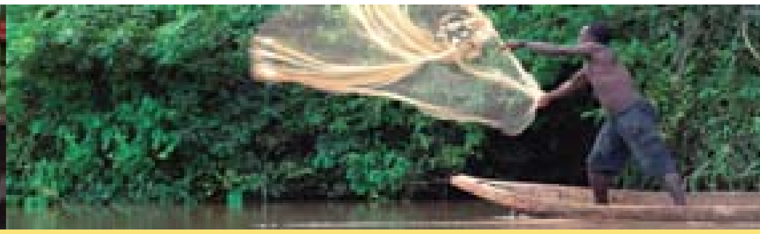


Agrobiodiversity and adapting to climate change: The example of coffee

Coffee requires specific conditions to grow. Climate change may coffee cultivation unprofitable in major production areas.

The average global temperature has increased by 0.74° C over the last hundred years, and it continues to rise. The temperature changes vary from place to place, and as do the amounts and distribution of rainfall. Many semi-arid areas, such as the Mediterranean, the western United States, northeastern Brazil and southern Africa, now receive less, and more variable, rainfall. In such areas, the risk of drought and the need for irrigation have both increased. Higher latitudes and the humid tropics receive more rainfall and experience more frequent extreme weather events.

At mid- and high latitudes, climate change is predicted to increase agricultural productivity, while lower latitudes are expected to suffer a decline in productivity. In Africa, rainfed areas are expected to yield up to 50% less by 2020, while the continent's arid and semi-arid areas may expand by 58%. More flooding is likely in the large river deltas of South, East and Southeast Asia, while in South America parts of the Amazon rainforest may turn into savannah, and agricultural productivity will decrease.

Climate change and coffee

Coffee is one of the world's most important export crops. Climate-induced changes in coffee production will affect all stakeholders in the coffee sector throughout the world.

Coffee requires very specific growing conditions. It is particularly sensitive to changes in seasonal temperatures and rainfall. The growth of Arabica coffee declines significantly if the daytime temperature exceeds 20°C. Only a few days that are too cold or too hot during flowering or maturing will reduce yields and quality. Higher temperatures make the coffee more susceptible to disease, and favour pests such as leaf miners, stem borers and certain nematodes, which multiply more rapidly under these conditions.

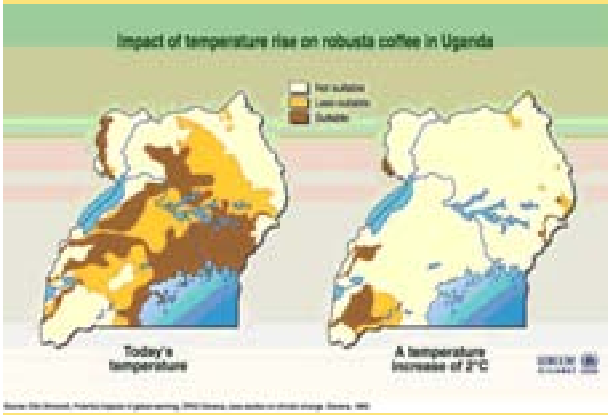
These findings from research are confirmed by reports from the field. Producers in Kenya, Mexico, Peru and Nicaragua suffer production losses as a result of prolonged drought, changes in the seasonal progression, and more common crop diseases. Models suggest that by 2020, yields in Mexico will decline by one-third, making coffee cultivation unprofitable in large areas.

The areas suitable for coffee production will shrink and shift in location as a result of the warming. In low-lying areas, it will not be possible to grow coffee in the future. Production will have to move to higher altitudes – if suitable land is available. But there is less land at these altitudes, so production areas will shrink. Plus, small-scale farmers lack the capital to buy new land. In the Brazilian state of São Paulo, the coffee-growing area is expected to decline by 10% as a result of a temperature increase of 1°C. Some countries, such as Guatemala, have substantial tracts of land at higher altitudes that might be planted to coffee; others, such as Uganda, have few such areas, so their coffee area will decline significantly (see figure). That will force coffee farmers to switch to other crops. A total of 30 million coffee farmers around the world are likely to suffer declines in yield as a result of the changing climate.

giz Sustainable management of resources in agriculture

On behalf of BMZ Federal Ministry for Economic Cooperation and Development

Change in area suitable for coffee cultivation in Uganda



Source: UNEP
http://www.grida.no/publications/vg/climate/page/3090.aspx

Shifting investment

The shift in cultivation to higher altitudes is likely to result in clearing the mountain forest, threatening wild coffee varieties and other species. At lower altitudes, coffee bushes are often planted in forests or under shade trees; replacing coffee with other crops will affect the environmental functions of these areas: water resources, local climate, soil cover and fire protection.

