BULLETIN
POLICY BULLETIN [FEBRUARY 2016]
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CEGA
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MAKE IT RAIN

Weather index insurance protects farmers against losses from extreme weather and facilitates investment in their farms, but randomized evaluations in South Asia and sub-Saharan Africa have shown low demand for these products at market prices, suggesting the need for alternative approaches.

Floods, droughts, heat waves, cold spells, and other natural disasters are large sources of risk for farmers. For instance, in semiarid areas of India, 89 percent of farming households cited drought as the largest risk to agricultural production. Climate change may make weather patterns more extreme and unpredictable, further exposing already vulnerable smallholder farmers.

A drought, heat wave, or other disaster can lead to a poor harvest, leaving uninsured farming households with little income for the season. In order to cope with unpredictable weather, farmers often plant low-risk, low-return crops instead of investing in more profitable crops that are more sensitive to weather. In India, farmers may plant sorghum, a low-risk crop, instead of groundnut, a higher-risk cash crop. Furthermore, farmers wary of bad weather may hesitate to make other investments in their farms, such as increasing fertilizer use. As a result, the threat of extreme weather can trap farmers in a cycle of low productivity.

MOHAMMED IBRAHIM

Weather index insurance, which makes payouts based on an easily observable variable such as rainfall, is an innovative financial product designed to make insurance accessible to poor smallholder farmers. Weather index insurance was first offered in the early 2000s, and it is now marketed to individual farmers in over fifteen countries. The ten randomized evaluations summarized in this bulletin tested take-up of weather index insurance products and, in three cases, effects on agricultural production decisions.

Key Findings:

Without substantial subsidies, take-up of insurance was low. Large discounts increased take-up substantially, and interventions designed to increase financial literacy or reduce basis risk also had positive effects. However, at market prices, take-up was in the range of 6–18 percent, which cannot sustain unsubsidized markets.

Insured farmers were more likely to plant riskier but higher-yielding crops. In the three studies that measured changes in farmer behavior, farmers who felt protected against weather risks shifted production toward crops that were more sensitive to weather but more profitable on average.

While self-sustaining markets for weather index insurance have not emerged, finding ways to address weather risk remains a priority for agricultural development. Some possibilities are improving index quality, providing subsidized insurance, selling insurance to institutions, and exploring other risk-mitigating technologies, such as irrigation and stress-tolerant crops.

CONTEXT

What is weather index insurance?

Few farmers in developing countries have any type of formal insurance. In contrast, nearly all farms in developed countries have some form of insurance. In many cases, these are indemnity-based insurance policies that compensate farmers for the exact losses they experience. It is costly for insurance companies to verify these losses, but when farms are large in size, sell to a small number of buyers, and maintain verifiable sales records, it can be feasible. Furthermore, many developed country governments subsidize insurance and require farmers to purchase it, thereby guaranteeing a market for insurance.

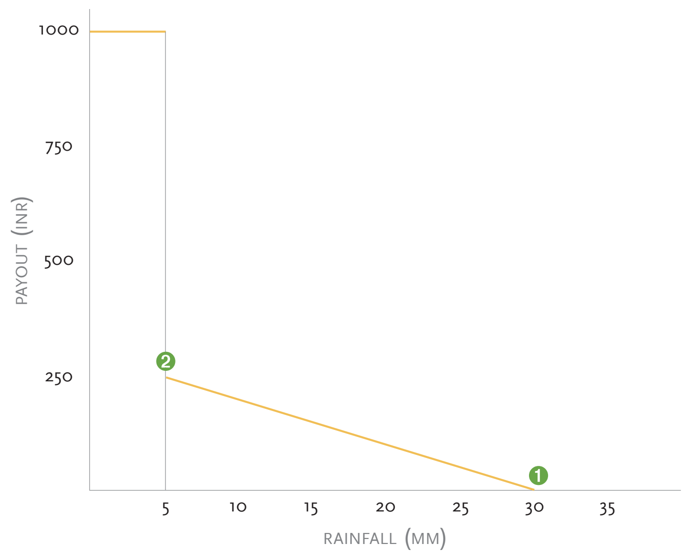
In low-income countries with numerous small farmers, high monitoring costs, poor regulatory environments, and limited government budgets, indemnity-based insurance is typically infeasible. Weather index insurance bases payouts on an easily measurable variable such as rainfall or temperature (see Figure 1). From the perspective of the insurance provider, this offers several advantages over indemnity-based agricultural insurance, making it possible to market to smallholder farmers:

- **Lower transaction costs.** Instead of verifying losses for each farmer who claims a payout, the insurance company makes payouts to all policyholders in the area based on a single measurement.

