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# Re-designing Crop Insurance

## Introduction

Agriculture and agriculture-based livelihoods in developing countries are highly prone to weather shocks. Although there exist various informal mechanisms in rural communities that allow farmers to pool their idiosyncratic risks, they provide little or no insurance when entire communities are affected.

This is typically the case with extreme climate events such as droughts, floods and heat waves. These shocks are correlated across regions and are called covariate risks. There is substantial evidence that rural households in high risk environments stick to low return subsistence agriculture and cope with a correlated shock by liquidating productive assets to maintain consumption and thus remain trapped in poverty<sup>1</sup>.

Formal insurance that protects crops and livestock from climate risks may, therefore, have large private and social benefits.

Notwithstanding these benefits, private provided unsubsidized agricultural insurance is the exception rather than rule. This is so even in the wealthy developed countries. Information on past yields of individual producers (or animal mortality in the case of livestock insurance), necessary for actuarial computations and necessary to avoid adverse selection, are rarely complete. Insurers fear moral hazard given the influence of producer actions on output. Insurers also fear that they may not have complete information to detect and prevent adverse selection.

These difficulties have led to index insurance products where payouts are triggered by an index such as rainfall, temperature or local average yields. Premium setting is relatively easier because past data on indices of weather and average yield are more readily available than on individual production histories. As individual farmers have little or no influence on payouts, index-based insurance

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<sup>1</sup> Rosenzweig and Binswanger, 1993; Carter and Barrett, 2006; Dercon and Christiaensen, 2011

<sup>2</sup> Glauber, 2004.

products are also less likely to fail due to asymmetry in information between the insurer and the insured.

While index insurance is practical, insurance companies can expect claims to be very large in some years because of covariate risks. This may quickly exhaust a company's capital unless they have access to reinsurance<sup>3</sup>. The most common response is for the government to offer reinsurance. To keep insurance affordable, governments typically offer subsidies. Indeed, without such subsidies, uptake of agricultural insurance generally remains low<sup>4</sup>. Past research has highlighted many reasons for the low uptake. These include the unfamiliarity among farmers of formal insurance, the lack of trust in the insurance provider, the difficulties of communication resulting in poor understanding of the insurance product. Poor farmers also face liquidity constraints and insurance demand is highly sensitive to price<sup>5</sup>.

However, even if the above factors were absent, research has highlighted the fundamental constraint of basis risk which occurs because of imperfect correlation between the index and farmer losses. If the association is weak, then index insurance might not be reliable. Research has shown, both theoretically and empirically, that basis risk reduces the demand for insurance<sup>6</sup>. The worst case scenario is when substantial subsidies are incurred on crop insurance and yet the basis risk is so high that it does not offer meaningful utility to farmers. The minimization of basis risk is a topic of current research.

## Basis Risk

India has had a long experience with index crop insurance and is globally one of the pioneers in this field. Indeed, it was here that rainfall insurance was proposed more than a hundred years ago<sup>7</sup>. Index (linked to area-yield) insurance was finally introduced in the country in the late 1970s as a subsidised scheme of the government. The take-up and the subsidy was, however, limited. In 2016, the government launched the Pradhan Mantri Fasal Bima Yojana (PMFBY) – a program of area-yield insurance. The program and the rate of subsidy were substantially scaled up. The Central government spends close to Rs. 15,000 crores annually. The program also involves equivalent expenditures by state governments. The program introduced several novel elements – in particular, the program implementation involved, for the first time, private insurance companies. The premiums are pegged to be very low – below the cost of providing insurance (actuarial cost plus administrative costs). The difference is the subsidy incurred by the central and state governments.

While the program coverage is much greater than the coverage in the earlier insurance programs, it is fair to say that the program has not expanded beyond the initial success. The budget allocations have stagnated. Why have farmers not responded more enthusiastically to the program? As noted earlier, such disappointing outcomes are not unique to India. Could it be because of basis risk?

In a recent work, we analyzed the all-India district-level relationship between crop yields

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<sup>3</sup> Miranda and Glauber, 1997

<sup>4</sup> Binswanger-Mkhize, 2012; Jensen and Barrett, 2017; Jensen et al., 2016

