Wake up and smell the coffee

The climate crisis and your coffee

May 2023

Above: Yadira Lemus, 31, from Quebrada Honda, Gracias Lempira is a dedicated producer of quality coffee, and member of WLSEE IXIK Organic.

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Christian Aid exists to create a world where everyone can live a full life, free from poverty. We are a global movement of people, churches and local organisations who passionately champion dignity, equality and justice worldwide. We are the change makers, the peacemakers, the mighty of heart.

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Foreword

Coffee. Coffee. How would many of us start the day without it?

In the UK alone, we drink more than 98 million cups of coffee a day, enough to fill more than nine Olympic sized swimming pools.

But like many other agricultural commodities, the UK's love of coffee is under threat from the climate crisis.

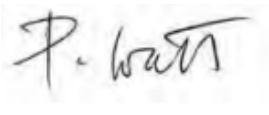
Coffee farmers in Africa, Asia, and Latin America are facing a host of climate-related impacts including rising temperatures, erratic rainfall, disease, droughts and landslides. If this continues, many areas currently under coffee cultivation will become increasingly unproductive and may no longer provide suitable environmental conditions for coffee plants.

These developments appear to also be concerning British consumers. Polling by Savanta, commissioned by Christian Aid to coincide with this report, reveals three in five (57%) UK adults say they are concerned that climate change will impact the cost, taste, and availability of coffee in the UK.

This report explores the impacts of the climate crisis on coffee farmers and the ways in which the industry may be able to adapt to these changes. It also explores the challenges for women in the industry, for food security, and for the taste and quality of coffee itself.

The report draws on five case study countries: Brazil and Vietnam as the world's largest producers, Ethiopia which is currently experiencing a climate-induced hunger crisis, and Honduras and Malawi, where Christian Aid has engaged with local coffee growers.

Building on this analysis, the report makes policy recommendations aimed at tackling the root causes of the problem.



Patrick Watt

Chief Executive Officer, Christian Aid

Below: Patrick Watt, Chief Executive Officer, Christian Aid.

On Coffee and the Climate Crisis

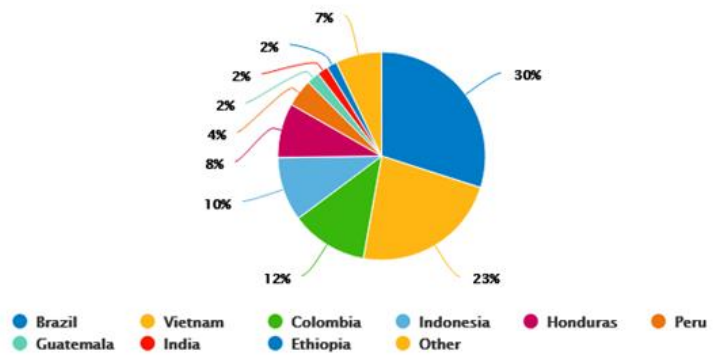
Introduction

Coffee is grown across broad areas of the tropics, on more than 27 million acres, or around the land area of Cuba[1] in more than 50 countries, by around 12.5 million largely smallholder farms[2] and plays an important role in the economies of many tropical countries.

Commercial coffee focuses on the cultivation of two main varieties; Arabica and Robusta. Arabica is regarded as having a better flavour profile than Robusta, and accounts for about 70% of worldwide coffee production[3]; grown at densities between around 2-5000 plants per hectare. Arabica also is made more vulnerable to climate impacts due to narrow genetic diversity[4]. Robusta plants are more resilient to sub-optimal climate conditions and, as larger plants, grown at densities of 1200-1800 plants per hectare. They require trimming to keep size under manageable control, and only start to produce fruit in 3-4 years. The time for coffee lants to mature represents a significant financial and time investment for a smallholder farmer[5].

Coffee production is sensitive to variations in precipitation and temperature outside of its optimum growing conditions. Both factors are likely to become more extreme with climate change and no variety of coffee can tolerate temperatures of around 32ºC[6]. Arabica's optimal growing conditions include a temperature range of 14-26ºC: higher temperatures lead to faster ripening of the berries and lower coffee bean quality[7]. It prefers annual rainfall between 1,000 and 2,700 mm, and a dry period of 1–3 months annually[8]. Robusta grows at altitudes up to 1000m and are less vulnerable to pests and weather conditions, while producing fruit more quickly and in greater quantity than Arabica[9].

