MSINO026 - PRODUCT, TECHNOLOGY AND OPERATION MANAGEMENT

THE FUTURE OF FOOD - NESTLÉ -

TEAM F

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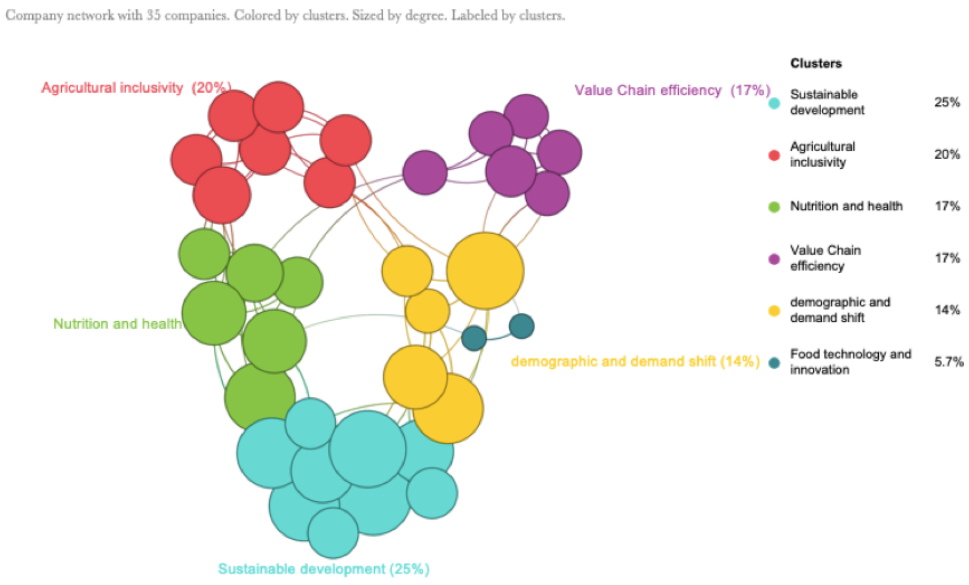
1. Introduction

Nestlé is the world's largest food and beverages company whose core business is the production of powdered and liquid beverages (22% of revenues)[1] followed by Nutrition and Health science (17% of revenue)[2], water[3], dairy, confectionary, Pet Care, etc. To offer this diverse value proposition, Nestlé has 440 factories in 183 countries and manages 2000+ brands.

Above its omnipresence in the food industry, Nestlé was recently involved in various scandals, including child labour and water usage, threatening its sales. Nestlé's PESTEL analysis[4] revealed that people are increasingly paying attention to the health effects and sustainability of what they consume. Furthermore, Nestlé must adapt to climate regulations, particularly the GREEN DEAL which strives to make the EU climate neutral by 2050[5].

Besides governmental regulations, tackling the challenges of the future of food is an essential path for Nestlé that purchases more than 1% of the agricultural production and works with 165,000 direct suppliers and 695,000 farmers worldwide. Furthermore, Nestlé's strong link with all branches of the food industry makes the company more vulnerable to the challenges of the future of food, but also makes it a potential gamechanger. This report will thus illustrate what challenges the food industry is facing and how Nestlé can benefit from taking action to ensure a sustainable future for food.

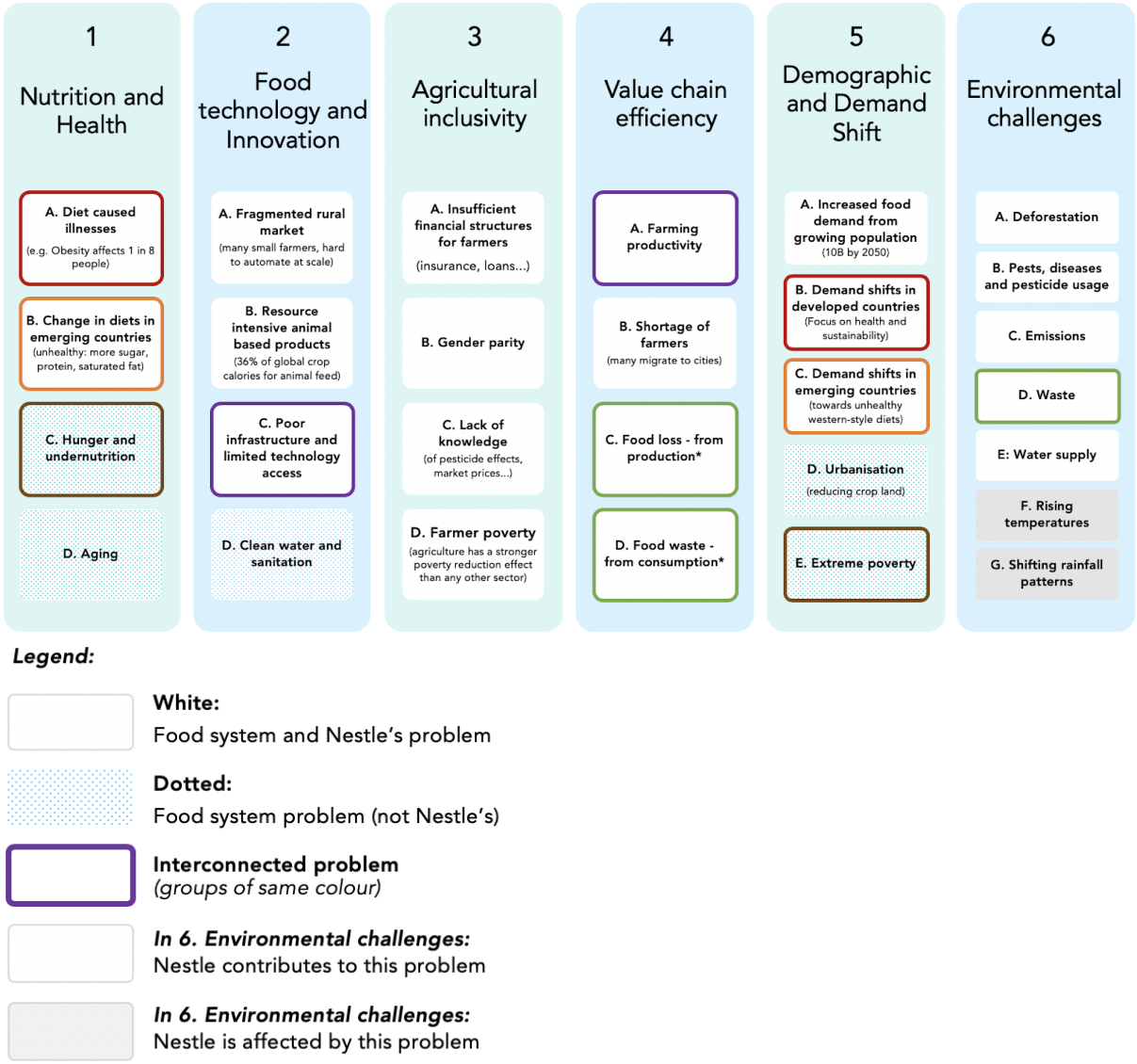
The challenges and trends of Nestlé and its main competitors[6]



[1] Calculated by Author.
[2] Calculated by Author.
[4] Appendix 1.

2. Problems facing the food system

a. Global food system problem map



The above diagram categorises the full range of problems facing the global food system. These problems are clustered in 6 main categories which represent the key themes from the WEF's Future of Food dynamic briefing[7].

As Nestlé covers nearly all food and beverage categories, it faces most problems identified. However, problems in dotted boxed are considered loosely connected to Nestlé. Therefore, Nestlé's problem footprint consists only of the white boxed[8] .

[8] Appendix 2.

As key links between problems of different categories were identified, the interconnected problem groups are outlined in the same colour[9] . For example, problem 2C leads to 4A as productivity of farmers largely depends on the infrastructure and technology they have access to.

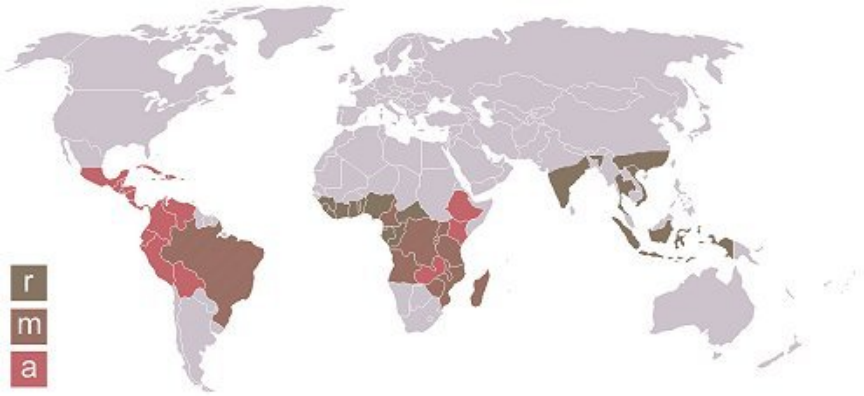
b. Problems in Value Chain (VC) efficiency and environmental challenges

This report focuses on parts 4 (VC efficiency) and 6 (Environmental challenges) of the problem map to provide an in-depth analysis of key problems and their link to Nestlé[10].

VC efficiency:

- Farming productivity (4A)

Nestlé buys many of its main commodities (e.g. coffee, cocoa...) from suppliers from developing countries (e.g. in Africa, Latin America and South Asia)[11] as they offer cheaper prices and benefit from appropriate climate conditions. However, most of these suppliers do not have access to suitable infrastructure, nor the funds for better equipment (27% of coffee farmers living in poverty[12]). Additionally, low internet penetration (44% in sub-Saharan Africa[13]) is seen as the biggest obstacle to tech-based farming as it hinders the use of smart tools like IoT.



Coffee belt countries consist of developing countries across Latin America, Africa and South Asia.

- Shortage of farmers (4B)

By 2050, the UN projects that 2/3 of the world's population will live in urban areas[14], reducing the rural workforce. The average age of a food producers is growing, and the numbers of them decreasing, threatening Nestlé's number of suppliers. Developing viable and attractive jobs for the new generation is crucial.

[9] Appendix 2 for explanation of links.
[10] Appendix 2 for further explanations of our choice.

- Food loss and waste (4C-4D)

Food loss (from production) causes a substantial economic loss as potential sales are lost and resources are wasted. Food waste (from consumption) represents a catastrophic impact on the environment as well as an unfair distribution as 800 million people are undernourished[15]. Nestlé estimates that losses from production and consumption of its products are at 12%[16]. Using Nestlé's 2018 revenue of £72B[17], this amounts to approximately £9B[18] worth of Nestlé food lost or wasted. Above economic and environmental incentives, anti-food waste regulations (eg those put into effect in France and Italy in 2016[19]) are forcing Nestlé to act.

Environmental challenges:

- Climate change issues (6A-6C-6D-6E)

Nestlé recognises that climate change is a big threat to society, but also to the future of its business, as it contributes to food insecurity. As a result of regulatory pressure, Nestlé has set ambitious climate goals. However, the company has recently announced that it will fail to verify 90% of its commodities deforestation-free[20] - a goal previously set. Moreover, although Nestlé announced it will cut its use of virgin plastics by 1/3 by 2025 to reduce waste[21], it currently uses only 2% recycled plastic in its 1.7 million tons of plastic packaging last year[22]. Nestlé also announced its bold objective to achieve zero net greenhouse gas emissions by 2050 following the Paris agreement[23].

- Water use

The company must also solve its water supply issues. Its business is largely based on agriculture, a sector consuming 70% of total global unsalted water[24]. Nestlé uses massive amounts of water during different steps of production. For instance, it takes 770 liters of water to grow and process the coffee beans to make one cup of Nestlé coffee[25]. Additionally, although Nestlé asserts that it releases 100% clean water and has implemented water-reuse facilities in its factories, Nestlé only reuses 30%[26]. Nestlé has also faced scandals over its Nestlé Waters' drawing business (biggest bottled water brand in the world)[27].

3. Coffee case study

a. Why coffee

Nestlé's main driver of sales is Powdered and Liquid Beverages with 11 brands, accounting for £17B of revenue in 2018 (£72B total revenue)[28]. Out of this, £15B comes from coffee sales from its 7 brands - notably Nescafé and Nespresso. Nestlé is one of coffee's leading buyers, purchasing 10% of the world's supply[29]. Therefore, solving the environmental and productivity-related issues along coffee's supply chain will greatly impact Nestlé's and the global coffee industry's future.

b. Coffee supply chain

The following coffee supply chain illustrates in practice the issues raised in the problem section of the report and identifies when they appear.

[18] Appendix 5.
[27] Appendix 2.

COFFEE SUPPLY CHAIN

1. Pre-planting

Shortage of farmers (4B)

Price of Arabica beans have fallen to a 14-year low, enabling farmers to cover their costs.

Urbanisation: 68% of population projected to live in cities by 2050 (55% today)

→ Decreasing interest in farming

Deforestation (6A)

100,000 ha more per year for coffee crops. Nestle announced it will miss its 2020 deforestation-free goal.

2. Planting & Harvesting

Pesticides (6B)

Nestle's farmers use toxic pesticides as producing countries lack sufficient regulations.

Use of Endosulfan and Methyl Parathion on coffee plantations, toxic pesticides for animals + prevents soil fertility after 50 years of use.

Crop yield issue (4A)

Higher temperatures alone (6G) would lead to a 10-20% decrease in coffee crop yields in areas where Nestle produces its coffee.

3. Milling Process

Pulp waste and Water pollution (4C & 6D)

Transforming 550,000 tons of non-sustainable coffee uses over 100 million litters of water and gives off 1.1 million tons of wasted pulp.
With 30% of Nestle's annual production coming from non-sustainable sourcing; this amounts to 120 million litters for Nestle 2019.

4. Distributing

Greenhouse gas emissions (6C)

Transportation accounts for 6% of total emissions of Nestle's coffee, majorly due to ships.

40% of coffee production must travel 5000 miles, with ships using nearly 3000 tons of fuel per travel.

Fuel powered trucks then distribute the beans to factories and retailers.

5. Transformation

Greenhouse gas emissions (6C)

Coffee machines (such as grinders) require a huge amount of energy.

The energy consumption in cafés has the largest carbon footprint.

1 pound of coffee involves 10 pounds of carbon emissions across the supply chain, and 5 pounds just for the final step.

6. Post-consumption

Waste (6D)

Between 3-5 million tons of coffee produced by Nestle is wasted per year.

Post-consumption issue (4D & 6D)

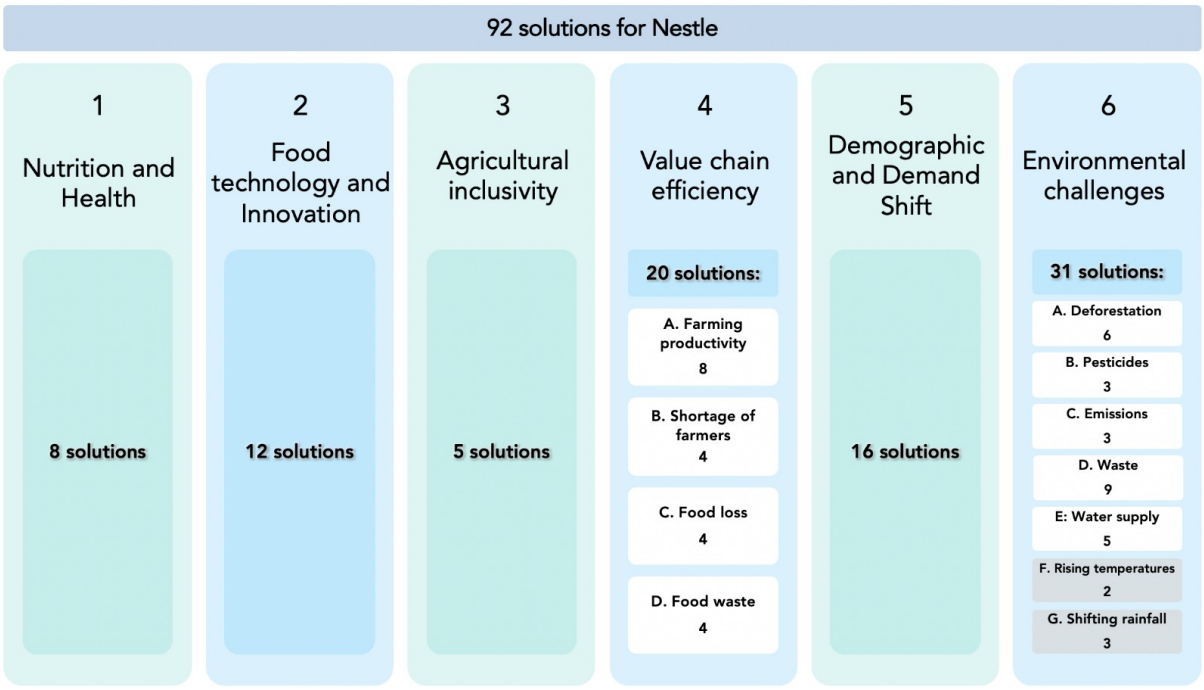
7 million disposable coffee cups used per day in the UK → that's 2.5 billion every year.

Only 1 in 400 coffee cups sold in the UK is being recycled.

References 30 to 41

4. Solutions for Nestlé

a. Solutions map



The above diagram clusters the 155 solutions we found to the issues raised earlier, 92 being relevant to Nestlé. This report focuses on the solutions to VC efficiency and Environmental challenges.

b. Solutions for VC efficiency and environmental challenges

VC efficiency: Increase farmers' productivity & reduce loss from production.

Centroamericano - *Farming productivity (4B)*

With the area suitable for coffee crops set to shrink 50% by 2050[42] as demand increases, Nestlé could boost long-term productivity and sustainability by using hybrid beans. Coffee hybrids, e.g. Centroamericano, are made by combining two genetically distant and complimentary coffee strains. Such hybrid varieties are not considered genetically modified organisms, eliminating health concerns. They produce a high-quality beverage, show high tolerance to pests, and fare better in changing climates. For Nestlé, switching to coffee hybrids alone yields over 20%[43] more coffee beans per hectare. Initial investments into pricier seeds would be offset by the long-term usability of coffee trees producing for over a decade.

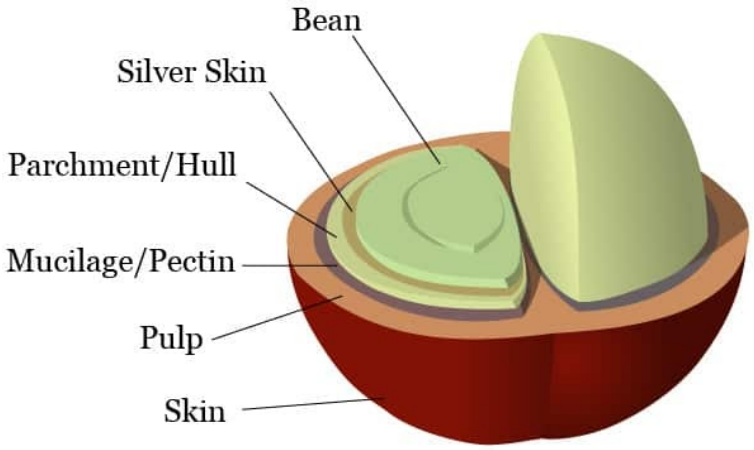
Mobbisurance - *Shortage of farmers (4B), Farming productivity (4A)*

By enabling the use of digital mobile phone tools like SMS-based Mobbisurance to its smallholder farmers in emerging countries, Nestlé can improve access to (1) financial services (payments, loans and insurance) and (2) information (weather forecasts, personalised agricultural analytics through satellite crop monitoring). Such tools could increase production

value of any commodity up to 6%[44], thus improving productivity (40-150 million tonnes of additional food produced across the industry) and farmer earnings ($15B-$70B additional earnings). Farmers and Nestlé can split this additional revenue, which helps get farmers out of poverty and makes farming a more viable and attractive profession to the younger generation, while also increasing profits for Nestlé.

Transforming loss from coffee berries - *Pesticides (6B), Food loss (4C), Waste (6D)*

During the initial drying process of coffee, farmers extract coffee pulp from fresh coffee cherries and throw it away. When dried, the pulp represents 30% of the bean but when wet, two tons of coffee pulp are obtained per ton of coffee cherry[45]. Above causing food loss, coffee pulp pollutes the water used during the wet-milling step by excessively enriching it with nutrients, harming organisms back in nature[46].