<sup>5</sup> Cole et al., 2013, 2014; Giné et al., 2008

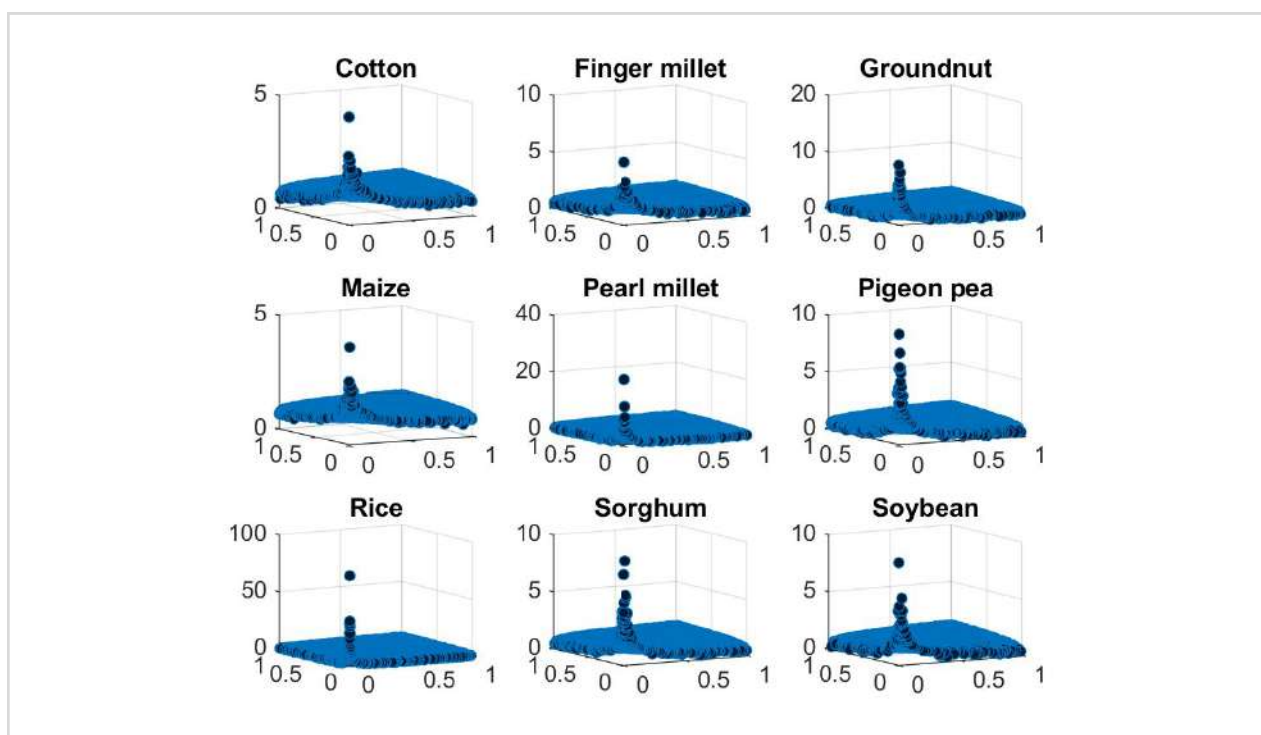
<sup>6</sup> Clarke, 2016; Elabed and Carter, 2015; Giné et al., 2008; Hill et al., 2016

<sup>7</sup> Chakravarti, 1920

and rainfall indices for 9 kharif season crops<sup>8</sup>. The empirical association between their cumulative densities is shown in three-dimensions in Figure 1. It can be seen that the association is strong for extreme shortfalls in rainfall. Statistically, such an association is called lower tail dependence. This means that the associations between yield losses and index losses are stronger for large deviations

than for small deviations. The major implication is that the value (to farmers) of index-based insurance relative to actuarial cost is highest for insurance against extreme or catastrophic losses (of the index) than for insurance against all losses. Or in simpler words, basis risk is least for large deviations of the index.

**Figure 1: Estimated Joint Distribution**



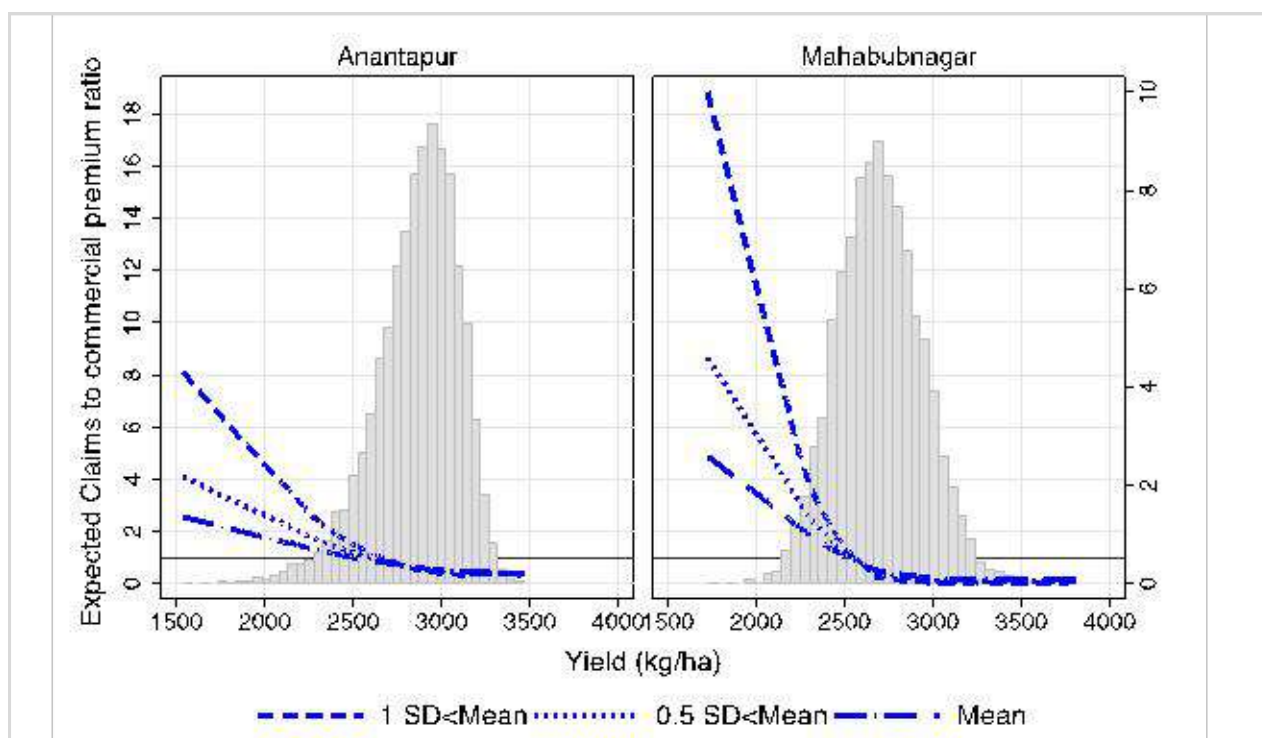
Source: Negi and Ramaswami (2024)