The expected changes in coffee cultivation will have consequences for the entire coffee value chain – from producers, through processors and marketers, to consumers.

Impacts of climate change in Wansho Woreda

Coffee growers in Wansho Woreda have reported a significant decline in yields over the last four years, which they say is due to drought, soil depletion and unusually high levels of precipitation during the harvest period. Meanwhile, the nearby weather station in Yirgalem has measured slightly above-average annual temperatures. Higher temperatures favour the spread of the coffee borer beetle. Analysis of the climate data collected by the Jimma weather station has shown that, until 1984, temperatures were too low to allow the coffee borer to complete a full generation cycle. The higher temperatures mean the beetle can now complete one to two reproduction cycles per year. If temperatures continue to rise, the reproduction rate may further increase, resulting in even greater harvest losses. Growing the coffee plants under shade trees is currently the most effective way of countering the problem.

Source: Oxfam (2010), 34-35

Coffee supplies will change radically, as will investment in old and new cultivation areas. This will in turn influence service providers, the regional distribution of employment, foreign-exchange earnings, and even national budgets. Consumers are likely to feel the effects in the form of higher prices.

Ethiopia's coffee diversity: A valuable basis for breeding

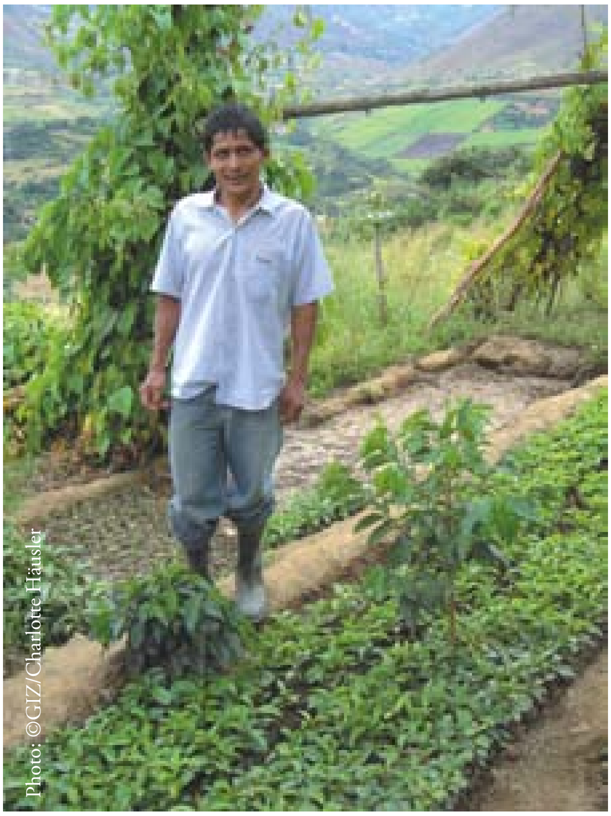
A changing climate has a bigger impact in Ethiopia, the centre of diversity of Arabica coffee, than elsewhere. A quarter of all jobs in the country depend on the cultivation, processing and marketing of coffee, as do 70% of Ethiopia's foreign exchange earnings and 10% of its national budget. Between 1960 and 2006 the average temperature of the country rose by 1.3°C, fluctuations in the seasonal and annual rainfall became bigger, and coffee harvests declined. Some coffee producers shifted their plantings to higher areas, while others were forced to stop growing coffee and switch to livestock and heat-tolerant crops such as *ensete* (a starchy root crop).

Ethiopia has a unique genetic diversity of cultivated, semi-wild and wild Arabica varieties with different types of disease resistance, environmental adaptations and quality characteristics. This natural diversity is the basis for breeding coffee varieties that are adapted to the changed climate. Arabica coffee (*Coffea arabica*) originated about 1,400 years ago through a natural hybridization of *Coffea canephora* (Robusta coffee) with *Coffea eugenioides* in Uganda. From there it was taken to Ethiopia, where it spread and was adapted to the conditions in various locations. From Ethiopia, coffee went to Arabia (what is now Yemen) and from there to India and Sri Lanka. The Dutch introduced coffee seeds to Java. In 1706 they presented a coffee bush to the Jardin des Plantes in Paris. Seeds of this single bush were planted in Martinique and from there were smuggled to Central and South America. The resulting bushes are the ancestors of all coffee plantations in Latin America.