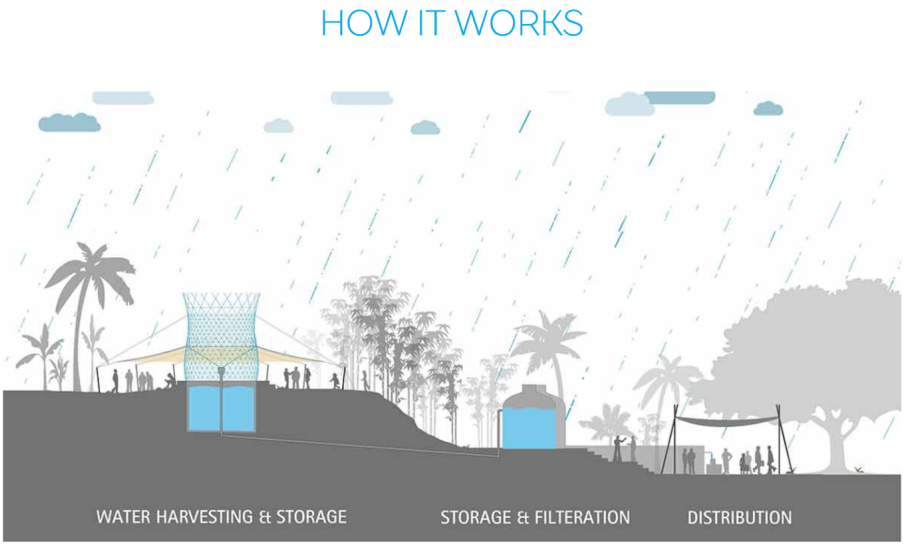


However, coffee pulp could benefit Nestlé, farmers and the environment, notably used as animal feed and fertiliser. Rich in protein[47], it can replace up to 20% of commercial concentrates in dairy cattle feed, with no adverse effects to the animal, leading to 30% cost savings. Moreover, it can also substitute livestock feed and could therefore lead to savings for Nestlé in its meat sector Herta and pet food products (eg Purina)[48]. As for fertiliser, compost of coffee pulp could lead to the reduction of 50% of fertilisers, reducing costs for farmers[49, 50].

Environmental footprint: Reduce deforestation & improve water usage.

Warka Tower - *Water supply (6E)*

Warka Tower is a vertical structure designed to drinkable potable water from air. The tower is 100% made from recyclable materials and easy to install. It functions thanks to natural phenomena, and as a result is power and maintenance-free[51].



The main coffee producers are located in equatorial regions, alternating between wet and dry seasons. Ivory Coast (a main Nestlé coffee provider) has a 6-month annual wet season[52], leaving farmers struggling to find alternative irrigation solutions for the last 3 months of coffee growth[53]. One Warka Tower costs £570[54] and collects on average 36,500[55] liters annually in equatorial regions. The collected amount can be kept until dry seasons to water coffee crops then, easing the burden of farmers by contributing to dry-season water supply.

Preventing deforestation: Café Solar - *Deforestation (6A), Emissions (6C), Food loss (4C)*
Since announcing its missed deforestation-free goal[56], Nestlé has further deforested 2,300 hectares in Central America[57] to supply firewood for drying the coffee harvest. Roughly 3 square centimetres of rainforest are destroyed for each cup of coffee, solely for the initial drying step. Café Solar[58] offers a forest-friendly solution powered by solar panels, combined with biodiesel energy made from coffee pulp. These two sources of green energy eliminate the need for firewood while also making use of all the coffee pulp (residue from the milling process) which previously went to waste. Café Solar would enable Nestlé to reach a 93% deforestation-free production in Central America within 2 years[59]. On the other hand, smallholders supplying Nestlé could free up 120,000[72] hectares by pursuing crop-yield improvements (Appendix 3).

c. Improved coffee supply chain (see next page)

[57] Appendix 5.
[59] Appendix 5.

NEW COFFEE SUPPLY CHAIN

1. Pre-planting

Shortage of farmers (4B)

Mobbisurance **+6% production value of any commodity**

Deforestation (6A)

Reuter's mobile app **+120,000 hectares of forest saved**

Café solar reaching **93% deforestation free production process**

2. Planting & Harvesting

Pests (6B)

Pulp recycling **– 50% fertiliser usage**

Crop yield issue (4A)

Plant shade trees **+ 450 000 farmers able to cope with rising temperatures**

Farming productivity (4B)

Centroamericano **+ 20% more coffee beans/hectares**

3. Milling Process

Pulp waste and Water pollution issues (4C & 6D)

Pulp recycling **+ 30% cost savings in animal feeding**

Water waste

Warka tower **+ 36,500 liters/year per hectares**

4. Distributing

Gas emissions (6C)

electric trucks **- 12tons of CO2/truck**

5. Transformation

Gas emissions (6C)

The Roastery costa **- 30% energy usage to roast coffee**

6. Post-consumption

Waste (6D)

Bio-bean **– 36 tons of coffee wasted per business**

Post-consumption issue (4D & 6D)

#THECUPFUND **+ 5million cups recycled**

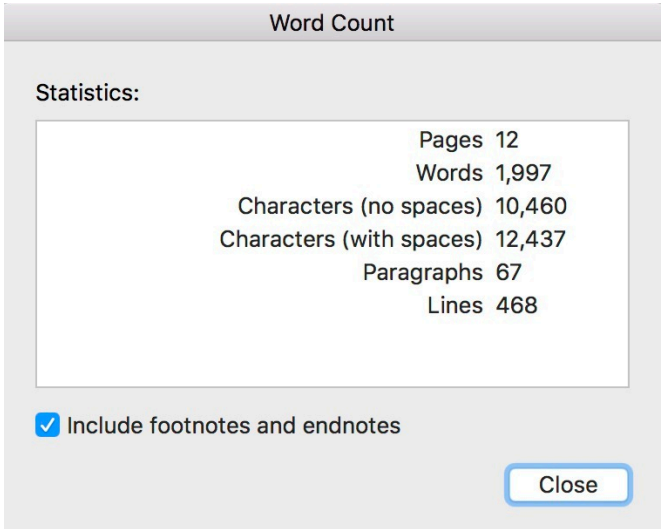
5. Impact

By adopting more efficient and sustainable agricultural practices, including the solutions analysed in the report, Nestlé's farmers could generate an additional £65 million for the company by 2030 while also producing 250,000 tons more crops, prevent 25,000 tons of greenhouse gas emissions and save 135B liters of water[60] .

Food loss and waste could decrease by 4%[61] (from Nestlé's current 12% to 8%), thus saving a substantial £3B[62] worth of food, by improving the supply chain with the solutions found (e.g. Cafe Solar).

Implementing such innovations in Nestlé's business and in its farmers would require heavy investment from the company and would have to involve government participation. It is estimated that Nestlé's farmers in Sub-Saharan Africa alone would need annual investments of up to £380 million[63] to adopt the changes suggested, which comparatively is five times the amount of Nestlé's 10-year Cocoa Plan[64].

Nestlé can lead a sustainable future for its business and the global food system, by partnering with the public sector and expanding current investment in its farmers and the rest of its VC.

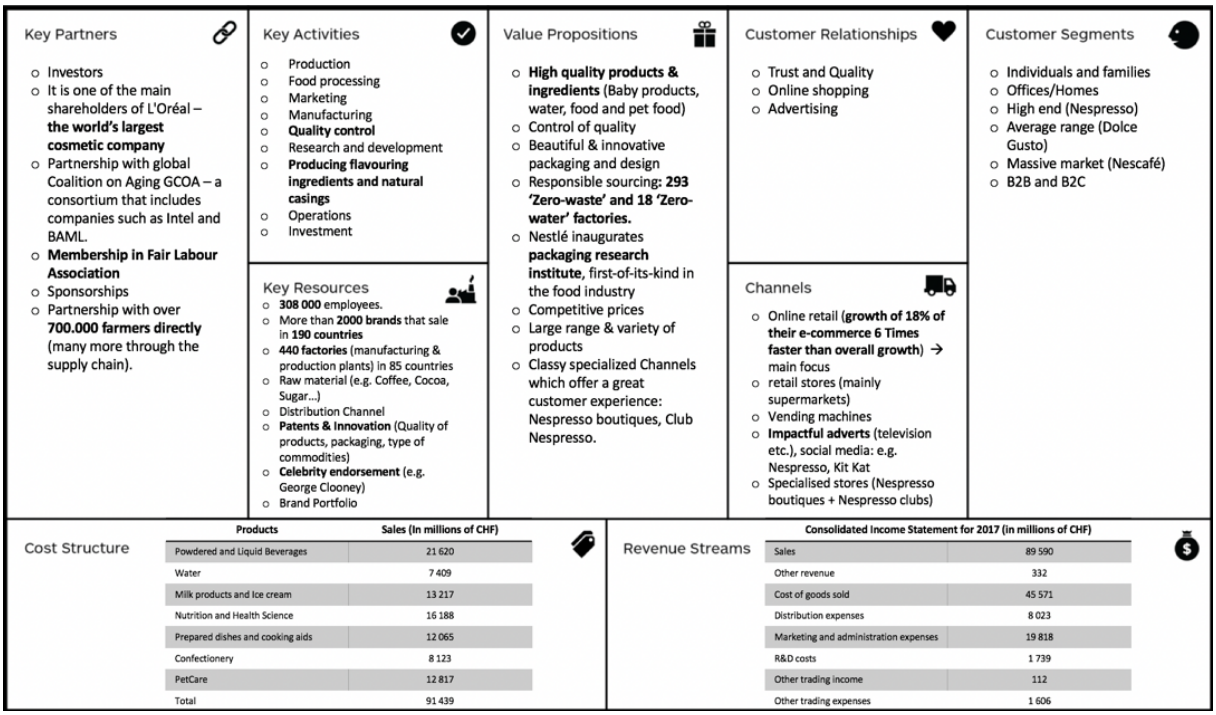


[60] Appendix 5.
[62] Appendix 5.
[63] Appendix 5.

6. Appendix

A. Appendix 1: Broader view of the company

a. Nestlé's BMC



Description of the Business Model Canvas:

Channels:

Nestlé main focus these days is on the online retail. With e-commerce becoming a bigger and bigger part of the financial transaction every year, Nestlé wants to sell more products on the internet. This goal was a success in 2019 as their e-commerce grew by 18% and six times faster than the overall growth of the company.

On the other hand, Nestlé wants to open more specialised stores like the Nespresso boutique to create a complete experience for the customers.

Key Resources:

Nestlé is made of more than 2,000 brands which are sold in 190 countries. Many of the brands created by Nestlé can be acknowledged by the customers thanks to its prefix "Nes" (i.e. Nescafé, Nespresso, Nestea, Nesquik…).

Nestlé uses 14 main commodities in more than 440 factories, which are mainly divided into two categories: manufacturing and production plant.

Key Activities:

Nestlé provides various key activities. The five more important are Production, Food processing of products based on fourteen main commodities, manufacturing other products, research and development and Investments on new companies. The goal of Nestlé regarding the future of their production is to find solutions to produce more with less space and less water.

Key partners:

Nestlé's key partners can be divided into two categories: On the one hand, the investors and shareholders, and on the other hand, the farmers and sellers. Nestlé is one of the main shareholders of L'Oréal, which is the world's largest cosmetic company. Nestlé also works with over 700,000 farmers directly, and many more through the supply chain. Nestlé also has a partnership with *Global Coalition on Aging (GCOA)*. Thanks to this organisation, Nestlé wants to find solutions regarding the Aging of the farmers they work with. Youth is going to cities and less people are attracted by the job because of its uncertainties. However, Nestlé needs more farmers as more people will need some food (+2 billion people by 2050).

Value Propositions:

As every big company, Nestlé's value propositions are numerous. In terms of production, Nestlé wants to propose high quality product & ingredients. The products are mainly baby products, water (Nestlé is the owner of a different water company in more than 40 countries), food and pet food. Nestlé frequently controls the quality in order to propose good products. It has a large range and variety of products, at competitive prices.

In terms of design, the company works on beautiful and innovative packaging. The company also works on its packaging to reduce the waste of plastic. Nestlé wants to sell more sustainable products and the company knows that the first thing the customer sees is the packaging, therefore, it tries to reduce the waste by removing as much plastic as possible. Nestlé has 293 'Zero-waste' and 18 'Zero-water' factories.

Finally, Nestlé wants to propose a complete experience on classy specialized channels such as Nespresso boutiques and Club Nespresso.

Customer Relationships:

The customer relationships of Nestlé are based on trust and quality. Although Nestlé faced some criticism, the company wants to recreate the trust of its customers by showing that the company is making some changes and improved the working conditions of its employees. Nestlé promotes its products thanks to strong advertising campaigns (i.e. have a break, have a kit-kat) and wants its products to be part of the common knowledge and common consumption.

Customer Segments:

Generally, big companies target specific customer segments. However, as Nestlé is a really big food and drink company, the company targets a lot of different customers. Nestlé's strategy is based on multiple brands. As an example, Nestlé founded and acquired different brands of coffee for different ends of people. Nespresso targets the high end and the people with more money to buy coffee. Dolce gusto targets people with average revenues, and Nescafé targets low ends and people with average revenues. Thanks to this strategy, Nestlé can propose different products coming from different brands.

In addition, at a B2B level, Nestlé deals with companies such as grocery stores which buy its products (i.e. instant coffee) to sell it to customers.

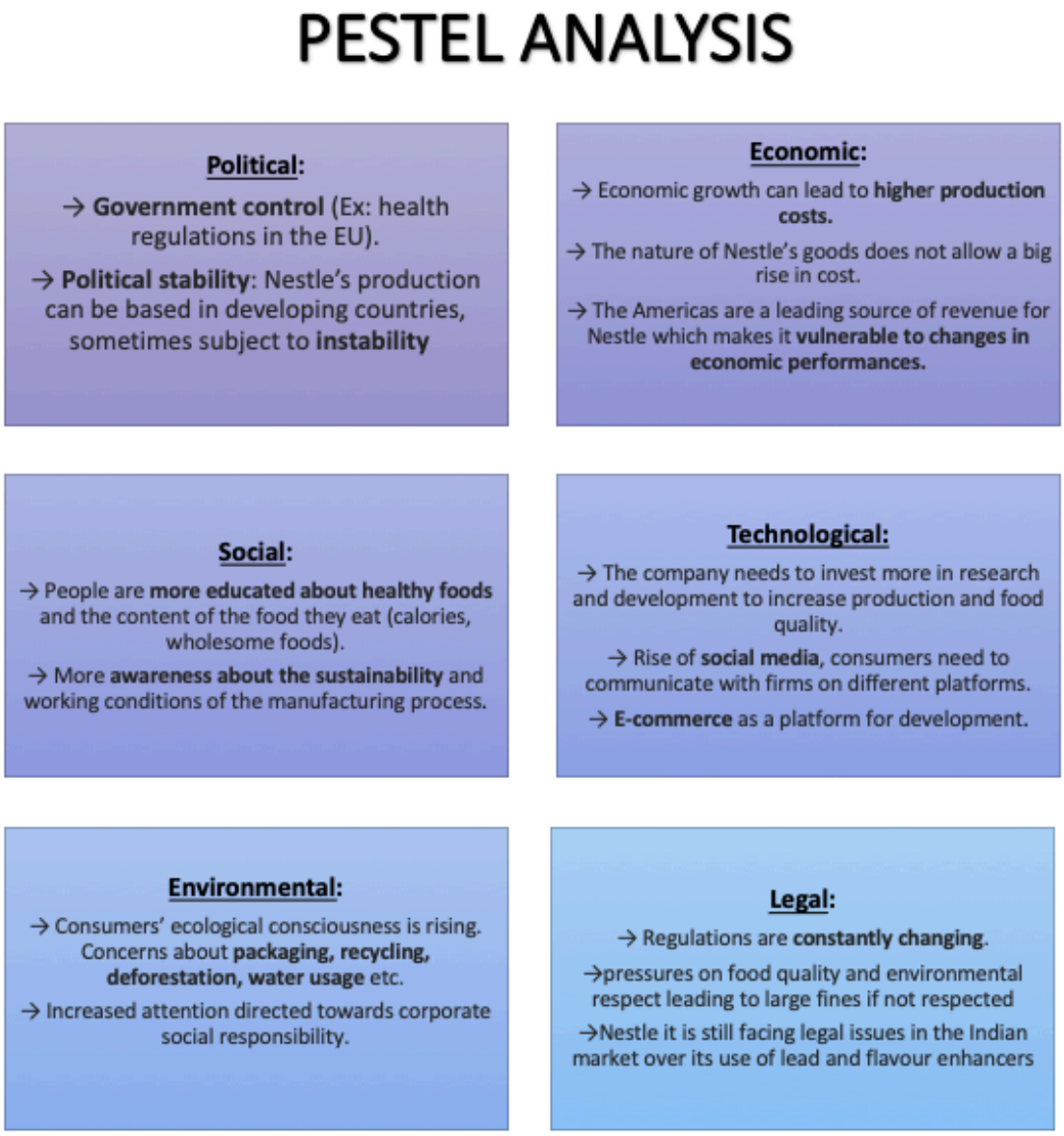
Cost structure:

Nestlé's cost structure is mainly made up of its Powdered and Liquid Beverages and its research on Nutrition and Health Science. Nestlé also spends a lot of money on its Milk and Dairy products and Ice cream. Together, it represents almost 50% of the company's cost. On the other hand, we should also consider the cost of Water, prepared dishes and PetCare as it represents almost a third of the company's total costs.

Revenue Streams:

With over 89,590 million CHF of sales in 2017, the sales of Nestlé are obviously the biggest source of revenue with 53% of the total of Nestlé. The second biggest source of revenue is the cost of goods sold, with more than 45,571 million CHF. The income statement shows that the total revenues were around 166 billion CHF in 2017.

b. Nestlé's Pestel



c. Nestlé's products[65]

In the common believes, Nestlé is commonly associated with its sweet product range (chocolate confectionery, breakfast cereals) and also known for its huge presence in the coffee production with famous brands (e.g. Nescafé Nespresso). However, being the world's largest food and beverage company, Nestlé's existence in the market is way wider. Indeed, the brand manufacture several types of products from various industries. Overall, the brand sells in the following categories:

1. Powdered and Liquid Beverage
2. Nutrition and Health Science
3. Milk and Ice cream

4. Pet Care
5. Prepared dishes and cooking aids
6. Confectionery
7. Water.

In order to have a deeper view of the company, the diagram below aims to show the amount of money (in CHF billion) that represent each of the above categories.

<u>Within those categories the brand owns many different brands[66] :</u>

B. Appendix 2: Deeper explanations and understanding of the problem map:

This section of the appendix aims to give further explanations on our problem map. It gives a deeper understanding of how the map is designed: 'Which problems are not relevant to Nestlé and Why?', 'Why did we focus on a specific range of problems', 'How we have chosen our focused categories'.

1. Interconnected problems from the Problem map:

Red: As diet caused illnesses such as obesity have reached significantly high numbers (more than 672 million adults in the world, or one in eight, are now obese[67]) particularly in developed countries (problem 1A), many people living in these countries are becoming aware of the importance of healthy (and sustainable) eating (5B). Demand for healthy and sustainable food has consequently increased in developed countries. 1A leads to 5B.

Orange: As the middle and upper classes in emerging countries are rapidly expanding, they gradually tend towards 'Western' style diets which are high in sugar, fat and protein, as they can afford more processed foods (which Nestlé typically offers) and meat. This means that demand for these products grows (5C) and their consumption radically changes diets for the worse health-wise (1B). Obesity, previously low in emerging countries, is now rapidly growing as a result. 5C leads to 1B.

Brown: Hunger and undernutrition persist mostly in zones of Poverty. 1C and 5E are therefore interconnected

Blue: Problem 2C leads to 4A as productivity of farmers largely depends on the infrastructure and technology, they have access to.

Green: Food loss from production (4C) and Foot waste from consumption (4D) increases overall waste of food (6D), therefore waste of the resources used for the production of this food.

2. Problems not relevant to Nestlé:

1C. As Nestlé is a for profit organisation, it does not conduct charitable actions against hunger and undernutrition as one of its main activities. However, Nestlé has donated more than 100 million pounds of food and water to support more than American food banks[68].
1D. As Nestlé is not a healthcare company, it has little impact on aging health-related issues which are not diet-caused.
2D. As Nestlé is a for profit food and beverage organisation, it does not conduct charitable actions for the construction of sanitation infrastructure.
5D. Nestlé does not have control over city planning.
5E. As Nestlé is a for profit organisation, it does not conduct charitable actions against poverty as one of its main activities. However, it has an impact on the income levels of the people involved in its supply chain, notably farmers. Farmer poverty is problem 3D.

