67. Can CO_2 fertilization compensate for progressive climate change impacts on coffee productivity?

Ovalle-Rivera Oriana[1], Van Oijen, Marcel[2], Läderach Peter[3], Roupsard Olivier[4], Rapidel Bruno[5]

[1]*CATIE, Division de Posgrado, 7170, Turrialba, Costa Rica*

[2]*CEH, Edinburgh, United Kingdom*

[3]*CIAT, Managua, Nicaragua*

[4]*CIRAD, UMR Eco&Sols, Montpellier, France, and CATIE, DID-PAAS, Turrialba, Costa Rica*

[5]*CIRAD, UMR SYSTEM; Montpellier, France, and CATIE, DID-PAAS, Turrialba, Costa Rica*

Different studies report negative impacts of climate change on coffee productivity using simple crop models. These models do not predict the effect of complex interactions between changing weather variables, like CO_2, temperature and rainfall, and their consequences on plant physiology. In this study, a coffee agroforestry process based model (CAF2007) was used to integrate processes and mechanisms that determine climate change effects on coffee. The model was calibrated using data of 11 experimental plots in different agro-climatic and managements conditions, using Bayesian calibration methods. We validated the model in commercial coffee plantations and finally used it to estimate climate change impacts and simulated shade tree management to explore adaptation options.

Bayesian calibration greatly improved the performances of the model. The RMSE were generally lower when calibrating independently on the 11 experiments, but the agreement was still good when the calibration was made in all experiments within one climatic zone, or even globally using all 11 datasets. The model calibrated globally was more robust. It performed adequately when using data from commercial farms located in all four climatic regions that form the coffee producing regions of Costa Rica and Nicaragua.

Annual average precipitation changes (predictions from RCP8.5 emission scenario and downscaled MIROC5 GCM) affect coffee yields both positively and negatively depending on site conditions and magnitude of change; temperature increases affect coffee yield negatively. However impacts depend on shade tree density and species. CO_2 fertilization affects coffee positively, and can compensate for negative effects of temperature and precipitation changes.

Shade from densely planted timber trees was more effective than heavily managed shade from Erythrina poeppigiana in mitigating the negative effects of temperature increase on coffee.

We discussed other adaptation strategies to adapt coffee agroforesty systems to climate change, as well as increase their CO_2 sequestration.