploaded/2022/05/2022111-IDH-Baseline-Report-V2-gecomprimeerd.pdf

IDH. (2024). Lessons Learned and Key Success Factors for African Agribusinesses working with Smallholder Farmers. [Video]. Youtube. https://www.youtube.com/watch?v=uxOgVt1LRLY

International Coffee Organization (2023). Coffee development report 2022-2023, Beyond Coffee, Towards a Circular Coffee Economy Overview. ICO. https://www.icocoffee.org/documents/cy2024-25/coffee-development-report-2022-23.pdf

International Trade Centre (2021). The Coffee Guide. ITC, Geneva. https://www.intracen.org/file/itccoffee4threport20210930webpagespdf

James Hoffmann. (2022, June 30). Coffee Certifications Explained [Video]. Youtube. https://youtu.be/PmwoSqg0dqI?si=e2pWitUNjYeNKONB

Kolb, D. A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Englewood Cliffs, N.J.: Prentice-Hall

Leahy, C. (2018, August 7). Shade grown coffee shrinking as a proportion of global coffee production. UT News. https://news.utexas.edu/2014/04/16/global-production-of-shade-grown-coffee-shrinking/

Meadows, D. H. (2008). Thinking in Systems: A Primer (1st ed.). Earthscan.

Mezirow, J. (2000). Learning as transformation: critical perspectives on a theory in progress. San Francisco, Jossey-Bass.

Moreno Bastidas, L. T., Luna Trimmiño, J. C., & Riaño Pedraza, L. T. (2023). Mas què cafè.

Peruccio, P.P., Menzardi, P., Vrenna, M. (2019). Transdisciplinary knowledge: A systemic approach to design education. In N.A.G.Z. Börekçi, D. O. Koçyıldırım, F. Korkut, D. Jones (eds.). Proceedings DRS Learn X Design 2019: Insider Knowledge (pp. 17-23). Ankara, Turchia: METU Department of Industrial Design. DOI: 10.21606/learnxdesign.2019.13064

Q graders. (n.d.). https://www.coffeeinstitute.org/certification/people/q-graders

Rojas Garzòn, M. A. (2024). The coffee value circle.

Rovera, F. (2020). Educare alla circolarità.

Rushton, D. (n.d.). Map of the Month: Bringing Smallholder Coffee Farmers out of Poverty. https://carto.com/blog/enveritas-coffee-poverty-visualization

Sai Platform. (2023). Regenerating Together programme: a global framework for regenerative agriculture. https://saiplatform.org/wp-content/uploads/2023/09/sai-platform_-regenerating-together_september-2023-1.pdf

Shanker, S., Sharma, H., & Barve, A. (2021). Analyzing the critical success factors and the risks associated with third-party logistics in the food supply chain: a

case of coffee industry. Journal of Advances in Management Research, 19(2), 161–197. https://doi.org/10.1108/jamr-11-2020-0307

Siles P, Cerdán CR and Staver C (2022) Smallholder Coffee in the Global Economy—A Framework to Explore Transformation Alternatives of Traditional Agroforestry for Greater Economic, Ecological, and Livelihood Viability. Front. Sustain. Food Syst. https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2022.808207/full

Smith, B. (202, March 9). Equal Origins launches tool to empower female coffee producers. Coffee Intelligence. https://intelligence.coffee/2022/03/equal-origins-launches-tool-to-empower-female-coffee-producers/
Steampower. (n.d.). Quali sono le certificazioni nel settore del caffè? https://steampower.it/certificazioni-nel-settore-caffe/

The Fairtrade Foundation. (2023, August 23). Coffee farmers - Fairtrade Foundation. Fairtrade Foundation. https://www.fairtrade.org.uk/Farmers-and-Workers/Coffee/

Thurston, R. H., Morris, J., & Steiman, S. (2014). Coffee: a comprehensive guide to the bean, the beverage, and the industry.

Umaran, T., Perdana, T., Kurniadie, D., & Parikesit, P. (2022). Co-Creation approach in designing a sustainable coffee supply chain (a case in Bandung Regency, West Java, Indonesia). Sustainability, 14(1), 476. https://doi.org/10.3390/su14010476

UNESCO. (2017). Education for Sustainable Development Goals. Learning Objectives. Paris, France: United Nations Educational, Scientific and Cultural Organization, © UNESCO, ISBN 978-92-3-100209-0.