3. Why we are not talking about other categories?

Rubric 1. Nestlé is already tackling problems 1A (diet caused illnesses) and 1B (shit to unhealthy 'western' diets in developing countries) as it has taken steps to reduce sugar, calories and saturated fat from its products. For example, Nestlé has made a pledge to cut sugar across its confectionery portfolio by 10%[69]. Moreover, Nestlé is redefining itself as a scientifically driven "nutrition, health, and wellness company", and now sells medicine products in the form of appealing food, such as its Optifast range for those with diabetes.

Rubric 2. As Nestlé does not substantially rely on animal-based products besides milk (meat is only present in its pet food products), problem 2B is not a major contributor to Nestlé's problem footprint. As for poor infrastructure and limited technology access (2C), this problem directly affects farming productivity, addressed in 4A, and as a result is partly discussed in the main body of the report.

Rubric 3. As agricultural inclusivity is faced only one the first stage of production (when farmers contribute) rather than being an issue recurring throughout the supply chain, it was excluded from the main report analysis.

Rubric 5. Nestlé does not affect worldwide population growth. Moreover, responding to increasing demand and demand shifts will require solving the problems in the other categories of the diagram, such as those in categories 4 and 6.

4. Nestlé Waters

Nestlé has faced scandals in Pakistan, Africa and US over drawing water from natural reserves for its Nestlé Waters business (biggest bottled water brand in the world). This practice severely impairs nature and dries up surfaces for the population. To make matters worse, Nestlé has not been compensating the local authorities it extracts from enough. Private organisations commodifying and capitalising water rather than treating it as a human right could leave two-thirds of the world's population facing water shortages by 2025[70].

C. Appendix 3: More about the solutions:

Preventing deforestation: Reuters' mobile app - *Deforestation (6A), Emissions (6C), Farming productivity (4A)*

The key to preventing deforestation resides in improving productivity of land-use. McKinsey's research indicates that smallholder farmers could increase their productivity by 70% by 2030[71]. Together, smallholders supplying Nestlé could free up 120,000[72] hectares by pursuing crop-yield improvements, even accounting for the fact that many will not be able to make use of all available technologies. Moreover, reducing pressure on additional deforestation could deliver a net benefit in reducing greenhouse gas. Increasing yields for smallholder farms is assumed to require additional nitrogen fertilizer of 25 kilograms per ton of yield increase, partially offset by the average global fertilizer use per hectare from avoided land expansion[73]. However, smallholders relying on low incomes tend to be very risk averse when it comes to adopting new practices. Tools like Reuters Market Light's mobile app can encourage farmers

to adopt further technological solutions and help them increase yield, by providing farmers with personalized agricultural data analytics for the entire growing cycle and remote support in their local language[74].

Cold storage - *Farming productivity (4A), Food loss (4D)*
Cold storage is in short supply for small farmers in developing countries with hot climates (such as those producing cocoa and coffee). For coffee beans who rapidly perish once harvested, cold storage is of essence. Food loss due to lack of adequate storage solutions contributes to Nestlé's 12% of products going to waste[75], hinders financial stability for farmers heavily relying on harvesting seasons, and leads to large price peaks for Nestlé outside of harvesting seasons. To remedy this situation, Ecozen developed micro cold storage, a solar-powered cold storage system. After two years of use, creating an additional 40% worth of profit[76], split across farmer and buyer, from increased coffee reserves.

Coffee flower - *Farming productivity (4A), Food waste (4D), Waste*
During coffee beans collection, coffee fruits are wasted as they ripe almost as soon as they are picked. Therefore, they have never been used in the past resulting in over 40% of coffee pulp wasted. However, the berries can be transformed into a fruity flour that can be used for cooking, but also flavouring chocolate (Seattle chocolate company). In addition to having high nutritional values, selling coffee berries could increase the revenue of the 25M livelihoods tied to coffee production, creating a more efficient VC environment wise and revenue wise. Finally, the exploitation of coffee berries is creating new jobs in the coffee industry including new opportunities for women.

Amaizz - *Farming productivity (4A), Food loss (6D)*
Amaizz developed a solution for post-harvest handling and storage, by drying the products. Thus, saving up to 50% of the products from going to waste this would have an effect on the losses of the early stages of the supply chain and participate to the VC efficiency as loss in the early stages of the supply chain in low income country accounts for up to 750 billion dollars of food not sold. This system could allow Nestlé to reduce the loss from its production for its baby food range using fruits as a key ingredient.

Elior - *Food waste (4D), Wate (6D)*
Elior, a French catering business, partnered with bio-bean to save 36 tonnes of coffee waste from being wasted, turning it into fuel. Coffee grounds are converted into logs, which can be used in cod bones, stoves and open fires. These logs burn 20% longer and hotter than regular wood and produce 80% less emissions than if they were going to landfills. We can also note that another company, first smile, first converts coffee grounds into essential oils before using the remainder for creating biofuels.

BioCarbon Engineering drones - *Deforestation (6A)*

Another way to deal with Nestlé's deforestation issue would be to reforest deforested part of the globe. The UK-based start-up BioCarbon Engineering[77] has developed a new planting system. They have designed a fully automated planting-drone that could become the cheapest and fastest means of reforestation. The company estimates that ten seeds can be planted per minute. The company aims to plant one billion seeds a year. Using this method, Nestlé could potentially overcome its issue regarding deforestation.

Pesticides **-** *Pesticides (6B)*

Without pesticides and insecticides, it has been estimated that global food could fall by as much as 35-40%, increasing the cost of food and threatening food security[78]. Endosulfan and Methyl Parathion are used as pesticides to prevent insect pests; especially from the Coffee Bettle Borer CBB[79]. Only 5% of the farmers are currently able to effectively renovate or rehabilitate their coffee crops once damaged because of the CBB. In 2017, scientists have discovered an environmentally friendly pesticide. The new Insect-pathogenic pesticides Beauveria bassiana would be able to fight the CBB without damaging the soil fertility and the wildlife. Above all, it will help Nestlé's local farmers to provide a sustainable coffee while keeping the same productivity.

GIZ - *Emissions (6C)*

In Costa Rica, the cultivation and processing of the coffee beans are responsible of ¼ of total greenhouse gas emissions from the domain of agriculture. The main sources of emissions are the organic waste from production and chemicals used to fertilise the soil. To tackle this problem, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has created a program that teaches farmers how to recycle their organic waste, for example they could use it as a fertilizer, and thus eliminate the need for chemicals, and help them to plant 'shade trees' in the plantations (trees that store the CO2). This will save around 60 000 tons of carbon dioxide emissions per year.

Electric trucks - *Emissions (6C)*

In the US alone, diesel fuel is representing about 25% of total energy consumed within the food system. To reduce greenhouse gas emissions, all farms and food companies will have to adapt to energy-efficient transportation methods, such as electric or hydrogen fuel cell trucks. According to Navigant (a research and consulting firm focused on global clean technology markets), sales of electric trucks will grow from 31,000 in 2016 to 332,000 in 2026.
Example of electric truck: The BMW YT202-EV which creates zero emissions and saves 12 tons of CO2 compared to a standard diesel.

Costa - *Emissions (6C)*

1 pound of coffee involves 10 pounds of carbon emission and that's a 4,320 million pounds of Carbon emission in 2019.

Costa coffee thus opened a roastery in 2017 that enabled to save 30% of energy consumption per ton of coffee in addition to producing 249KW of energy thanks to solar panels[80].

THECUPFUND - *Waste (6D)*

7 million disposable coffee cups used per day in the UK (which represents 2.5 billion every year) and only 1 in 400 coffee cups sold in the UK is being recycled. To tackle this problem, the environmental charity Hubbub installed bins shaped like giant coffee cups with the message "recycle your coffee cup here" written on it. (campaign called #THECUPFUND). In London, since 2017, more than 5 million disposable cups were recycled due to this initiative.

Shade trees - *Rising temperatures (6D)*

To fight against rising temperatures, and therefore the rise of temperature in the coffee trees, a good solution for smallholder farmers would be to plant shade trees[81]. It could help the farmer to regulate the temperature of the coffee tree because these trees would create a microclimate and protect the coffee trees from bad weather conditions.

In a more general way, the crop diversification[82](intercropping) requires less water than monoculture farming.

Planting shade trees can be useful for the 450,000 Tanzanian[83] smallholder farmers as they mainly use monoculture to produce the coffee which increases the ecosystem vulnerability. Moreover, with the overall temperature rise of 1.5 to 3 degrees in 2050[84], the farmers need to create a microclimate suitable to the coffee crops.

Diversifying crops - *Rising temperatures (6D)*

Producing some crops that are more climate-resilient can be really useful if the farmer needs to produce its coffee at a higher altitude or on new lands he doesn't really know. Moreover, producing different crops, although it would take more time, would help the farmer to decrease its risk in its production. By diversifying crops[85], the farmer is going to change its monoculture which requires a lot of water to a climate smart agriculture which requires less water, and which could resist more to the rise of temperature.

Weather forecasting and irrigation - *Water supply (6E)*

Although these solutions will be expensive (Nestlé could theoretically financially help its farmers)[86], it is the most efficient solution to face the future water stress due to the Shifting rainfall patterns. Using some weather forecasting could help the farmer in his water management, especially in countries where there is a rainy season, such as China, Vietnam and Indonesia[87], which are the future producers of coffee with some countries in Africa.

Shifting from Arabica to Robusta - *Shifting rainfall patterns (6G)*

Arabica is mainly produced in South America, India and Ethiopia, and although it is generally the favourite coffee, some farmers who will face shifting rainfall could choose to start producing Robusta instead of Arabica. By having more caffeine in its grains, the Robusta is willing to resist more to difficult growing conditions.

Nowadays, Arabica represent between 70 and 80% of the coffee production. However, shifting a part of the production from Arabica to Robusta could help the farmers to resist the small droughts of the shifting rainfalls[88].

Extract of the excel solutions sheet (only the first solutions out of 155)

1	Solution
2	
3	Keeping produce fresh by controlling temperatures throughout the supply chain
4	The Small Robot Company has created a Robot able to harvest faster the crops
5	The Small Robot Company has created a light Robot able to replace the blanket spraying fields done by tractors
6	Modified Banana's genome to avoid ripe black patches
7	Portable sample roaster which allows farmers to roast and cup their coffees on-site.
8	Mobile app that gives coffee farmers access to real-time trading prices
9	Modified wheat breeding increasing the stability during the productivity
10	scientists have used plant selection and breeding techniques to reduce pest spreading within the crop
11	Extensive flood control measures should be adopted to prevent the devastation caused by floods
12	Use of data analytics to get better insights on which fertilizers to use and when to use it
13	Purchase of equipment or machinery to improve animal handling
14	Provide incentives to farmers to produce more by offering rewards based on the production rate
15	Smart Water system to increase productivity; reducing over-watering the crop
16	Greenhouse gardens that imporve heat tolerant varieties allow the plant to maintain yields at higher temperatures.
17	Robot beetle detects killers beneath the soil
18	Analyzing earth day-to-day composition to ensure the best productivity rate regarding the percentage of crop
19	Modified plants producing more grains on a single harvest
20	M&A: Investment in growth markets
21	Demand and Supply Planning Optimization
22	Increase Farmers' incomes
23	Blockchain for Agri-Food Supply Chain
24	Integrate farming within educational programs
25	Managing risk to protect the brand and consumers
26	short food supply chain
27	connected fields (imagery, humidity analysis...) with IoT
28	connectivity of supply chain (sensors)
29	Global bath traceability with connected supply chains

	B	C
1	**Problem**	**Category**
2		
3	Unsold edibable products	Demographics and Demand Shift
4	Increase production/Unability to increase the production rate	Demographics and Demand Shift
5	Compactation of the soil due to heavy tractors; leading to unproductivity	Demographics and Demand Shift
6	Loss in sell involving unsold products that could have been consumed	Demographics and Demand Shift
7	Need to increase productivity to meet the booming demand	Demographics and Demand Shift
8	Less incentives for farmers to produce more due to higher prices	Demographics and Demand Shift
9	Part of the wheat crop that were non-productif	Demographics and Demand Shift
10	Pest spreading affecting the soil quality; reducing the productivity	Demographics and Demand Shift
11	Irrigation problem affecting crop productivity	Demographics and Demand Shift
12	Develop and improve productivity	Demographics and Demand Shift
13	Waste of time regarding cow milking process	Demographics and Demand Shift
14	Less incentives for farmers to produce due to a lack of technology (e.g. machinery)	Demographics and Demand Shift
15	Over-watering which involved a lower productivity	Demographics and Demand Shift
16	Enhance the productivity using new tehcnology to replicate a perfect climate	Demographics and Demand Shift
17	Kill insects affecting crop production without using pesticides	Demographics and Demand Shift
18	Not 100% of the crop field is used for the production	Demographics and Demand Shift
19	Increasing the amount of production while keeping the same field size	Demographics and Demand Shift
20	more effiient markets	value chain efficiency
21	expired produced and cut cases	value chain efficiency
22	Ageing Farmers	Value chain Efficiency
23	IoT to optimize agriculture supply chain	value chain efficiency
24	Stagnant prices	Value chain Efficiency
25	health regulations and trust	Value chain Efficiency
26	diminish overall waste	Value chain Efficiency
27	inacurate knowledge of farming condition	Value chain efficiency
28	contaminated products/unrefrigirated products going bad	Value chain efficiency
29	untraceable ingredients	Value chain eficiency

D. Appendix 4: How we have used QUID/ for our analysis:

FIG 1: Quid search outlining the main challenges faced by the global food industry about the "Future of Food". The Network Map exposes the sectors that are to be considered as the main challenges for the future of food. The sentiment map associated to this search illustrates the global opinion relative to those challenges. The comparison between the two maps allows a clear understanding on which challenges to focus on: firstly, by identifying the key relevant sectors to our concern, and then by eliminating the ones that give off a negative associated sentiment (negative sentiment could be interpreted as a likely non-exploitable search lead

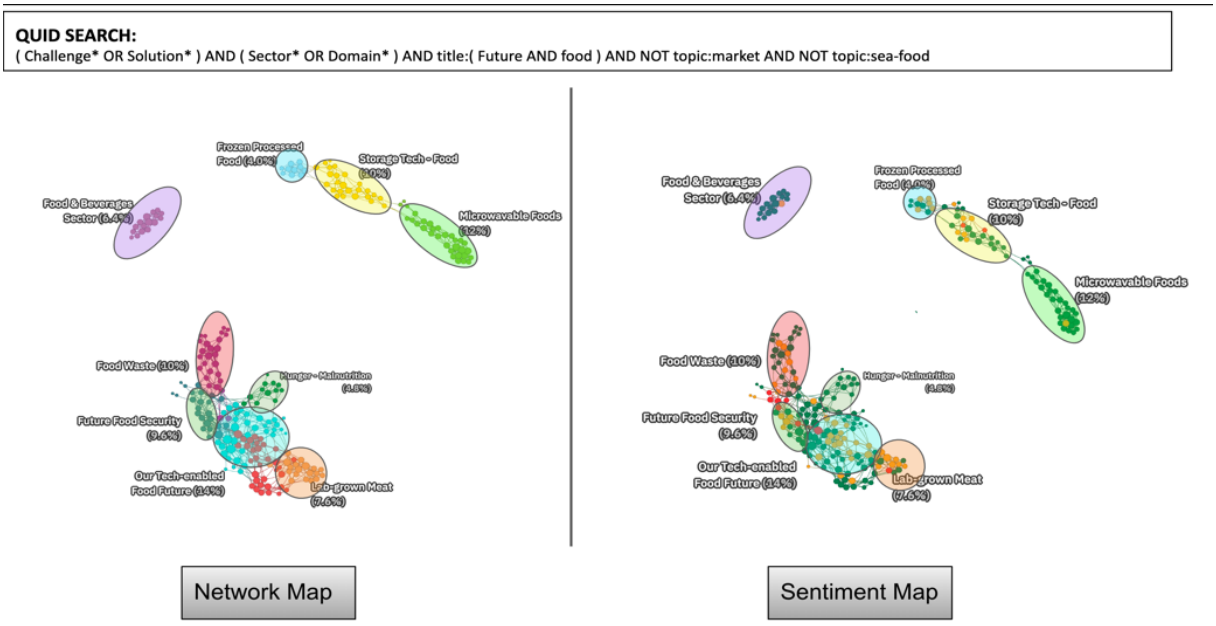


FIG 2: QUID search outlining the main challenges that will be faced by the agri-food sector regarding the "Future of Food". **This map illustrates why Nestlé is particularly concerned by those challenges**, and therefore why it is particularly important for them to forecast solutions for those upcoming challenges. Indeed, out of the 6 clusters exposed on the map above, we can see that Nestlé is directly concerned by half of them ("Supply chain", "Agricultural/Crop/Food Production", "Food & Beverages sector"). Nestlé il also strongly linked to the "Restaurant/Contact" cluster as most of their brand distribution is made through restaurants. We therefore understand why Nestlé is interesting, concerned and relevant regarding the "Future of Food" matter.

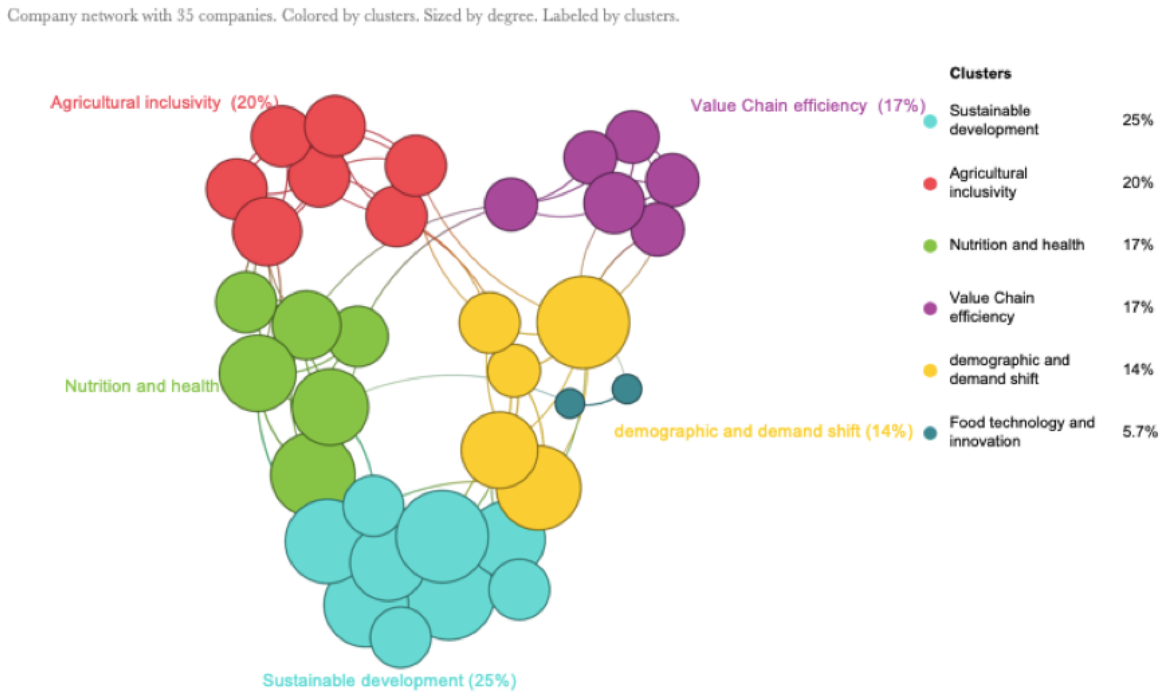
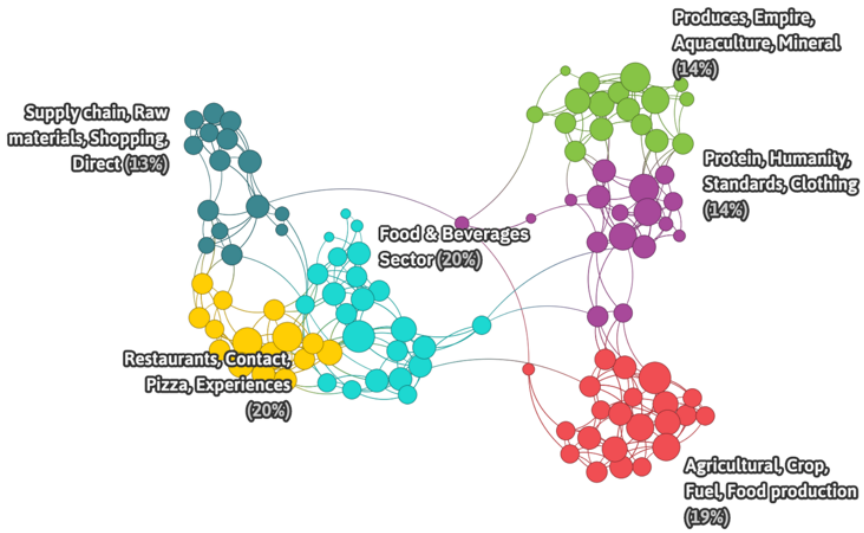


FIG 3: («Nestlé" OR "Unilever" OR "Kraft foods" OR "mondelez international" OR "pepsico" OR "Mars") AND ["sustainability"]("sustainability" OR "climate change" OR "social responsibility" OR "sustainable")

This quid represents the main focuses of Nestlé's competitors regarding sustainability and climate change and therefore shows the trends of behaviour around this topic.