- **Reduced moral hazard.** Moral hazard occurs when insured farmers increase risk taking or put less effort into protecting an insured crop. With index-based insurance, farmers have a limited ability to increase damages from adverse weather events. Insured farmers may plant riskier crops, but this is desirable as long as these crops are more profitable on average.

- **No adverse selection.** As the characteristics of an individual farmer do not affect the likelihood of payout, farmers who are more likely to receive payouts do not disproportionately choose to purchase insurance.

FIGURE 1 STYLIZED PAYOUT SCHEDULE FOR DROUGHT INSURANCE



If rainfall is below threshold 1, farmers receive a payout which depends on the size of the rainfall deficit. Below threshold 2, corresponding to total crop failure, farmers receive a lump-sum payment. The products tested in featured evaluations 6, 8, and 10 follow this schedule, with exact thresholds and payouts varying by location.

Because payouts are not based on actual losses, weather index insurance has one major drawback relative to indemnity-based insurance: basis risk. This is the risk that the index will not reflect a farmer's loss. For instance, a farmer may experience a drought but not receive a payout because there is adequate rain at the weather station.

When rural financial institutions and other development organizations began promoting weather index insurance, it was unclear whether farmers would consider it a useful financial product and whether self-sustaining markets would develop. As a result, researchers sought to test demand for these insurance products and their impact on agricultural production decisions.

TRISTAN REED

Featured evaluations

This bulletin focuses on ten randomized evaluations from four countries (Ethiopia, Ghana, India, and Malawi) that contribute to the debate on the viability of weather index insurance as a tool to help small farmers cope with weather shocks.

All of the evaluations studied rainfall-based index insurance, but there was considerable variation in product and study design (see Table 1 on the next page). There were differences in the crops insured and the conditions that triggered payouts. Some of the products (2, 3, and 4) insured by unit of land. For others (1, 5, 6, 8, 7, and 9) the premium and payment schedule was given and farmers determined how many policies to buy to insure a meaningful portion of production—we refer to these as "stand-alone policies."

Many evaluations tested the effect of different encouragements to purchase insurance. Several studies (2, 4, 7, and 8) randomized the price farmers faced by offering discounts or giving a cash grant at the time of purchase. Some studies (1, 5, 8, and 9) also evaluated the effect of different approaches to marketing and training on demand for insurance. In two cases (2 and 10) the insurance policy was bundled with a loan. In order to directly measure the impact of insurance on production decisions, which is statistically challenging with low take-up rates, two of the evaluations (3 and 5) offered free insurance policies.

In addition to these evaluations, this bulletin also refers to some examples of yield-based index insurance. Full citations for the featured evaluations, plus other studies and review papers, are on page 11.

FEATURED EVALUATIONS

TABLE 1

	Location	Year	Insurance Provider	Product Description	Additional Treatments	Premium Price[1]	Discounts Offered
❶	Central Ethiopia	2010	Nyala Insurance Share Company (NISCO)	Rainfall index insurance marketed to funeral societies	Randomized weather groups received training that emphasized the advantages of group risk-sharing	ETB 100(US$7.40) for moderate loss policy, ETB 50 (US$3.70) for severe loss policy	None
❷	Amhara, Ethiopia	2011–2012	Nyala Insurance Share Company (NISCO)	Rainfall index insurance	Some villages were also offer interlinked credit and insurance contracts	ETB 250 (US$14.57)	Discount vouchers of up to ETB 500 (US$29.14)
❸	Northern Ghana	2009	Presbyterian Agricultural Services (PAS)	Free rainfall index insurance policies	A second treatment group received cash grants in addition to insurance and a third group received grants but no insurance	Actuarially fair price of GHC (US$25.19) per acre	Policies provided for free
❹	Northern Ghana	2010–2011	Ghana Agricultural Insurance Program (GAIP), Presbyterian Agricultural Services (PAS)	Rainfall index insurance policies	None	Competitive market price of GHC 9–14 (US$6.26–10.43) per acre	Insurance sold at randomized prices from GHC 1 (US$0.74) to full market price
❺	Andhra Pradesh, India	2006	BASIX, ICICI Lombard, ICRISAT	Rainfall index insurance	Randomized endorsement from well-regarded local NGO and additional financial education	INR 80–125 (US$2.04–3.19 per phase or INR 260–340 per season (US$6.64-8.68)	Cash grants of INR 25 or 100 (US$0.64 or 2.25)
❻	Andhra Pradesh, India	2009	ICICI Lombard, ICRISAT	Ten free rainfall index insurance policies	Comparison group was promised a cash grant equal to the expected value of the insurance	Estimated value of INR 340 (US$7.55)	Policies provided for free
❼	Andhra Pradesh, Tamil Nadu, and Uttar Pradesh, India	2010–2011	Agricultural Insurance Company of India (AICI)	Insurance indexed to number of days of delay in onset of monsoon	Distance to measurement station was varied in Uttar Pradesh	INR 80-200 (US$1.86–4.66)	Discounts of 0, 10, 50, or 75 percent
❽	Gujarat, India	2007	IFFCO-Tokio, SEWA	Rainfall index insurance	Marketing with different video messages or flyers	INR 44–86 (US$1.20–2.34)	Discounts of INR 5, 15, or 30 (US$0.14, 0.41, 0.82)
❾	Gujarat, India	2009	Agriculture Insurance Company of India (AICI)	Rainfall index insurance	Marketing to increase financial literacy and product knowledge	INR 800 (US$17.77)	Some clients offered money-back guarantee if no payouts were made
❿	Central, Malawi	2006	Insurance Association of Malawi (IAM), Malawi Rural Finance Corporation (MRFC), Opportunity International Bank of Malawi (OIBM)	Loan for maize and groundnut seeds bundled with insurance to forgive loan in event of poor rainfall	Comparison group received uninsured loans	MWK 300–530 (US$2.25–4.51) for groundnut and MWK 650–1080 (US$5.53–9.18) for maize, in addition to repaying loan with interest	None