Van Keulen, M., & Kirchherr, J. (2018). The Implementation of the Circular Economy in the Coffee Value Chain: Insights from Action Research.

Appendices

Toolkits

Even more toolkits, strategies, and canvases have been collected to deepen the design processes, from concept creation and user collaboration to system management. These toolkits are proposed to be clear about what tools could be brought to support complex educational output.

Danish Design Center

Align on Your Participatory Approach

https://www.designkit.org/methods/align-participatory-approach.html

Participatory design involves collaboration with individuals most affected by a problem in order to come up with just, collective solutions. It's centered on collective decision-making and challenging oppressive structures. Approaches vary from consultation with communities to deeply involving them in decision-making, impacting the way projects make decisions on priorities and engage with them. It results in authentic conversation between stakeholders and the design team.

Peers Observing Peers

https://www.designkit.org/methods/peers-observing-peers.html

During the Inspiration Phase, work with and involve directly the people you are designing for and allow them to conduct research themselves. This can bring out insights that are obscured due to social or gender dynamics or sensitive topics. Co-creation with them and facilitating tools to express their perspectives promotes learning and co-creation at a more fundamental level.

Recruiting Tools

https://www.designkit.org/methods/recruiting-tools.html

Before engaging with your target audience, have a clear plan of whom to speak to, what questions to ask, and what data is needed. Planning and tracking ensure balanced sampling of experts, laypeople, genders, ethnicities, classes, and a range of opinions.

Power Mapping

https://www.designkit.org/methods/power-mapping.html

It is critical to understand how different kinds of power exist within the stakeholders of a project. There are powers that need to be with the individuals who are nearest to the issue, and where it is not then there it needs to be redistributed. Power Mapping can help you break down these dynamics. This tool enables self-reflection and collective action; once you understand how power exists on your project, you are able to take action to redistribute it.

Immersion

https://www.designkit.org/methods/immersion.html

The Inspiration Phase aims to understand the lives of the people you are designing for by interacting with them directly in their environment. Methods include shadowing, observing decision-making situations, and watching activities, such as cooking or socializing, to gather rich information.

Collaborative Synthesis

https://www.designkit.org/methods/collaborative-synthesis.html

Bringing in co-designers or other stakeholders into the research synthesis is an incredible method of actually bringing to the surface vital themes and to identify the most significant and fresh ideas and opportunities. Involving community co-designers in the synthesis raises the voice and perspective of those who are most directly affected by the issue. Use the following steps to structure this collaborative work and amplify lived experience.

Explore Your Theory of Change

https://www.designkit.org/methods/explore-your-theory-of-change.html

A Theory of Change helps map how different parts of a solution contribute to the desired outcome. It involves defining and refining assumptions about the solution's effectiveness. It is an effective design tool, shaping the choice of which prototypes and ideas to move forward with.

Headlines from the Future

https://www.designkit.org/methods/future-headlines.html

Apply this method to motivate your project stakeholders to work towards demanding goals. This creative exercise stimulates thinking beyond existing constraints to envision perfect success. It is particularly useful for team goal-setting and investigating aspirations and anxieties about a project. Consider the implications if nothing changes.

Create Frameworks

https://www.designkit.org/methods/create-frameworks.html

A Framework is a visual description of a system, and a great way of sensing data. The toolkit works to create focus on key relationships and inform your strategy.

Co-Creation Session

https://www.designkit.org/methods/co-creation-session.html

Co-Design Session is active engagement with the target public during the process of design. Participants work in partnership to generate services, build communities, or shape elements such as names and logos. Such methodology encourages people-owned solutions and avails richer understanding to fine-tune your solution.

Integrate Feedback and Iterate

https://www.designkit.org/methods/integrate-feedback-and-iterate.html

Feedback from your target audience is at the core of human-centered design. Upon finishing the learning phase in Inspiration, proceed to the Ideation Phase by unveiling prototypes, collecting feedback, and refining your ideas. This process increases the likelihood that your solution will be embraced and adopted.

Optimize and Adapt for Scale

https://www.designkit.org/methods/optimize-and-adapt-for-scale.html

Scaling often involves some kind of optimization or realignment. New customers bring new demands, new partners bring new strengths, and new investors bring new metrics for performance. It is often

a matter of compromise between maintaining your human-centered solution and being lean enough to scale. Repeated cycles of research-and-prototyping-and-optimization are required for continuing to fine-tune.