FIG 4: ("food" AND («sustainability" OR "environmental impact" OR "waste") AND "solutions").
This quid shows the areas where solutions are designed to tackle the future of food challenges



E. Appendix 5: Calculation Section:

This section aims to explain how we have used our knowledge from our maths calculus module and from the previous scenario weeks to calculate figures that we have included in the report.

1. Deforestation:

value written in the Café solar example

Nestlé's deforestation for the drying of its coffee still account for 10% of its production. It represents 7,800 ha of forest that have been deforested by Nestlé's local farmers in 2019, with 2,300 ha in Central America[89]. Therefore with:

10% <=> 7,800 ha
3% <=> 2,300 ha

Therefore, we can conclude that using the new innovative CaféSolar technology – already used by farmers in Honduras, Central America – could reduce its impact on deforestation by 3% and reach a 93% deforestation-free drying method for its coffee in central America. As the CaféSolar estimates 1 year for the installation of all the machines, we assume that Nestlé would need an additional year to apply successfully this new innovative technique throughout its production[90].

2. Nestlé's food waste and loss:

**value written in Problems section **

0.12 (12%) * 72B annual profit = 8.64 -> 9B worth of food.

3. Gas emission:

**value written in the supply chain – Carbon emission **

Nestlé produces 9600 million kilograms of coffee per year in 2019[91].

On the other hand, during the transformation part, 10 pounds of coffee, 10 pounds of carbon emissions.

Besides, 1 pound = 0.45 kilo[92] → 9600 million kilograms = 4320 million pounds of carbon emission for Nestlé's transformation process.

Lastly, 10 pounds of coffee = 10 pounds of carbon emissions → 4,320 million pounds of Carbon emission for Nestlé's transformation.

4. Impact:

values written in the last section of the report

The source[93] indicates that the potential impact concerns 115 million farmers and would be $40-100B. We chose to take the average $70B.
Considering that 115 million farmers is 115 million / 570 million[94] farmers in the world, that's 20% of farmers worldwide.
Assuming that the share of Nestlé farmers impacted is also 20% and that Nestlé has 695,000 farmers, that's 135,000 farmers.

135,000 Nestle farmers * 70B impact / 115 million potential farmers = $85 million impact for Nestle
= **£65 million**

100-300 million tons more crops produced for 115 million potential farmers → Average is 200
→135,000 Nestle farmers * 200 million tons more crops produced/ 115 million potential farmers = **250,000 tons more crops produced for Nestle**

Up to 20 less megatons of CO2 for 115 million potential farmers
→135,000 Nestle farmers * 20 megatons / 115 million potential farmers = **25,000 tons of CO2**

50-180 billion cubic meters water saved for 115 million potential farmers → Average is 115 billion
= 115000000000000 liters
→135,000 Nestle farmers * 115000000000000 / 115 million potential farmers = **135 billion liters**

4% of £72 = 2.88 → **£3B saved**

The source[95] indicates that "sub-Saharan Africa alone requires additional annual investments of as much as $50 billion". Assuming that Nestlé's share of sub-Saharan agriculture is equal to 1% (share of global agriculture produced for Nestlé), then Nestlé would have to contribute 1%* $50B = $500 million = **£380 million**

F. Appendix 6: Feedback:

1. Feedback from our presentation:

Feedback	Improvement
Even though the content was good, the problem map was too complex.	Indeed, our problem map was too complex. We had used many different colors without explaining the legend. Therefore, we have simplified it. To do so, we have used only 2 light colors to differentiate the different categories in order to illustrate our problem map in a clear and easy-to-read illustration. On the other hand, we have carefully explained each color, shade, and type of edge within a legend to facilitate the understanding of our readers.
Nestlé is a huge company. We must identify specific problems to discuss in report and explain why we are focusing on those problems.	As you have suggested during the presentation, it was not viable and efficient for our team to focus on all aspects of the problem map as Nestlé is a broad company. Therefore, we have searched and analysed in order to know which categories and sub-problems are more relevant for our company. Consequently, we have carefully explained in appendix our choices and our reasoning.

We must number and be more accurate about the problems and subproblems of the problem map too clearly identify them in Supply chain and in the report.	Our problem map just stated each problem. We were missing a clear and understandable design. Therefore, we have annotated using a simple numbering method each of the categories and sub problems.
Must use Quid as it was not explicit how we have used it the presentation	It was not clear during the presentation how we had used the powerful software Quid. Therefore, in order to avoid misunderstanding, we have created an appendix entirely dedicated to Quid. The aim was to show how and under which context Quid has allowed our team to get a better vision and deeper insights on Nestlé, the industry and the main topic 'Future of Food'.
Nice idea of including one commodity within a supply chain to have a better visualization; but we must illustrate problems and be more specific.	As we have mentioned previously, Nestlé is a huge company. Therefore, as you had liked our idea during the presentation, we stuck to illustrating in depth how Nestlé's supply chain works, and where Nestlé encounters challenges. However, as we were too broad and non-specific, we have narrowed down our research in order to illustrate every rubric of the supply chain with relevant figures.

2. Inspiration from other teams

Observation	Improvement
Team AB InBev: Nice use of Quid to understand main topic 'Future of Food'	Use Quid to get deeper insights on the understanding of the Future of food topic. Besides, Quid has been really useful to find problems within the subject directly related (especially for the category 'Environmental footprint': 31 solutions).
Team Mowi: Split a category into sub-problems in the problem map if and only if there is more than 1 solution.	Therefore, we made sure to identify and to include more than 1 sub-problems in the problem map.
Team Cargill: Make sure to specify how many solutions we have within each category.	That being said, we made sure to specify in our solution map the exact number of solutions per category in order to improve the understanding of our map.

Team General Mills: Chose too many commodities; Make sure to explain why we focus on a specific commodity.	As a result, we have carefully explained why we chose to focus on the coffee production.
Nice idea of including one commodity within a supply chain to have a better visualization; but we must illustrate problems and be more specific.	As we have mentioned previously, Nestlé is a huge company. Therefore, as you had liked our idea during the presentation, we stuck to illustrating in depth how Nestlé's supply chain works, and where Nestlé encounters challenges. However, as we were too broad and non-specific, we have narrowed down our research in order to illustrate every rubric of the supply chain with relevant figures.

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TEAM F // MSIN0024 // DESIGN

FUTURE OF FOOD
NESTLÉ

LANCELOT DOUCET
JUSTINE MALAPERT.

GABRIDEL DADOUN
PHILIPPINE BONNAUD

LENA ROWE
HADRIEN BACQAERT

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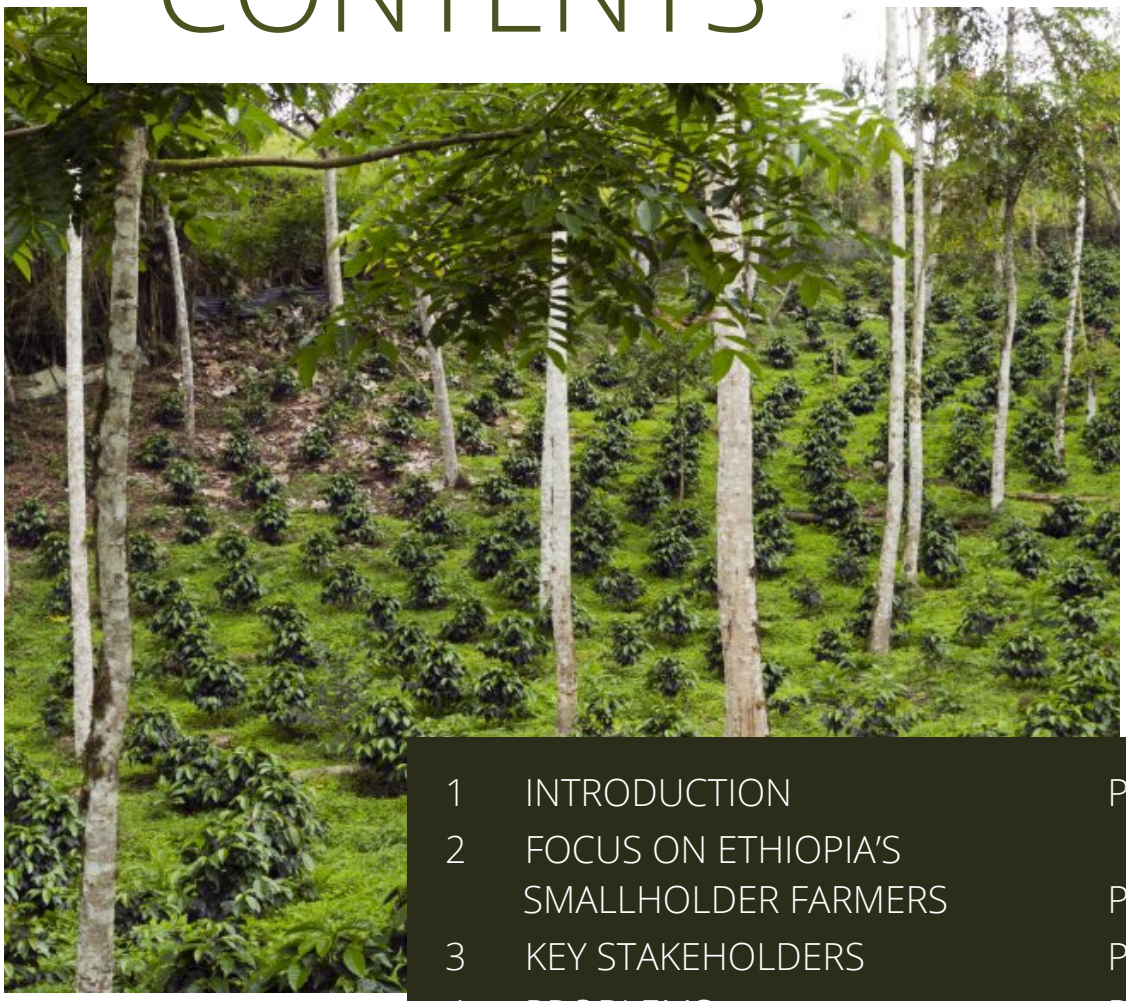


1. INTRODUCTION

£15B

Nestlé's revenue from coffee

Nestlé is the world's leading food and beverage company, whose main driver of sales is coffee, accounting for £15B[1] of revenue in 2018 (£72B total), distributed through its 7 brands - notably Nescafé and Nespresso. Nestlé is a major buyer of coffee, particularly of Arabica (the most favoured variety, representing 80% of the coffee market).

-2.7%

decrease in global production

The demand for Arabica is increasing at a steady pace, with an expected CAGR of 5.5%[2] in 2019-2024. However global production is declining, experiencing a 2.7%[3] decrease in 2019 alone, as climate change becomes a growing threat to this especially sensitive coffee variety.

50%

of land unusable by 2050

50%[4] of the global land currently used to grow coffee is set to be unusable by 2050 due to unfavourable higher temperatures and water supply challenges, induced by climate change. As a result, the 25 million[5] coffee farmers worldwide are increasingly vulnerable. They cannot produce enough under these harsh conditions and consequently struggle to provide for their families.

10%

of global Arabica supply

As Nestlé purchases 10%[6] of the world's Arabica, ensuring a sufficient and sustainable supply is essential to its business, today and in the future. Nestlé relies heavily on these farmers and its supply chain is highly susceptible to the impacts of climate change. Nestlé's could see a harsh decline in revenue if its coffee supply fails to meet growing demand. Thus, Nestlé must introduce a practical and sustainable solution to ensure coffee production targets are met.

2. FOCUS ON ETHIOPIA'S SMALLHOLDER FARMERS

Why Ethiopia

The focus of this report is on Ethiopia as it is the **5th worldwide Arabica producer** and **1st in Africa**, where coffee growing areas could decrease by **60% by 2050** (higher than the global average).[7]

This is particularly challenging as Ethiopia is a **low-income country**, poorer than all Latin America coffee-producing countries and **7th poorest worldwide**.[8] Its lower capacity to adapt is expected to heighten the impact of climate change. Moreover, the more tropical climates in Latin America are less subject to see coffee growing areas decrease. For example, top grower Brazil has experienced a production surplus in 2019 despite climate challenges.[9]

Why smallholders

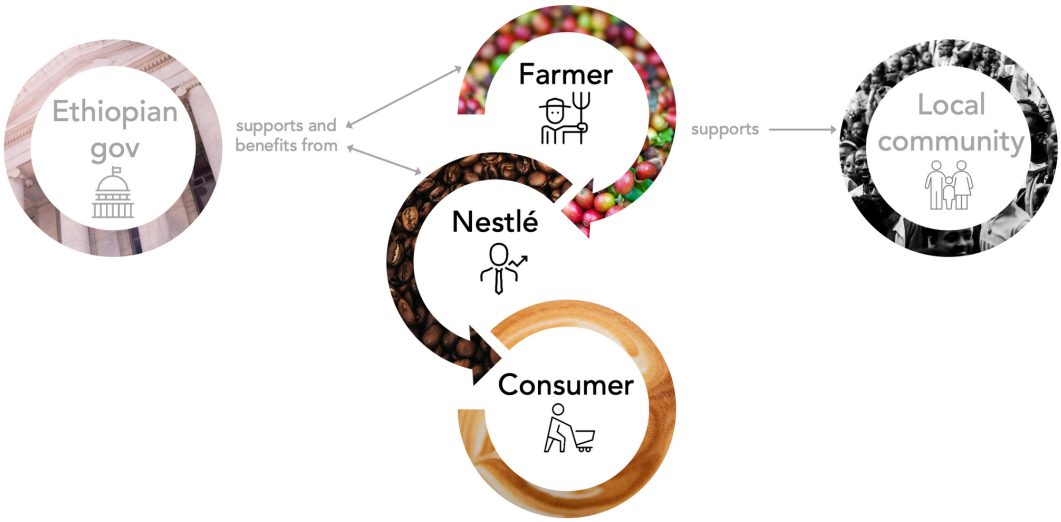
Ethiopia's **2 million smallholder coffee farmers** (working on farms of less than 2 hectares) struggle to fight climate change to save their coffee production, with their very **limited resources** (compared to large farmers).[10] This hits the country's production and population hard as **they produce 95% of the country's coffee and provide a livelihood for 15 million Ethiopians**.[11]

Thus, the following opportunity statement is a common thread for this report:

Ethiopian coffee smallholders need to **produce more coffee** under **climate change** to **satisfy global demand and provide for their families**.

3. KEY STAKEHOLDERS

There are 3 direct stakeholders, at different parts of the supply chain, affected by the coffee problem and impacting 2 indirect parties.

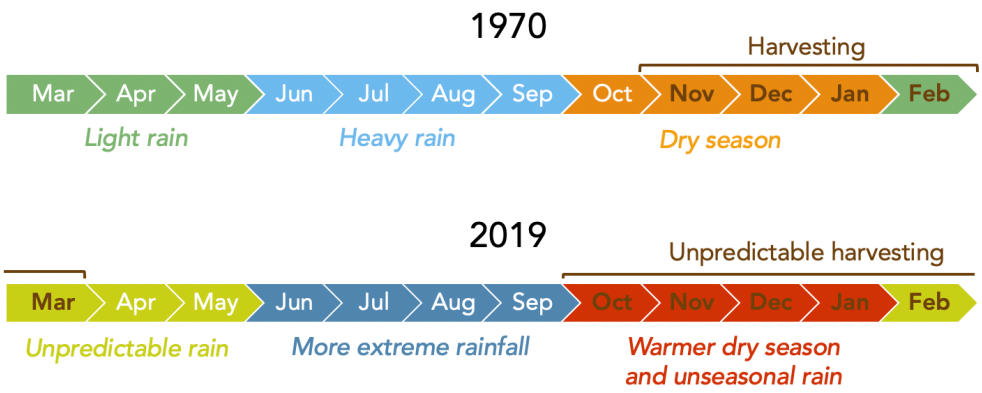


3.1. FARMERS

Fifty years ago, Ethiopia's three seasons were well defined and ideal for coffee's cyclical growth. However, with climate change, dry seasons are warmer and droughts last longer, while rain seasons are more extreme. Farmers struggle to adapt their production methods to these effects.[12]

“One year it’s too short, one year it’s too long.”

"It’s early October, the coffee plants should not have been blooming for weeks. This means low yield for this year." [13]



FARMERS - 3 PERSONAS

"PAUL"
(Paulig)

- 1 hectare
- Coffee trees are planted all over the crop.
- Selectively cuts stems to keep only most productive ones.
- Insufficient income. *"I make as much as my grandparents did before me, I can't afford to invest in my crops."*
- Low productivity
- Very high impact of climate change

JIMMY

- 2 hectares
- Most coffee trees are planted under the shade of larger trees, some are not shaded.
- Cuts stems, uses compost and protective plant layers on the land.
- Tight. income *"I just about manage to pay the school fees for my 6 children."*
- Moderate productivity
- High impact of climate change

"BOB"
(Brahanu)

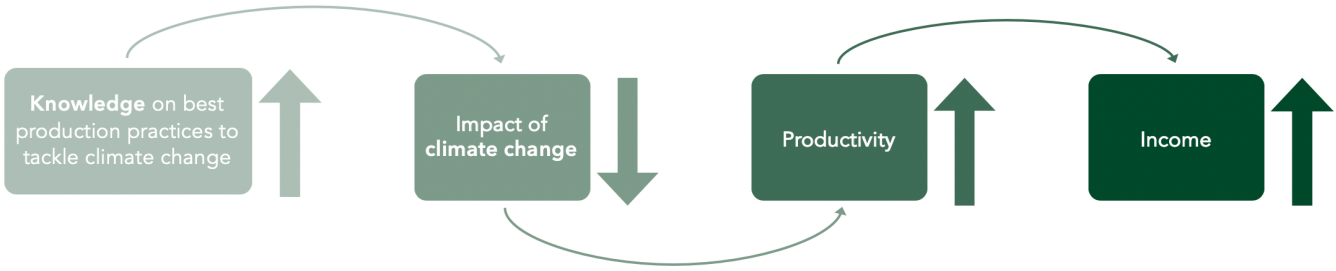
- 2 hectares
- All coffee trees are planted in a forest environment.
- Cuts stems. (reduced need for compost and layer due to forest environment)
- Just enough income. *"I can provide for my family, but with the price of coffee declining, it's getting harder."*
- Good productivity
- Low impact of climate change

Knowledge on best production practices to tackle climate change

−

+

When building farmer personas from the many testimonies found, relationships between different factors were identified:



When farmers' production knowledge is high, they are better equipped at tackling climate change, thus engendering superior productivity and higher income. Moreover, shaded crops tend to yield more.

