



Tropentag, September 16-18, 2026, hybrid conference

“Towards multi-functional agro-ecosystems
promoting climate resilient futures”

Exploring the impacts of climate change on food security and household income: A CGE model approach

SAIDAQA AYAR¹, STEFAN SIEBER^{2,1}, GOETZ UCKERT¹

¹*Leibniz Centre for Agric. Landscape Res. (ZALF), Germany*

²*Humboldt-Universität zu Berlin, Thaer-Institute of Agricultural and Horticultural Sci., Germany*

Abstract

Climate change poses an increasing threat to the commercialisation of agriculture, food security, and rural livelihoods in Afghanistan, where horticultural crops such as grapes, apples, and potatoes play a key role in income generation and food consumption. This study uses an integrated econometric-stochastic-CGE modelling framework to investigate the impact of climate variability and extreme events on crop productivity and commercialisation, and to examine the implications for household income and food security. The analysis follows a three-step approach. First, climate–yield relationships are estimated using panel data at the agroecological zone (AEZ) level, incorporating the non-linear effects of temperature and precipitation, as well as indicators of heatwaves and frost events, and time trend. Second, these relationships are embedded in a stochastic Monte Carlo simulation to generate crop- and region-specific yield distributions under adverse, average, and favourable climate scenarios, producing climate-induced productivity shocks. Third, these shocks are integrated into a computable general equilibrium (CGE) model calibrated to Afghanistan’s social accounting matrix to assess the impacts on agricultural commercialisation, food prices, household income, and consumption across the entire economy. Climate variables are obtained from the ERA5-Land dataset (1974–2024), and extreme indicators are constructed using AEZ-specific percentile thresholds. Provincial yield and cultivated area series are reconstructed from national data and limited provincial observations using back-casting, spatial borrowing, normalisation, and smoothing. The regression results revealed AEZ level heterogeneity in crop responses to climate variables, while Monte Carlo simulations indicated yield losses exceeding 20 percent in highly vulnerable regions under adverse climate conditions. Overall, the findings showed that the impacts of climate change on food security and household income depended critically on agroecological conditions, crop composition, and commercialisation pathways. By integrating AEZ-specific econometric estimation, uncertainty-based scenario construction, and CGE modelling, the study provided a coherent empirical bridge from climate variability to distributional and economy-wide outcomes, underscoring that uniform national policy responses masked substantial subnational vulnerability and that climate-resilient agricultural and market strategies were essential for safeguarding food security and rural livelihoods in Afghanistan.

Keywords: Afghanistan, CGE model, climate change, crop commercialisation, food security, household income, Monte Carlo simulation

Contact Address: Saidaqa Ayar, Leibniz Centre for Agric. Landscape Res. (ZALF), Münchehofer weg 75, 15374 Müncheberg, Germany, e-mail: ayar.saidaqa@zalf.de