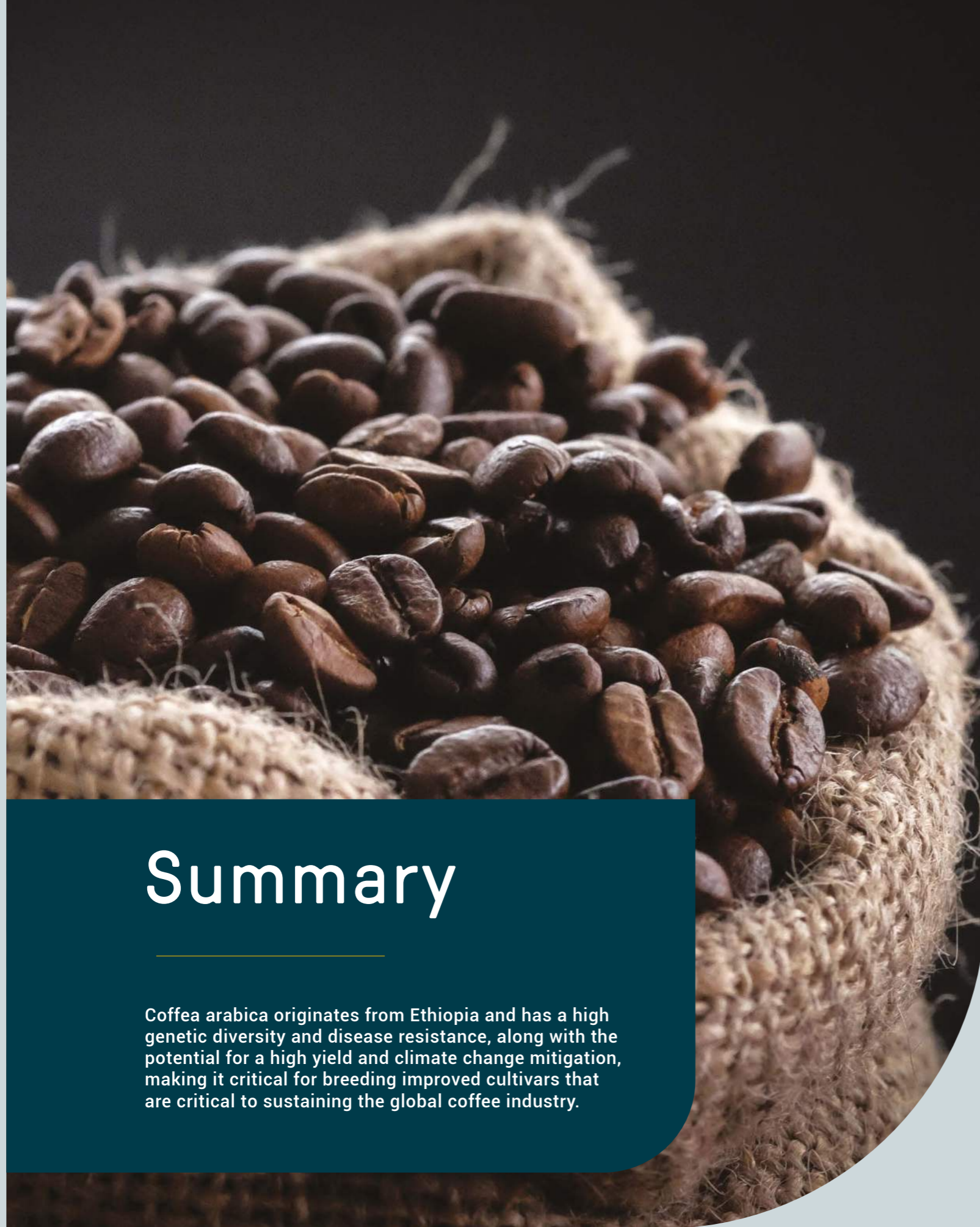


Investing in the
sustainable conservation
of *Coffea arabica*

How Ethiopia can derive
economic value from nature



Summary

Coffea arabica originates from Ethiopia and has a high genetic diversity and disease resistance, along with the potential for a high yield and climate change mitigation, making it critical for breeding improved cultivars that are critical to sustaining the global coffee industry.



Coffea arabica (also known as Arabica coffee) is the most economically significant coffee species in the world.



Investing in conservation and sustainable management of the forests from which *Coffea arabica* is obtained can serve to preserve the coffee species and increase its availability to the coffee industry.