3.2. NESTLÉ AND CONSUMERS

CHARLOTTE[14]

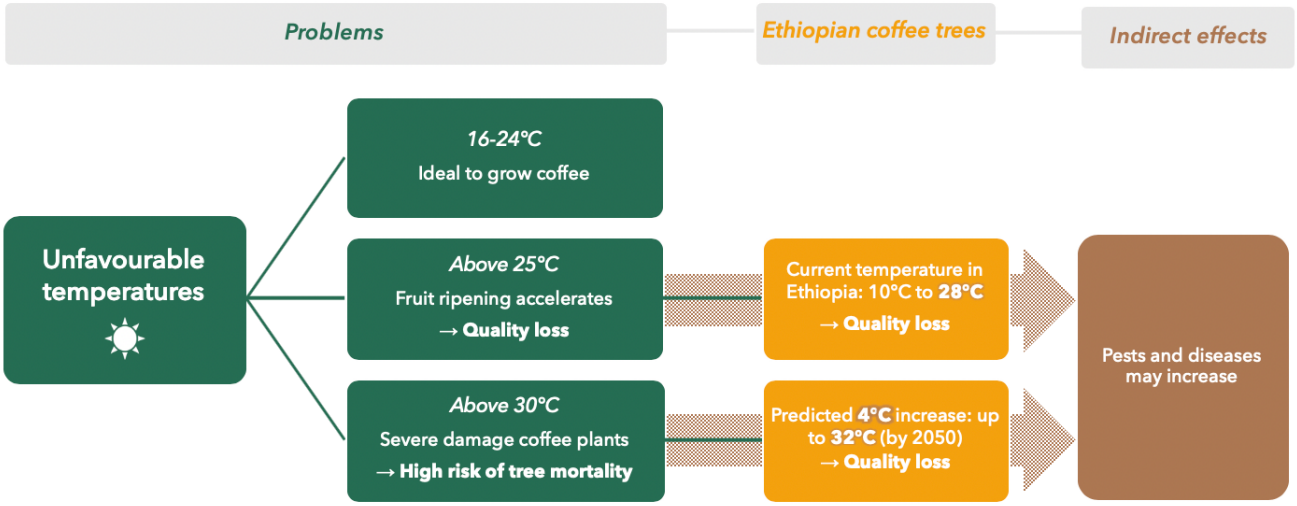
- Head of Nestlé Coffee, goals include:
- Increase coffee production by at least the demand growth of 5.5%.
- Expand organic range and improve quality of coffee.
- Help coffee farmers.

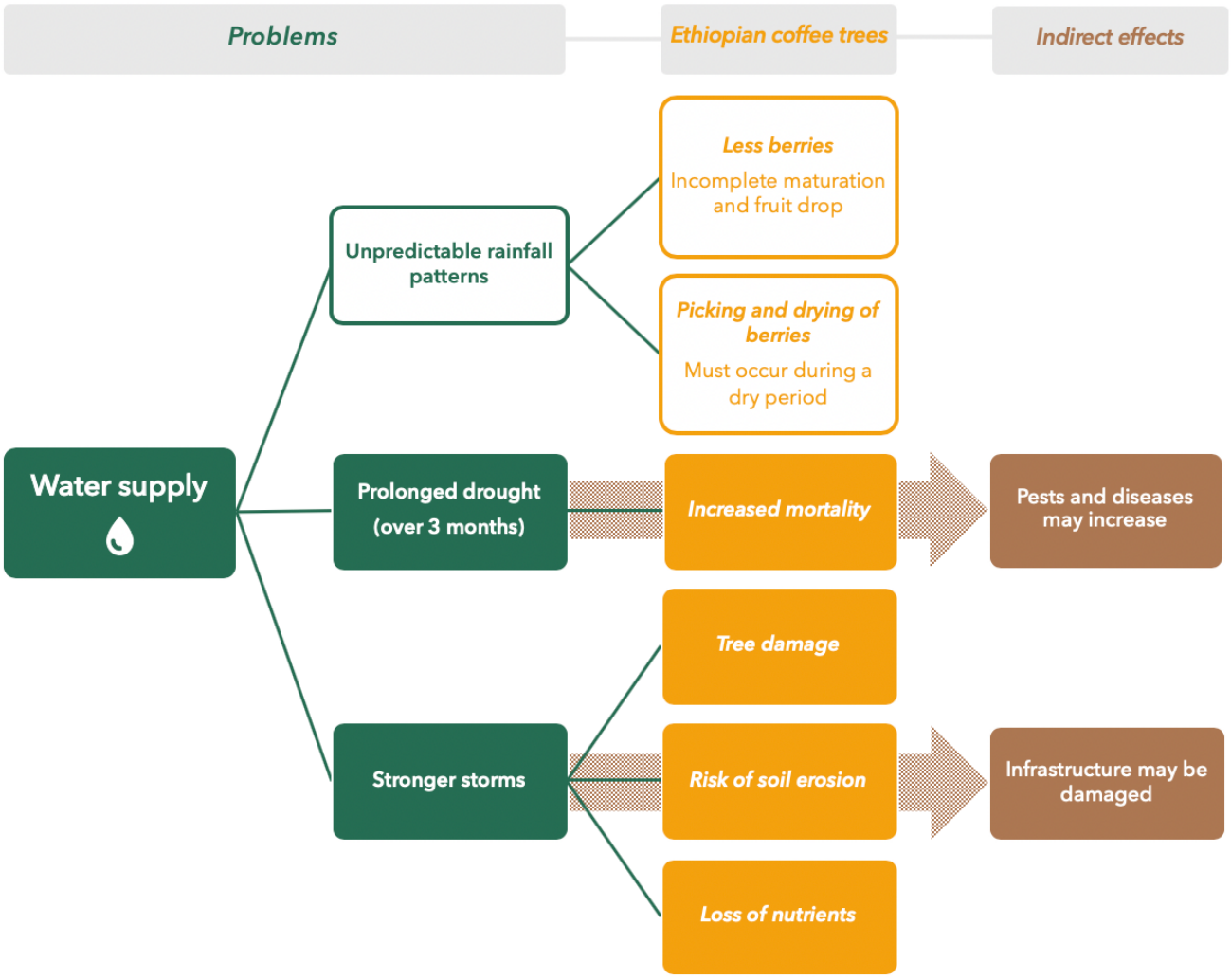
- Teaching Assistant
- Drinks 2 cups of coffee per day.
- Would pay slightly more for a cup of coffee that benefits the people who grow it.
- Wishes to consume more environmentally friendly products.
- Favours high quality coffee.

JOE[15,16]

4. PROBLEMS

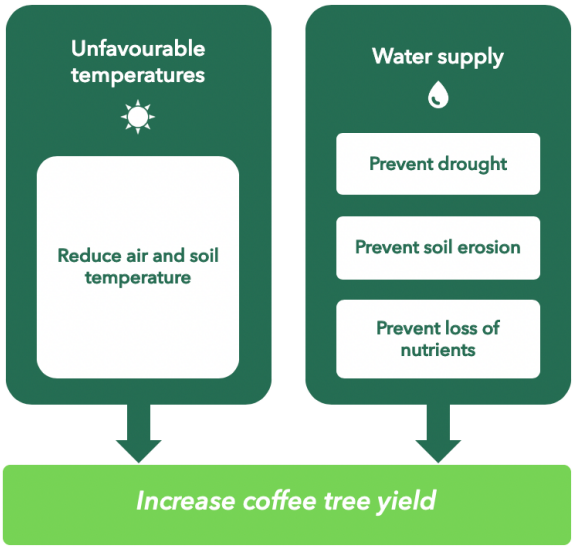
Climate change affects two main coffee growing conditions: **temperatures and water supply**. Problems within each condition can be further categorised, as shown in the following figures:[17]





5. SOLUTION REQUIREMENTS

In order to increase coffee tree yield, the potential solution must tackle unfavourable temperatures and water supply issues. 4 solution requirements were identified (white boxes):



6. POTENTIAL SOLUTIONS

How might we increase coffee tree yield? This report focuses on maintaining the yield of Arabica trees, rather than altering the trees (e.g., using hybrid seeds).

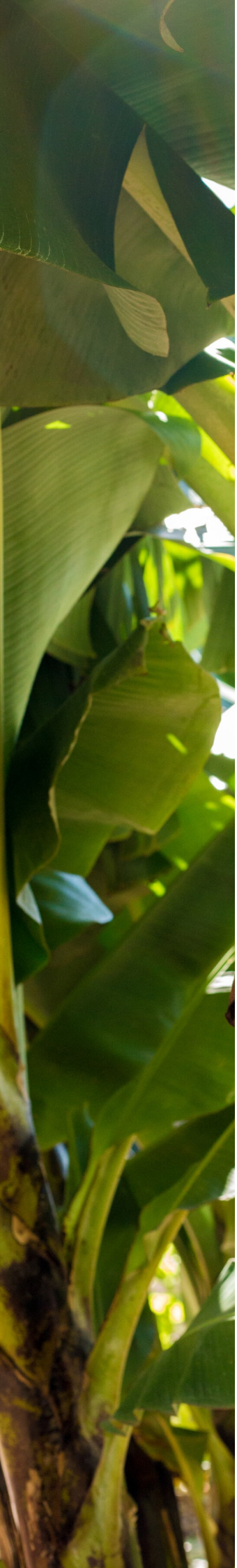
4 categories of solutions can be defined to tackle the climate challenges faced on Ethiopia's coffee crops (appendix 11.7):

- Protection of the plants with **shade trees**
- Increased watering with new **reservoirs and irrigation**
- More efficient use of resources thanks to **smart information technology**
- Boosting growth with **fertilisers and pesticides**

However, as not all solutions tackle all aspects of the problems identified, they make an **imperfect system**. A breakdown of the categories and their fit to the solution requirements can be found below:

Solution	Reduce air and soil temperature	Prevent drought	Prevent soil erosion	Prevent loss of nutrients
Shade trees	✓	✓	✓	✓
Reservoirs and irrigation	✗	✓	✓	✗
Smart information technology	✗	✓	✗	✓
Fertilizers and pesticides	✗	✗	✗	✓

This report explores **shade trees** as they constitute the only category fitting all requirements.



7. SHADE TREES

Arabica is native to tropical environments, thus it is not suited for garden and plantation production practiced by 55% of smallholders.[18]

Shade trees imitate coffee's natural environment and provide a suitable microclimate by:[19]

- **Reducing air and soil temperature by 4°C**, reducing the maximum temperature to **24°C** (ideal for coffee).
  - Indirectly decreases likelihood of certain diseases (e.g., **leaf rust**).
  - Indirectly reduces **frost damage** by decreasing day/night temperature fluctuations.
- **Preventing drought** by decreasing evaporation, and increasing air humidity.
- **Preventing soil erosion** by increasing water absorption.
- **Preventing loss of nutrients** thanks to nitrogen fixing.
- Additionally, they **reduce wind** and **air pollution**.

Thus, shade trees **naturally increase coffee yield** and **extend the productive life** of trees.

An optimal result is obtained by **intercropping** coffee trees with **a mix of non-fruit and fruit shade trees**.[20] While non-fruit trees create a larger shading surface, fruit trees provide a diversified income for farmers while offsetting the loss of extracting some coffee trees to replace with shade trees.

The **density** of shade trees needed is relatively low, with 62 shade trees per hectare.

Coffee grown under shade trees does not require pesticides/herbicides, thus can be classified as **organic** and can be sold at a premium price.

The **impact** of shade trees is an estimated **40% increase in coffee production**[21] once the shade trees have reached sufficient height (up to 4 years). This increase is in terms of weight of dried beans produced, thanks to decreased fruit falling, larger berries and increased tree stems.

8. ADAPTING SHADE TREES TO ETHIOPIA'S COFFEE

An evaluation of native Ethiopian shade varieties was conducted, in respect to coffee production. *The explanation can be found in appendix 11.3.*

	Growth time	Nitrogen fixing	Nutrient compatibility	Wind resistance	Price
Erythrina					£15

→ Ideal

	Growth time	Nitrogen fixing	Nutrient compatibility	Wind resistance	Price
Acacia					£27

→ Good but expensive

	Growth time	Nitrogen fixing	Nutrient compatibility	Wind resistance	Price
Ficus natalensis					£16

→ Good if already planted

	Growth time	Nitrogen fixing	Nutrient compatibility	Wind resistance	Price
Maesopsis					£10

→ Cheap and grows rapidly

	Growth time	Nitrogen fixing	Nutrient compatibility	Wind resistance	Price
Cordia africana					£14

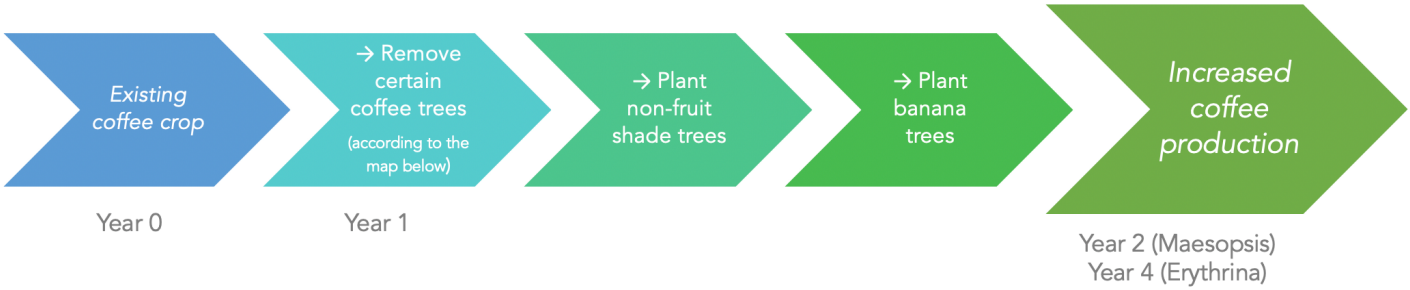
→ Easiest to find in Ethiopia

Erythrina presents the best characteristics with a mid-range price, thus it appears as the ideal option. However, **40% of Ethiopian coffee smallholders are too poor to send their children to school**[22] and require a lower-priced solution producing faster results. Erythrina bushes - taking three years - are not adapted in this case. **Maesopsis** is for them the best option as it is the cheapest and fastest growing variety. Erythrina remains the leading option for the remaining 60% of farmers.

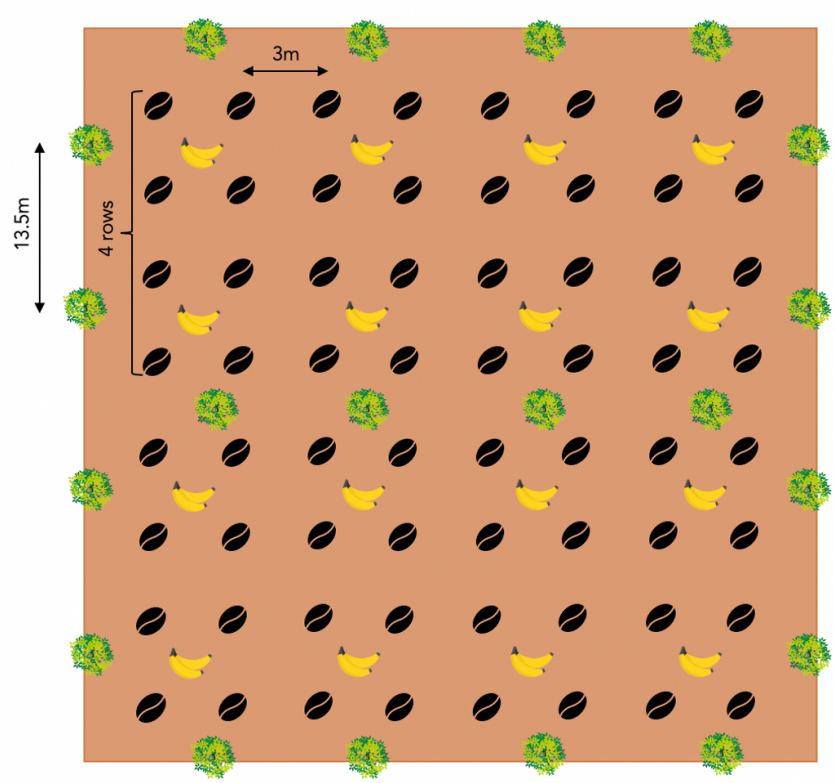
In terms of fruit-tree shade, **banana trees** are preferable due to their ability to moderately shade coffee plants and produce fruit from their first year.[23] Farmers can decide to consume or sell this produce. Banana trees require little labour and are compatible nutrient- and climate-wise with coffee plants. As a result, they are the best fruit tree to intercrop with coffee.

Thus, a **combination of Maesopsis and banana tree** is recommended for the poorest **40%** of smallholders, and a **combination of Erythrina and banana tree** is suggested for the other **60%**.

A process map for intercropping can be found below:



The following map shows how to efficiently implement shade trees:



9. IMPLEMENTING SHADE TREES

9.1. EDUCATING & ASSISTING FARMERS

Although the shade trees presented are native to Ethiopia, only **9%** of smallholders[24] select and implement the right shade trees on their own. There is therefore a need to inform and guide smallholders on the right trees to adopt.

The biggest obstacle is that farmers closely follow the decisions and beliefs of **local authorities** such as village elders, religious leaders or local teachers. Therefore, similarly to Syngenta's successful pesticide implementation[25], Nestlé will initially sponsor **6 "model farms"** of influential farmers in different Ethiopian villages (1 per producing region), for farmers around to witness the results of the shade tree strategy and gain trust in the proposed methods.

In order to maximise adoption, Nestlé should also **directly incentivise** farmers. Thus, the benefits of shade trees should be clearly explained. Additionally, as Nestlé understands that farmers have no financial buffer, the company would **guarantee** a certain level of production in the three years of implementation, and would **pay for the difference** if it is not met during this period. Lastly, banana trees should be promoted as an **added source of income** for farmers.

Local teams hired by Nestlé will then bring the selected bushes (planting grains would delay results) to all farms and assist the farmers in planting the shade trees. This enables faster planting as well as knowledge transmission to the farmers.

The following "**7 day +**" programme was designed:

9.2. IMPLEMENTATION COSTS

The cost of shade trees for Nestlé's Ethiopian smallholds is **£52M** (appendix 11.6). As the farmers targeted do not have the funds to invest £370-540 (cost per farm), Nestlé could finance the shade trees as the increase in production and quality, as well as the organic label, could significantly increase its revenue, and justify this expense.

Nestlé could split these costs with the **Ethiopian government and nonprofits** through partnerships, as its strategy is in line with their goals. Ethiopia intends to restore 22 million hectares of drylands by 2030 and support tree planting initiatives (such as a £1.1bn tree planting project in 2019).[26] Moreover, large organisations - e.g., FAO - are working with the Ethiopian agricultural sector to instore better practices tackling climate change.

10. IMPACT

Nestlé currently makes approximately £743M annually from Ethiopian coffee.

Implementing shade trees would become profitable within 4 years and increase production by **40%**. Assuming that all shade tree production would be organic, and that with growing demand for organic coffee Nestlé manages to sell all the coffee produced, **Nestlé would make £1.13bn from Ethiopian shaded coffee** (excluding inflation). Thus, shade trees could **increase Nestlé's revenue by £387M**, which more than offsets the £52M shade trees cost (and other tied costs such as onsite labour), potentially split with other stakeholders.

To conclude, financing a shade tree program would **benefit farmers, the environment and Nestlé's business**. The increase in production would improve the financial health of farmers and their communities, while respecting Ethiopia's eco-system, thus having a profound social and environmental impact. Lastly, Nestlé could ensure a sustainable and quality Ethiopian coffee supply despite climate change, guaranteeing a substantial increase in revenue.

For calculations, view appendix 11.6.

11. APPENDIX

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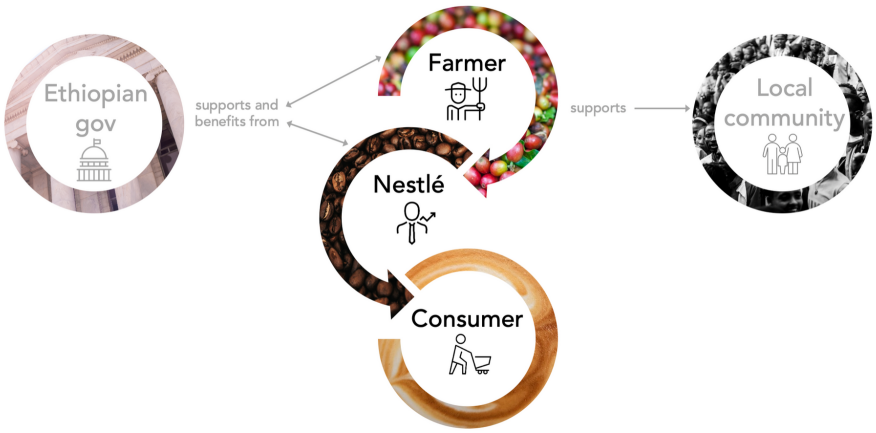
11.1. HOW WE HAVE USED DESIGN THINKING

A. Stakeholder map

In order to have a clear view of the organisations where the people interact with the system, we established the Stakeholder map of the process.