The way that coffee spread across the globe led to an extreme narrowing of the genetic base, which has affected the disease resistance of varieties grown outside Ethiopia. For example, in 1970 the disastrous coffee berry disease was introduced to Ethiopia. But the country's genetic diversity enabled it to be controlled, as a result of the 1974 discovery of variety no. 741, which is resistant to coffee berry disease as well as other major diseases. It is now the main type of coffee in Ethiopia. Breeding does not focus only on disease resistance; it also aims to stabilize yields, improve quality, and adapt to site-specific conditions such as drought and humidity. All these play an important role in adaptation to a changing climate. The genetic diversity of coffee in Ethiopia is of global importance for the breeding of varieties that are adapted to future environmental conditions and that are disease-resistant.

Apart from breeding activities, other ways to adapt to climate change include improved cultivation methods and relocating production areas to more suitable locations.

In recent decades, the shade trees in about half the coffee plantations have been felled in order to grow "sun coffee". Studies indicate that shade trees reduce the temperature in lowland coffee plantations by up to 4°C, and by 2°C in the highlands. The shading reduces fluctuations in temperature, soil moisture and solar radiation, as well as limiting pest numbers. Planting new shade trees can revive these protective effects, and the trees can diversify the farmers' incomes. Soil- and water-conservation measures also act against increasing drought. But breeding and planting new varieties and planting shade trees take years to have an effect.



Producers urgently need to know whether they will be able to grow coffee in the coming century.

Strategic climate-adjustment programme for coffee

In order to prepare the necessary changes, producers and governments need clarity as soon as possible on where coffee can, and cannot, be produced in the next century.

A strategic climate-adjustment programme must consider the whole coffee value chain. In producing countries, the coffee sector includes growers, producers' associations, pulpers, buyers, certification agencies, wholesalers, transporters and exporters. In importing countries there are roasters, wholesalers, retailers and consumers.

In addition to customers and markets, information and support programmes should consider the conservation of wild coffee varieties, sustainable plantations and environmentally friendly processing. The *Rainforest Alliance* certification initiative, for example, uses a whole set of criteria when certifying coffee farms. These criteria are currently being reviewed for their relevance to climate change and CO_2 storage. The goal is to use a higher level of certification for climate-friendly cultivation, so achieving higher sales prices. Other schemes award CO_2 emission certificates for the planting of shade trees, or promote the diversification of coffee plantations. Voluntary commitments by coffee companies to source a certain percentage of their beans from environmentally friendly farming also constitute incentives. Sara Lee and Nestlé, for example, buy a portion of their coffee directly from growers at higher prices.

Scientific tasks in addressing climate change in the coffee sector include continued observations of the changing climate and the development of climate models to make reliable predictions of local impacts in individual countries. Research institutes and gene banks have an important role in *ex-situ* and *in-situ* conservation, in providing varieties for breeding, and in identifying, studying and characterizing such varieties (*see also the issue paper "Deep frozen? Alive and kicking? Different approaches to the conservation of farm animal diversity"*). For example, the Institute of Biodiversity Conservation and Research in Keffan, Ethiopia, houses 4,500 coffee varieties that are only partly studied and characterized.

Tasks for development cooperation

Numerous tasks await development cooperation agencies:

- Most coffee-producing countries lack institutional capacity in policy making, research and civil society, especially in implementing measures to adapt to and mitigate climate change. Interventions required include information, education and advice to actors in the public and private sectors; "climate-proofing" (strengthened mainstreaming of agricultural biodiversity and climate change adaptation into national sector programmes); as well as cross-sectoral coordination and implementation of large-scale measures.

Photo: ©GIZ/Carsten Schmitz-Hoffmann

Current varieties must be studied systematically for their adaptability to climate change.

- At the producer level, short-term, effective adaptation measures can be funded through new and ongoing development projects. Traditional coffee varieties can be reintroduced and enhanced, and shade-tree species and coffee varieties can be diversified.
- Training and organization of producers are necessary, as is promoting local and regional seed networks.
- In collaboration with research institutes and the private sector, existing varieties should be tested for their tolerance to different climatic conditions, and new varieties must be bred that are adapted to changed growth conditions. This requires the systematic identification and characterization of wild resources and the holdings of gene banks.
- Measures to adapt coffee cultivation to climate change also contribute to reducing CO_2. Other environmental benefits include enhanced water storage, the regulation of local temperatures, and biodiversity conservation. Approaches must be developed and put into effect to reward such environmental services to provide greater incentives for sustainable cultivation.

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