By country, the world's biggest producers



Pie 1: The main green coffee suppliers to the UK, 2021.

Source: Centre for the Promotion of Imports from developing countries, Entering the British coffee market, 2022, https://www.cbi.eu/market-information/coffee/united-kingdom

	Global biggest producers	Coffee Production (Metric Tonnes)	Biggest suppliers to the UK in 2021	The percentage share of the UK market
1	Brazil	2,592,000	Brazil	30%
2	Vietnam	1,650,000	Vietnam	23%
3	Colombia	810,000	Colombia	12%
4	Indonesia	660,000	Indonesia	10%
5	Ethiopia	384,000	Honduras	8%
6	Honduras	348,000	Peru	4%
7	India	348,000	Guatemala	2%
8	Uganda	288,000	India	2%
9	Mexico	234,000	Ethiopia	2%
10	Guatemala	204,000	Other	7%

Table 1: Source: Szenthe, Adriana, 2020, "Top Coffee Producing Countries". WorldAtlas

UK coffee consumption

UK consumption of coffee is on the increase and reached 29g per person per week, or more than two cups a day on average[10] of coffee (including beans, ground and instant) in 2020-21, up from a steady 17g in the period 2006-8[11]. This means that Brits get stimulation through 98 million cups of coffee a day, the national contribution to the global two billion cups drunk every day[12]. Despite this gallant contribution to coffee consumption, the UK lies only 7th in the countries that drink the most coffee in the world and fails to make the top ten on a per capita basis[13].

A study conducted for the British Coffee Association found that the coffee industry's Gross Value Added (the value generated by any unit engaged in the production of goods and services) for indirect, direct and induced impacts in the UK was £9.1 billion in 2017 and that 210,325 jobs were directly, indirectly or induced involved in the industry[14].

Coffee and the climate crisis

Coffee's own impact on climate depends on a number of factors including production and preparation. Preparation is optimised by boiling only the water actually needed – knowing the line on the kettle that corresponds to your own mug's volume is a small but important life skill. Far greater though, can be the impact of production, which can contribute 40-80% of the total emissions associated with a mugful.

However, like chocolate, coffee's carbon footprint can range from negative to high, depending on whether it comes from low-input agroforestry systems, where perhaps fruit trees provide the shade for shade-grown coffee, or high-input monocultures, where the coffee is the only plant grown, in full sun, on land which may have been deforested. High production emissions in full sun fields arise because of the irrigation often needed, fertilisation using fossil-gas intensive fertilization systems which can lead to emission of the powerful greenhouse gas nitrous oxide[15, 16].

However, coffee production is itself highly vulnerable to changes in climate. Coffee plants, particularly Arabica, have clear preferences about what growing conditions they find optimal and the greater number of hot days and increasing variability in rainfall between droughts and floods because of climate change may stress the plants to lower yields, or even mortality. In the year 2000, 36,240km^2 of land was assessed as being highly suitable for growing coffee. Under a scenario consistent with temperature increases of 1.5-2ºC by 2100 this could decline by 54.4%, for a 2.5-3ºC scenario (we are currently on track for around 2.7ºC of warming[17]) this would fall by a further 53.7%. For a 5ºC scenario, 59.5% of prime coffee growing land would be lost by 2050[18].

Climate change may also create conditions that are more favourable for pests and diseases to the plants, further adding to the stressors they have to face. Even by 2011, climate change impacts on coffee berry borer (Hypothenemus hampei), the most important pest of coffee worldwide, were clear with evidence that it was already increasing its range and levels of damage[19]. Modelling future climate impacts and finding that annual generations of the beetle could double from 5 to 10, the study concluded: "These outcomes will have serious implications for C. arabica production and livelihoods in East Africa." The beetle is not exclusive to Arabica and will also happily attack Robusta[20].