B. Personas

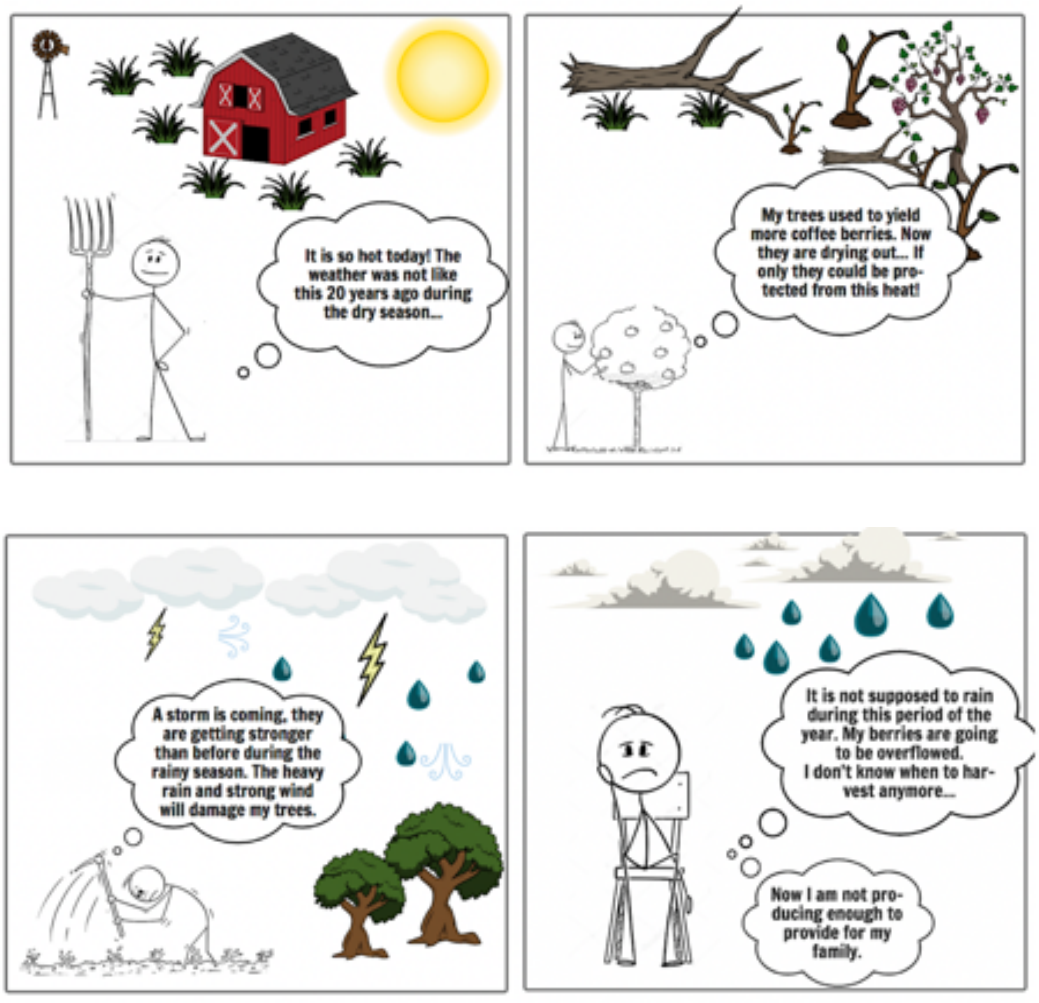
As it is discussed in the parts 3.1 & 3.2 of the report, we created personas of key stakeholders based on many interviews found online, with an emphasis on farmers (as they are at the basis of production). We placed **farmer personas** on a spectrum, based on an essential factor: Knowledge on best production practices to tackle climate change. This spectrum approach enabled us to insights, particularly relationships between different factors. The names of the farmers correspond to the real names of the farmers on the pictures, for more authenticity In order to get a global perspective on the problem, we also included a **Nestlé persona**, to understand and take into account Nestlé's goal within our solution for farmers, as well as the **average consumer's**.

C. Egocentric empathy gap

When we were given the challenge for this scenario week, we directly thought of a techy innovation to solve Nestle's coffee branch problems, drawing inspiration from the solutions of our previous report like the warka tower. However, after watching interviews of Ethiopian farmers and reading reports on their daily life, we were able to grasp their culture, realising how much influence village authorities had on farmers regarding their growing methods. Therefore, we saw that it is key to prove to them how efficient yet simple our solution is. We also realised that the simpler the solution, the cheapest and simplest it would be, and therefore the more convincing. Moreover, we understood the need for farmers to be educated on the rules and specificities of agroforestry, this is why we decided to create education and show off farms, to make it easier for farmers to learn the techniques from a real situation and see the results for themselves. By fitting the needs for a cheap (relatively to other existing solutions and efficiency), natural, and understandable solutions, in addition to reducing the risks of farmers, we managed to create a solution without the egocentric empathy gap.

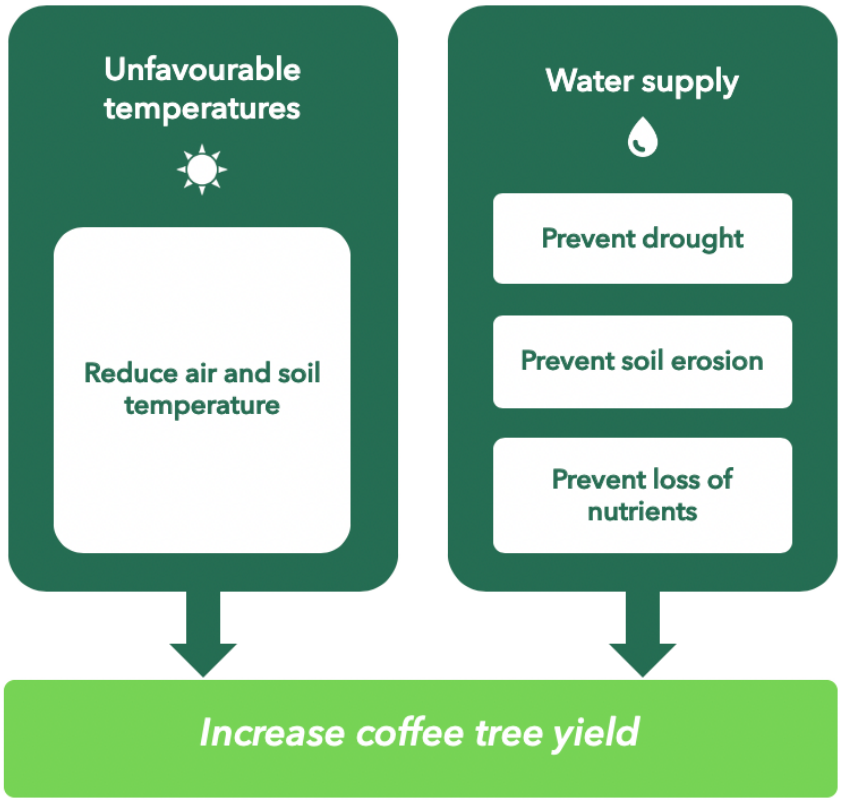
D. Story board

In addition, in order to provide a simple and understandable view of a farmer's life in Ethiopia, we have designed 2 story boards corresponding to different seasons (dry & rainy). This illustration is not in the main, but still represent a valuable source of information to deeply understand farmers' problems due to the climate change.



E. JTBD

We defined the **JTBD** under the form of solution requirements in part 5.



F. How might we?

We came up with solution categories using the **"How might we?"** approach (How might we increase coffee tree yield? in part 6) during a group **brainstorming.**

G. Imperfect system

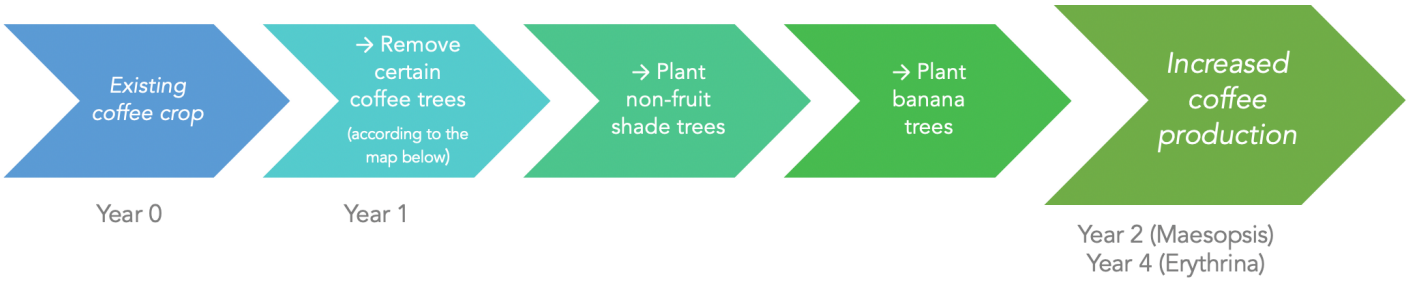
We described the **imperfect systems** made by the range of different solutions addressing our problems in part 6, in the shape of a table.

Solution	Reduce air and soil temperature	Prevent drought	Prevent soil erosion	Prevent loss of nutrients
Shade trees	✓	✓	✓	✓
Reservoirs and irrigation	✗	✓	✓	✗
Smart information technology	✗	✓	✗	✓
Fertilizers and pesticides	✗	✗	✗	✓

Once shade trees were chosen as the solution, we analysed a second **imperfect system** to choose the right shade tree variety **(part 8).**

H. Process map

We built a **process map** in part 8 to generate an overview of different steps taking the farmer from his existing crop to the time he achieves results.



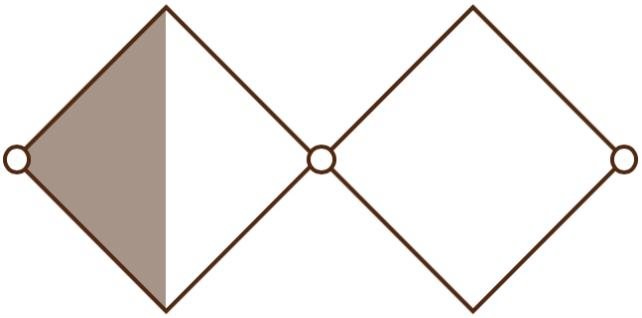
A detailed **process map** ("7 day + programme") was then defined for the implementation part of the process, in which Nestlé directly helps transform farmers' crops **(part 9).**

I. 5 Whys

Once we defined the technicalities of our solution, we had to strategically choose how to concretely implement it. Notably, we had to specify who should pay for the costs of implementation and how to make sure farmers implement it. Thus, before starting the implementation section in part 9, we took a step back using the **5 WHYs method**. We started with our introductory problem and worked our way down to what truly matters. We then realised 2 essential points: (1) an educational programme was needed to inform farmers and (2) farmers require financial support. Thus, we came up with our "model farm" approach, followed by hand-in-hand planting program financed by Nestlé.

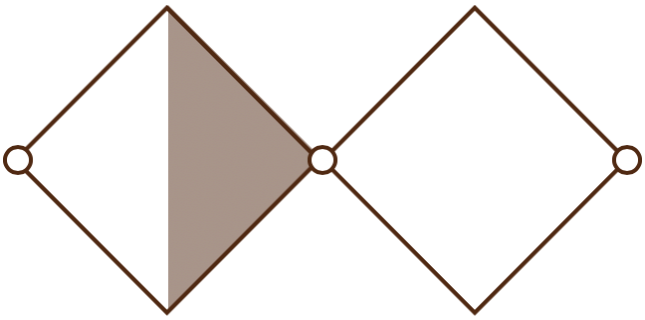
J. Double diamond

We used the double diamond approach when structuring our report:



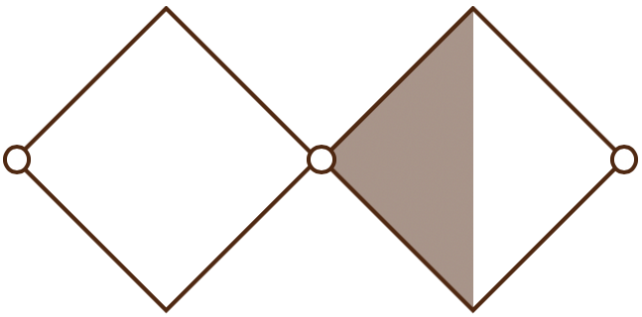
DISCOVER

1 INTRODUCTION



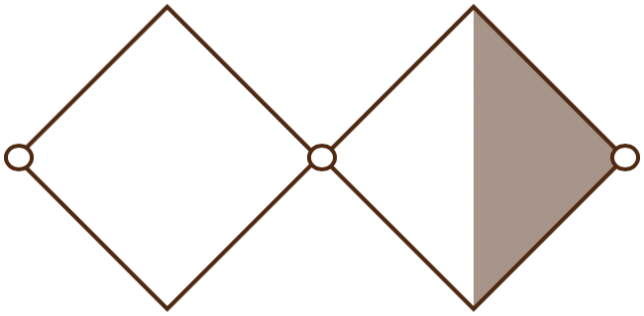
DEFINE

2 FOCUS ON ETHIOPIA'S SMALLHOLDER FARMERS
3 KEY STAKEHOLDERS
4 PROBLEMS
5 SOLUTION REQUIREMENTS



DEVELOP

6 POTENTIAL SOLUTIONS
7 SHADE TREES
8 ADAPTING SHADE TREES TO ETHIOPIA'S COFFEE

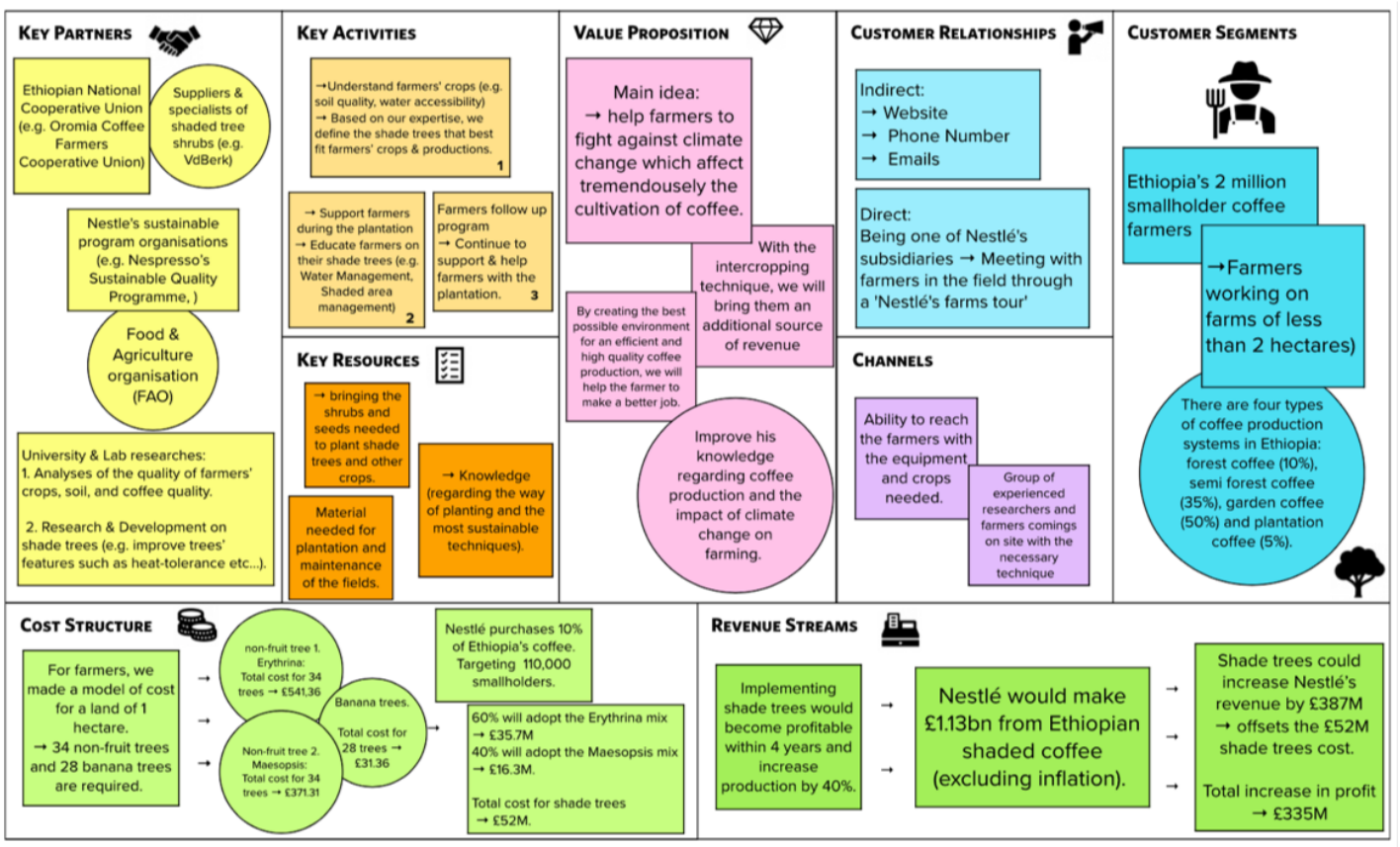


DELIVER

9 IMPLEMENTING SHADE TREES
10 IMPACT

11.2. BUSINESS MODEL CANVAS

Acting as one of of Nestlé's subsidiaries, we have established the Business model Canva of the multinational's branch.[27,28,29,30]



11.3. SHADE TREE DESCRIPTIONS

A. The acacia (Fabaceae)[31,22,33,34]

The Acacia is used as a shade tree mainly because of its fast-growing and windbreak capabilities. It also provides some edibles seeds that can be consumed raw or as some porridge. Originally from Australia, the best Acacia to use are the Acacia Colei and Acacia Torulosa. This domesticated desert tree is able to resist to really bad weather condition, to protect the crops, to increase the fertility of the soil and to fix the nitrogen in the soil which could limit the use of fertilizers. Our job, before providing the shrubs to the farmers, is to soak the acacia seeds in boiling water for 24 hours, and to put the seeds into the appropriate soil for it to germinate. Then, the seeds have to grow in an individual tree nursery to make it more resistant. Finally, if the farmer uses the Acacia as his shade tree on a 2 to 3 hectares of plantations, him and his family will have enough firewood for a year.

B. Erythrina (Fabaceae)[35]

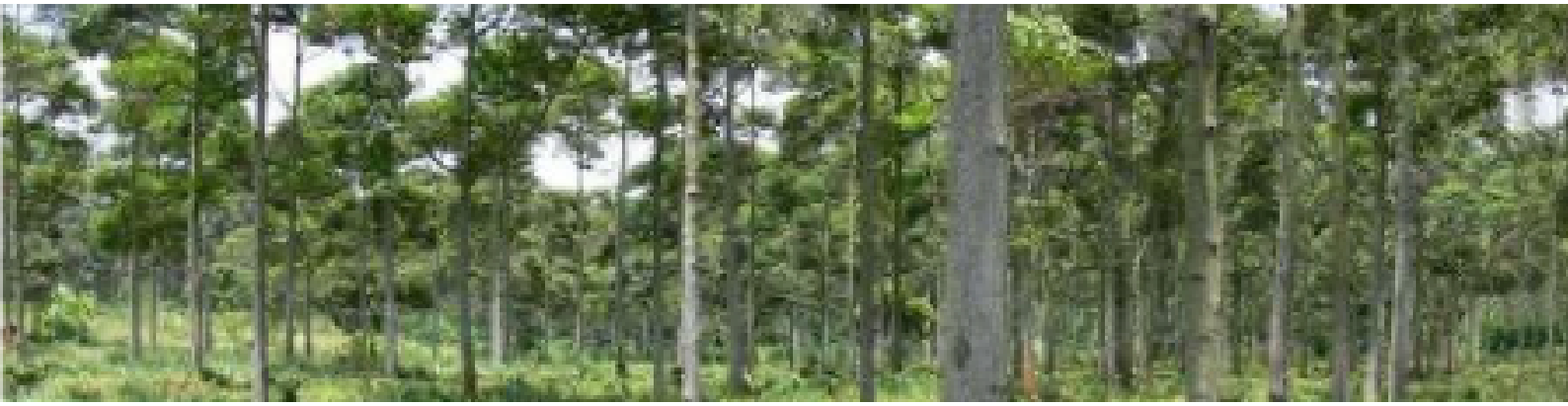
Nicknamed ‘the Coral Tree’, the Erythrina is a member of the Fabaceae family. This tree is already used by many different farmers who cultivate any kind of crops throughout the tropics. With its ability to grow in different kinds of soil (from sandy to almost muddy), it feels the best in the tropical lowlands and moderate rainfalls, which suits the Ethiopian weather. Moreover, it is an excellent nitrogen fixer which can live in poor soils. With favourable conditions, it is able to grow of 1.5m per year. It has a real ability to adapt what it needs to the trees that are around. It makes it really compatible with coffee plantation. With an overstory shade, it helps to keep a microclimate suitable for the coffee trees and a high rate of shadow during the day. It is also an excellent wind breaker. Our job, before providing the shrubs is to let the seeds grow in optimal conditions for at least 2 years to provide a shrub which will we useful as soon as possible for the farmer.

