

# Coffee: More biodiversity, better harvest

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Bees, birds and bats make a huge contribution to the high yields produced by coffee farmers around Mount Kilimanjaro – an example of how biodiversity can pay off. This effect has been described as result of a study now published in the *Proceedings of the Royal Society B*. It has been conducted by tropical ecologists of the University Würzburg Biocenter, jointly with colleagues from the LOEWE Biodiversity and Climate Research Centre (BiK-F, Frankfurt/Main) and the Institute for experimental Ecology of the University of Ulm.

A large amount of [coffee](#) is grown on Kilimanjaro, the East African massif almost 6000 meters high. The most traditional form of cultivation can be found in the gardens of the Chagga people. Here the sun-shy coffee trees and many other crop plants thrive in the shade of banana trees and other tall trees. However, the largest part of the coffee is grown on plantations. Usually, the plantations still feature a large number of [shade trees](#). But these are progressively being chopped down because of the increasing replacement of "conventional coffee varieties, which rely on shade, by varieties that tolerate lots of sun and are more resistant to fungi," explains Professor Ingolf Steffan-Dewenter, a tropical ecologist at the University of Würzburg's Biocenter. This crop intensification is expected to result in higher yields. The plantation harvests might however stagnate: If there are only few shade trees left, the habitat may become unsuitable for the animal species that pollinate the coffee, eat pests, and thereby help to improve the yield.

## Teamwork on the slopes of Mount Kilimanjaro

Steffan-Dewenter and his doctoral student Alice Classen therefore wanted to understand how bees, birds, bats and other animals contribute to pollination and to biological pest control in the coffee fields. The aim was to find out whether and how intensified farming affects these services provided by the ecosystem. This research has been carried out in close cooperation with teams from the Biodiversity and Climate Research Centre (Frankfurt/Main) and the Institute of Experimental Ecology at the University of Ulm. The tropical experts conducted experiments in twelve areas on the slopes of Mount Kilimanjaro in Tanzania, located in all three cultivation systems (Chagga gardens, shade plantations and sun plantations). They used finely woven nets to prevent animals' access to the coffee flowers or even to entire coffee trees. Then they examined how the presence or absence of the "animal service providers" affects the quantity and quality of the harvest.

## **Contribution of animals to coffee cultivation**

The results revealed that where birds and bats had access to the plants, there was almost a ten percent higher fruit set. "We believe that this is due to the fact that the animals eliminate pests that would otherwise feed on the coffee plants" says Julia Schmack (BiK-F, Frankfurt). Reduced leaf damage is supposed to reduce the number of coffee cherries falling from the tree while ripening.

The pollination experiments showed interesting results as well: Bees and other insects should actually be redundant here, as the examined coffee variety, *Coffea arabica*, is self-pollinating. Yet, the researchers found that if pollinators have access to the coffee blossoms, the cherries were about seven percent heavier, which contributes to a higher coffee quality.

"So, the effects of pollination and pest control complement each other perfectly; both are important for higher yields," says Steffan-Dewenter:

"Birds and bats provide more cherries; bees and other pollinators ensure better quality."

## **Same effect with all cultivation systems**

To the surprise of the researchers, intensified farming seems to have no negative effect: the impact of the animal provided services on the harvest was equally good in all three cultivation systems, even in the unshaded plantations. "We put this down to the mosaic landscape structure on Mount Kilimanjaro with its gardens, forests and grasslands," says the doctoral student, Alice Classen. Given that much of the landscape is divided into small parcels, pollinators, birds and bats still could find a suitable habitat with nesting places, and from there spread into the plantations.

## **Shaky foundations in sun plantations**

"However, it is likely that these seemingly stable ecosystem services rest on shaky foundations in the sun plantations," believe the Würzburg scientists. This is due to the fact that they registered merely one type of visitor, honey bees, to the blossoms. On the coffee blossoms in the Chagga gardens, however, they additionally recorded wild bees, hoverflies and butterflies. So, if honey bee numbers were to decrease, as they might in climatically unfavorable years, this could reduce the harvest in the sun plantations.

## **Findings of a DFG research group**

These findings have been published in the journal *"Proceedings of the Royal Society B"*. They have been produced by a research group that focuses on the ecosystems of Mount Kilimanjaro and is funded by the German Research Foundation (DFG).

**More information:** Classen, A, Peters, MK, Ferger, SW, Helbig-Bonitz, M, , Maassen, G, Schleuning, M, Kalko, EKV, Böhning-Gaese, K & I Steffan-Dewenter (2014): Complementary ecosystem services provided by pest predators and pollinators increase quantity and quality of coffee yields." *Proceedings of the Royal Society B*, 10.1098/rspb.2013.3148

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