COSTA RICA

A Case Study of Roberto Mata's farm – February 2023

By Liam Worsley

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CONTENTS

PROLOGUE

Dearest reader, I hope this writing finds you well. My name is Liam Worsley and I am Sustainability Manager at Cafeology Ltd, a coffee company based in Sheffield, UK. This document has been written following my first trip to origin in February 2023 where I visited one of our long standing coffee producer partners in Costa Rica. During my stay, I lived on the farm, worked on the farm and tried to absorb as much information as physically possible.

This document's purpose is therefore twofold… partly to document my trip but mainly to provide a case study for coffee farming in Costa Rica – specifically the farming practises of Roberto Mata, and his family, located in the Dota valley of the Tarrazú region. I also aim to shed light on issues that Roberto's farm faces, many of which are related to climate change, where my expertise as Sustainability Manger come into play. I hope that you will find the information within this document as interesting and educational as possible. Perhaps readers may also feel inspired by some of the issues raised and said inspiration may yield potential collaborative action and solutions.

Liam Worsley pictured with Roberto's Geisha coffee trees at Las Nubes.

I will endeavour to communicate what I have learnt in the most accessible way possible. My aim is for this document to not only be read and understood by coffee professionals, and those with basic coffee knowledge, but coffee novices too. The latter being especially important, as I believe more people should have a better understanding of where their daily cup of joe comes from and the hard work before the coffee lands in the UK. Modern consumers typically want to know where their food comes from and coffee, being the second most traded commodity worldwide, should be no different.

It is worth mentioning that the information presented within this document was gathered during my trip to Roberto's farm where I only observed his farming practises. Therefore, the information that I present to the reader may not be true for all coffee farmers nor all Costa Rican coffee farmers for that matter. On the contrary, Roberto's farm is very unique in many ways. There will be many similarities that you may come across but coffee is a diverse industry and farming practises can vary dramatically across farmers and countries of origin. So please bare this in mind when making comparisons.

Another caveat relates to how I refer to whom the farm belongs. I have already referred to the farm as Roberto Mata's and, for the most part, it is his farm. However, strictly speaking the company is called Mata & Montero Pura Vida (Mata from Roberto's family name and Montero from his wife Doris' family name, while Pura Vida literally translates into "pure life", which is more than just a phrase but actually a way of life, appearing casually in nearly all Costa Rican conversation). Roberto is very much the face of the company (and by extension the farm) and he has the most experience but his family are also tremendously involved and thus not to be overlooked. Many of his family work on the farm as well as own shares in the company/land where the coffee is grown. Therefore, when I write "Roberto's farm", it is important to remember that the reality goes a lot deeper than just one man (even though he is an incredible man but that is beside the point).

In closing, I hope this document brings value not only to you, the reader, but also to Roberto and his family. The week I spent on the farm was extraordinary and, if I manage to capture the slightest piece of that within my writing, then I am delighted. This document is made to be shared so I implore you to share it with anyone who will benefit, especially Roberto who now has his operation fully documented for ease of communication.

Roberto Mata proudly pictured with his coffee at El Llano farm.

Overview of El Llano farm, featuring workers turning coffee that is sun drying on tarps.

INTRODUCTION

Who/where?

Roberto Mata is a 4th generation Costa Rican coffee farmer located in the Dota valley, near Santa María, within the Tarrazú region. His son Michael and grandsons Mario, Javier and Jose Alvaro also work on the farm and are 5th and 6th generation farmers respectively. Across the farm, coffee is grown in five distinct areas, covering 50 hectares total: El Llano (the plain) 1500 masl, Las Nubes (the clouds) 1700-1950 masl, La Pachuca (the nickname of the previous owner) 1600 masl, La Tuna (the catus) 1550 masl and Montes De Oro (mountains of gold) 1500 masl. El llano also contains the wet mill facilities for pulping and drying the coffee cherries, as well as solar power, accommodation, cupping lab, and a swimming pool that local people are free to utilise. The farm currently produces five varieties of coffee: Red Catuai, Yellow Catuai, Caturra (the main three varieties), Typica and Geisha but also contains other experimental varieties under trial which are not yet commercially viable. These five varieties are then pulped, dried and processed into washed, honey (black honey), natural and juicy (fermented) coffees. The coffee produced here is of very high standard, for example Roberto's honey process Geisha was awarded a score of 87.74 in the 2022 cup of excellence competition.

Roberto Mata and Bryan Unkles meeting for the first time in 2008.

Cafeology and Roberto

It was 2008 when Cafeology's co-founder Bryan Unkles first met Roberto Mata in Costa Rica. Roberto was the first farmer that Bryan met "in the field" and, at the time, Roberto was part of Coopedota (a coffee cooperative in the Los Santos area). In 2013, Bryan then celebrated Cafeology's ten year anniversary with Roberto in Costa Rica and also hosted Roberto at our home town in Sheffield in 2015. Over the years we have met during coffee Expos In the USA and even video called during difficult times in lockdown. It has been a pleasure buying Roberto's coffee and developing the relationship overtime. The latest development was Liam's solo trip to Costa Rica in Feb 2023 which is documented here! Following this recent visit, a full container of Roberto's coffee landed at the roastery in April 2023 and the entire team is excited to get the new crop to our customers.

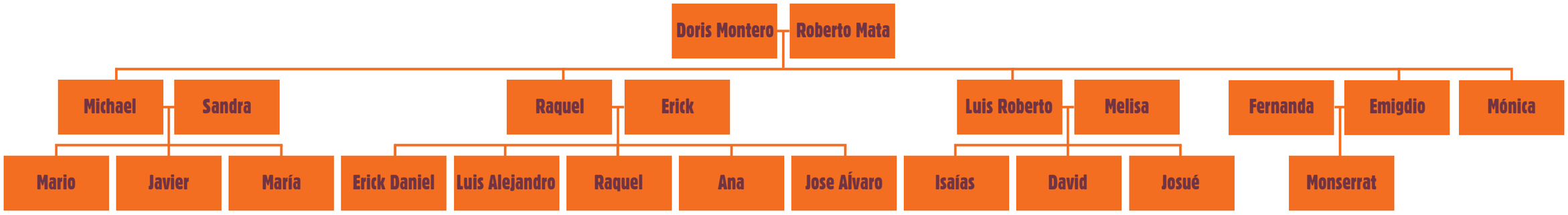
Roberto Mata and Bryan Unkles continuing their partnership in 2013.

Liam Worsley and Roberto Mata meeting for the first time in 2023.

The Mata-Montero family

Roberto values family above all else. So to write about his farm and not include the entire family would be impossible. Being a 4th generation coffee farmer means there is a long history of coffee within the Mata family. Moreover, not only does his son and grandsons work on the farm but his wife Doris and their children are all shareholders within the company. Roberto and Doris are lucky enough to have five children and twelve grandchildren. They all live nearby and not a day goes by without someone visiting and none of them can escape how coffee has touched and moulded their lives.

Roberto's great-great grandfather started coffee farming in the early 1880/90s. Later, Roberto's father was the first to implement crucial innovation, utilising new technology, new varieties, new processes and fertilisation techniques. His innovation upped the farm's yield from five fanegas per hectare to twenty-five fanegas per hectare (-fanega explained later-). Roberto is the youngest one of thirteen siblings, all of whom inherited part of the farm from their father. Out of the thirteen, only three are still left in coffee with the rest selling their share of the farm. When Roberto left the coop and moved to El llano, he began innovating with his milling and processing to add more value to his coffee. His passion for innovation and sustainability yields excellent coffee which is constantly improving. His hope is that he can maintain interest in the 5th and 6th generations to continue the Mata-Montero coffee legacy.