In contrast, Robusta has far greater resistance than Arabica to leaf rust, caused by the fungus Hemileia vastatrix, and which can prove fatal to the plant. The fungus likes warm and humid conditions and is spread by rain[21], but cannot survive below 10ºC. In some area rising temperatures are preventing it being killed off[22]. The fungus caused average reductions of production of 31% in epidemic years, compared to a non-epidemic year. There is evidence that this fungus will benefit from the changing climate[23]. The rust can be managed with careful hygienic pruning and chemicals, which can be toxic to humans. The trees can take years to recover[24].

Soila Cristina Carbajal Vega

Soila is from Atima, Santa Bárbara, Honduras.. She has been supported through the Breaking the Barriers programme which aims to improve the status of women, with the goal of achieving more gender equality. Women are supported to nurture their environment, in climate change prone areas, where they need to adapt and mitigate the impact of climate change, for example, through clean energy or agricultural diversification.

Solar dryers have helped enable her and the women's group, to more effectively dry and produce quality coffee.

"Climate change is due to ourselves. If we don't do something for the planet, we are causing total destruction and damaging ourselves"

"Now, with the hurricanes, the Covid pandemic, the rust, global warming, really there are many people who are affected. Producers have to resort to taking out loans in order to cultivate"

Adaptation responses

Because climate change is affecting coffee in a variety of ways – temperature and precipitation changes directly affecting the plants, and indirectly promoting plant pests and diseases – a variety of approaches will be needed to make the coffee industry more resilient to climate impacts. These may include altitudinal and other spatial shifts, introduction of new coffee varieties, shade management, soil nutrient management, and pest management[25, 26].

Changes in climate are already causing people to move into new areas, including to higher altitudes, causing deforestation that can lead to landslides. This cautions that planning and management of the land and providing support for the smallholders would be important to avoid further environmental degradation. A Christian Aid partner in Honduras, Yadira Lemus, observed: "I went to find out how many producers of the high zone are affected. It hurts to see how there are whole areas without a single tree. After having been a very dense forest, there is nothing now. But how am I going to tell that producer you cannot continue to do this when it is there where they produce the beans and corn they are going to eat. What solution am I going to give him which takes away their hunger?"

Creating new plantations also requires a time investment: the plants do not produce berries until about age 3-4, and not commercially for about a decade, although they can produce for around another 30 years[27].

As for all life on earth, biodiversity is important for the future resilience of the coffee industry. Although Arabica and Robusta are the predominant varieties of coffee plants: there are over 100 others, each producing a different type of coffee bean[28]. Around 70% of these are threatened with extinction due to decline in quantity and quality of needed habitat[29]. This potential loss of coffee biodiversity may reduce the resilience of the industry that might otherwise be able to use these alternative varieties to produce new, more climate resilient, varieties.

Using new varieties, both directly and for breeding new varieties, is a climate adaptation the coffee industry is exploring, despite the threat to so many coffee species. Native to central and western Africa, the Liberica variety of coffee currently accounts for 2% of the global market, but is of increasing interest as it is hardier to changing climate

Below: Yadira Lemus, 31, from Quebrada Honda, Gracias Lempira is a dedicated producer of quality coffee, and member of WLSEE IXIK Organic.

conditions, particularly in the lowland conditions where Robusta currently predominates, and may serve as a rootstock for both Robusta and Arabica[30]. It is harder to process and is seen to have a less desirable flavour, but some types of the variety have received favorable comment *(translated from French)*: "Many farmers consider it to have a great future, as it is very resistant to diseases and insects, and it gives high yields of good quality coffee"[31] and farmers in Uganda have been choosing of their own accord to increase production from this variety[32]."

Shade grown coffee produces lower yields and is more labour-intensive than 'open' plantations, but the flavour of the coffee is considered superior and may be sold at higher prices[33]. Shade management, including integrating agroforestry, is a possible adaptation method but it is complex socially and environmentally. Socially, financial and technical constraints limit the availability of these approaches to smallholder producers and policy measures would need to be put in place to support the farmers[34]. Environmentally, shade trees can reduce the impact of rising temperatures on Arabica coffee[35], Conversely, full-sun plantations of Robusta, which is generally seen to be more robust to climate impacts than Arabica, can face increased vulnerability to landslides where it displaces diversified agroforestry systems that provide[36]. Overall, synergies and tradeoffs will need to be considered and managed carefully at the local level[37].

