

Plant Biology

High extinction risk for wild coffee species and implications for coffee sector sustainability

by **Aaron P. Davis**¹ | Senior Research Leader

¹: Royal Botanic Gardens, Kew, Richmond, Surrey, UK

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ABSTRACT

*Coffee is a globally significant commodity and the source of livelihoods for millions of farmers worldwide. Our coffee crop plants, Arabica (*Coffea arabica*) and robusta (*C. canephora*), represent very recent domestication events. We found that at least 60% of all coffee species are threatened with extinction, 45% are not held in any germplasm collection, and 28% are not known to occur in any protected area.*



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It has been estimated that coffee farming provides livelihoods for around 100 million people worldwide, most of which are smallholder farmers. For many coffee producing countries, coffee exports make up a significant and critically important proportion of their export earnings. Despite the number of producers and the importance to economies, it is often asked if ever-increasing global demand for coffee can be met? For the foreseeable future, the answer is yes, with bumper harvests recorded in recent years, and plenty of scope for increasing production in many areas. If, however, you look at the history of coffee cultivation, it has not been plain sailing. In recent years there have been some catastrophic problems with coffee production in many major producing countries due to issues such as fungal diseases, pests, and drought. And what

about the future, particularly with an increasing population set against a backdrop of accelerated climate change?

For more than 150 years, coffee agronomists and other scientists have been working hard to resolve issues concerning production and sustainability, and this work continues to the present day. One of the main resources for this work, and especially for plant breeding, has been the use of wild plants, particularly those related to our crop species, which house the genetic resources capable of providing disease and pest resistance, climate resilience, and other useful traits such as improved flavour and quality. These plants, whether for coffee or other crop plants, are often referred to as crop wild relatives (CWRs).

History also tells us that coffee production is dynamic, in terms of where coffee is grown and also what species we grow. Currently, we mainly depend on two species, Arabica and robusta, to provide us with the coffee we drink, but what does the future hold? The increasing severity of pests and diseases, the loss of suitable space to grow coffee and climate change are all having their impact, putting increasing pressure on coffee farmers. There are a number of possible solutions to these problems. Important opportunities could come from the use of wild coffee species, and the incorporation of specific genes from wild plants via breeding. This may seem fanciful to some, but this is exactly what has happened in the past. In the future might we be using wild or under-utilized wild coffee species, or the useful genes they contain? In total there are 124 coffee species, growing wild in tropical Africa, Madagascar, Asia and Australasia, and this wild species gene pool could have considerable potential for the long-term future of coffee farming.

With the support of International Union for the Conservation of Nature (IUCN) and Toyota Motor Corporation, the Plant Assessment Unit of the [Royal Botanic Kew](#) is now assessing the extinction risk of 1,000 plant species each year. As part of this project, during 2017 and 2018 we had the opportunity to review many decades of research on wild coffees, to produce formal IUCN extinction risk assessments for all 124 coffee species.

Using data gathered from herbarium specimens (including the important collections held at Kew), in combination with field work and information from other sources, the occurrence of coffee species and the factors that threaten their survival, we were able to reveal that more than 60% of coffee species are threatened with extinction. In addition, we found that those species with the greatest potential for use

in coffee crop development are amongst those with the highest extinction risk, and do not have adequate measures in place for effective conservation. Several species haven't been seen in the wild, or in cultivation, for over 100 years. Some of these may already be extinct. Around 45% of coffee species are not found in living collections or seed banks ([germplasm collections](#)), and 30% have no protection in the wild (do not fall within the boundaries of national parks, wildlife reserves, and other protected areas). Given the importance of wild coffee species for crop development and long-term sustainability, these are worrying figures.

An additional extinction risk assessment was carried out by Kew and Ethiopian researchers on Arabica coffee, with the incorporation of climate change projections ([Moat et al. 2019](#)), something that has been done for only very few species. The analyses reported that wild Arabica is now listed as an Endangered species, with its natural population estimated to reduce by up to 50% or more by 2088 due to climate change alone. This paints an increasingly worrying picture for many other coffee species - if climate change were to be considered when assessing their extinction risk.

It's clear from our work that existing protected areas (for example, nature reserves and national parks) need better management and protection, and that new protected areas are required. Germplasm collections also require more resources, so that they can incorporate more coffee species and greater coffee genetic diversity, upgrade their facilities and improve management. These actions are particularly relevant for those African countries (such as Ethiopia, Tanzania, Cameroon, and Angola) and Madagascar, which have the highest levels of wild coffee species diversity.