Doris Montero and Roberto Mata's familiy tree. Illustrating their five children and twelve grandchildren, 5th and 6th generaton coffee farmers respectively.

ICAFE

In the same vein as Roberto and his family, you cannot talk about Costa Rican coffee without ICAFE (the Coffee Institute of Costa Rica). Founded in 1933, ICAFE is a non-state public institution in charge of coffee production and exportation in Costa Rica and is regulated by law number 2762. ICAFE's objectives are: to promote unique and equitable production model among producers, millers, roasters and exporters; to support production, processing, export and marketing of Costa Rican coffee; to promote national and international coffee consumption; to research and develop agricultural and industrial technology; to approve a fair minimum price that goes to producers (farmers). Essentially, they are present at every step of the coffee's journey to guarantee quality, sustainability and traceability. Fundamentally, ICAFE protect everyone in the chain which creates a system that provides producer protection unlike anything else worldwide. This is crucial because, in most countries, the producer receives the least amount of money and has the least business knowledge.

Costa Rica has

~26,000 producers, ~290 mills and ~90 exporters (some do just one, others two or all three) with 5 or 6 exporters exporting 75% of the coffee produced nationwide. ~92% of producers are small scale (<2 hectares) so they deliver their coffee in fruit to a mill. The miller will process the coffee and sell it to an exporter at the best possible price. This transaction is set out in a contract which must be approved by ICAFE. At the end of the harvest, ICAFE inform the mill of their final average sale price. By law, the exporter and miller have a right to keep a percentage of the profit and an amount to cover expenses – the rest must go back to the producer (aka the final liquidation). Thus, a producer, with no knowledge of the global commodity market, can rest assured that they are receiving the best price for their hard work. Exporters can earn a maximum of 2-5% whereas millers earn 9% of the total value. On the other hand, producers earn 80% which is the largest percentage that a coffee producer earns anywhere in the world.

Sustainable coffee must balance environmental, social and economic issues. ICAFE ensure that research and development carried out by one farmer, miller or exporter is shared with all. Therefore, everyone has access to cutting edge research. Farmers are taught the importance of cupping, so they know how their coffee tastes, to help improve the quality of their product. Farms must be agroforest ecosystems that are majority shade-grown to reduce the need for herbicides etc. Millers must abide by laws governing usage, treatment and purification of water. All coffee must be produced with respects to human rights (including child labour laws). Exporters are required to put various safety measures in place when moving coffee in containers. All coffee exported must also be checked that it is indeed 100% genetically Costa Rican. The list goes on but the result is quality coffee without exploitation, produced in harmony with nature, and sold at a relatively higher price because it is worth that price.

What is coffee – The basics

Coffee is more than just brown beans that a barista grinds to make your morning latte. Many books exist that explain exactly what coffee is, in excruciating detail, better than this paper has the capacity to do. However, it is prudent to include some basics, so that the rest of this paper makes sense as a self-contained document.

Coffee grows on trees, in countries around the equator, within the tropics of Capricorn and Cancer (aka The Coffee Belt). These trees produce cherries that contain two seeds each. These seeds (aka beans) need to be removed, dried and roasted before you can think about drinking anything. There are >100 species of coffee identified however only two are available commercially: Arabica and Robusta. Arabica is the majority of coffee produced and Robusta yields only 30-40%, mainly because arabica tastes better but both have various varieties with different flavour profiles. Arabica can be basically classified, according to bean density, as hard bean (HB), good hard beans (GHB) and strictly hard beans (SHB) (SHB also interchangeably used with SHG = strictly high grown). HB are the least dense and SHB the most dense. Density is proportional to the altitude that the coffee is grown at – higher altitude means more dense coffee. More dense coffee (e.g. SBH) tastes better and holds up better during roasting, so SHB are preferred by speciality coffee roasters, which means coffee grown at high altitude is preferred.

In the 1980s, most coffee was sold as HB, GHB or SHB according to country of origin. In the 1990s, coffee was beginning to be sold according to regions too (e.g. Tarrazú, Costa Rica, SHB). Come the 2000s, consumers want more specialisation into estates. Micro-lots were introduced in the 2010s. Now, consumers want more boutique coffees, separated by all the above categories as well as by variety and processing method. Evermore recently, weird and wacky fermentation methods are the next best thing available to consumers. Each innovation becomes increasingly more specialised to produce a product that is more unique than the last. In essence, this is the evolution of speciality coffee and, by extension, the producers/millers/exporters that need to keep up with demand just as much as roasters.

Ripe coffee cherries, on the branch, ready for picking.

Red and Yellow Catuai varieties in the back of a truck, heading to the wet mill for processing.

Liam's haul of Red Catuai (left) and his mentor's Yellow Catuai (top - picking out unripe cherries).

COFFEE FARMING

Coffee production can be broken into four parts:

Growing & harvesting

Wet milling

Dry milling

Exportation

Roberto pictured with his coffee resting in parchment, sealed in reused hessian sacks.

Growing and harvesting are relatively straight forward concepts. A farmer and their workers will plant, grow and maintain their crop of coffee trees over the course of a year (much like any other commodity). Then harvesting takes place over a three month period, when the cherries are ripe. Wet milling is the first stage of processing after harvesting. This involves the removal of the cherry's pulp and/or mucilage (but not always), before drying in the sun and/or with mechanical dryers. After wet milling, the coffee is dry but still covered in a hard parchment. Dry milling is the next stage of processing and involves removing the parchment as well as classifying the coffee in terms of size, density, colour and taste. Once dry milling ceases, the coffee is prepared for exportation around the world (usually in shipping containers) to end up in roasteries where the raw coffee is roasted, packed and sent to cafes or homes for brewing, drinking and enjoying.

It is possible for each of the four parts to be done by different parties. A farmer might have just enough land to grow and harvest coffee but no room for drying. So they send their cherries to someone else with space and capacity for wet milling but they may not have dry milling facilities. So the dried coffee, in parchment, goes to a dry mill which can be separate from the exporter. In Roberto's case, his operation covers growing and harvesting as well as wet milling. His dried coffee is then sent to Coricafé who deal with dry milling and exportation. Having the wet mill facilities allows Roberto a lot more control over his final product. Additionally, it means that his costs are reduced since he does not need to pay someone else to dry his coffee for him (usually), and he can also rent his wet milling facilities to other farmers if they lack facilities/ drying capacity.

Naturally, the four parts mentioned above are a massive simplification of the entire process. Each part is as intricate as the next and, will be broken down in chronological order and explained in further detail beneath subheadings.

Cupping (tasting) the same coffee at low altitudes (caliente = hot) verses high altitudes (frio = cold).

Liam turning coffee that is drying on the floor inside the greenhouse at El Llano farm.