Nutrient and pest management may be adaptation options but may imply greater use of fossil-fuel originated agrochemicals that may have other deleterious impacts on the environment. For example, pesticides have an impact not only on coffee insect pests such as the berry borer (Stephanoderes hamjei)[38] , but other native insects which may be important pollinators for the coffee[39]. However, this would also imply additional costs to the farmers which they may not be able to afford.

A study of small-scale coffee farmers in Chiapas Mexico found that while some have adopted strategies that help cope with short-term climate risks, overall, their adaptive capacity is "not very flexible or stable due to the deprivation of resources, insufficient crop variety, food insecurity, and income or employment instability"[40]. To help the smallholder farmers become more resilient, including to longer-timescale climate impacts, the study concluded they will need support for locally appropriate interventions from outside their communities.

Below: Glenda, 38, lives in Nueva Esperanza, Las Flores, Lempira, Honduras. She is a coffee producer and partner of the WLSEE SOLAR COFFEE. Here she looks at the damage to her farm and with her father, Angel María Reyes Funes.

Women

Women play an important role in the coffee industry. Depending on the region, up to 70% of labour is provided by women. Women are not just laborers: between 20% and 30% of coffee farms are female operated. However, women generally have lower access to resources, such as land, credit and information on input use and financial services, leading to lower incomes from lower yields[41]. These are all factors that act against women's economic resilience in the face of increasing climate impacts. Programs targeting the fundamental power imbalance between men and women are likely to be more sustainable than those that simply seek to educate women and increase access to resources. Policies to change land tenure inheritance rules can also help women to better secure land tenure[42].

Below: Soila Cristina Carbajal Vega, 30, from Atima, Santa Bárbara, with her partners Nilsa Rubí Hernández (L) Nuvya Irery Vega (R) and her child Allison Zoé Castellanos, inside a solar dryer. Solar dryers help enable Soila to more effectively dry and produce quality coffee.

Impact on food security

Climate, coffee and health interact in a variety of ways and act in a vicious circle for smallholder farmers. Indeed, 80% of coffee is produced by 25 million such farmers. Already economically vulnerable smallholder farmers are seeing the climate crisis increase the variability of coffee prices, leading to health impacts that can further increase their vulnerability.

As an agricultural commodity, coffee is already subject to the vagaries of weather conditions and global coffee production fluctuates year by year, as a result. This means that as a baseline, smallholder farmers are already exposed to the resulting wide fluctuations in coffee prices which affect household incomes and their food security because of their heavy reliance on a single crop for income. Studies of such smallholders in southern Mexico and Central America showed their further vulnerability because of limited institutional and governmental support, an issue also raised by Christian Aid partners in Honduras, and limited negotiation capacity and access to markets because of access to resources, information and decision-making processes[43]. Lack of food security because of the variability in prices has obvious nutritional impacts on health, both in terms of overall calories consumed and having access to a variety of food to gain the needed range of nutrients. Lack of food security is also correlated with a higher risk of depression.

In addition, Christian Aid partners in Honduras note that coffee production itself has the impacts of contaminating their water supplies, already stressed from climate impacts. They also note that mosquitoes breed on wastewater and coffee residues,

increasing the risk of mosquito-borne diseases in regions where this is an issue.

Climate change is exacerbating this baseline variability and vulnerability. The sensitivity of coffee to weather conditions, more notable in Arabica than Robusta, means that as temperatures rise and droughts and excessive precipitation become more common, some regions will no longer have growing conditions that make coffee farming a viable livelihood. In the tropics, the hottest days are projected to become even hotter: the hottest 5% of days are expected to warm by 20% more than the average day. This will have impacts on human health, as well as on coffee cultivation.

Increasing storms may result in landslides, especially where coffee cultivation is undertaken in upland deforested to create the plantations – this again has already been an issue observed by Christian Aid partners in Honduras. The greater variability in climate already being experienced can only increase the coffee price fluctuations, even if production itself remains viable. And climate changes increasing invariably fatal coffee leaf rust further feeds the cycle of existing vulnerability, climate impacts, economic impacts, health impacts, greater vulnerability.

Climate impact on taste

If farmers choose to grow more Robusta as an adaptation measure, as is being seen in Brazil, this will have an impact on the global availability of the better-flavoured Arabica.