Explore Scalability

https://www.designkit.org/methods/explore-scalability.html

After you have solidified your solution, you can consider possibilities for growth or scaling. Growth requires proportionate investment in resources to increase reach or outcomes, but scaling seeks exponential payoff with minimal incremental investment. Stakeholder alignment around goals and definitions of success is essential. Though scaling is complex and long-term, there are tools that you can use to identify and address early-stage issues.

Build Partnerships

https://www.designkit.org/methods/build-partnerships.html

During the Implementation Phase, you may have to work with several partners. Identify the funding partners required through the Funding Strategy and Sustainable Revenue methods. Utilize the Business Model Canvas and Capabilities Quicksheet to chart the entire process of bringing your idea to the marketplace. The major objective is to determine the type of partners to look for and begin building relationships with them.

Monitor and Evaluate

https://www.designkit.org/methods/monitor-and-evaluate.html

Before you launch your solution, you need to have a plan to measure and determine if it will be successful. The measurement process depends on what you are aiming for; some are straightforward, like monetary success, but others, like a change in behavior or adoption of services, require more sophisticated measures.

Keep Getting Feedback

https://www.designkit.org/methods/keep-getting-feedback.html

Obtaining feedback from your target audience is an ongoing exercise and critical in moving your idea forward. While you proceed to carry out live prototypes, test your idea through pilot, and define measures of success, team members responsible for obtaining feedback from influential partners as well as from the people that you are endeavoring to support are required.

Danish Design Centre

Circular Value Chain Tool

https://ddc.dk/tools/the-circular-value-chain/

Work with your value chain stakeholders to provide an overview of your combined activities, participants, and resources. Leverage their knowledge to develop concepts for circular activities in your value chain.

Ecosystem Mapping

https://ddc.dk/tools/ecosystem-mapping/

This is a tool utilized to provide an overview of the actors and potential participants on your platform and how they connect to your future platform. This is essential in an effort to build and mobilize an existing and new actor ecosystem within a platform-based solution. Unlike the traditional stakeholder mapping, this tool focuses on the motivations, resources, and capabilities that will be beneficial for the entire ecosystem.

Value System Mapping

https://ddc.dk/tools/value-system-mapping/

It's a tool that helps you to uncover and map the ecosystem of your business, project, or platform by making interaction between yourself, your stakeholders, and those with whom they're in contact visible. It shows who's trading value with whom and what value is traded. Once you've completed it, showing the map to stakeholders or colleagues will reveal connections you didn't previously realize existed.

Circular Behavior Toolkit

https://ddc.dk/tools/the-circular-behavior-toolkit/

The Circular Behavior Toolkit is a starting point for the intersecting disciplines of circular economy and behavioral design. Its aim is to help you begin to work actively with the human factor in a circular context.

Circular Design Toolkit

Big Picture Setting

https://circulardesign.tools/

This exercise is intended to express the firm's present vision and future mission. Through an analysis of environmental megatrends and sustainability objectives, it defines needed actions and steps, and identifies possible competitive benefits.

Life Cycle Model

https://circulardesign.tools/

It's asking the correct question that brings about change. The two works uncover needs and questions for all phases of the life cycle and point to many opportunities to build positive influence and circularity.

Life Cycle Discussion

https://circulardesign.tools/

The right question is the beginning of change. The canvas identifies needs at every step of the life cycle. Asking the right questions, you can discover and create a lot of opportunities to maximize positive impact and circularity.

Life Cycle Design

https://circulardesign.tools/

Develop an end-to-end product-service system and identify the gaps in the loops. Consider how to close the loops, what the operating needs are to be, which companies can provide the solutions, and how these will profit.

Exemples of course outputs

Below is the Sawa World case study and subse-quently the cards developed to support the course. They have been included for better understanding and deeper reading.

Sawa World case study

UJANA COFFEE PROJECT

MUSHROOM GARDENS

LEARNING POSTER

10 Steps TO MUSHROOM GARDENS

INGREDIENTS

Small plastic bags	50 pcs
Ethanol	1/2 L
PV tubes cut in small rings	1, size 3
Watering can	1
Mushroom spawn (seeds)	5 kg
Strings	5 rolls
Water	20 L
Empty rice sack	1
Metallic drum	1
Water basin	1
A pair of scissors	1
Small dark room (or kitchen)	12 by 15 ft

SUBSTRATE

The following materials can make 50 oyster mushroom gardens

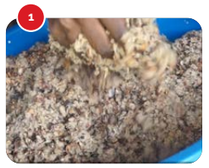
Cottonseed hulls	1 bag
Coffee husks	1 bag

FACTS

In Uganda, the spawn is UGX 3,000 per bottle from the National Agricultural Research Organization in Kawanda. For those located outside Uganda, a local supplier can provide the spawn.