Growing coffee

There is only one harvest of coffee a year in Costa Rica so growing coffee runs annually. The rainy season begins in May and runs until November. Once the rain stops in an area, 12 days later you get mass blossoming on coffee branches. Plantations are covered in small white flowers as far as the eye can see, and the air fills with jasmine aroma for 2 days until the flowers die. Approximately 9 months after the end of the rain, each blossom has now become a ripe cherry. Harvest season begins once the cherries are ripe (August to March) but ripening times, and by extension harvest times, vary due to farm altitude. HB (at lower altitudes) ripen first, then GHB (at higher altitudes) and then SHB (highest altitude) are the last to ripen towards the end of the season. Due to the altitude of his farms, Roberto's harvest season is January to March (3 months long).

Banana tree canopy providing shade for the coffee trees below.

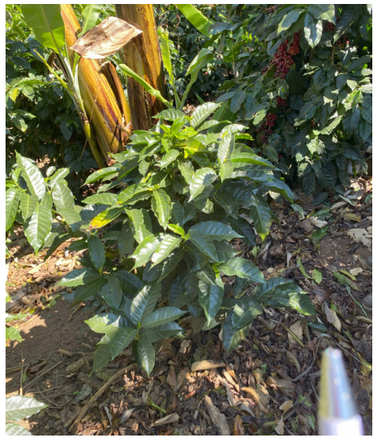
So in between harvest seasons, coffee plantations need to be maintained by planting, pruning, fertilising, etc. Roberto's farms are typically on the sides of mountains (like most coffee plantations) with coffee trees planted in rows 2 m apart, with 1.5 m between each tree. The trees are planted in slight terraces that cut slightly into the incline with small trails behind. This helps reduce erosion but also allows pickers to work along the rows of the terrace, without scaling up the mountainside carrying full baskets and risking spillage.

Banana tree providing shade for coffee trees.

Bananas (to be collected) and underfoot leaf litter.

Every 10 m Roberto grows banana trees. Banana trees provide shade for the coffee trees with their large leaves. Growing crops in the shade sounds counterintuitive, and there are some benefits to no shade (mainly higher yields but this is not as good as it sounds – more to come), however shade growing is important for many reasons. Mainly, sunlight is required for photosynthesis and photosynthesis is one requirement for the coffee trees to grow and produce fruit. This explains why no shade plantations produces higher yields but no shade actually harms the trees because there is such a thing as too much sun. Coffee trees grown in the shade might produce lower yields but the coffee tastes nicer and the trees live longer lives. When you plant a coffee tree it will take 3-4 years before the tree produces fruit, and reaches peak maturity on year 5. Then every 7-8 years (or sooner if the tree looks tired) they are pruned low down. Pruning is important because when a coffee tree flowers, that flower will only bloom once and therefore only produce fruit once. When picked clean of fruit, a branch will never grow cherries again. So pruning is crucial to allow trees more room to produce new branches (else you would have tall trees, empty of fruit except for where it is too high to pick!). Roberto's trees last for approximately 30 years after their first prune, if the tree is sufficiently looked after. Once a tree has reached the end of it's life, it is pruned at the base (killed) and then seeds are planted where the old tree was. Sufficient shade is one part of the puzzle that helps Roberto's trees live long lives, require less pruning and produce higher quality coffee.

Fertile soil is critical in all agriculture and coffee is no different. Keeping soil optimally fertile is difficult and has major consequences if there is too much or too little nutrients in your soil. A large part of what makes soil fertile is available Nitrogen (i.e. Nitrogen in specific molecules that are available for plants to absorb and use) because Nitrogen is vital for life via protein synthesis and therefore plant growth. Nutrient rich trees are stronger and produce better tasting coffee. Inorganic fertiliser is used by most farmers worldwide to make sure their land is optimal for growth. Roberto is no different. During the rainy season, Roberto, his son and grandsons apply 450g of fertiliser per tree, every 2 months. This fertiliser is an optimal mixture of Nitrogen and Phosphorous for growth; Potassium for coffee body/mouth feel; Boron to help blossoming; and Zinc for flower fertility. The fertiliser needs to be 19% Nitrogen which is impossible to get with organic fertilisers (typically ~3%), without adding vast quantities, which is not only costly and impractical but also introduces too much of other components. However, Roberto does not solely rely on inorganic fertiliser. Leaf litter is constantly underfoot when traversing the plantations, which suppresses weeds (shade helps too!) but also decomposes to add nutrients back into the soil. Roberto aids this decomposition by adding good fungus (Trichoderma) to the soil (5 oz per 200 L of water). Additionally, every 10 m there are leguminous trees. Leguminous trees fix Nitrogen in the soil which is a natural way to increase the available Nitrogen for all the nearby coffee trees. These Legumes are pruned every year to help produce more leaf litter and organic material for the ground.



A juvenile trial rust resistant variety.

A leaf showing scars from a rust outbreak.

Another essential part of agriculture is disease control. Coffee gets diseases, just like we do, and one big problem is leaf rust (aka La Roya) . Leaf rust is caused by a bad fungus Hemileia vastatrix which covers leaves in spores that look like rust. These spores hamper the leaves ability to photosynthesise by physically covering it (blocking light) and/or causing the leaves to drop. The disease spreads through physical contact tree-to-tree and you can diagnose a tree by rubbing the rust… if it comes off = infected, if it stays on = controlled. Best case scenario, the rust is minor and under control. This only reduces photosynthesis slightly which ultimately reduces the quality of the coffee end product. Worst case, photosynthesis is hampered so drastically that the coffee tree can no longer make food for itself and dies (and so too does every nearby tree until the entire plantation is dead). There are rust resistant varieties, and also many in research stages, but they are typically lesser quality or Robusta. Therefore, rust resistant varieties struggle to meet the flavour profiles that consumers expect. Fungicides are used on the farm and help reduce rust but fungicides are costly and also kill off the good fungi in the soil. Roberto finds that a nutrient rich tree is the best defence because, like a healthier person more easily fighting off a cold, the tree is healthier and thus more resistant to infection and can fight it easier. Banana tree shade also helps creates good airflow that dries the trees more easily thereby lowering the humidity (a natural fungal control – fungi like moisture). So, nutrient rich trees are a good defence for rust but, conversely, super productive trees are more susceptible to rust. If a tree is super productive (i.e. producing lots of cherries) it is allocating more resources to growing cherries and therefore weakening it's resources devoted to defence. So controlling production by shade growing and pruning helps limit production within the harvest season (which sounds counterintuitive but a balanced production year on year is better than maximum production one year and very little next year because your crop was overexploited). Finally, if coffee trees are stressed during harvest season (dry weather) the ground stays dry, which helps good fungi survive, so next season the trees come back stronger and the harvest will be better and more rust resistant.

Harvesting

Liam picking coffee on the mountain side, basket positioned underneath the branches.

Roberto's coffee is harvested over 3 months (January to March). Harvesting 4000 trees per hectare, over 50 hectares, across 5 different farms is not easy. This is exacerbated because the farms are atop/on the side of mountains and the cherries need to be hand-picked. Therefore, the rainy season workforce of 3-4 family members becomes 40+ when harvest season begins. Workers from bordering countries like Nicaragua (many of which are indigenous) travel to Costa Rica for harvest season to pick coffee and make money before travelling back home. Producers, like Roberto, must provide pickers with accommodation as well as coffee to pick. Many of Roberto's pickers return to his farm every year because they know he provides safe accommodation, pays above the legal requirements, and his crop is good so they can maximise how much they are able to pick. These men and women feel so safe under Roberto's care that they often bring their children too (which is not always safe to do when traversing through the boarding countries). The trust works both ways, as Roberto knows that these pickers can be trusted to harvest only the ripest cherries. How do you know when a cherry is at it's ripest? When it is bright red all over (unless it is a yellow variety… then it must be bright yellow).

