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A quantile viability frontier for characterising basis risk in crop index insurance for climate-vulnerable food systems

Inhalt

Smallholder farmers produce nearly half of the world's food, yet 80% lack formal insurance. In Colombia, the highest disaster-risk country in the Americas, less than 3% of cultivated hectares are insured against climate risks. Crop index insurance is a scalable instrument for climate risk transfer, but its effectiveness is limited by basis risk: the mismatch between index-triggered payouts and actual farm-level losses. Loss thresholds are conventionally estimated through mean-based methods that systematically underestimate the asymmetric, tail-concentrated behaviour of agricultural losses.

This research proposes a viability frontier that delimits the empirical loss domain of insurable risk through quantile regression on field-level yield distributions. By estimating conditional quantiles without distributional assumptions, the approach captures the tail risk that conventional methods overlook. Optical and radar satellite covariates (Sentinel-2 vegetation indices, Sentinel-1 backscatter, and the SPEI as a proxy for soil water deficit) are explored as conditioning variables to reflect plot-level agronomic conditions.

This contributes to the One Health framework by operationalising the Soil-Plant-Atmosphere continuum as the interface where climate stress, agroecosystem health, and human food security converge. Strengthening climate risk-transfer instruments protects the food systems on which the health of vulnerable rural communities depends.

Keywords

crop index insurance, basis risk, One Health, food security, quantile regression, climate vulnerability, SPEI

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Junior Scientist Status

Yes, I am a Junior Scientist.

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