In addition, climate impacts risk affecting the specific quality of coffee's taste. Coffee's unique tastes come from the mixture of primary and secondary metabolites, such as (to delight any chemists who might be reading this) p-coumaric acid, 3-caffeoylquinic acid and 4-caffeoylquinic acid, that influence the sensory experience of the consumer, as well as the coffee's shelf stability and nutritional qualities[44]. While a recent meta-study found that farms at higher altitudes were associated with better flavour and aroma, climate conditions of the lower altitudes are creeping up mountainsides as the climate warms[45]. Overall, though, the science to date is producing mixed results on climate impacts to coffee quality. As would be expected from the complexity of coffee's chemistry, different chemical pathways in the plant respond differently to changing conditions. There is, however, no doubt that coffee quality is vulnerable to factors associated with climate change including light exposure, temperatures, precipitation patterns and CO_2 concentrations[46].

Below: Consequence of climate change on coffee production: Coffee plant bearing lots of flowering and the same plant with fewer fruits at Gamo zone, southern Ethiopia.

Increasing light exposure is one area that has been found to be a clear associate of reduced quality in the taste and smell of the coffee[47], suggesting a possible means of adaptation in some cases.

Coffee is sensitive to temperatures outside of the range of its optimal growing conditions and these temperatures are becoming ever more likely. Higher temperatures have been correlated with higher caffeine concentrations if temperatures were elevated during the last four months of the fruit ripening[48], but overall sensory impacts are mixed, as some chemicals, like caffeine, above a threshold, are associated with greater bitterness of taste, while increases in other chemicals are associated with improved flavour profiles. However, higher temperatures are associated with faster ripening of the fruit, which degrades coffee bean quality. Continuous temperatures above 30ºC can severely damage the plants[49].

Water stress also varies in its impacts by region: in one region, it enhanced flavour and acidity (a desirable feature) while in another only flavour was enhanced. In this second region, however, the number of dry months (<90mm rainfall) was a critical determinant of coffee quality. Important for flavour, the coffee plants would experience steady annual rains throughout fruit development and a dry period of 1–3 months leading up to harvest[50]. Climate variability makes this stability less likely, with concomitant impacts on prices paid to producers for lower quality coffee beans.

Coffee by country

Brazil

Brazil is the largest coffee producer in the world, as it has been for more than 150 years. The country produced more than 2.5 million metric tonnes in 2016[51], of which around 1% entered the UK market[52]. The total value of the industry to the country in 2021 was US$5.8 billion, representing 16.1% of total coffee exports worldwide[53]. Brazil grows both Robusta and Arabica, producing respectively 28% and 41% of the world's crops[54]. The states of Minas Gerais, São Paulo, and Bahia are the main producers of Arabica and the state of Espírito Santo the almost exclusive source of Robusta.

Brazil lacks high elevations, so its coffee production of both Arabica and Robusta is at low elevations, which are predicted to suffer substantial losses in suitability as the climate changes[55]. A 2021 drought in Brazil saw declines in productivity of Arabica, with Minas Gerais seeing a 22% decline in its exports. With an increase in farming of Robusta, it would appear that farmers are responding to the climatic signals. In 2011, 30% of total production was Robusta, but ten years on in 2021, it was 40%[56]. However, Robusta is not immune. In 2016, drought badly affected Espirito Santo. Exacerbated by deforestation in the state's hills, the drought denuded coffee plants of their leaves and farmers lost up to 90% of their coffee crops, leaving them indebted and with hungry families[57].

Brazil's coffee growing capability is projected to decline markedly, even under low heating scenarios. If global average temperatures increase by 1.5-2°C by 2100, it has been projected that Brazil could lose as much as 76% of its highly suitable and 28% of its moderately suitable coffee growing lands by 2050, compared to the year 2000. If heating follows current projections, those figures rise to 79% (highly suitable) and 36% (moderately suitable land). Heating of 5°C (not impossible if feedbacks in the climate system kick in), would lose Brazil 97% of its highly suitable, and 43% of its moderately suitable coffee growing areas[58].