When picking cherries, pickers are organised into small groups with one manager overseeing. Daily, each group is allocated a different area of trees and each picker within the group is allocated specific trees within that area. Pickers go from tree to tree, starting at the bottom and working their way up and around, hand picking the ripest cherries from each branch (working from the base of the branch towards the tip). Using both hands, they roll the cherries off the branches with their thumbs into their hands until they drop a handful into a basket tied afront their waist. They position the basket underneath where they are picking to catch any falling cherries. The tricky part is not only doing this fast enough to earn a living but also avoiding the unripe cherries. Not all the cherries ripen at once. Over the 3 month harvesting period, pickers will do 1 pass over a single tree every month, culminating is 3 passes per tree. Unripe green cherries are left on the branch to ripen overtime until the next pass in a months' time. The only exceptions are if there are any cherries that have dried prematurely on the tree (which need picking when you see them) or, for whatever reason, any few unripe cherries left at the end of the season. Once their basket is full, pickers make their way down the mountain and pour the basket into their own designated sacks. It is then back up the mountain to go again… and again. At the end of the day, managers signal to the pickers to bring their last payload down for counting.

In Costa Rica, pickers are paid via a defined volumetric measurement called a Cajuela. This measurement is volumetric, not by weight, because unripe cherries weigh more than ripe cherries. Unscrupulous pickers might therefore be more inclined to favour unripe cherries for more pay. Unripe cherries do not make tasty coffee, so farmers use volumetric measurements to incentivise picking ripe cherries which are larger and take up more volume. Pickers work together to pour each other's sacks into the back of a truck, through a calibrated

Roberto's son Michael measuring the picker's total Cajuelas for the day.

Roberto's son Michael measuring the total Fanegas picked, into the pulper reservoir.

hopper that measures 1 Cajuela. Micheal (Roberto's son) oversees the measurement and notes down the number of Cajuelas for per picker. Each picker is then paid $3.00 per Cajuela (40% more than the legal minimum for pickers in Costa Rica). The pickers are then given a ride down the mountain in the truck back into town. On average, pickers pick 13-15 Cajuelas a day ($39-$45).

The truck full of cherries makes it's way to the mill at El Llano. Here the truck pulls up to the pulping machine which has two large reservoirs sunk into the floor. Above the reservoir is a hopper similar to the one atop the truck but bigger. This hopper holds exactly 10 Cajuelas and is filled by tipping the cherries out of the truck and pulling two slides across the top. Once full, the hopper is emptied into the reservoir and a notch is marked on a nearby board. The hopper is filled once more, then emptied, and another notch is marked. These 2 notches now translates to 1 Fanega (20 Cajuelas). The Fanegas are recorded down to the partial Cajuela, which is then added to monthly reports that Roberto must send to ICAFE. If the pulper reservoirs are full, then the cherries are loaded into sacks ready to count the fanegas once the cherries in the reservoir have been pulped… but pulping must happen soon because the clock started ticking once the cherry was picked.

Pulping

Roasters do not receive coffee still in the cherries. These cherries need processing and, in order to understand coffee processing, it is helpful to first understand the anatomy of a coffee cherry. The outermost layer is the skin, which starts off green and ripens red or yellow depending on the variety. Next is the pulp – the flesh of the cherry just below the skin. Then there is the mucilage – a sticky, sweet protective layer. The parchment (or hull) is next – a thick, hard skin over the seed. The silverskin follows – a very thin translucent layer of skin over the seed (which comes off during roasting and known as chaff). Finally, there is the seed (two per cherry) which we know as coffee beans. A coffee cherry is 42% pulp, 20% water, 18% seed, 16% mucilage and 4% parchment (silverskin is negligible).

Syrupy water flushing the cherries from the reservior upwards into the pulper.

Pulping is the first stage of processing after picking (not all methods are pulped) and involves removal of the pulp, and the mucilage, in varied amounts depending on processing method. Once the cherries have been picked, pre-fermentation has begun. Roberto will pre-ferment most of his coffees for 1-2 days before pulping. Here, cherries are left in sacks, or in the pulper reservoir, to rest before removing the fruit. This natural fermentation allows the coffee to take on some flavours, sweetness and body from the cherry before it's removal. The fruit of the cherry contains many flavonoids and sugars that are often desirable in the finished product. However, after 2 days, different kinds of fermentations begin which yield less desirable flavours. Therefore, the cherries should not be left more than 2 days before pulping.

Pulping begins with the cherries sitting in the reservoirs that they were measured into (i.e. when the fanegas were counted). Water pumps the cherries upwards and through a destoner which removes any foreign bodies that could damage the machinery. The cherries then pass through a screen (similar to a spinning cheese grater) which removes the pulp and/or mucilage. The pulp/mucilage will drop out of the bottom and pulped coffee runs down a shoot into a hopper. The water cycles back through the system to pick up more cherries from the reservoir. This helps to save on water usage and causes the initially clear water to end up syrupy from all the sugars. Additionally, not every cherry will get pulped on the first run through. The screen on the pulper can be set to different diameters, which allows multiple runs per batch of cherries. The first run is set to the widest diameter and will pulp only the highest quality cherries, whilst the rest go into a rejects section. The diameter can be tightened for a second run on the rejects, which will pulp these slightly lower quality cherries. Any rejections left after the second run are unripe or prematurely dried cherries, which get collected and sent to another mill that has facilities capable of processing them (these would damage the pulper).

The main body of the pulper machine and a worker sorting rejects for a second run.

After a batch of cherries has been pulped, you are left with 1 or 2 m^3 of syrupy water and a pile of pulp/mucilage that both need disposing of. This water and fruit is very acidic so Roberto does not like to spread it on his coffee plants and upset the nutrient balance of his soil. However, the water is great for his allotment and he has an agreement with a local cattle farmer who likes to spread pulp over his pastures as an organic fertiliser. In return, the farmer provides Roberto with beef from the cattle.

Pulper screen (top left), corkscrew (top right), exit shoot (bottom left), washed coffee (bottom right).

When processing coffee, the batches are predesignated a processing method that they will be subject to, either: washed, honey, natural or juicy. Each method is pulped slightly differently (or not at all). Washed coffees are pulped using more water which will fully remove the mucilage as well as the pulp but at the added cost of more water usage. Roberto's honey process involves removing 90% of the pulp but leaving 100% of the mucilage intact (aka black honey process). Whereas natural and juicy processes are not pulped and thereby dried with the pulp/mucilage still intact, allowing the beans to absorb more flavonoids from the fruit.

A pile of pulp, under the pulper, with furnace ash added to it for use as organic fertliser.