[1] All prices have been converted to USD using the World Bank's standard exchange rate from the year of the intervention and then inflated to 2014 USD.

Crops Insured	Unit Insured	Duration of Policy	Payout Trigger	Payout Schedule	Sample	Researchers
Not crop-specific	Stand-alone policy	Monthly contract	Cumulative rainfall falls below moderate or severe loss target	One-time payout of ETB 500 (US$29.41)	20,475 members of 117 iddirs (funeral societies)	Dercon, Vargas Hill, Clarke, Outes-Leon, Taffesse
Maize, sorghum, teff, and wheat	Timad (1/4 hectare)	One growing season	Rainfall falls below target	Fixed payment of ETB 1000 (US$58.28) per timad	Over 4,000 farmers in 49 villages	McIntosh, Papadopoulos, Sarris
Maize	Acre	One growing season	Drought or flood (too many wet days or dry days per month)	Maximum payout of GHC 100 (US$76.34) per acre	502 households	Karlan, Osei, Osei-Akoto, Udry
Maize	Acre	One growing season	Drought or flood (too many wet days or dry days per month)	Maximum payout of GHC 70–100 (US$46.30–69.88)	1,406 households	Karlan, Osei, Osei-Akoto, Udry
Not crop-specific	Stand-alone policy	35- to 45-day phases (corresponding to sowing, flowering, or harvesting) or entire monsoon season	Drought during the first two phases of the monsoon and flood during the third phase	Maximum payout of INR 1,000 (US$25.52) per phase or INR 3,000 (US$76.56) per season	1,047 households in 37 villages	Cole, Gine, Tobacman, Topalova, Townsend, Vickery
Not crop-specific	Stand-alone policy	Sowing phase of season	Rainfall below first threshold triggers partial payout and rainfall below second threshold triggers maximum payout	Maximum payout of INR 1,000 (US$22.22)	1,479 farmers in 45 villages	Cole, Gine, Vickery
Not crop-specific	Stand-alone policy	Monsoon season	Days of delay in onset of monsoon	INR 300 (US$6.99) if monsoon is 15–20 days late, INR 750 (US$17.48) if 20–25 days late, and INR 1200 (US$27.97) if 25–40 days late	4,667 households in 42 villages	Mobarak, Rosenzweig
Not crop-specific	Stand-alone policy	Monsoon season (June–August)	Cumulative rainfall over monsoon season is below threshold	Maximum payout of INR 1,000 (US$27.17)	3,804 households in 50 villages	Cole, Gine, Tobacman, Topalova, Townsend, Vickery
Cotton, groundnut	Stand-alone policy	Monsoon season (July–October)	Deficit rainfall (July–September) or excess rainfall (September–October)	Maximum payout of INR 6,500 (US$144.41)	600 farmers in 15 villages	Cole, Gaurav, Tobacman
Groundnut, maize	Loan contract, average value of MWK 4,692 (US$39.89) for groundnut and MK 4,972 (US$42.27) for maize	Growing season (September–March)	Rainfall below first threshold triggers partial payout and rainfall below second threshold triggers maximum payout	Maximum payout covers total loan amount, premium, and interest	800 farmers in 32 localities	Gine, Yang

