Tropentag, September 10-12, 2025, hybrid conference

"Reconcile land system changes
with planetary health"

Heterogeneous efficiency effects of agro-ecological fruit fly management transition and intensification among smallholder mango farmers: a latent class stochastic metafrontier approach

Sulman Olieko Owili[1], David Jakinda Otieno[1], Evans Ligare Chimoita[1], Frederick Baijukya[2]

[1] *University of Nairobi, Dept. of Agricultural Economics, Kenya*
[2] *International Institute of Tropical Agriculture (IITA), Tanzania*

Abstract

Agro-ecological transition is a precondition for sustainable and resilient food systems amid systemic threats from climate-change-induced disturbances. Agro-ecological pest management (APM) offers the prospect of reconciling agronomic performance with environmental and social imperatives by replacing indiscriminate chemical applications with locally derived biorational options. This is the first attempt at evaluating the multidimensional efficiency effects of agro-ecological transitions in relation to invasive alien pests prone to resurgence and reinfestation under suboptimal management. We evaluate whether adopting and intensifying APM for Oriental fruit fly (Bactrocera dorsalis L.) control in smallholder mango (*Mangifera indica* L.) orchards in Makueni County, Kenya, enhances both technical and eco-efficiency. Using a latent-class stochastic metafrontier on a survey of 418 orchard managers selected via multistage sampling, we compute meta-technical and meta-eco-efficiency scores and derive an environmentally adjusted efficiency metric (MTEadj). Respondents are classified as non-adopters, non-intensive adopters and intensive adopters. Treatment effects are estimated via a doubly robust inverse-probability-weighting regressionadjustment estimator. Intensive adopters attained an average MTEadj of 66 % versus 56 % for non-adopters and non-intensive adopters; adopters were on average 39 % below the frontier. Intensive adoption yielded a significant average treatment effect (ATE) and average treatment effect on the treated (ATT) of 7.8 % and 6.3 %, respectively, whereas non-intensive adoption showed no significant change (ATE = –2.1 %, ATT = –1.4 %). Thus, piecemeal APM adoption yielded no efficiency gains over conventional pesticide regime. Efficiency effects were heterogeneous and inefficiency varied with orchard manager's APM adoption intensity, education level, orchard prospects, group membership, and participation in knowledge co-creation activities. Policymakers and development practitioners should support farmers by institutionalising continuous learning and establishing multi-pronged participatory training platforms that utilise existing social networks.

Keywords: Agro-ecological pest management, agroecology, environmentally adjusted efficiency, fruit fly, mango, meta-eco-efficiency, meta-technical efficiency

Contact Address: Sulman Olieko Owili, University of Nairobi, Department of Agricultural Economics, Po Box 29053, 00625 Nairobi, Kenya, e-mail: oliekosulman@gmail.com