Pre-drying

Moisture levels are high after picking and pulping. Like many other crops, coffee must be dried before storage and export. Drying coffee on Roberto's farm is done over two stages: pre-drying using traditional methods before going to completion in a mechanical dryer. Pre-drying is carried out either in the greenhouse, on raised beds or on tarps laid across the floor outside. Either way, pre-drying involves spreading the coffee out over the floor (or the raised bed) and allowing it to dry in the heat of the sun. This is very labour intensive. The coffee must be turned every 1-2 hours (by 1-3 workers rotating around the batches all day) to ensure even drying because the top layer will dry much faster than the coffee underneath. Additionally, turning protects against rot by mixing the wetter underneath layer to the top so it will not be sat wet and dark for too long. The coffee is turned using paddles and leaves behind furrows similar to ploughing fields. Periodically, the batch will get pushed into piles and left to sit for a while before being spread back out. This is because areas of the batch might be drying faster than others, so the piling helps to concentrate and equilibrate the moisture and sugars across all the beans - yielding a more consistent batch.

Robero and grandson Javier turning coffee in the greenhouse.

Pulper tower (top left) and a worker turning coffee on floor tarps.

Depending on the processing method, and the weather conditions, coffee will take 3-8 days to complete the pre-drying phase. Rainy days lengthen drying times because the coffee must be covered (quickly) and hopefully very little or no water gets added back in. Fortunately, Costa Rica typically has a very warm and sunny harvest season which is ideal for drying coffee. Each of the three pre-drying methods have their own advantages and disadvantages. Raised beds allow air to circulate underneath the coffee and for water to drain away – generally leading to a more even drying and consistent product. But raised beds can be expensive and require maintenance, whereas using plastic tarps laid on the floor is much cheaper. Tarps also allow the coffee to spread out over a larger surface (to dry quicker) whereas raised beds are limited by the size of the bed (possibly leading to thick layers). However, tarps lack the airflow and drainage of a raised bed. Moreover, raised beds and tarps need to be covered if it starts to rain, whereas the greenhouse is always covered. In the greenhouse, there is no issue of re-wetting via rainfall and it higher temperatures are maintained (coffee is spread along the floor so drainage is limited – raised beds could be used inside but these would reduce space and drying capacity). Nevertheless, the greenhouse is an expensive investment. The plastic sheeting that surrounds the frame is prone to damage in high winds and must be replaced every 5 years anyway. Similarly, the concreate base is very expensive and also means that the greenhouse cannot be moved (like tarps and raised beds can) for repurposing the ground space during the off season.

Natural processed coffee drying on a raised bed.

The coffee is monitored throughout the day by touch, sight and smell to determine how well the batch is drying. Small batches may be allowed to dry to completion using these traditional techniques, but typically Roberto likes to finish the drying in his mechanical dryer. There are various batches drying simultaneously, at different degrees of wetness, so constant monitoring is important to decide which coffees are next for the dryer. Once the coffee has reached around 35% moisture, it is ready to be loaded into the hoppers above the mechanical dryer for this final stage of drying (any wetter 35%, and the coffee is too sticky to unload out the hoppers) .

Coffee drying on the greenhouse floor, furrows clearly visable.

Drying

Mechanical dryer with a walkway for sampling and numbered doors for each compartment.

The mechanical dryer like a giant tumble dryer. Essentially, it is a large horizontal metal drum with 8 separate compartments, reaching a maximum capacity of 60 sacks (45 kg per sack). The automated drum rotates constantly and is attached to a furnace that blows warm air consistently through the tumbling coffee to evaporate moisture. Combustion is indirect, so the air does not directly touch the flame, reducing smoke that would alter the coffee flavour. The furnace is temperature controlled via a computer that automatically adds reused coffee husks into the furnace to keep the temperature at a constant 50-52°C. The constant temperature is crucial for consistent drying as well as keeping the beans alive. The air temperature running through the drum (and the coffee) is 30°C lower than the furnace, which works out at 20-22°C. Subjecting beans to temperatures exceeding 35°C kills the embryo within the bean causing deterioration in quality before they have had a chance to be shipped. Keeping beans alive keeps the coffee fresher for longer, until a roaster roasts the coffee and kills the embryo anyway.

Roberto sampling coffee.

Roberto and his daughter Mónica sample milling.

Every day, the furnace is emptied of ash (which is added to the pulp destined for cattle pastures) and the flame ignited. Once up to temperature, the pre-dried coffee sitting in hoppers can be dropped into the dryer compartments. Each batch is noted and then sampled every hour or so for moisture and density. Here, a few 100 grams are taken from a compartment and put through a small sample huller. This huller removes the hard parchment from the coffee and allow for moisture and density checking inside specialised equipment. Visually, you can see how dry coffee is by colour change: white (soft to touch) is high moisture, dark jade as it gets dryer, lighter green once it's complete (10.5-11.5%) and white (hard to touch) if the coffee is overdried. The moisture reading is recorded and, depending on the result, the batch will be resampled again throughout the day at varied intervals. If the coffee is still too moist, the batch will be left longer between samples, conversely if it is nearing completion, sampling needs to be more frequent. Additionally, if it is late in the day, a decision needs to be made as to whether the dryer can be run over night or if it needs switching off and turning on in the morning. These decisions are made on a case by case basis and are crucial to maintaining optimal drying times. For example, you would not leave a 13% moisture coffee over night because it will likely be overdried in the morning but a 20% moisture will be fine because it will not get below 11% by morning.

The furnace, kept at constant temperature, to dry the coffee in a controlled manner.

Coffee was dried for generations without mechanical dryers but their addition has many advantages. Firstly, coffee dries much faster than it would in the greenhouse, raised beds or on tarps. Quicker drying frees up drying space so the next batch of picked cherries can be pulped and start drying (drying is the biggest bottleneck in production). Secondly, there are financial benefits. Faster drying will save money and allow for a faster return on investment. If coffee cannot be dried fast enough, Roberto must pay to send his coffee off to be dried by another miller. Additionally, time is money and time saved drying (especially workers manually turning coffee) is time better spent doing other work on the farm. Finally, the mechanical dryer allows for a lot more control over the final moisture of the coffee. Roberto can consistently and reliably get his coffee to 10.5-11.5% moisture, and without the inconsistencies sometimes brought about by traditional drying methods. Ultimately, the dryer results in a more consistent and higher quality final product – if frequently monitored and dryer/furnace maintained (which it is).

Dried coffee underneath the dryer.

Liam cleaning the furnace in the morning.

Once a batch is at the correct final moisture, the compartments are opened and the coffee empties onto the concrete floor. This coffee is dry but is still in parchment (some with dried pulp/mucilage too) so it needs to be dry milled. The coffee is shovelled into plastic bags inside reused hessian sacks (new sacks are pointless at this stage, as this is only for transportation to the dry mill). Each sack is weighed to 45 kg, air pushed out, plastic bag tied shut, hessian sack sown shut and then stacked on top of each other in the barn. Once dried, coffee is left in these plastic bags to rest in parchment for 1-2 months, creating more uniformity and avoiding the coffee tasting too fresh. This resting will not take place solely at Roberto's farm because he lacks the space to store too many sacks. Lorries arrive periodically to take the coffee in parchment onto Coricafé who rest it before milling, classifying and exporting. The lorry arrives early in the morning and workers load the 45 kg sacks by hand, which takes majority of the day, and is not easy work. Transporting coffee is highly regulated and Roberto must complete a report that travels with the driver in case he is stopped and searched. The report contains what lots, how many sacks, what producer, which miller, license plate, details of the driver, etc. Without this report, the coffee would be seized by the police and it is very difficult to get back. With this report, the coffee has a paper trail back to the farm to prove its legitimacy and traceability (another reason why ICAFE is so important to the Costa Rican coffee industry).