Vietnam

Vietnam is the second biggest coffee producer in the world, in 2016 contributing more than 1.6 million metric tonnes of coffee towards the world's mugs and cups[59] and 3% of the country's GDP[60]. The UK imports 2.6% of this impressive coffee output[61]. Robusta represents about 95% of production output, mainly from the Central Highlands. Arabica production is scattered across the country and is farmed by smallholders[62]. Coffee is

Below: The small cocoa and coffee producer Jose Ignacio Perez, 85, stands in a field of ruined crops in the village of La Paz del Tuma, in Jinotega, Nicaragua.

the country's 19th biggest export, with a value in 2022 of US$4.056 billion[63].

Vietnam's coffee industry is threatened by the changing climate and its increasing variability. Rising temperatures have brought the farmers uncertainty of when extreme weather will hit, whether in the form of longer droughts, more frequent floods, or greater outbreaks of pests and diseases that reduce productivity and profitability[64]. The production of 'full sun' Robusta as a monoculture, a form of agriculture that is based on growing only one type of crop at a time in a specific field. This is made possible through high-input methods of agriculture and on land deforested of its biodiverse natural life, increasing the farmers' climate vulnerability as it is associated with water depletion and land degradation from loss of biodiversity. The monocultures simply have low resilience to climate impacts[65].

Historically, Vietnam's coffee industry developed in ways that have led to inequalities of distribution of benefits. Both colonial and communist administrators worked with farmers of the Kinh ethnic group, leading to the disadvantages of other ethnic groups, such as the Ede, reducing the security of their needs being met. A 2008 study advised that improvements could be made to the situation by offering disadvantaged groups "education, economic advancement, land ownership, and access to resources."[66]

Overall, Vietnam's coffee industry is likely to be less impacted than Brazil's, as it grows about 95% Robusta coffee as the country's climate and elevation make it more suitable for this more resilient variety [67]. This is not to say that the hit Vietnam could take to its coffee growing because of climate change is trivial. If temperatures rise 1.5-2ºC by 2100, by 2050, Vietnam could lose 48% of its highly suitable coffee, and 25% of its moderately suitable, growing land. If global policies to cut emissions don't improve substantially and temperatures rise to the 2.5-3ºC that seems currently likely, Vietnam's prime coffee growing land could be reduced by 71% and its moderately suitable land by 37%. In a 5ºC scenario, the loss of 86% and 47% of highly and moderately suitable land, respectively, may be less of a hit than Brazil would experience, but still be a big impact for Vietnam's coffee industry.

Ethiopia

Although it is not known where coffee's effects were first discovered, Ethiopia is legendarily the place where coffee's enlivening effects were first seen when a goatherd noticed his goats had perked up after eating the fruit of the plant[68].

"Africans make up 17% of the world's population but we generate just 4% of the greenhouse gas emissions that have caused the climate crisis. And yet it is we who are suffering the brunt of the impacts of climate change.

"Our coffee industry is Ethiopia's most important export and generates significant employment. But now it is under threat from climate change. The impact of climate change on coffee production is in plain sight, including through high levels of coffee leaf rust

"There is a lot the UK Government can do, starting with cancelling the debts of the world's poorest countries and mobilising the vital climate finance we need to adapt to the impacts of the climate crisis on our country."

Yitna Tekaligne, Christian Aid's Ethiopia Country Manager.

In any case, it is now the fifth largest coffee producer in the world[69]. Coffee is Ethiopia's most important export, bringing in US$1.2 billion in 2021, with the UK comprising 1.04% of Ethiopia's export market [70]. Ethiopia's coffee production represents 3.3% of the global total exports and grew by 49% between 2020 and 2021[71]. Almost all the coffee, across 10% of all the country's commercial cropland, is produced by about 5 million smallholder farmers[72].

The impact of climate change on coffee production has been well documented in many parts of coffee growing regions in Ethiopia, including through high levels of coffee leaf rust[73]. Deforestation has also contributed to coffee plant stress. These impacts will continue, but Ethiopia's varied landscape means that with planning, areas that are currently suitable for production but will become less so, can be offset by the substantial areas that were previously unsuitable for coffee farming becoming suitable[74]. Site-specific adaptation of varieties can help build resilience[75].