RESULTS

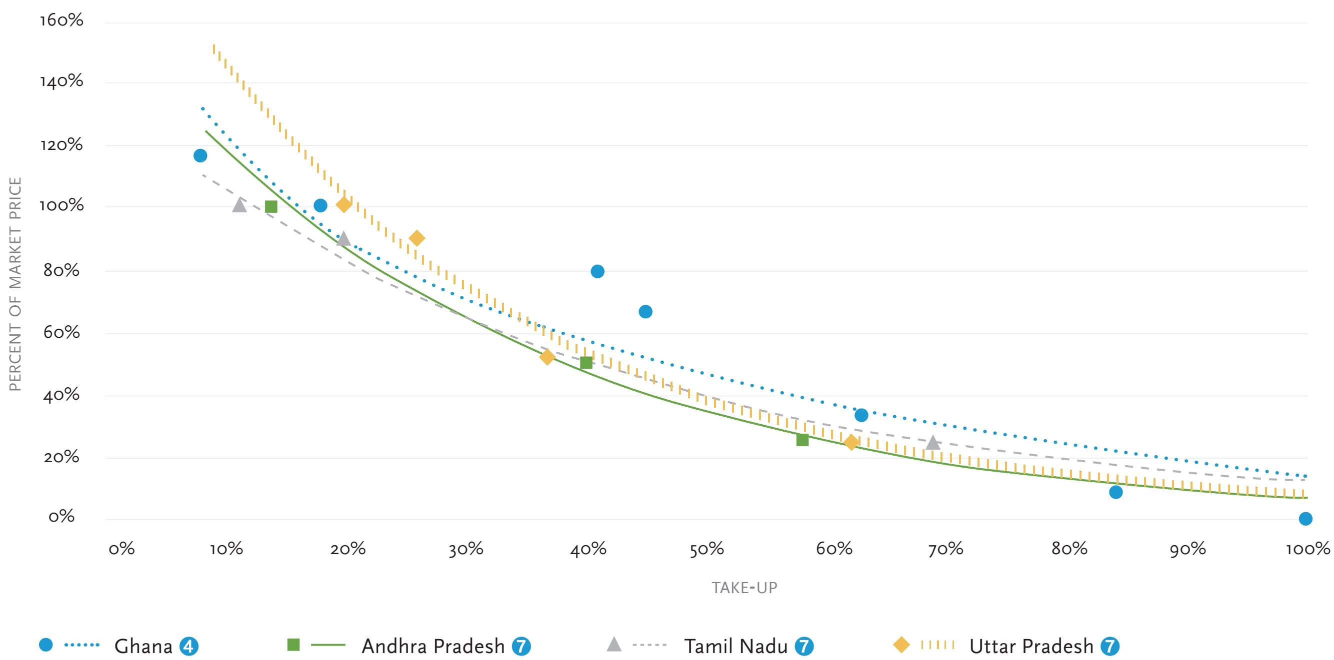
1. Take-up of index insurance was low at market prices, but large subsidies succeeded in raising demand.

In the four studies (2, 4, 7, and 8) that measured demand for weather index insurance among farmers who received no discounts or other encouragement to purchase, take-up ranged from 6 percent 8 to 18 percent 4. Farmers did not insure all of their land. In Ghana 4, farmers purchasing at market price covered less than 10 percent of their acreage. Similarly, in a study in Andhra Pradesh, Tamil Nadu, and Uttar Pradesh 7, the 15 percent of farmers who bought policies typically purchased just one policy costing on average INR 145 (US$3.38) and with a maximum payout of INR 1,200 (US$27.70).

Reducing the price of insurance increased take-up (see Figure 2). In Ghana 4, 45 percent of farmers purchased insurance at the actuarially fair price, which was about one-third lower than the market price and did not cover the insurer's administrative costs. In another study in India 7, over 60 percent of farmers purchased insurance with a 75 percent discount. Whether farmers had cash on hand also mattered: in Andhra Pradesh 5, farmers who received a cash grant of INR 100 (US$2.55) were 40 percentage points more likely to purchase a policy costing INR 260–340 (US$6.64–8.68) than farmers who received INR 25 (US$0.64).

The low demand in these studies raises the question of whether commercial markets can develop. Some of the insurers have continued to operate, generally with large subsidies or technical assistance.[2] The Ghana Agricultural Insurance Program (3 and 4) has expanded throughout the country, but the number of customers remains limited. The most successful expansion has taken place in India, where approximately 13.6 million farmers bought policies in 2013. The fact that most of these farmers purchased heavily subsidized premiums under the Weather Based Crop Insurance Scheme—which is compulsory for farmers borrowing from formal financial institutions—further suggests that private markets for weather index insurance are unlikely to scale.