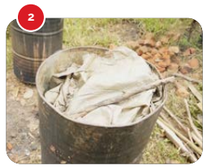
Benefits
- Rich in vitamins (B, C, D)
- Boosts immune system

1



Dry mushroom substrate in sunlight to reduce the moisture and contamination from the field.[1]

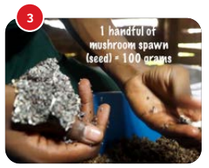
2



Take substrate through a two-step sterilization process.

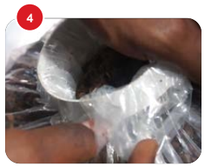
Step 1 - Wet sterilization: Mix the substrate with water in a basin until it is wet but not soaked.[2]
Step 2 - Steam sterilization: Pour 20 liters of water in the drum and place a rice sack with substrate in the water. Heat the water to allow steam to pass through the substrate in the garden sack. Steam for 3-4 hours and let cool for 1-2 hours.

3



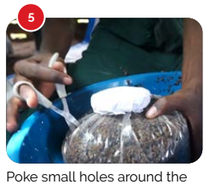
Start the inoculation, adding spawn (seeds) to substrate.[3] Mix the 100g of spawn with 2 kg of substrate to make 1 garden. Ensure to disseminate the spawn fully in the substrate. 100g is roughly a handful.

4



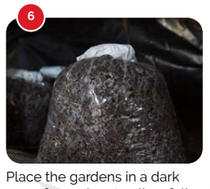
Place the mixture in a small plastic bag, tie it with the small PV tube rings and then cover the top of the bag with paper.[4, 5]

5



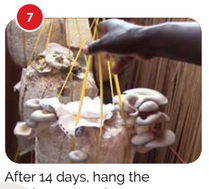
Poke small holes around the bag to allow aeration into the gardens.

6



Place the gardens in a dark room for 14 days to allow full colonisation of the spawn with the mixed substrate.

7



After 14 days, hang the mushroom gardens on a string in the dark room with temperatures above 32 degrees.[6]

8

Cut vertical slits around the garden and remove the paper to irrigate. [7]

9

Water the mushrooms bags in the morning and evening (1 cup each time). Do not soak the gardens. Just leave them moist.

10

The mushrooms start sprawling 3 to 5 days after hanging and will be ready for harvest. You can dry and package the mushrooms or sell them fresh.

TIPS

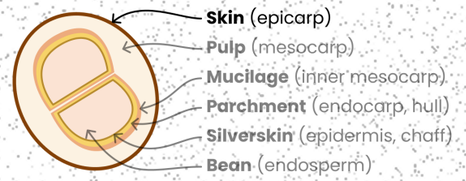
1. *The mushroom substrate is a mixture of coffee husks and cottonseed hulls. The cottonseed hulls can be bought at a local ginnery at UGX 30,000 a sack. Sifting helps to aerate the flour and give the cake a great texture.*
2. *This process eliminates microorganisms.*
3. *Before you start, disinfect your hands and materials with ethanol.*
4. *These tube rings allow the flow of water during irrigation*
5. *The paper prevents infections and contamination while in the dark room.*
6. *The gardens have colonized when the garden turns white.*
7. *The slits make the irrigation process easier.*

Coffee by-products cards

Coffee Husk

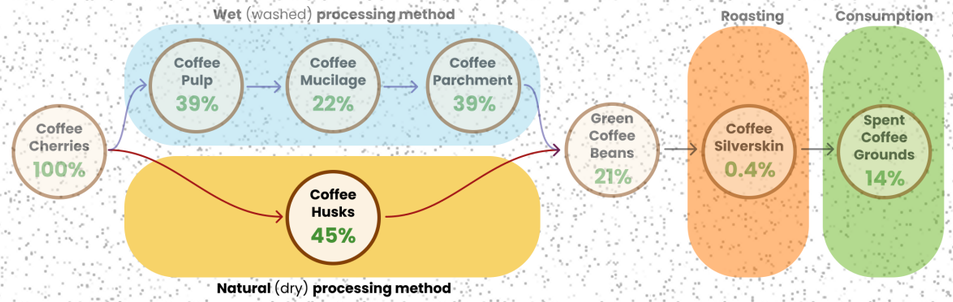
What is it?