Dry milling

Wet milling is complete and the coffee has arrived at Coricafé via lorry. Coricafé is a family owned coffee exporter in Costa Rica. They are one of the leading coffee exporters in the country and play a crucial role within the supply chain – ultimately making sure that the coffee arrives to us safe and sound. In our case, the first job Coricafé carries out is dry milling the coffee from Roberto's farm which is still in parchment. Dry milling not only removes parchment and bags the coffee ready for export, but also involves sorting, classifying and tasting for quality so each sack is uniform. Uniformity is important because inconsistent size, shape, density and colour of beans will mean that a batch will roast unevenly. The unevenness is because, once inside a roaster, individual inconsistent beans will roast faster or slower than others. Inconsistent roasts ultimately yield inconsistent flavour. Dry milling is traditionally done by hand (and still is in many parts of the world) but Coricafé have many large machines that help to automate and remove much of the manual labour.

Roberto's grandson Mario and mulitple workers moving sacks into a lorry heading for Coricafé.

45 kg sacks of coffee, still in parchement, on their way to Coricafé for dry milling.

Defects (bottom tray) removed during the dry milling process because of size, colour, damage.

After resting in parchment for 1-2 months, the coffee is ready to be dry milled. 45 kg sacks from Roberto are checked for stones before being loaded into a machine called a huller. The huller will use friction to abrade the parchment (and any dried pulp/mucilage too if the coffee is natural, honey or juicy processed) until the coffee bean is ejected with only the silver skin remaining. Finally, only after hulling does the coffee now resemble how roasters see it (we refer to it as "green coffee" due to its green-ish colour). Now hulled, the coffee needs sorting. The coffee will pass through: sieves that sort the coffee by size, along a vibrating plate that sorts the coffee by density, and through a spectrometer that looks at each individual bean to sort them by colour. The different sizes, densities and colours are separated and defects removed. Once sorting is complete, the coffee is loaded into large silos that dispense a precise weight (69 kg) into a natural fibre hessian sack, lined with a plastic grainpro for freshness, which then travels along a conveyor belt that sews the sack shut. Prior to filling, the sacks are printed in house using vegetable based food-safe ink atop templates and can be printed in full colour. The templates include numbers for identifying the coffee inside with codes for country of origin, producer, exporter, and batch number. However, templates can also be customised with graphics and designs so companies can personalise their sacks (with company logos etc).

Printing on hessian sacks, prior to filling, using food safe vegetable based inks and templates.

The coffee is now fully processed, graded and packaged in hessian sacks ready for the final leg of its journey within Costa Rica - exportation.

Stacks of coffee, ready for export, and stacks of pallets in Coricafé's large

Export

Coricafé are, again, vital in this final step. We will have spoken directly to Roberto (over Whatsapp believe it or not) to see what coffee he has available this season and agree a price per pound. Once the deal is confirmed, we go to Coricafé and say “we want Roberto’s coffee at x price per lb” and Roberto will go to Coricafé and say “we want to sell Cafeology our coffee at x price per lb” and Coricafé will calculate extra costs etc and draw up two contracts (one for us and one for Roberto). For us to sign the contract, it is subject to approval based off a 300 g sample taken directly from our coffee at Coricafé and flown to us. We then roast this sample and cup (taste) it using Speciality Coffee Association (SCA) brewing standards. Once we are happy with the flavour profile, the contract is signed.

Sample roasting Roberto’s coffee using IKAWA electric sample roasters, prior to cupping.

The exporter is now in charge of making sure that the coffee gets to us safely, almost like insurance. Coricafé must ensure the coffee is stored and transported in a food safe manner, free from cross contamination with allergens or strong smells (perhaps a container was previously used to transport nuts or soap). Furthermore, they need to make sure that the container is loaded correctly and lawfully, under the watchful eyes of the ICAFE representative who is present whenever a container is loaded. Once loaded, it must be secured to avoid tampering, paperwork must be completed and then approved by the ICAFE representative. Then Coricafé must have all the logistics organised to get the container from their warehouse to the correct port – including GPS tracking and/or an armed convoy. The journey from exporter to port must be protected as this is prime opportunity for interception by a nefarious party. For example, a 40ft container of pineapples would be worth $6,000-$8,000; a 40 ft container of televisions would be worth $75,000; but our 20 ft container (half the size) of coffee was worth $135,000. Additionally, coffee is relatively easy to sell on… simply remove the hessian sacks, put in new sacks and sell as your own (less traceable) coffee.

The container of Roberto’s coffee arriving at Cafeology HQ.

Liam and the open container.

Head of coffee Steve, unloading the first sack.

Once at the port, the container is unloaded from the lorry onto a shipping vessel alongside thousands of other containers. In our case, our container will leave Coricafé via lorry, drive to Puerto Moín (Limón), where the ship will sail to London Gateway , the container is then unloaded onto a train, the train will haul the container to Newell Wright Transport, then a short journey via lorry (0.3 miles) to our roastery in Sheffield, UK (transportation via train, instead of lorry, from London will produce half the $CO_{2\text{-eq}}$). We must unload the sacks by hand, onto pallets for storage in our warehouse. A sample of the coffee received will be roasted, to check its flavour alongside the 300 g sample we received pre-shipment. All going well, the coffee is then ready for us to roast and our customers to brew (and enjoy!).

The final, final step

All of the hard work documented above culminates in your daily cup of coffee (after it has been roasted, packed and brewed of course). Hopefully, the next time you sip said cup of coffee, there will be more of an understanding of how that coffee came to be. No other commodity worldwide involves more hard work, by so many people, for so little (which sounds like an outlandish statement but hear me out). Hard work is not the only cost of coffee production, wastage is a fundamental cost too. For example, a farmer will grow their coffee cherries; a picker will pick their cajuela (20 L) of cherries; 20 cajuelas will make up 1 fanega (400 L) weighing ~550lbs; this fanega is wet and dry milled to remove water, pulp, mucilage and parchment, yielding ~100lbs of green coffee; 75% of which is 1st grade (what we buy), so ~75lbs is left; we then roast this ~75lbs, and lose approximately 20% weight as moisture, yielding 60lbs of roasted coffee; we sell then this coffee to customers. Why is this important? The coffee sold to customers, by weight, is only 11% of what was originally picked by the picker at the start of the chain! Therefore, 89% of the product is lost through nobody’s fault, merely part of the process. There is lots of recycling and reuse within the chain (pulp for fertiliser or parchment for the furnace etc), so it is not all doom and gloom, but fundamentally Costa Rican coffee (and coffee generally) involves lots of hard work and wastage. Thus, no other commodity worldwide involves more work, by so many, to yield so little, than coffee.

A diagram illustrating the weight loss from picked (Cajuela) to what we sell to customers after roasting.

EACH PROCESSING METHOD

The four processing methods of Roberto's wet milling all have their own unique flavour profiles due to exact nature of the process itself. By processing the same cherries, in different ways, Roberto can expand his offering to potential buyers. Similarly, the different processing methods may improve the quality of the coffee so there is also added value to the final product. Below are the four processing methods, listed in order of fastest to slowest: washed (5-6 days), honey (8-12 days), natural (12-16 days), and juicy (18-23 days). All processes are then bagged, rested in parchment (1-2 months) and dry milled at Coricafé.