FIGURE 2 DEMAND FOR INDEX INSURANCE WAS LOW AT MARKET PRICES BUT INCREASED WITH LARGE DISCOUNTS



Two studies (4 and 7) randomly offered discounts to customers, generating enough data to estimate demand curves for weather index insurance. Demand was low—below 20 percent—at market prices but increased when farmers were offered large discounts.

[2] J-PAL found very few examples of unsubsidized weather index insurance in the developing world. One such product was offered by SANASA Insurance Company Ltd. in Sri Lanka. ACRE, an insurer in Eastern Africa, has successfully offered some unsubsidized weather index insurance products, but other products in its portfolio are subsidized. The World Bank has helped the Government of Mongolia set up and scale a livestock insurance program, which uses an index based on local animal mortality rates; under this model, unsubsidized commercial markets cover moderate losses and the government guarantees coverage for catastrophic losses.

2. In order to increase take-up of weather index insurance, researchers tested variations on training, marketing, and product design with modest results.

Financial literacy

Improving farmers' understanding of insurance may increase take-up. In Gujarat ❾, researchers tried four approaches: holding six hours' worth of financial literacy training, offering a money-back guarantee, providing a forecast of the upcoming monsoon, and demonstrating the relationship between rainfall and soil moisture. Receiving an invitation to the financial literacy training increased take-up by 5.3 percentage points from a base of 6.4 percent among farmers who were not offered training or other marketing inducements. The money-back guarantee was also effective—although this would be costly for insurance agencies—but the other two approaches had no effect. Similarly, in China, 50 percent of farmers attending a 45-minute information session purchased a yield-based insurance product, compared to 35 percent of those attending a simpler, 20-minute session (all farmers also received a 70 percent subsidy from the Chinese government).

This may not be a cost-effective way to raise demand. The workshops in Gujarat ❾ cost about US$62.82 per additional policy purchased, more than the full premium of US$17.77 and the commission of US$2.00 that the marketing organization earned for selling a policy. In 2011, ACRE, an insurance initiative in Eastern Africa, spent 40 percent of its budget on trainers, a telephone hotline, and radio advertising.

MOHAMMED IBRAHIM

Trust and experiential learning

Farmers may not trust that they will receive payouts if there is too little or too much rainfall. This is a reasonable concern, as some insurance providers have delayed payouts for months or years. It is unclear whether farmers are more willing to purchase an insurance product endorsed by a trusted organization. In Andhra Pradesh ❺, households were more likely to purchase insurance if an agent from a well-known microfinance institution endorsed the product, but in Gujarat ❽, a similar endorsement in a marketing video had no effect.

Observing payouts over time may increase trust. In Ghana ❹, take-up was 4–5 percentage points higher (from a mean of 44 percent) among farmers who received a payout in the previous year, and these farmers insured more land. Farmers whose friends or family members received payouts were also more likely to purchase insurance. In Gujarat ❽, researchers estimated that if one household in a village received a payout of INR 1,000 (US$27.17), the probability that neighboring households purchased insurance in the next year increased by 25–50 percent. Finally, in China, farmers whose friends received payouts were more likely to purchase insurance the following year and were less sensitive to changes in price.

Conversely, not receiving payouts made farmers less likely to purchase insurance ❹. This suggests that farmers may be shortsighted: they believe the next year's weather and payouts will be similar to the year they just experienced. Most insurance policies only make payouts during extreme weather conditions, but researchers have tested demand for products designed to make smaller payouts more frequently. While farmers in Andhra Pradesh were more willing to purchase these policies, they are less effective in protecting farmers against catastrophic losses.

What is basis risk?

Basis risk is the risk that the index will not accurately predict a farmer's loss. The farmer experiences a poor harvest, but rainfall at the weather station is adequate, so there is no payout. This possibility of not receiving a payout reduces demand for index insurance.

Basis risk increases with distance from the weather station. Farmers recognize this: in Uttar Pradesh 7, researchers randomly varied the location of weather stations. For every kilometer increase in perceived distance from the weather station, demand declined by 6.4 percent (similar to removing a 10 percent discount from market price). Furthermore, topography can generate microclimates where nearby locations experience different conditions (see Figure 3).

In order to reduce basis risk, insurance providers have sought to design contracts using indices that are better correlated with farmer yields; for example, a double-trigger contract that pays out if the average yield in a farming cooperative and the average yield in the surrounding area both fall below certain thresholds or using satellite imagery to measure yields in more locations. However, there is a trade-off between simplicity, which makes the index easy to understand, and sophistication, which reduces basis risk.