C. Ficus natalensis (Moraceae)[36]

The Ficus natalensis is the most massive shade tree which suits coffee plantations. It is a tall tree, which provide shade to coffee crops and is an excellent windbreaker. Within 3 to 5 years once it is planted, the root system of the tree maintains the soil and prevent from erosion. The tree also drops a high amount of leaves each year. These leaves rapidly decay and improve tremendously the fertility of the soil. If this tree is chosen, the farmer will have to cut the branches pretty often. It is additional work, but once the wood is dried, it gives an excellent firewood and enough for an average family for a year. This tree fits perfectly the coffee trees by using none of its required nutrients. However, it usually grows in humid areas, and struggles to live in a poor/dry soil. Also, it is a bad nitrogen fixer, which may be an issue for the Ethiopian farmers.

D. Maesopsis (Euphorbiaceae)[37,38]

The Maesopsis is the fastest growing shade tree. It is commonly used in the tropics in Africa for the monoculture plantations. Its trunk grows vertically, while its branches are exactly horizontal, which is the origin of its nickname: the umbrella tree. Thanks to this natural shape, it provides shade especially at the hottest hours of the day, when the sun is at its highest. With its fast-growing rate (2-4 meters per year), the farmer can easily cut some of its branches to make some firewood and can even sell some of it to create additional revenue. However, it does not fix the nitrogen at all, which may be an issue for the coffee plantations. It does not prevent erosion as its roots system is not really wide. Finally, some trees have died because of some fungus and insects which can be found in Ethiopia. Therefore, it is not a resistant tree. However, with its ability to grow really fast, it may not be a big issue as the farmer can replace the tree easily.

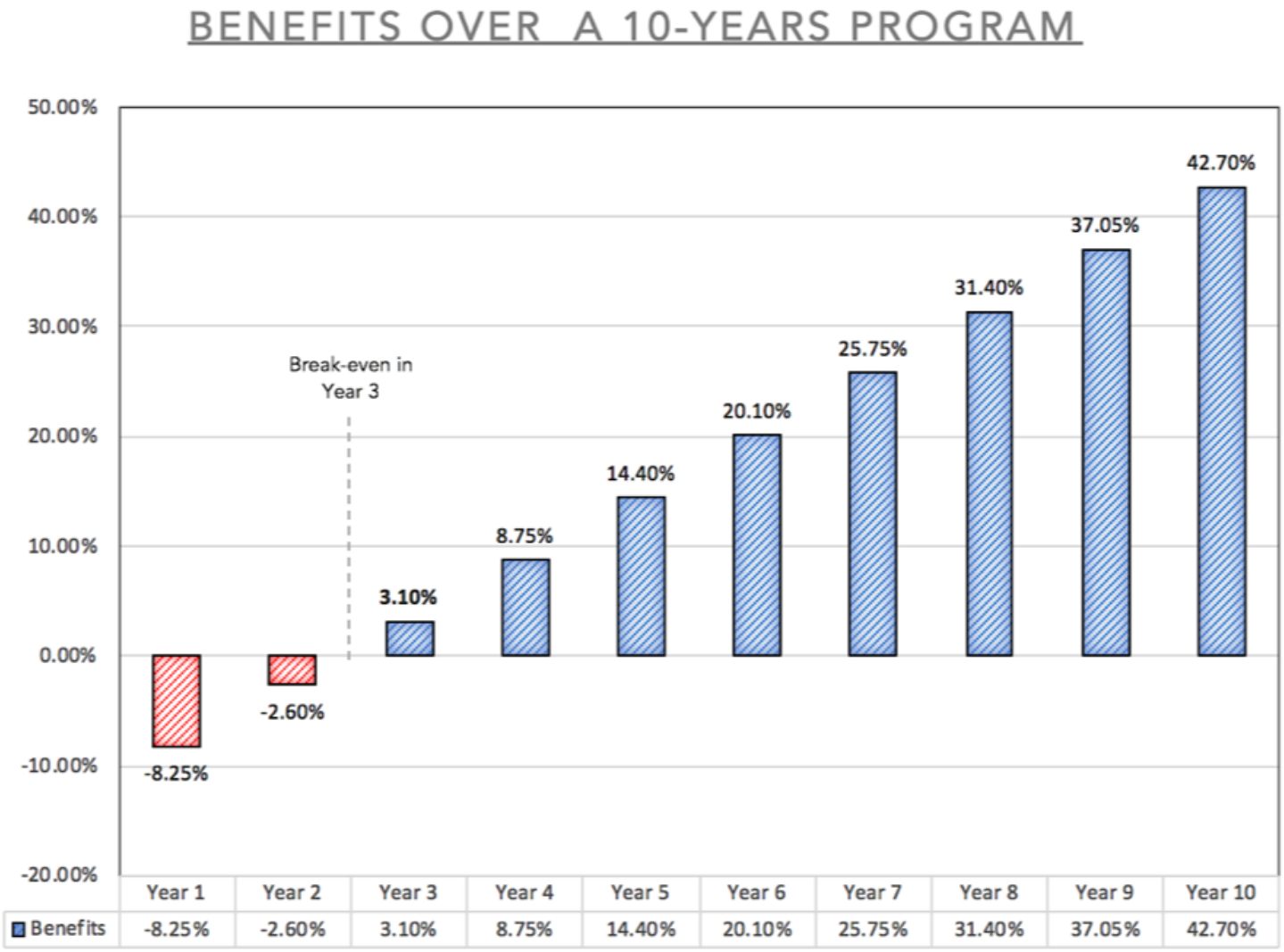


E. Cordia Africana (Boraginaceae)[39,40]

The Cordia Africana is the easiest shade tree to find in Ethiopia. The factor that makes the Cordia Africana one of the best shade trees are its leaves. With leaves which are 30cm long and 20cm large, it provides a real shade which lowers the temperature around it. By planting these trees around the coffee plantation, the farmer can create a microclimate which temperature is lower during the day, and higher during the night. These thick leaves also protect the plantations during big rainfalls. It has an ability to thrive in dry regions or during the dry season, by stocking some water in its trunk. Therefore, it can cut its demand in water for a couple of months. During these periods, it sheds its leaves which give some nutrients to the soil. Finally, it helps the productivity of the plantations by pumping the nutrients and giving it to the coffee trees. It is considered by many Ethiopian researchers and farmers as the most important tree in Ethiopia.

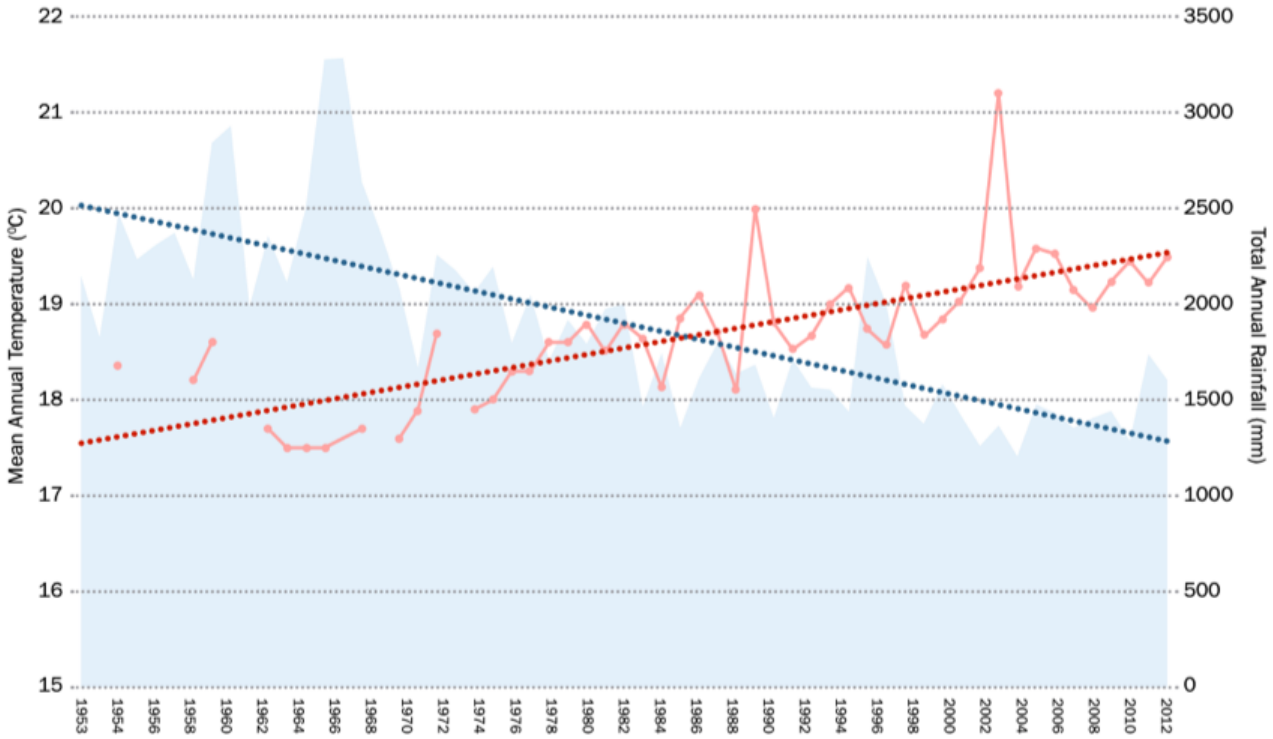
11.4. SHADE TREES PROFITABILITY: CASE STUDY

Shade trees implementation solutions refer to long-term programs. Depending on the type of tree, on the area to cover, and on the quality of the soil, the number of years required to build a complete crop with shade trees can vary. However, studies tend to agree that the break-even point occurs around the third/fourth years after the implementation of the solution. As an illustration, based on the One-Hectare Agroforestry Project from the Food and Agriculture Organization(FAO), this report points out the huge potential of the shade trees in terms of benefits over a 10 years period; despite the two first years characterized by a decrease in profit due to the first investments. This increase in benefit comes from 1) an increase in productivity from the yield of the crop, 2) a better coffee production (organic & fresher coffee).[41]



11.5. HISTORICAL CLIMATE DATA FROM ETHIOPIA

Historical climate data from Ethiopia, showing an increase in air temperature, and decrease in annual rainfall, since 1953. Dashed red line represents the temperature trend (increasing); dashed blue line represents the annual rainfall trend (decreasing).[42]



11.6. CALCULATION SECTION

A. Cost calculation

For farmers, we made a model of cost for an average land of 1 hectare with the chosen shade tree combination, knowing that 62 shade trees are required per hectare, thus 34 non-fruit and 28 banana trees (view previous land map for proportions). Below is a breakdown of shade tree cost per farm: Firstly, let note that **28 banana trees at £1.12 each equates £31.36.**

Tree	**Cost of shade trees**	**Total cost**
Erythrina	£15*34 = **£510**	£**510**+ £31.36= **£541,36**
Maesopsis	£10*34 = **£340**	£**340** + £31.36= **£371.31**

Nestlé purchases 10% of Ethiopia's coffee. By taking 10% of Ethiopia's 2 million coffee smallholders and targeting the 55% who produce garden coffee (no shade) within that population, we get 110,000 smallholders.

As discussed earlier, 60% will adopt the Erythrina combination (£35.7M total) and 40%, the Maesopsis mix (£16.3M). Thus, the total cost for shade trees is **£52M**.

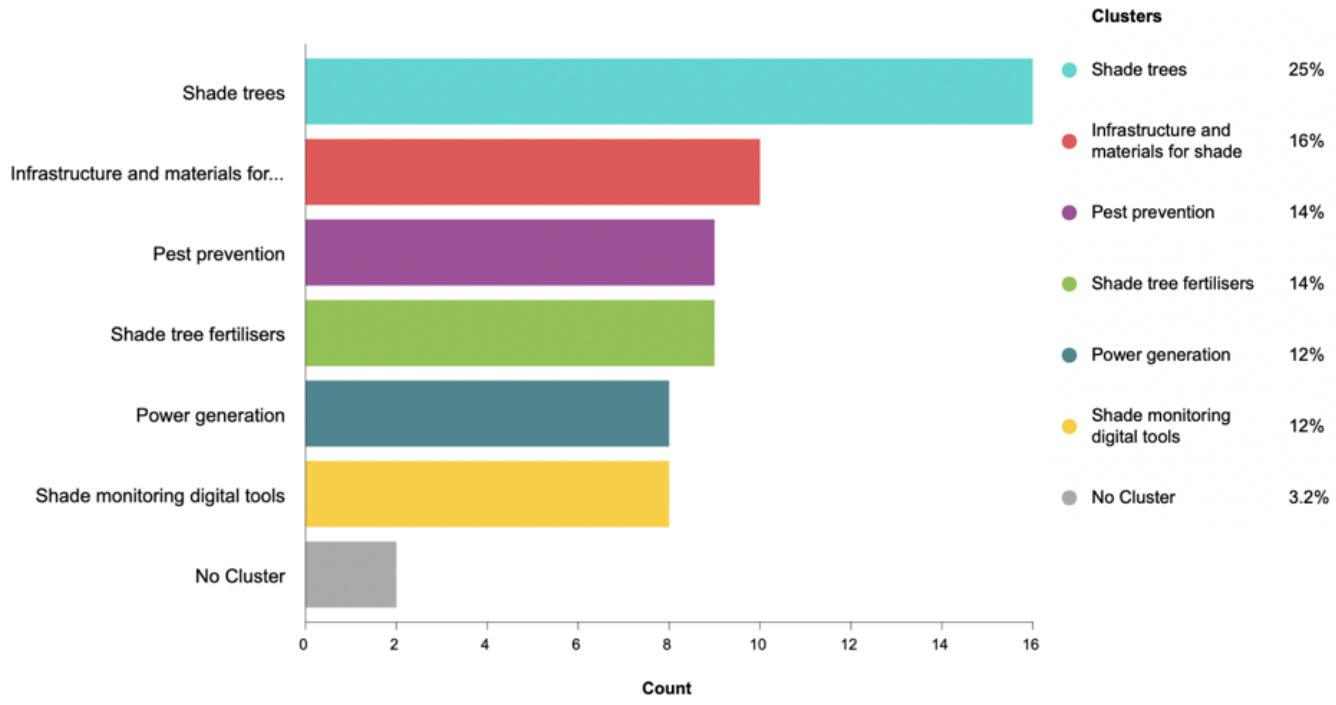
B. Impact calculation

Ethiopia produced 426,000 tons of coffee in 2018/2019, with 90% coming from smallholders, 55% from garden coffee and 10% purchased by Nestlé, bringing Nestlé's focus amount to 21,087 tons. Out of this, 20% is organically produced. Moreover, Nestlé currently sells its Instant Gold Blend (best seller) at £3.80/100g, and the organic version at £4.21/100g. Thus, Nestlé currently makes approximately £743M annually from Ethiopian coffee.

11.7. HOW WE HAVE USED QUID

Once we defined solution categories using brainstorming, we made QUID patent search for each category in order to better understand them. Below is the result of these searches and the explanation of why each one was selected/not selected.

A. Shade



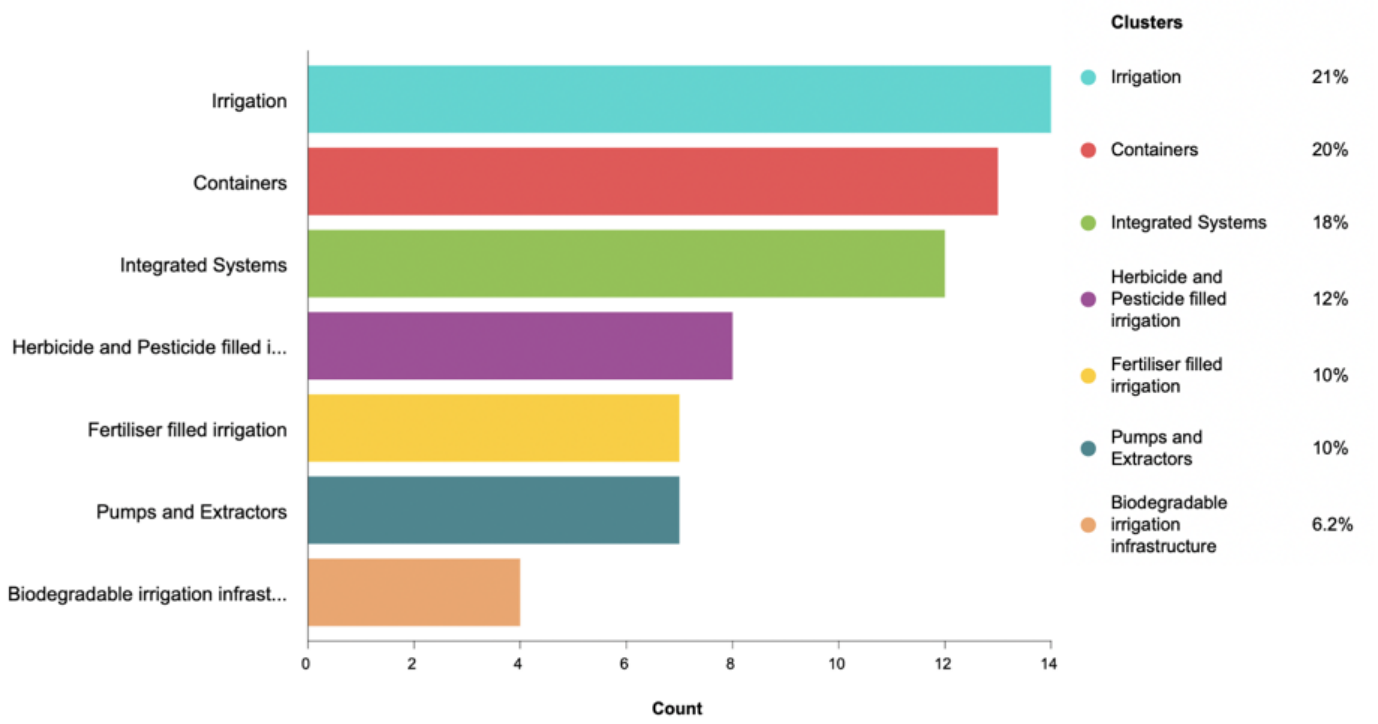
Patent bar chart with 62 patents
Query: (shade OR shading) AND (tree* OR method) AND agriculture

Shade solutions can be further broken down into natural (trees) and artificial (e.g., protective films).

It should be noted that shade trees are a much more widespread solution than reflected on this Quid chart. As planting different varieties of trees is an ancestral solution, shade trees are not patented.

Shade trees have a stronger cooling effect than artificial shade and naturally retain nutrients and can absorb excess water to prevent soil erosion, unlike artificial shade. Though shade trees require water, it is assumed that only varieties adapted to Ethiopia's climate will be selected for the final recommendation. Thus, only shade trees were kept as part of the shade category.

