Tropentag, September 20-22, 2023, hybrid conference

"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

A tool for analysing sustainability of smallholder farms: farm input subsidy policy use case

Powell Mponela[1], Quang Bao Le[2], Grace Villamor[3], Lulseged Tamene[4], Christian Borgemeister[3]

[1] *The Alliance of Bioversity International and CIAT, Ghana*
[2] *International Center for Agricultural Research in the Dry Areas (ICARDA), Egypt*
[3] *University of Bonn, Center for Development Research (ZEF), Germany*
[4] *International Center for Tropical Agriculture (CIAT), Agroecosystems and Sustainable Landscapes Research Area, Ethiopia*

Abstract

The research and development needed to achieve sustainability of African smallholder agricultural and natural systems has led to a wide array of theoretical frameworks for conceptualising socioecological processes and functions. However, there are few analytical tools for spatio-temporal empirical approaches to implement use cases. This is a prerequisite to understand the performance of smallholder farms in the real world. This study builds a multi-agent system (MAS) to operationalise the Sustainable Agricultural Intensification (SAI) theoretical framework (MASSAI). This is an essential tool for the spatio-temporal simulation of farm productivity to evaluate sustainability trends into the future at fine scale of a managed plot. MASSAI evaluates dynamic nutrient transfer using smallholder nutrient monitoring functions which have been calibrated with parameters from Malawi and the region. It integrates two modules: the Environmental (EM) and Behavioural (BM) ones. The EM assess dynamic natural nutrient inputs (sedimentation and atmospheric deposition) and outputs (leaching, erosion and gaseous loses) as a product of bioclimatic factors and land use activities. An integrated BM assess the impact of farmer decisions which influence farm-level inputs (fertiliser, manure, biological N fixation) and outputs (crop yields and associated grain). A use case of input subsidies, common in Africa, markedly influence fertiliser access and the impact of different policy scenarios on decision-making, crop productivity, nutrient balance and economic benefits are simulated. This is of use for empirical analysis smallholder's sustainability trajectories given the pro-poor development policy support. For 15 years the government of Malawi has championed input subsidy as a pro-poor strategy to ensure food security, poverty reduction and improved nutrition but its impact on human behaviour and soil nutrient balance as indicators of sustainability has not been evaluated. After the 15 years of fertiliser subsidy program, farmers have internalised it in their expenditure plan: some source increasing amounts from the market while those that rely on limited fertiliser acquired through subsidy proactively reduce the nutrient gap by increasing manuring. Subsidy might not significantly shift the nutrient and productivity trajectories for the next 20 simulated years, increased subsidy could relatively accelerate nitrogen gain but lead to phosphorus losses thereby jeorpardising farm sustainability.

Keywords: Farm input subsidy, multi agent system, nutrient balance

Contact Address: Powell Mponela, The Alliance of Bioversity International and CIAT, IITA CSIR Campus, Accra, Ghana, e-mail: p.mponela@cgiar.org