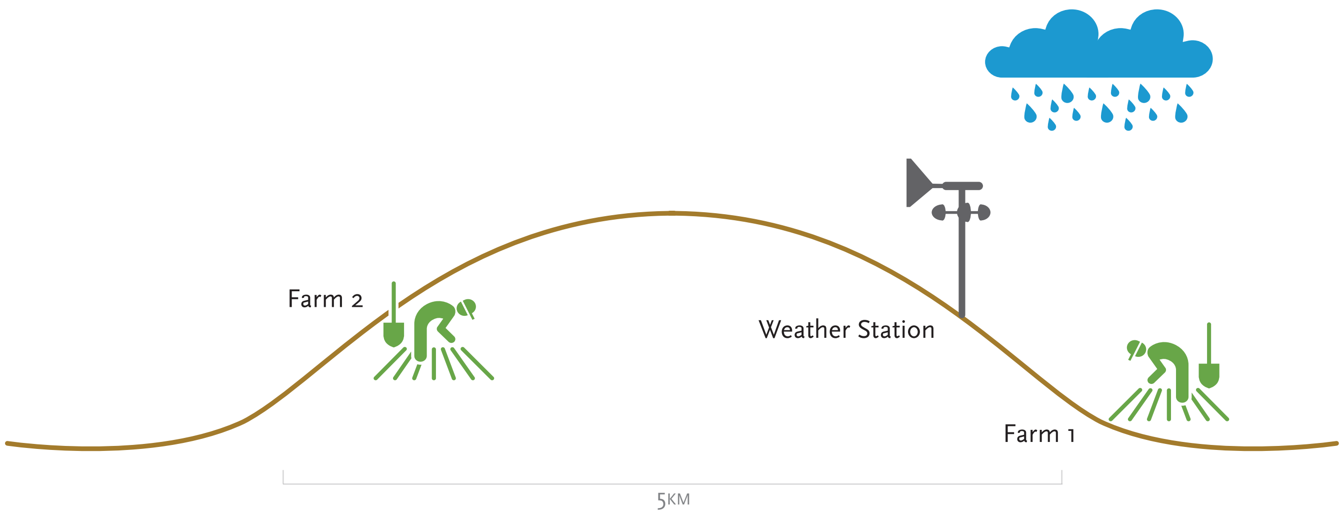
Group risk-sharing

Informal risk-sharing networks may be able to compensate farmers affected by basis risk. In general, bad weather is an aggregate risk, affecting a large geographic area, but smaller variations due to basis risk are idiosyncratic, affecting an individual but not others nearby. Farmers belonging to the same extended family, caste, cooperative, or another informal risk-sharing network may therefore be able to compensate those affected by basis risk. However, the success of group insurance schemes depends on the extent to which farmers understand these mechanisms and trust in group members to indemnify losses.

In Ethiopia 1, researchers marketed rainfall index insurance to iddirs (funeral societies). They randomized training sessions such that some emphasized how risk-sharing between members could complement formal insurance, while others did not. Take-up was 27 percent among iddirs trained in group risk-sharing, significantly higher than the 18 percent take-up rate among those that were not. This suggests that increasing awareness of a way to mitigate basis risk made index insurance more attractive.

Similarly, researchers examined jatis (subcastes) in three Indian states 7. Some jatis are dispersed across villages and districts, making it less likely that basis risk will affect all members at once. The informal lending that already takes place among jatis could compensate farmers who have poor harvests but do not receive payouts. The study found that demand for index insurance was higher among members of these geographically dispersed jatis that should be better able to mitigate losses from basis risk.

FIGURE 3 STYLIZED DEPICTION OF BASIS RISK



CHRISTINA TORRES, LUIS PRADO | THE NOUN PROJECT


PUTUL GUPTA

Interlinked credit and insurance

Weather index insurance may be more appealing to farmers if bundled with another financial product: credit. Knowing that a loan is insured may make farmers more willing to borrow and banks more willing to lend. However, in Malawi ⑩, 33 percent of farmers took up a credit product, but only 17.6 percent took up a product that bundled credit and index insurance. The interlinked product was designed to make the loan less risky, but since farmers often do not repay loans if the harvest is poor, adding insurance (and charging a premium) effectively increased the interest rate. In Ethiopia ②, farmers in some villages were offered insurance-only contracts, while in other villages farmers were offered both insurance and insurance linked with credit. Overall take-up was lower in villages offered interlinked insurance, though due to logistical problems, no loans were made.