Factors such as deforestation, shifting farmer focus from coffee to other cash crops, and climate change threaten the continued existence and availability of Ethiopia's *Coffea arabica*.



Ethiopia stands to gain immense economic benefits, including USD2.37 – 5.84 billion per year, from exploiting *Coffea arabica* genetic resources for coffee production locally. Where coffee producing countries use coffee genetic resources in Ethiopia for coffee production, there is a potential economic benefit of USD7.6 – 8.1 billion per year for the country.

Background

Coffee is the one of the most exchanged products in the world, second only to petroleum. It is the most internationally traded agricultural produce, and millions of smallholder farmers depend on the species for their livelihoods. *Coffea arabica* (*Coffea arabica*) is the most economically significant coffee species among the over 120 coffee species in terms of volume of production and trade. It was the most produced and exported coffee species in 2018 according to the 2018/2019 Annual Review report of the International Coffee Organization.



Coffea arabica is native to Ethiopia, where it grows wild in the montane forests. Its wild populations found in the forests have high genetic diversity, setting them apart from cultivated *Coffea arabica*, which has a limited gene pool. In 2020, Ethiopia was the fifth largest producer of coffee in the world, producing 7.3 million kilogrammes while Brazil, the top coffee producer, produced 63.4 million kilograms.

Ethiopian wild coffee populations provide a much-needed diversity of genetic information for future coffee breeding, as well as valuable traits such as disease tolerance, drought resistance, high yield potential, and low caffeine content. As such, the species can play an important role in the economic potential, ecosystem conservation, and survival of the coffee species.

Problem

Ethiopia is losing its *Coffea arabica* biodiversity. Deforestation, shifting farmer focus, climate change, and pests and diseases threaten the continued existence of wild populations of *Coffea arabica*. Clearing the montane forest for food production leads to a loss of wild coffee genetic resources and associated plant and animal diversity. The instability of coffee prices has caused many farmers to shift focus from coffee to other cash crops, reducing the quantity of cultivated coffee produced. Climate change is a threat to both wild and cultivated coffee populations, with a study revealing that at current rates of warming, about 40-60% of land used to cultivate coffee will no longer be suitable for coffee production.

Preserving and sustainably managing the ecosystems from where Ethiopia's *Coffea arabica* is obtained can prevent its extinction. Taking such actions will not only ensure the sustainability of the global coffee industry, but help Ethiopia to realise significant economic returns from its natural resource.

Partnerships for Forests (P4F), a programme that leverages investment into regenerative business models in the land use sector to address climate change, benefit people and protect biodiversity, is supporting the Ethiopian Wild Coffee (EWC) project. The EWC project aims to improve the quality of coffee produced in Ethiopia and attract buyers from the global specialty export market, securing better prices for farming communities, while ensuring protection of conservation (planting) areas. The project fosters partnerships between private sector and government entities that promote sustainable farming practices and land use, and support restoration efforts.

As part of its conservation goal, the EWC project in 2020 commissioned a study on the economic values of *Coffea arabica* biodiversity in Ethiopia. The study explored the economic benefits of *Coffea arabica* in producing improved coffee cultivars with desirable traits such as high yield, disease resistance, climate change resilience and mitigation, caffeine content, and 'cupping' (tasting) scores, and the ecosystem service of the coffee forest in climate change mitigation.



Key findings

Findings from the study provide proof of the value of *Coffea arabica*'s genetic biodiversity for improved coffee enhancement and the economic gains that Ethiopia can obtain should the appropriate and adequate efforts be made by the government of Ethiopia.

Increased yield / productivity

High yield, or productivity is one of the key benefits of *Coffea arabica* biodiversity. As at 2021, Ethiopia produced on average 0.683 tonnes of coffee per hectare per year, a quantity below the world average and the average of the leading coffee producer, Brazil, at 0.8 tonnes per hectare and 1.6 tonnes per hectare respectively.

Researchers in Ethiopia have identified 42 new varieties of *Coffea arabica* that show significant productivity, between 0.7 to 2.6 tonnes per hectare depending on whether they are grown on research plots or farm trial plots. This indicates the potential Ethiopia has to increase its *Coffea arabica* productivity beyond the current national average of 0.7 tonnes/ha. A key finding from the biodiversity study is that upon adoption of high yielding cultivars of *Coffea arabica*, Ethiopia can generate an estimated USD1.465 billion per year from the resulting improved productivity.