A recent study investigated the potential for Ethiopian coffee farmers to produce five premium specialty coffees, considering local details of microclimatic, topographic and soil characteristics. The model found that 27% of Ethiopia is generally suitable for coffee, but only up to 30% (91,122 km^2) of this was suitable for the specialty coffees, which can command a premium of 20-50% compared to regular coffee beans. With climate change, this study agreed with some estimates that up to half of the current specialty coffee growing areas could be significantly altered by climate change with effects on production and local society, but that there were opportunities for adaptation that could produce years of the specialty varieties[76]. These could include relocation of coffee areas, in combination with forest management or as new plantations[77]. To be successful, this will of course require careful planning and engagement with the smallholder farmers.

Honduras

Honduras is the 6th biggest global coffee bean producer, and third in Latin America[78]. Coffee is Honduras' most important export product and the UK accounts for 3.4% of the country's export market[79]. Honduran exports grew rapidly from 2020 to 2021, increasing by 48% to bring in US$1.3 billion in income, 3.6% of the global export market[80].

The 2020 double whammy of Category 4 hurricanes Eta and Iota hurt coffee growers previously hit by the drought of El Niño in the years before. The hurricanes caused landslides in areas that had been deforested, including higher altitude areas, that

"We need to educate. If human beings knew the damage they are doing to nature, and the consequences that this is going to bring, I think that they would never do what they are doing now"

Petronila Barahona Cedillo, 52, from El Porvenir, Honduras.

had settled as an adaptation attempt to be able to keep growing coffee. Water availability is far lower than it was, linked to climate change, but also likely due to the altered hydrodynamics caused by the deforestation. Temperatures are rising and weather conditions are less and less predictable, including inter-annually[81]. Leaf rust is a worsening problem[82].

Migration is a factor that may limit the long-term sustainability of Honduras' coffee industry. Locals note that it is the young and fit 18-40 age group that tend to leave to seek opportunities elsewhere. "They say, I am going to leave, and I will help my family, and they are better there. They send $100 -$200 weekly, or monthly, depending on how they do over there. To live only from coffee is difficult" [83].

Climate impacts are affecting people beyond coffee growers. The hurricanes lead to loss of homes and so displacements. Gangs are using the increased vulnerability of people because of the impacts of extreme weather to tighten control over them and impose restrictions on movement. Climate impacts are leading to increasing numbers of people leaving Honduras and not just from the coffee fields[84].

Malawi

Malawi's coffee growers consist both of estates and smallholders. The estates practice high input farming and have yields of 2-3 metric tonnes of green coffee beans per hectare. Most estates don't have coffee as their major crop, but also grow other cash crops like tea, tobacco and macadamia. In fact, the coffee plants are sometimes planted in contours to control soil erosion[85]. Production from the estates has fallen considerably since the early 1990s, from 6700 to today's 1000 tonnes[86].

The 3-4000 smallholders together grow 350-450 tonnes of coffee annually and the area under cultivation is growing with the help of donor support. Productivity may be lower than on estates because small-scale farmers tend to grow at higher altitudes, but it does mean higher quality coffee. Although their lower or no chemical fertiliser use can also lead to lower short-term productivity as they adopt agroecological methods such as organics, this delivers better longer-term and more sustainable yield improvement prospects and greater resilience to drought and flood. The smallholders are arranged in six cooperatives, which together formed the Mzuzu Coffee Planters Cooperative Union (MCPCU). The Union aims to:

- Promote formation of self-sustainable farmer organizations

Yadira Lemus

Yadira Lemus, a coffee farmer born from generations of coffee producers in Honduras, is part of a women's group working with the support of Christian Aid partners to implement climate adaptation projects and improve the income of women.

"As a coffee producer, it is more and more difficult to produce," Yadira Lemus explains. "And yes, that is obviously related to climate change, because before we would plant coffee and it produced almost by itself."

She adds: "With regard to climate change, we are seeing an increase in temperature. It is harder to predict the weather. Before we could say which is winter or summer, and when we can plant. Not anymore. We cannot say that because it changes from one year to the other, and it is not easy to predict. Who was going to predict that we were going to have the storms and hurricanes we had last year. Now you see there is a lack of rain. We are more vulnerable to these types of changes.