Coffee husk is the skin of the coffee bean after it is dried.



When is it produced?

Coffee husk is produced during the natural (dry) processing method, and rapresent the 45% of the initial mass of the coffee cherry.



Characteristics

- Antioxidant
- Fermentable sugars and organic acids
- High fiber and complex carbohydrate content
- Rich in lignin and cellulose
- Biodegradable organic matter
- Natural pigments

Legend

P Priority **T** Time
E Ease **R** Resources

Good Medium Bad

Case studies

N.B. All applications are feasible with the right time and resources. With this classification we do NOT want to discourage making the most complex applications, but simply to highlight which ones are the most accessible.

Applications

- Cascara products for human consumption (fruit infusion, Qishr sweet tea in Ethiopia, distilled alcohol, ready to drink beverages)
  Nossa Familia, Nestlè, Caskai P E T R
- Gluten-free flour alternative
  The Coffee Cherry, Sawa World P E T R
- Animal feed
  HKN EXIM Co. P E T R
- Substrate for mushroom cultivation
  Sawa World P E T R
- Compost and fertilizer
  Jacobs Douwe Egberts & Solidaridad, Melitta P E T R
- Paper production
  Kofi-Remix El Barrio, Conifer Handmades, Bluecat Paper, The Urban Nordic P E T R
- Dyes
  Batik Aksara Karo P E T R

Animal feed

Natural food intended for feeding farm animals, formulated to provide the nutrients necessary for their growth, health and productivity.

From Coffee Husks produced during the dry processing method.

Materials & resources

To produce 100kg of feed:

- 30-40 kg of clean, dry coffee husk (from dry processing or parchment)
- Water
- 10-15 kg of molasses or fruit scraps (to reduce bitterness)
- Max 1 kg of urea (optional, as a nitrogen source)
- 40-50 kg of hay, straw, dried grass (for blending)
- Containers for mixing and fermenting (bins, plastic bags)

Warnings

1. Coffee husk by itself is not a complete food. It should be processed and mixed with other ingredients to reduce antinutritional compounds (such as caffeine and tannins) and make it digestible.
2. Do not feed to monogastrics (chickens, pigs) without more advanced industrial processing.
3. It is important to monitor the response of the animals and consult a local veterinarian/ zootechnician.

Steps

1. Make sure the coffee husk is well dried and clean of contamination. Chop it coarsely if there are too large pieces.

2. Soak the coffee husk in warm water for 24-48 hours, changing the water every 12 hours to remove caffeine and tannins. Finally drain and let drain.

3. Blends processed coffee husk with: Molasses (2-5%) to improve taste and provide energy; hay or straw (50-60%) to balance fiber; urea (1% max) only for adult ruminants to improve protein content; fruit scraps (10-20%) such as bananas and fruit peels to enrich nutritive value.

4. Put the mixture in tightly closed plastic bags or barrels. Let it ferment for 5-7 days in a shady environment. This process is optional ,but recommended to further reduce anti-nutritional compounds and improves digestibility.

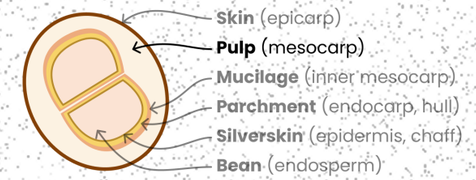
5. After fermentation, you can re-dry the feed to keep it longer, or use it fresh within a few days.

6. Administer in small amounts as a supplement to the diet (no more than 15-20% of the total ration). This feed is suitable for cattle, sheep and goats.

Coffee Pulp

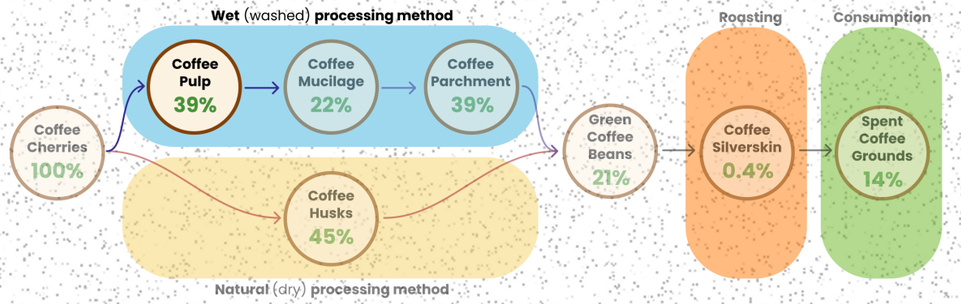
What is it?