Increased disease resistance

Disease and pest infestation are significant problems for coffee production worldwide. Coffee berry disease (CBD) attacks *Coffea arabica* in Africa and Latin America and can cause significant yield losses in certain conditions. In East Africa, infestation rates of up to 96% have been recorded, with Ethiopia known to lose up to 1.6% of its annual coffee yield to the disease.

There are more than 47 species of insect pests that affect coffee in Ethiopia, among which Antestia bugs (*Antestiopsis intricata* and *A. facetoides*) and coffee blotch miner (*Leucoptera coffeana*) cause the most significant damage. Antestia bugs are documented to cause productivity losses of up to 13% worldwide and 96% in Africa.

The use of disease resistant coffee varieties mitigates disease risk without compromising on yield. The *Coffea arabica* biodiversity in Ethiopia has been shown to be resistant to coffee leaf rust, CBD, and *Meloidogyne incognita* and can potentially save Ethiopia about USD100 to 157 million per year in fungicide and pesticide cost.

Increased drought tolerance or climate change resilience

Coffea arabica genetic resources are promising or developing varieties for drought tolerance. Having a wide ecological range and gradients in rainfall and temperature, Ethiopia offers opportunities to select drought tolerant varieties. The drought tolerance or climate change resilience benefit of *Coffea arabica* genetic resource is estimated to be USD5.5 billion in total, or USD3.95 billion in export earnings.

Climate change mitigation

Forests, including the forests that grow *Coffea arabica*, act as a sink for carbon. The coffee forest areas in Ethiopia cover around 4.97 million hectares and store an estimated 600 tonnes of carbon dioxide equivalent per hectare. If efforts are made to reduce deforestation, Ethiopia can reduce emissions by 14.9 million CO2 equivalent, which can provide about USD64.61 million per year from potential trading of carbon credits.

Cup taste quality and low caffeine content

Coffee quality, including fragrance, flavour, sweetness, and physical attributes of the coffee bean such as shape, colour, length and thickness, is of crucial importance to the coffee industry. It's influenced by environmental factors, such as soil type and amount of rainfall, and depends on the genetic composition of the variety of coffee.

The biological biodiversity of *Coffea arabica* provides a broad spectrum of desired traits that can be genetically manipulated to breed coffee varieties that satisfy consumer and import or export needs. By exploiting *Coffea arabica* in this way, coffee with cup taste quality akin to specialty coffee can be produced which attracts higher prices than commercial grade coffee, (usually of lower cup taste quality), and would help increase the national export value of Ethiopia's coffee. Ethiopia can gain about USD1.26 billion per annum by improving the cup taste quality of *Coffea arabica*.

Coffea arabica has a naturally low caffeine content. The global decaffeinated coffee market is expected to witness significant growth in the coming years. Decaffeinated coffee has been linked with the reduction of emissions and is sustainably grown to avoid industrial decaffeinating processes, which are water and energy intensive. The economic estimate for decaffeinated *Coffea arabica* could range from USD225 – 292 million annually. Considering this calculation and the growing demand for decaffeinated coffee, an investment in caffeine-free cultivators would have significant economic potential.

Policy and other implications

As the continued availability of Ethiopia's unique *Coffea arabica* gene pool is vital to sustaining Ethiopia's and the global coffee industry, efforts towards conserving, protecting and improving this natural resource are paramount – and can be a source of significant economic benefit for Ethiopia.

By investing in exploring the vast genetic diversity of *Coffea arabica*, Ethiopia can generate additional yearly income of about USD2.37 – 5.84 billion by exploiting *Coffea arabica*'s genetic diversity for coffee breeding programmes to improve local coffee production in terms of increased yield, disease resistance, and the other benefits of *Coffea arabica*'s genetic biodiversity.

Additionally, Ethiopia can potentially earn up to USD8.1 billion per year from coffee producing countries who use its coffee genetic resources to resolve their coffee production challenges, and an additional USD380 – 403 million per year if an agreement is negotiated with those countries to pay 5% of their economic gains from using those resources. However, for Ethiopia to realise these economic benefits, the government must:



Create demand for Ethiopian *Coffea arabica* varieties and biodiversity, design and implement certification schemes for shade and forest coffee



Source payment for ecosystem locally and globally for Ethiopia to realise the cup taste quality and low caffeine content characteristics of its coffee and realise the resulting ecosystem services benefits



Devise the means to garner the global benefits accruable from conservation of *Coffea arabica*. Consequently, the Ethiopian government should invest heavily in research, development of institutional framework, and resource management