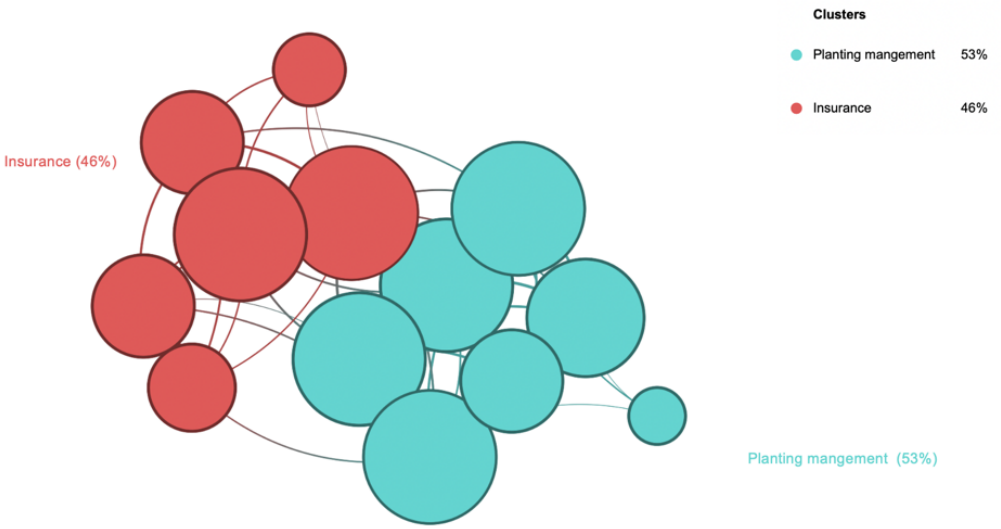
B. Reservoirs and irrigation



Patent bar chart with 65 patents
Query: 'coffee AND (plant* OR tree* OR trees OR grow* OR farm* OR crop*) AND (reservoir OR irrigation)'

Though optimal reservoirs and irrigation systems have the potential to solve water shortage issues, they represent a substantial financial investment which is not adequate for implementation across all smallholder coffee farms in a country as poor as Ethiopia.

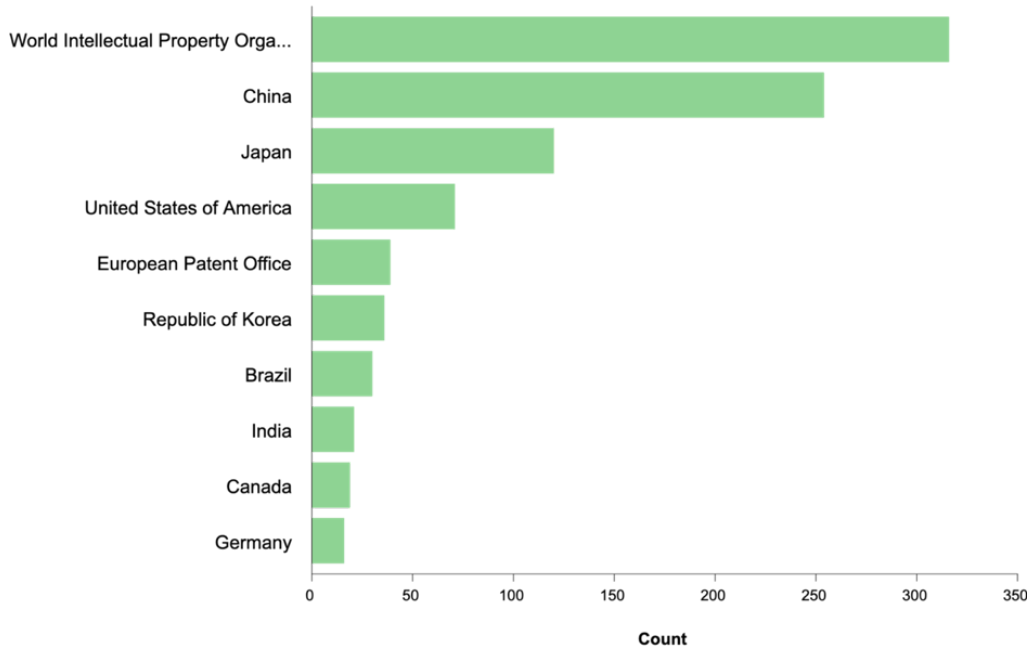
C. Information system



Patent network with 13 patents
Query: (plant* OR crop*) AND (forecast* OR "mobile application" OR predict*) AND poor

Information systems do not directly impact the solution requirements but can prompt the farmer to water at the optimal times maximising growth, hence they can prevent drought and help prevent soil erosion, thus improve tree quality. However, they were not kept due to temperature and water issues being too substantial for a simply optimising use of resources.

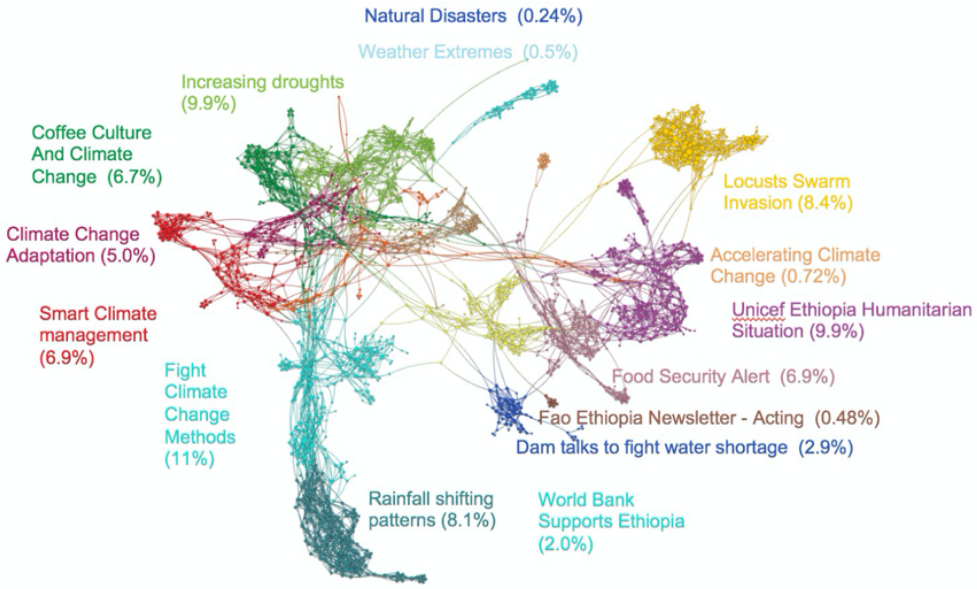
D. Fertilisers and pesticides



Patent bar chart with 922 patents
Query: coffee AND (fertili* OR pest*)

Due to the toxic nature of most fertilisers and pesticides available, they were not kept as a sustainable solution.

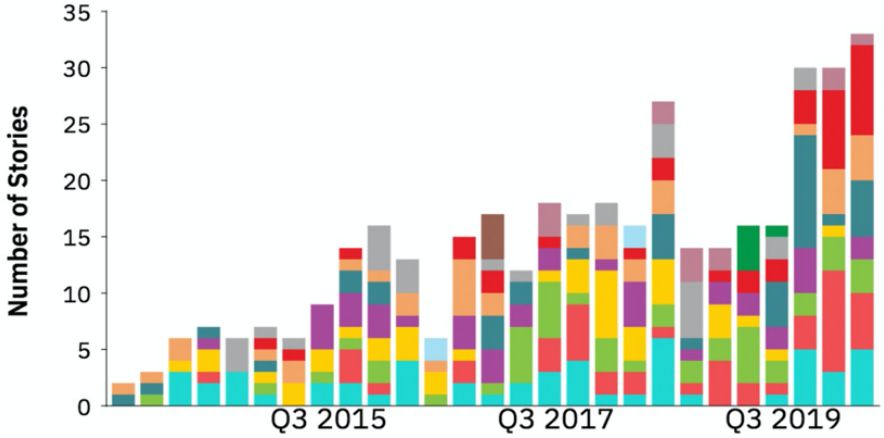
E. Climate change in Ethiopia



News and blogs network with 8.6K stories
Query: (Ethiopia) AND (climate change OR drought OR temperature change)

Ethiopia is also impacted by climate change regarding shifting rainfall patterns and increasing droughts. This affects the future of food and coffee production, giving birth to climate change adaptation methods like we do with shade trees.

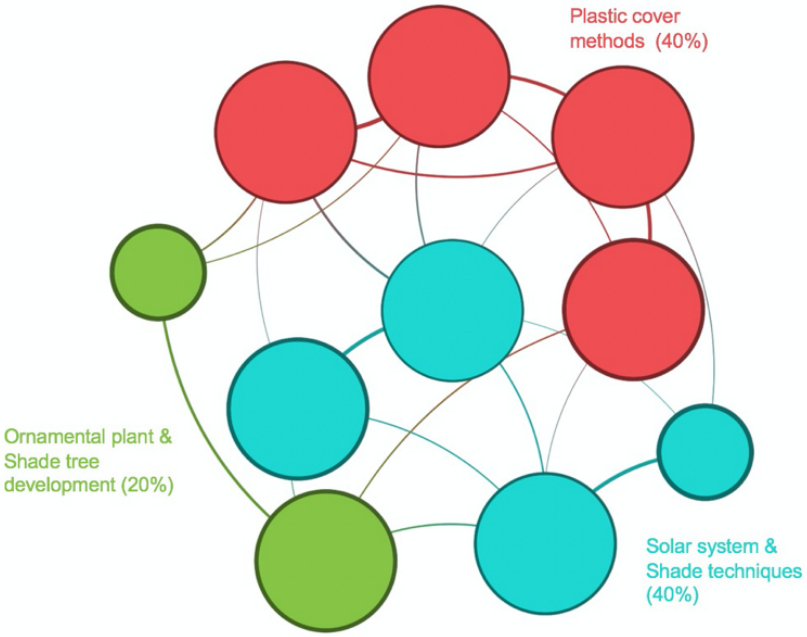
F. Shade trees in Ethiopia



News and Blogs bar chart with 561 stories
Query: (Shade OR shading) AND (tree * OR method) AND (agriculture) AND (Ethiopia)

There is an overall increase in interest on agroforestry and shade trees. Therefore, our solution appears to be built in a favourable economic and social environment. It is also because agroforestry is more and more spoken of that we chose to focus on this solution.

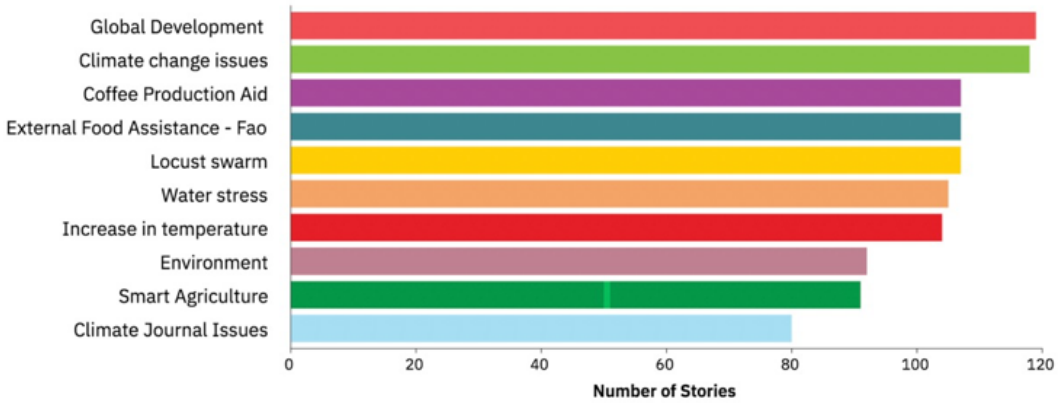
G. Shade trees and agriculuture



Companies network with 10 companies
Query: (shade OR shading) AND (tree * OR method) AND [agriculture](agriculture OR agricultural OR agribusiness)

10 major companies offer products to give shades in an agricultural context; However, only 2 use trees which highlights an opportunity for shade trees development solutions like ours.

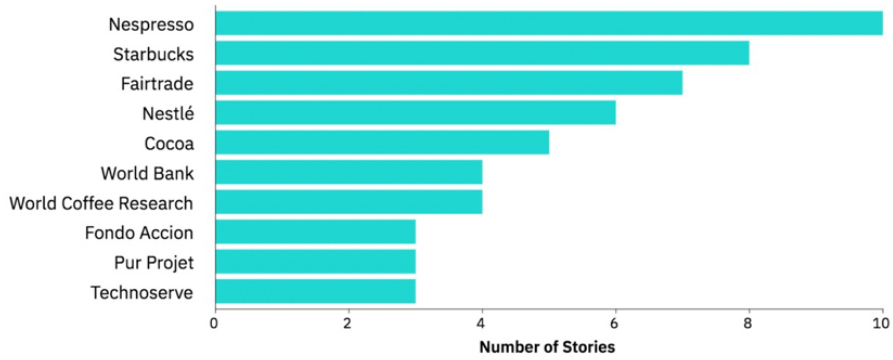
H. Farming conditions in Ethiopia



News and blogs bar chart with 1.8k stories
Query: (farmer) AND (conditions OR farming conditions) AND (Ethiopia)

We used this search to help us through making our personas. It illustrates the main problems that farmers in Ethiopia Face. The second biggest problem is the Climate change issues to which we try to give a solution.

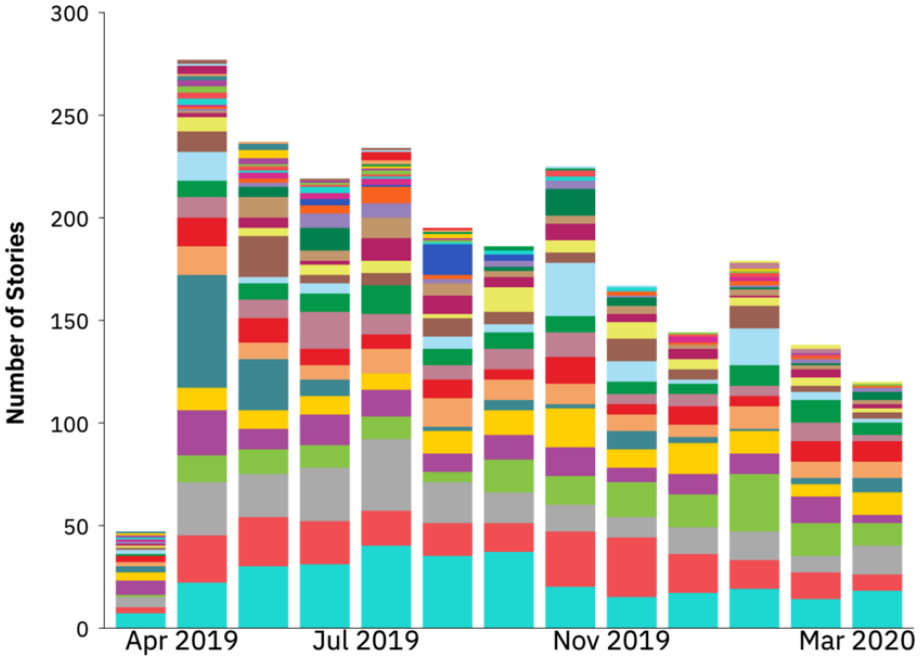
I. Shade trees in coffee production



News and blogs bar chart with 250 stories
Query: (Coffee production OR coffee industry) AND (Shade trees OR shade methods)

We made the query to identify the key actors in the shade tree development and it appears that coffee producers like Nespresso and Starbucks are the most interested. Moreover, it shows that Nestle is the leader in developing shade trees so we found a solution that corresponds to the organisation's focuses.

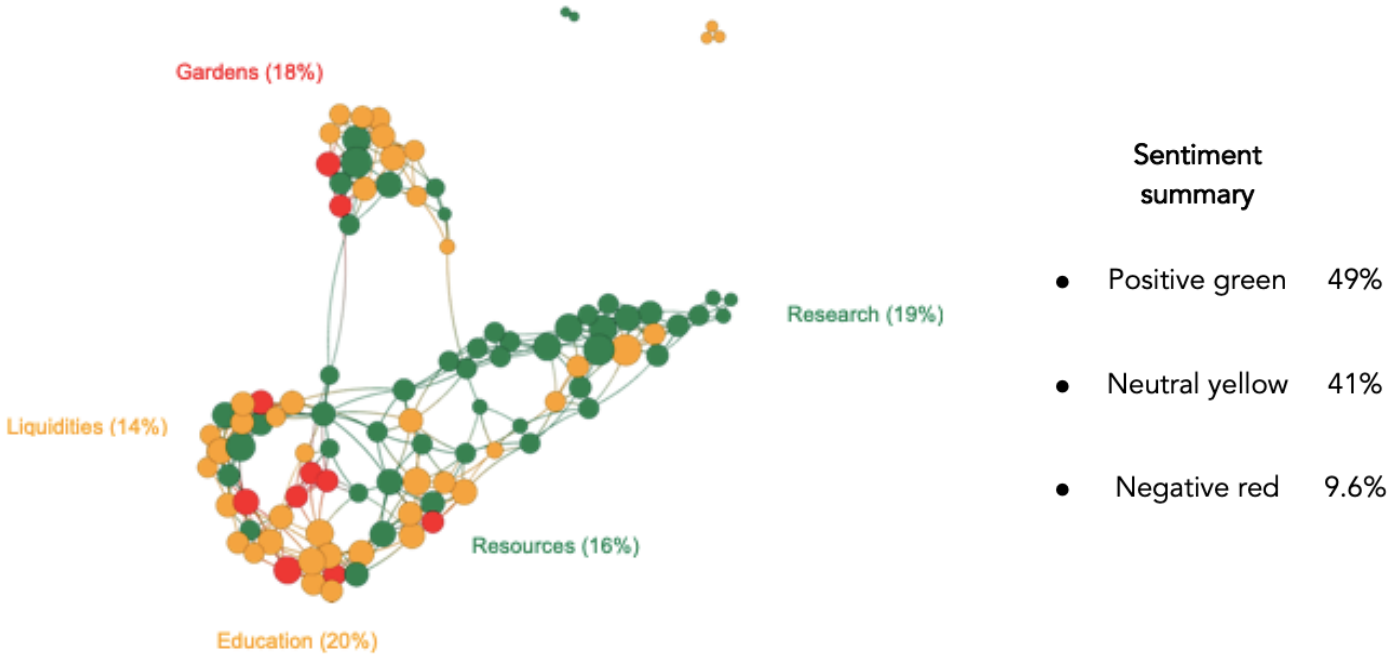
J. Shade trees in Africa



Query: "Africa" And ("Shade trees" OR "shade trees")

We made the query at the beginning of our research to see if this method was used or a long time in Africa in general for their agriculture or not. We can clearly see the difference between April 2019 and after, which shows that this solution is new. Due to the climate change, a lot of research have been made, a lot of trees have been tried.

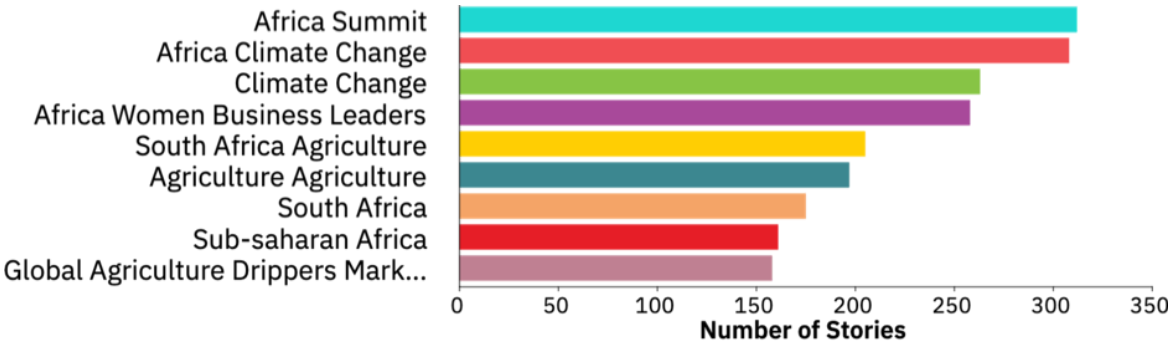
K. Shade trees' sentiment map



Query: "shade trees" OR "large shade trees" AND "names"

We made this query to have a sentiment map and to see how researchers and farmers across the world were feeling about shade trees as a solution. We can see from this query that people are enthusiastic about this solution, but not for small and private garden as there is probably not enough space. However, the research and resources are optimistic about it.

L. Acacia trees in african agriculture



Query: "acacia trees" AND "agriculture sector" OR "agriculture" AND "Africa"

Before choosing the best shade tree, we realized that the acacia was the most expensive one, and therefore, we wanted to see if it was used in the agriculture industry in Africa in general. Thanks to quid, we saw that the only coming out of the query was South Africa, which is the richest sub Saharan country. Therefore, we deduced that it was going to be too expensive for nestle and for farmers in Ethiopia, which is clearly a less developed country.

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