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Climate Change Impact on Legume Species Used as Shade Trees in Coffee Agroforestry Systems in Mesoamerica

Edwin Treminio[1], Alvaro Tinoco[1], Pablo Siles[2], Carlos Zelaya[2], Charles Staver[3]

[1] *UCATSE, Nicaragua*

[2] *International Center for Tropical Agriculture (CIAT), Nicaragua*

[3] *Bioversity International , CCAFS (Climate Change for Agriculture and Food Security), France*

Abstract

Climate change (CC) is projected to reduce the suitability for coffee in Mesoamerica. Coffee's medium and high altitude ecological niche with mean annual temperatures from 18 to 24°C and annual rainfall between 1200 to 1500 mm will be shifted and often reduced by increasing temperatures and altered rainfall. Multi-strata agroforestry systems are being promoted both to reduce maximum temperatures up to 5°C, compared to full-sun coffee, and to accumulate carbon. Most coffee agroforestry tree species are Fabaceae with the ability to biologically fix nitrogen and a similar ecological niche to coffee. In this study, we use ecological niche models to estimate the potential current distribution of ten legume tree species (*Inga jinicuil, Inga densiflora, Inga oerstediana, Inga punctata, Inga vera, Inga laurina, Inga spectabilis, Erythrina berteroana* ,*Gliricidia sepium* and *Inga edulis*) commonly found in coffee agroforestry systems and to evaluate the impact of climate change in the future suitability. We hypothesise that CC will reduce shade species suitability important for smallholder coffee resilience. Species presence data from herbarium records and studies on coffee agorforestry were used to model potential distribution with the Maximum Entropy algorithm using 19 environmental variables. Future distribution was mapped with climate change scenarios (RCP 2.6 and 8.5 for 2030 and 2050) and key environmental variables. *I. edulis* is the only species to show increased future suitability, while *I. laurina* presented the lowest reduction. Both species are concentrated at lower altitudes of current coffee distribution. The future distribution of the most common shade tree species, *I. oerstediana, I. punctacta* and *I. vera*, is reduced between 50 to 60 % of current potential suitability area. In Mesoamerica, CC will reduce the area suitable for all species by 5.2 %. The suitable area for 3 or more species will be reduced by 10 %. These results suggest that coffee growers will suffer a loss in the useful species from which they can choose for agroforestry-based adaptation to CC. The lowest reductions in suitability of all species were found in Costa Rica and Panama, while reduction in suitable area was much higher in Nicaragua, El Salvador and Guatemala.

Keywords: Climate change, coffee agroforestry, ecological niche models, *inga*, legume tree species, shade trees

Contact Address: Pablo Siles, International Center for Tropical Agriculture (CIAT), Soils, Managua, Nicaragua, e-mail: p.siles@cgiar.org