N°	Attributes of <i>Coffea arabica</i> biodiversity	National value Ethiopia (million USD \$)		Global value (million USD \$)	
		Low	High	Low	High
01	Yield increment benefit	1,465	4,688	-	-
02	Disease resistance	100	157	600	1,000
03	Low caffeine	-	-	225	292
04	Cup taste quality	65.80	65.80	1,260	1,260
05	Climate resistance	615.30	615.30	5,500	5,500
06	Ethiopian coffee forests ecosystem services – climate change mitigation	64.61	64.61	-	-
07	Pest control of forest birds	60	248	-	-
TOTAL		2,370.71	5,838.71	7,585	8,052

Recommendations

Regarding actionable steps that the Ethiopian government can take, researchers of the EWC study recommend the following:



Strengthen research and capacity building

The government must invest in intensive research to identify Ethiopia's *Coffea arabica* genetic resources and their potential to develop new coffee varieties that can withstand existing and anticipated coffee production challenges. Along with this should be increased efforts to conserve available coffee genetic resources, conduct research into required extension services through which smallholders are provided information, advice and other support to improve their productivity, and commence extension services.



Proactively mobilise resources from coffee both locally and internationally

It can do this locally by creating a system to ensure resources are obtained from coffee related business. Globally, it can undertake a campaign to promote the important role of coffee biodiversity to the global coffee industry, gaps in capacity and lack of policy frameworks to exploit this biodiversity and the need for collaboration among those that can benefit from the diversity of Ethiopia's coffee gene pool.



Developing partnerships

Since coffee production is multisectoral, government should involve itself in developing partnerships and collaborations. It should concentrate efforts to establish partnerships that aid transfer of scientific knowledge and production technologies with scientists and experts in coffee producing countries. It should also devote resources to strengthening extension services for the coffee industry, which has implications for developing the coffee sector.



Policy enforcement

Ethiopia has many policies and is party to international protocols to enable it to obtain value from *Coffea arabica*, but capacity to enforce these policies is often lacking. The government must thus strengthen policy enforcement for the coffee sector if it hopes to accrue benefits from it. For example, Ethiopia is party to UN Convention

on Biological Diversity, which instils a governance structure that involves national sovereignty of genetic resources. The government endorsed the National Biodiversity Strategy and Action Plan in 2012; this strategy addresses the strategic priorities of biodiversity protection, restoring land health, food security management and livelihood improvement of rural communities (farmers). Although the Ethiopian government has designated several protected forests in areas of southwest Ethiopia, with regions embarking on projects to fence and protect the forests, poor implementation and monitoring of these projects has led to haphazard execution due to poor or no remuneration of executors. To ensure sustainability and incentives for protection, a farmer-based institution in the form of Participatory Forest Management Cooperatives (PFMCs) is strongly recommended.

In 2012, Ethiopia became a signatory to the Nagoya Protocol on access and benefit sharing (ABS) mechanism, which aims to ensure owners of genetic resources receive fair and equitable benefits on products developed from their utilisation in research and development based on Mutual Agreement Terms (MATs). However, Ethiopia lacks adequate capacity to negotiate and enforce MATs for it to obtain benefits under ABS. The government should firmly enforce checkpoints at entry to avoid genetic pollution and exit points to combat biopiracy. By promoting market segmentation policies and ensuring proper registration of branding mechanisms, the government of Ethiopia can help generate additional revenue from the supply chain of coffee.



Awareness creation and technology transfer

This should be a major priority for players in Ethiopia's coffee sector. Relevant institutions and other stakeholders should promote the values of *Coffea arabica* biodiversity to key coffee actors, including coffee producing countries, national and international policy makers, donors, and the research community through awareness creation activities. Equally important is the promotion of knowledge and technology transfer and adoption of improved varieties.



Adequate support for conservation of *Coffea arabica*'s genetic resources

Efforts should be made to develop *Coffea arabica* field gene banks, as well as identifying genetic resources that differ in characteristics and qualities for the purpose of developing new varieties of required traits. With the ever-increasing threat from climate change and land use change, it is important for the government to fund the in situ conservation of *Coffea arabica* biodiversity to collect genetic materials from all possible ecological ranges, ecosystems and production system and establish additional field gene banks primarily designated for research. This could involve conservation of the wild population in situ in the forest, cultivated local varieties in situ on farms, and vulnerable populations no longer in suitable areas ex situ in field gene banks close to the natural ecological range. This can be completed under the framework of the UN Convention on Biological Diversity, which may take the form of establishing UNESCO biosphere reserves like the Yayu Coffee Forest BR, or community forest reserves with clearly designated areas for conservation.




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