This proposition is illustrated in Figure 2 below for a hypothetical rainfall contract for paddy crop calibrated to data from two districts in India: Mahabubnagar and Anantpur. Figure 2 plots the insurance performance measured by the ratio of expected claims to commercial premium (computed as 1.56 times the actuarial cost) at every level of output. The performance ratio is plotted for three different insurance designs. In the first insurance design, the farmer is compensated for all losses below mean output. In the second

insurance design, the farmer receives compensation whenever output is less than half of a standard deviation away from the mean. The third insurance design corresponding to drought insurance pays off only for severe losses – whenever output is less than a full standard deviation away from the mean. It can be seen that the performance ratio rises steeply above 1 for the drought insurance design. In the other insurance designs, basis risk is higher and so is the premium cost.

<sup>8</sup> Negi and Ramaswami, 2024

**Figure 2: The ratio of expected claims to commercial premium**



Source: Negi and Ramaswami (2024)

The important implication of our findings is that, for farmers, the utility of index-based insurance relative to actuarial cost is greater for insurance limited to catastrophic losses than for insurance against all losses. For this reason, tail dependence boosts the demand for catastrophic insurance. This may, therefore, be one route for rainfall index insurance to receive greater uptake and for it to be an effective, if limited, risk management strategy.

## Policy Implications

Index insurance is the most practical form of crop insurance. To encourage uptake, countries frequently subsidize index insurance. If basis risk is the reason for low uptake, it is unlikely that the subsidy is socially valuable. Farmers do not receive protection when they need it.

Our findings show that basis risk is least for catastrophic insurance. These are low

when probability events. In subsidising crop insurance, the extreme layer of risk should, therefore, receive priority. What about higher probability events that involve moderate losses? This should receive lower weight in subsidy allocation. The basis risk in index insurance that covers these events is large. Hence, its value to farmers is low even though it will be actuarially expensive. A policy that fully subsidizes insurance against severe losses may well be revenue neutral compared to an insurance that partially subsidises all shortfalls from an index. need it.

An example of an insurance against extreme events is drought insurance. Besides farmers, drought insurance is likely to be useful to local aggregators of risk such as banks, producer companies, cooperatives, agri-business firms and local governments. Index insurance to such entities may be socially valuable but they may not require a subsidy. There is a very established protocol for drought relief expenditures by the government. However, its

timeliness is often questioned because of many layers of permissions required for such expenditures. On the other hand, an extreme loss insurance program offers the benefits of drought relief but in a timely manner.

The PMFBY is a complex partnership between the Centre, the State and the insurance companies and breaks new ground in shared governance. The program is operationally difficult because of the extensive demands it makes for coordination among stakeholders. States have to notify the program and declare the crops to be insured well in advance. Past data on yields have to be supplied to the prospective insurers by them as well. States have to float tenders for clusters of districts and select the lowest cost bidder. Finally, the average yields for the 'notified' area have to be collected by crop cutting experiments and

accordingly the claims have to be adjudicated. Scientific yield assessment is the stiffest constraint to scaling up the program.

While greater experience has smoothened some of these operational glitches, the program lacks an in-built evaluation design to assess basis risk. By their very nature, the utility of insurance programs to its beneficiaries cannot be judged within a year or two but may be apparent over a crop cycle of 4-5 years. However, for this to happen, it is vital that a sample of sufficient size be tracked over time. The costs of such evaluation are trivial given the scale of the program but such data will be invaluable in understanding how these programs benefit farmers and in working tweaks or design changes to reduce basis risk and make them more effective.

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