Although farmers may not want to pay a premium for an insured loan, interlinked credit-insurance products are appealing to financial institutions because they protect lenders against default in poor weather conditions, allowing them to extend credit to riskier clients. As a result, some institutions have made insurance mandatory for borrowers. One of the partners in the Malawi study ⑩, the Opportunity Bank of Malawi, no longer offers uninsured loans, but borrowers often do not know that loans are backed by rainfall index insurance. Without knowing that they are insured, farmers cannot change their behavior, investing in riskier crops or more inputs. However, when farmers are aware that they are insured—as is the case with India's Weather Based Crop Insurance Scheme—they may make production decisions that account for the fact that they are protected against extreme weather events.

Linking product and insurance markets

Linking agricultural insurance with crop sales may also increase take-up. In Kenya, researchers compared selling sugarcane farmers yield-based insurance at full price, at a 30 percent discount, and at full price (plus interest) deducted at harvest time. Preliminary results from an ongoing evaluation found that only 4.6 percent of farmers purchased the product at full price upfront, while 71.6 percent purchased it when the payment would be deducted from the value of their harvest. This suggests that both a lack of cash and behavioral biases may prevent farmers from purchasing a product they want.

ACRE, an insurer in East Africa, has several innovative products that link index insurance with product or input markets, but these approaches have not yet been rigorously evaluated. They insure dairy cattle through milk cooperatives, who initially cover the premium. Farmers repay through deductions from payments for milk delivery. ACRE also offers "replanting" insurance, with the premium included in the cost of seeds. If poor weather triggers the index, farmers receive the amount needed to purchase new seeds.

3. When farmers were insured, they took more risks on their farms, growing higher-risk, higher-return crops.

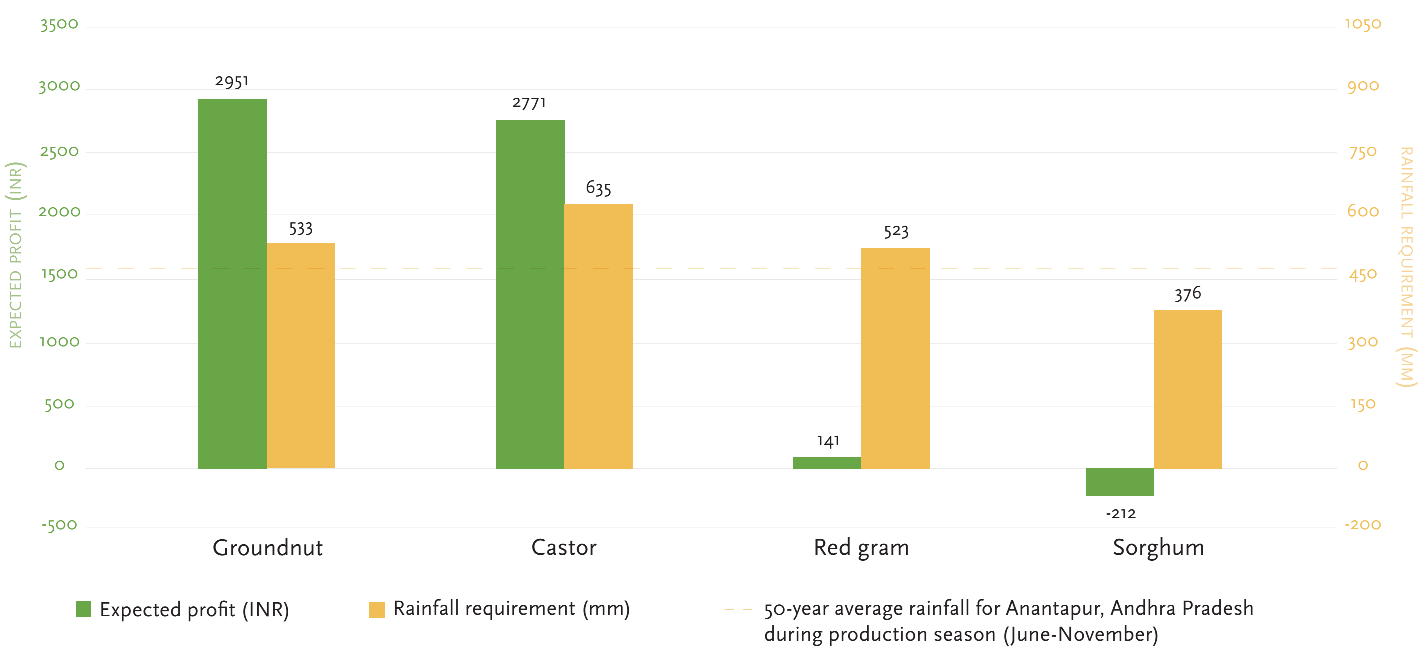
Due to low take-up rates, many of the evaluations featured in this bulletin could not measure the impact of weather index insurance on agricultural production decisions. However, in the three studies that did (3, 6, and 7), insured farmers made riskier, but potentially more profitable, choices. They shifted their production toward cash crops and they invested in inputs such as fertilizer.