	Picked	Pre-fermentation	Additional fermentation	Pulped	Pre-drying	Mechanical drying	Bagged, rested, dry milled
Washed	✓	✓	✗	✓	✓	✓	✓
Honey	✓	✓	✗	✓	✓	✓	✓
Natural	✓	✓	✗	✗	✓	✓	✓
Juicy	✓	✗	✓	✗	✓	✓	✓

A table illustrating the similarities and differences between the four processing methods.

Washed

- Picked
- Pre-fermented (1-2days)
- Pulped
- Pre-drying (2 days)
- Mechanical dryer (2 days)
- Bagged, rested and dry milled

- tastes clean, well balanced, good critic acidity, good body, cacao, milk chocolate sweetness

Washed coffee drying in the sun, with no muscilage or pulp present.

Honey (black honey)

- Picked
- Pre-fermented (1-2 days)
- Pulped (100% mucilage and 10% pulp left on)
- Pre-drying (3-6 days)
- Mechanical dryer (4 days)
- Bagged, rested and dry milled

- tastes clean, well balanced, good critic acidity, good body, dried fruit sweetness

Honey coffee, golden due to muscilage and speckled with some pulp.

Natural

- Picked
- Pre-fermented (1-2 days)
- Pre-drying (6-8 days)
- Mechanical dryer (5-6 days)
- Bagged, rested and dry milled

- tastes clean, good critic acidity, great body, very sweet, watermelon, peanut

Natural coffee sun drying with pulp fully present.

Juicy (fermentation)

- Picked
- Additional fermentation using yeast [producing maltic and acetic acid] in large plastic sacks (7-9 days)
- Pre-drying (6-8 days)
- Mechanical dryer (5-6 days)
- Bagged, rested and dry milled

- tastes vibrant, bright acidity, great body, boozy, green apple candy

Freshly picked cherries being loaded into sacks of yeast for fermentation.

ISSUES FACED AT ROBERTO'S FARM

The desire to be more sustainable

Costa Rican coffee is some of, if not the most, sustainable coffee in the world. Despite Roberto's own wants to be sustainable anyway, he must adhere to the strict environmental laws regardless. For example, water usage and treatment is highly regulated, with monthly reports required by the ministry of health and ICAFE during harvest season. All of the water in Costa Rica is drinkable but water is still a precious resource not only for life but for coffee production. Pulping, if you aren't careful, can use vast quantities of water and leave behind polluted water that will leach into ground water. At the wet mill, Roberto tends to do mainly honey process coffee which uses less water than washed process. Moreover, the pulper continuously recycles water back through the system rather continuously pumping in fresh water. This helps to dramatically reduce the amount of water used. Water usage is one of the many things that must be reported and audited frequently.

The pulper tower, as viewed from ground level.

The furnace, used to heat the air for mechanically drying the coffee, is a source of pollution that must also be regulated and monitored. You might think Roberto uses wood as fuel but this would lead to increased deforestation (the nearby area is protected too!) and is relatively expensive. To solve this, the husks from sample milling are used as fuel for the furnace. This (waste product) is bagged up and stored until it is needed. The small surface area of the husks makes them a great fuel source that burns efficiently and cleanly. In order to be allowed to burn the husks, the ministry of health had to analyse and accredit the emissions.

All Costa Rican coffee is shade grown and thereby the farms form an agroecosystem, meaning natural ecosystems are modified for human agriculture (coffee farming) in harmony with nature. These shade-grown coffee farms help to maintain local wildlife populations, improve soil health, reduce soil erosion, sequester carbon, naturally supress weeds (less herbicide), naturally control pests (less pesticide), etc. This is important because coffee farming can quite easily be converted to sun-grown systems where you have typical agricultural monoculture, with rows upon rows of nothing but crops (devoid of any other forms of life). Agroecosystems such as Costa Rica are important because even non-beneficial plants are left to live on the farms (like the enormous Eucalyptus trees at Las Nuves that slightly protect from strong winds but actually compete heavily for resources with the coffee trees).

All electricity in Costa Rica is 100% renewable due to their long daylight hours for solar and mountainous high winds for wind farms. However, Roberto has his own solar panels to produce his own electricity. He does not produce enough to fully cover the usage of his operation but has reduced his electricity bills by over half. He is considering buying some electric trucks that he could charge from the mill with solar power. These trucks will then be used to shuttle workers around, run errands and collect cherries from the farms. So they need to be able to drive in suboptimal conditions (rough roads, steep inclines, carrying heavy loads, etc). Electric vehicle technology is constantly improving so Roberto remains hopeful that he can begin electrifying his fleet soon.

El Llano farm, as seen from the plantation (noitce the rooftop solar panels).

Liam and his mentor picking coffee on the mountain side.

Social benefits are also important when it comes to sustainability. Roberto and his family do a lot for the local community. Roberto built a swimming pool at El Llano which local people are allowed to use free of charge. Similarly, there are a lot of bananas that grow on the farms due to the need for the shade. Roberto does not sell these bananas, he gives them away to people for free because he has more than he could even want to eat. His wife Doris spent nearly the whole time during my visit cooking food to donate to their local church for their patron day celebrations – helping to raise lots of money for the church which will then benefits the parish. Roberto also pays his pickers $3.00 per Cajuela (40% more than the legal minimum for pickers in Costa Rica) which helps to provide them with a better quality of life as well as a fairer price for their hard work.

Pickers decending down the mountain after a long day picking.

Impacts on farming

Climate change has a multitude of effects on the farm. Leaf rust, for example, used to only be an issue at lower altitudes but is now present everywhere and more frequently. Roberto has many processes in place to manage rust outbreaks (mentioned previously) but the issue will only worsen as climate conditions become more favourable for rust. Similarly, this year there has been a lot more mosquitoes around the farm. They congregate around the pulper and the drying coffee, where there is lots of moisture and sugar. Trying to work with these buzzing around is incredibly annoying but there is also the possibility of them carrying diseases. It is known that disease carrying mosquitoes have begun migrating to new countries as the climate warms. Diseases like zika and malaria have already been found in Costa Rica but the risk is currently limited to certain regions. However, as the climate continues to warm, the risk will continue to increase and likely spread across the country.

Rainfall has also become more unpredictable. The harvest season typically has very little rainfall (which is why it is perfect to harvest and dry coffee) but, in recent years, there has been more instances of unseasonal rainfall. This issue is three-fold: premature blossoming, early drying on the tree, and interruptions during drying. As mentioned previously, coffee mass blooms 12 days after the rainy season has ended – after which the blossom dies and eventually becomes a cherry. Unseasonal rainfall during harvest season can cause buds on new growth branches to prematurely blossom. This blossom may produce a cherry but it will mature out of harvest season. Likewise, buds only blossom once so this premature blossoming has led to a loss of production on next year's harvest. A few instances of premature blossoming is annoying, but on a large scale it is potentially devastating.

New growth for next year.

Premature blossoming.

Premature drying.

Comparable to premature blossoming, unseasonal rainfall can cause cherries to dry whilst they are still on the branches. Here, the cherries shrivel up, turn black and become hard. This is problematic because these cherries are now low quality and must be processed elsewhere. Therefore, Roberto will lose productivity from what could have been a ripe cherry. This drying is common to see sporadically on branches, amongst plenty of ripe cherries, however, it is possible for entire trees to afflicted too (especially if the tree is positioned in a sunnier spot, subject to less shade). Again, a few instances are annoying but large scale is devastating.

