Resilient land use and food security in Afghanistan: A mathematical-econometric framework for sustainable agriculture

MOJTABA NIKZAD[1], EVA GERHARZ[2]

[1]*Hochschule Fulda (Fulda University of Applied Sciences), Dept. of Social and Cultural Sciences, Germany*
[2]*Hochschule Fulda (Fulda University of Applied Sciences), Social and Cultural Sciences, Germany*

Abstract

In Afghanistan, where resource constraints, economic instability, and climate variability limit agricultural productivity, food security and sustainable land use continue to be major issues. In order to optimise land use and assess the effects of policy interventions on food security over the period 2000–2025, this study combines econometric modelling and mathematical programming. In order to ascertain the best distribution of land resources among important crops, a multi-objective non-linear programming (MONLP) model is created, taking into account limitations like labour supply, soil fertility, water availability, and economic profitability. Concurrently, the relationship between agricultural policies, market dynamics, and food security indicators over the previous 25 years is examined using an econometric panel data analysis (fixed and random effects models). Both primary and secondary data are used in the study. Structured farmer surveys in various agro-ecological zones of Afghanistan are used to collect primary data, which includes factors like farm size, crop yield, input costs, and climate adaptation strategies. FAO databases, World Bank indicators, national agricultural reports, and remote sensing data on land use changes are some of the sources of secondary data. Land-use configurations that optimise food production while reducing environmental degradation are identified by the MONLP model. The econometric analysis evaluates how important policy measures, such as trade regulations, irrigation infrastructure, extension services, and input subsidies, affect agricultural sustainability and food security. According to preliminary research, the best land allocation techniques can reduce soil degradation and water stress by 15–25 % and increase food security by 18–36 %. The econometric findings show that while poorly thought-out subsidy schemes may distort production incentives, targeted policies like better irrigation management and market access programmes greatly increase agricultural resilience. This study offers policymakers practical insights, highlighting the necessity of: (1) developing policies for climate-smart agriculture; (2) investing in effective water management systems; (3) strengthening rural credit and insurance programs; (4) promoting crop diversification to reduce risk; and (5) enhancing regional trade cooperation to stabilise food markets. This study provides a solid foundation for developing sustainable agricultural strategies in Afghanistan and other resource-constrained economies by integrating quantitative modelling with empirical policy evaluation.

Keywords: Afghanistan, agricultural sustainability, econometrics, food security, land use optimisation, mathematical programming, policy evaluation

Contact Address: Mojtaba Nikzad, Hochschule Fulda (Fulda University of Applied Sciences), Dept. of Social and Cultural Sciences, Leipziger straße 123, 36037 Fulda, Germany, e-mail: mojtaba.nikzad@sk.hs-fulda.de