In Ghana 3, researchers compared offering free rainfall index insurance policies with offering cash grants in order to test whether credit or risk constraints were a larger barrier to increasing agricultural investment. Farmers were randomly offered either insurance policies, cash grants, both insurance and cash, or nothing. The group of farmers receiving insurance increased total farming expenditure, fertilizer use, and land cultivated. They increased the share of land planted to maize from 31 to 40 percent, and they decreased production of drought-resistant fruit crops such as mango. (However, these changes did not lead to higher profits in that season.) The cash grants led to increased fertilizer use but had less dramatic effects on other production decisions, suggesting that risk, not credit, was the binding constraint preventing farmers from investing in their farms.

Researchers also gave away free rainfall index insurance policies in Andhra Pradesh 6, compensating the comparison group with a cash grant equal to the expected value of the insurance. They found that receiving insurance led farmers to shift production from subsistence crops (red gram and sorghum) to rainfall-sensitive cash crops (castor and groundnut) (see Figure 4). Although total expenditure for the growing season did not change, insured farmers were 6 percentage points more likely to plant cash crops (from 48 percent).

In Tamil Nadu 7, insured rice farmers shifted away from drought-tolerant rice varieties and grew more high-yield varieties. There were similar effects with insurance products that used yield-based, rather than weather-based, indices. In China, expanding access -to insurance increased production of tobacco, the insured cash crop, by 22 percent. In Mali, farmers belonging to cooperatives that were offered insurance planted 0.39 more hectares of cotton, a 15 percent increase over the comparison group average of 2.53 acres.

FIGURE 4 EXPECTED PROFIT AND RAINFALL REQUIREMENTS IN ANDHRA PRADESH



This stylized graph shows the trade-off a farmer in Andhra Pradesh 6 might face when deciding what combination of crops to grow. The most profitable crops are highly sensitive to rainfall, while the most drought-tolerant crop is unprofitable—but may feed the household during a difficult year.

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POLICY LESSONS

Weather risk remains an important barrier to agricultural development. Although low demand has prevented markets for commercial weather index insurance from scaling, in cases where farmers were given subsidized insurance, the protection led them to make investments to increase farm productivity. These facts point to the need to study a range of alternative approaches to address weather risk.

Farmers' lack of interest in purchasing insurance has limited the growth of commercial markets. Many insurance providers rely on generous government subsidies, technical assistance from aid agencies, or bundling insurance with more popular products.

Insured farmers made different production decisions, underscoring how weather risk limits farmers. They shifted production toward crops that were more sensitive to weather but more profitable on average. Whether through index insurance or another approach, providing protection against weather risk may be a crucial step in getting farmers to plant cash crops, use more fertilizer, and make other investments to increase production.

Weather index insurance has fallen short of an elusive goal: becoming an insurance product that can be profitably sold to poor farmers. This points to the need to research alternatives that help smallholder farmers manage weather risk, including:

- **Improving index design.** Using indices based on yields, rather than weather, may reduce basis risk, especially with remote sensing technologies that can accurately measure yields for small areas. These improvements, which increase data quality and better tailor payouts to actual risks, may allow insurers to offer products that more effectively protect farmers from the risks they face.
- **Using subsidized insurance to deliver cash to farmers.** The studies that gave away free insurance (3 and 5) compensated comparison group farmers with cash grants. While insurance led farmers to shift production toward higher-value crops, receiving cash did not. For policymakers seeking to influence farmers' production decisions, large insurance subsidies may be more effective than cash transfers. Over time, experience with subsidized insurance may increase farmers' willingness to pay for these products.
- **Selling insurance to institutions that are also affected by weather risk.** Weather shocks are a source of risk for agricultural lenders as well as governments providing disaster relief or social safety net programs. Unlike individual farmers, banks and government agencies cover broad geographic areas, which reduces basis risk. Although this approach has not yet been rigorously tested, insurance providers have begun to offer these products, which have the potential to both protect institutions and increase credit supply.
- **Promoting irrigation and stress-tolerant crops.** Most smallholders rely on rainfed agriculture, so improving irrigation systems is a natural first step in helping them cope with variation in rainfall. In addition, agricultural research centers have developed crop varieties that tolerate conditions such as drought, flood, and salinity while maintaining good yields under normal conditions. Results from India are promising: farmers planting a flood-tolerant rice variety planted more rice, used more fertilizer, and used better planting techniques.

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