

Innovation bundling and food security nexus among smallholder farmers in Kenya's drylands. A triple hurdle approach

Achieving food security among smallholder farmers remains an ultimate goal in the arid and semi-arid lands (ASALs) of sub-Saharan Africa. However, it remains a persistent challenge as climate shocks, weak institutions, and limited access to agricultural services constrain smallholder productivity and resilience. In response, socio-technical innovation bundles (STIBs) have emerged as a promising strategy for improving household welfare. Yet empirical evidence on their effectiveness in enhancing food security remains limited. This paper assesses the effect of STIBs on household food security among smallholder farmers in the drylands of Makeni County, Kenya. The study used cross-sectional data from 626 smallholder farmers and a triple-hurdle model to jointly estimate the determinants of awareness, adoption, and food security outcomes. Results reveal that awareness of STIBs is significantly enhanced by education ($\beta = 0.109$, std. err = 0.033, $p < 0.01$), participation in farmer groups ($\beta = 0.385$, std. err = 0.196, $p < 0.1$), and field schools ($\beta = 1.190$, std. err = 0.45, $p < 0.01$), access to climate information services ($\beta = 1.541$, std. err = 0.314, $p < 0.01$), and extension engagement ($\beta = 0.177$, std. err = 0.063, $p < 0.01$). Adoption is more likely among older farmers and female-headed households, but is constrained by larger household sizes, longer farming experience, and greater distance from main roads. The findings further show that among the innovations adopted, technical innovations increased the likelihood of being food secure and reduced the probability of being moderately or severely food insecure by 8.3, 4.9, and 3.4 percentage points, respectively. The paper concludes that STIBs offer a viable pathway for building resilient agrifood systems in Kenya's drylands. It recommends that the government and development partners strengthen extension systems, improve rural infrastructure, promote gender-responsive approaches, integrate credit with innovation support, and enhance shock-responsive safety nets to maximize their impact.