Once coffee is laid out to dry, the last thing you want is for more moisture to be added back in by rain. This is precisely what can happen on evermore frequent rainy days during harvest season. When rain starts, everyone at the mill stops what they are doing to cover the coffee as soon as possible. They start with the driest batch first and work their way around until all the coffee is covered. It is then a waiting game until the rain stops and conditions brighten up before the coffee can be uncovered and start drying again. Stopping drying is a major issue for production, especially because drying coffee is the biggest bottle neck within the process. If you lose a day of drying because of rain, you now have even more coffee that is picked and waiting to get pulped than usual (remember, once picked, pre-fermentation should only be left for 1-2 days before undesirable fermentation takes hold). If the backlog is large enough, Roberto will need to send even more than usual off to another mill for drying. Furthermore, if coffee has been re-wetted there is chance that mould can set in – destroying batches. Therefore, unseasonal rainfall can be catastrophic in regards to production and profitability when you combine premature blossoming, premature drying and drying delays.

Following on with regards to drying being the biggest bottleneck in production, Roberto's mill is able to pulp 20 fanegas per hour but can only dry 60 fanegas per day (assuming the weather is warm and sunny). Therefore, picked coffee could sit pre-fermenting for too long before pulping and/or you have pulped more coffee than you have room to dry (at which point you pay for someone else to dry your coffee). A slight solution is to designate more batches as washed process instead of natural or honey because washed processed dries faster than natural or honey (but this is not ideal when you have specific orders to fulfil). Roberto is a clever man and owns the patent for a raised coffee bed, made up of three beds that rotate around like a ferris wheel, from his days at Coopedota (inspired a visit to London and seeing the London Eye). He plans to construct some of these to essentially triple his raised bed drying capacity. However, these require lots of materials to build and maintain. They are also more unwieldy to move and store when harvest season is over. I suggested utilising roof space to dry coffee however this would involve significant investment to flatten rooftops, to add injury avoidance measures while working at height, and equipment capable of transporting coffee up and off of the roof.

Another issue pertains to the fertiliser supplements that are needed for growing coffee. Production of inorganic fertiliser is typically done in factories using the Habor-Bosch process, which is very resource intensive and terribly polluting. However, inorganic fertiliser is crucial to Roberto's operation (as it is for agriculture worldwide). Innovation is needed to make organic fertiliser more viable and/or to make inorganic fertiliser production less polluting. This is perhaps beyond the scope of a coffee farmer to solve but the issue remains nevertheless. On the other hand, the cost of fertiliser has skyrocketed. The pandemic and the war in Ukraine has strained supply chains for traded goods the world over and, as usual, it is the producers that has to take the financial hit (do they then absorb the damage or pass it up the supply chain?). Without fertiliser, productivity levels are unviable but, with the current price of fertiliser (and its environmental impact), using fertiliser is becoming less viable.

Finally, staying competitive within the fast paced coffee industry is challenging. If farmers are not constantly innovating, improving their coffee or keeping up with new trends, then it can feel like they are being left behind. For example,

A tree that has been devastated by cherries drying prematurely while still on the branches.

Roberto's juicy fermentation was born out of the need to keep up with the current trend of fermented coffees and their unique flavour profiles. However, many fermentation methods require significant investment in terms of equipment (silos etc) and time (juicy needs an extra 7-9 days to ferment before drying). From a farmers point of view, they need to decide if that investment is worth the risk of potentially ruining a batch of coffee (or creating a flavour that is undesirable) as well as the trend disappearing and then owning expensive equipment that is now useless. Therefore, the juicy process is intentionally low tech, using large food safe plastic sacks and yeast rather than metal silos and funky reagents. During my visit, we cupped some experimental batches of juicy using a different yeast that was supposed to produce the same flavour in half the time. This would help production massively but the flavour was not comparable to the current method. Loading the cherries into the plastic sacks is time and labour intensive too. Roberto is looking for equipment to reduce this but he wants to see if the fermentation trend is here to stay before he makes that investment (unless any cheap equipment goes on sale from a closed farm – which happens more often than you think).

Costa Rica in general

Issues regarding sustainability and climate change are also more general in terms of impacting Costa Rica (and coffee) as a whole. For example, when speaking to Eric and Stephan at Coricafé, they explained that, in addition to increased coffee rust, new diseases have begun to appear. Last year a few consignments of coffee sent to them were mysteriously black in colour. They determined this to be a disease of some kind but have never seen anything like it before. This affliction soon disappeared, and has not re-emerged since, but they have increased their vigilance going forward. As a species, we all know too well how devastating new diseases can be – just look at Covid 19 – and the same is true for crops.

The drying barn (right) at El Llano farm with mountains in the distance.

When it comes to shipping products worldwide, many exporters are still reeling from the pandemic. During the height of the pandemic, there were no containers, no room on ships, ports were congested and this is still a thing today. There were cases of large companies, making substantial investments to charter their own ships to collect product stuck in ports. This is incredibly expensive for any company to undertake but no product means no business. The situation has improved slightly but there are still frequent delays getting products shipped from one country to another. This ultimately slows the whole process, and can lead to shortages, but also increases the costs of export. Exporters are charged for any delays when containers are stuck at port (usually at no fault of their own). We live in a highly interconnected world that relies on international trade but, at the moment, the system is not working as it should.

Costa Rica, 7 years ago, used to produce >3 million sacks of coffee annually. Now, this has nearly halved to 1.6-1.8 million sacks. This is mainly due to lack of rentability (i.e. farmers unable to make enough of a return on their investment to remain profitable). Roberto said that, ideally, a farmer needs >5 hectares to be profitable. Labour costs, suboptimal weather conditions, fluctuating market prices etc combine to put strain on coffee farmers. If farming coffee is no longer viable, small scale farmers often sell land to larger farms or to developers.
In the Dota region, where Roberto lives and farms, housing development is becoming more common as people migrate out of the overcrowded cities into the countryside (many now work from home so they move to where it is cheaper – and nicer!). Therefore, land that was previously used to grow coffee is now being altered for other uses. As supply of Costa Rican coffee production continues to fall, the demand and price is likely to increase.

Mountains covered in coffee plantations as far as the eye can see.

The nearby town of Santa Maria, situated within the Dota valley and surrounded by coffee.

As our climate warms, the previously cooler temperatures at higher altitudes become warmer. These higher altitudes and cooler temperatures (amongst other associated environmental factors) are what allows high quality arabica to grow. Worldwide, coffee farmers must grow coffee at increasingly higher altitudes because of this warming. Unfortunately, there will eventually be no more mountain to climb and farmers have to deal with the worsening conditions and crop quality. There are researchers working on cross-breeding coffee species and varieties, that are more resistant, but the resistance must come with arabicas distinctive flavour profile. Without this work, there is a large risk that farmers will eventually need to switch to growing Robusta (or other crops entirely) out of necessity. A no Arabica future would mean a complete overhaul of the current coffee industry.

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Liam Worsley

Sustainability Manager

Cafeology Limited
4 Vantage Park 2
Coborn Avenue
Sheffield
South Yorkshire
S9 1DA

T: **0114 255 8007**
E: **info@cafeology.com**
W: **www.cafeology.com**
@cafeology
Cafeology
RoastologyUK
@cafeologyltd
@roastologyuk