"Each time we have to search for higher places to produce. People are now deforesting higher zones, which generally are recharge zones for springs, which in the end are the water sources we take the supply from. They are also contaminating them because they are not implementing good agricultural practices."

- Production of coffee through use of sustainable technologies and facilitating access to finance by producers, cooperatives and the Union
- Processing and marketing of coffee and other products on domestic and international markets
- Promote women participation in coffee business at all levels
- Promote business diversification at farmer, cooperative and union levels with aim of self-sustaining business at each level[87]

MCPCU supports the smallholders to reach export markets through fixed contracts and its formation led to the smallholders' earnings rising to up to 70-80% of the final sales price[88]. It has also led to them being able to certify their production as Fairtrade and organic, both of which can help the coffee reach premium markets.

Because of Malawi's topology and underdeveloped infrastructure, heavy rains can make it challenging to bring the beans to export terminals. Malawi is already experiencing changes to the start, length and quality of the growing season and increasing intense extreme weather events, especially droughts and flooding[89]. Coffee wilt disease, coffee berry disease and leaf rust are all challenges for the farmers and ones that are affected by the changing climate[90]. These all impact the quantity and quality of the coffee production and thus the livelihoods of the farmers.

Mackson Ng'ambi

Chief Executive Officer of Mzuzu Coffee Cooperative in Malawi.

"Our experience is that in a year where the early season rains have been poor or non-existent, coffee flowering has also been grossly poor. This is now having a frequent recurrence.

"The global coffee pricing should take an objective consideration that the farmer is making more effort to maintain a field of coffee and hence increased cost of production. If this is not recognised and informs coffee prices, sadly most growers will abandon coffee farming.

"There is also a need for direct funding that would benefit the small-scale coffee growers, such as access to low interest financing which is currently not available in Malawi. If nothing is done, we should forget about coffee in a few years to come."

Recommendations

To tackle the climate crisis which is making coffee growing in Honduras and elsewhere so challenging we recommend the following actions. These address root causes of the problem, help countries adapt and aid coffee growers whose livelihoods are under threat.

Ultimately, to ensure coffee production continues only fairer and better coffee prices for farmers will enable investment in the necessary resilience-building.

- **Boost climate finance to help governments support farmers** including coffee growers to adapt to the changing climate and assist in the diversification of livelihoods to climate resilient crops. This means support to diversify crops, adopt production methods that protect and enhance soils, reduce reliance on inputs that are multiplying in price and wiping out profits, increase resilience to climate change, maintain and increase long-term productivity and quality and off and on-farm biodiversity.
- **At the governmental level, make country-wide strategic land use plans.** For small-scale coffee growers this means that any shifts in coffee regions of cultivation do not have adverse impacts on nature and compete with other land uses in an uncontrolled and managed way.
- **Get the Loss and Damage Fund agreed at COP27 up and running;** and rich countries to provide their fair share of finance, based on the polluter pays principle. Ensure it makes finance accessible speedily to farmers and others affected by climate which can't be adapted to.
- **Debt cancellation to help poorer countries gain the fiscal space to better respond to the impacts of climate change.** The debt crisis is undermining scope for governments to invest in basic services like healthcare, or action to address the climate crisis, risking setting back decades of progress in tackling poverty. Cancelling unpayable debts will free up resources to invest in tackling climate change and poverty.

"Small-scale coffee farmers are living on the frontline of the climate crisis, despite having contributed little to the problem of global warming.

"The UK government must wake up and smell the coffee. As a country that has benefitted far more than most from industrialisation, and has contributed disproportionately to the climate crisis, we have a particular responsibility to people whose livelihoods are under threat from climate change.

"To tackle the root causes of the problem, the UK and other wealthy countries need to follow through on their promises and fund support for farmers in poorer countries to grow climate resilient crops and diversify their sources of income. Cancelling the unsustainable debts held by many coffee producing countries would also free up further resources to tackle climate change and poverty."

Patrick Watt, Christian Aid's Chief Executive.

- **Cut emissions to keep global warming within 1.5C and prevent climate change from accelerating the harm caused farmers including coffee growers.** Governments need to submit more ambitious commitments ('Nationally Determined Contributions') in advance of COP28; rich countries need to lead the way on ending fossil fuel extraction and use.

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