Fibrous mucilaginous material obtained during the wet or dry processing.



When is it produced?

Coffee pulp is produced during the wet (washed) processing method, and rapresent the 39% of the initial mass of the coffee cherry.



Characteristics

- Antioxidant
- Antimicrobial
- Anti-inflammatory
- Pigment

Legend

P Priority **T** Time
E Ease **R** Resources

Good Medium Bad

Case studies

N.B. All applications are feasible with the right time and resources. With this classification we do NOT want to discourage making the most complex applications, but simply to highlight which ones are the most accessible.

Applications

- Cascara products for human consumption (fruit infusion, Qishr sweet tea in Ethiopia, distilled alcohol, ready to drink beverages)
  Nossa Familia, Nestlè, Caskai P E T R
- Cosmetics
  Sanam P E T R
- Nutraceuticals
  Pectcof, BioFortune Group, Department of Cauca P E T R
- Food industry
  Coffee Pixels P E T R
- Natural pesticide
  EEET ans RAS journals P E T R
- Paper production
  Kofi-Remix El Barrio, Conifer Handmades, Bluecat Paper, The Urban Nordic P E T R
- Dyes
  Batik Aksara Karo P E T R

Cascara

Dried peel of the coffee fruit that can be used to prepare aromatic infusions with a fruity and slightly sweet flavor.

From Coffee Pulp produced during the wet processing method.

Materials & resources

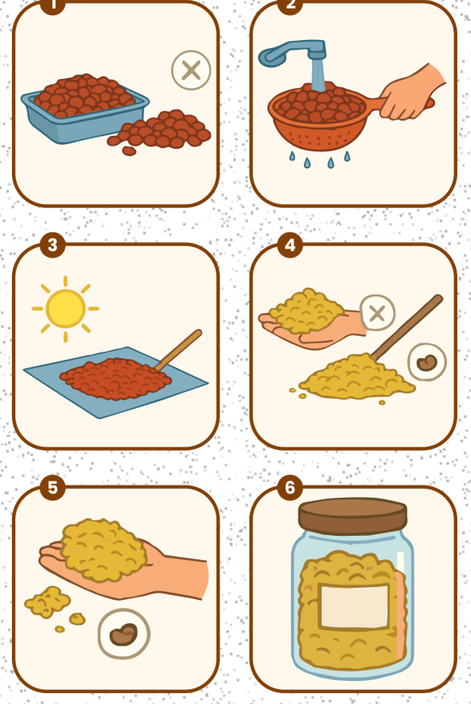
- Fresh coffee pulp (pulp removed from ripe cherries)
- Washing container
- Clean towels or mats for drying
- Sunny, well-ventilated area
- Solar dryer (optional but recommended in case of rain/humidity)
- Airtight containers for storage

Suggestions

- For consumption put 10g of cascara in 200ml hot water for 5-7 minutes, strain and enjoy as a fruity, sweet and slightly tart infusion.
- The cleaner and well-dried the cascara is, the higher its quality.
- It can also be an additional source of income for small growers (sold to stores, local markets, or exported).
- It can be flavored (e.g., with cinnamon, ginger, or orange peel).

Steps

1. Select coffee pulp: use only fresh, good quality pulp from ripe cherries, paper material that is too fermented, mold or dirty scraps.
2. Rinse the pulp thoroughly with clean water. Repeat the washing until excess sugars and impurities are removed. This is to prevent unwanted fermentation and bad odors.
3. Let the pulp drain on a sieve or in a colander for a few hours. The drier it is before drying, the better the process will succeed.
4. Place the pulp in a very thin layer (1-2 cm) on clean sheets or mats. Place it in a sunny but well-ventilated area. Then stir regularly (every 2-3 hours) to avoid mold. Leave the pulp to dry until the material is crisp and crumbly (may take 7-10 days depending on climate).
5. Check that the cascara is well dried, with no fermentation odor. Discard any blackened or moldy pieces.
6. Store cascara in airtight containers, away from light and moisture. Label with date of production.



I would again like to thank my family, friends and Camila for supporting and helping me through this journey, without them everything would have been more difficult. Thanks also to Professor Silvia Barbero and Dr. Fabiana Rovera for their professionalism, advice and patience.

Arturo Barina