I4 INDEX INSURANCE INNOVATION INITIATIVE

BASIS

# TWO TRIGGERS ARE BETTER THAN ONE: INNOVATIVE INSURANCE DESIGN FOR COTTON FARMERS IN MALI

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I4 BRIEF

## UNDERINVESTMENT AND RISK RATIONING

The fluctuating yields inherent to rain-fed agriculture may discourage investment in risky but profitable crops, even when farmers have ample access to agricultural loans. Small-scale cotton farmers in Mali exhibit this exact behavior, limiting their cash exposure by investing less in cotton production than they otherwise might, limiting their yields and earnings from this potentially high returning cash crop. Under these circumstances in which farmers leave money on the table every year, risk management instruments that reduce income fluctuations should increase investment and thus raise farmers' income.

Agricultural index insurance has been put forward as an instrument to achieve these goals, especially for small-scale producers for whom transaction costs, moral hazard and adverse selection problems rule out conventional insurance that pays out based on individual losses. However, a weakness of index insurance is that the average yield, weather or other indices on which payments are based are imperfect predictors of individual farmer losses. Under index insurance farmers are thus exposed to residual, or basis risk, creating the possibility that the farmer will not be covered even when losses occur. Such an outcome happens when the index gives a 'false negative' signal, meaning the index says no loss, when in fact a loss has occurred. The likelihood of a false negative signal—or the false negative probability (FNP)—depends on the type index used (a weather index versus an area yield index) and on the geographic scale covered by the index. If the FNP is large, then the value of the index insurance for the farmer would be low and she may not buy it, eliminating the possibility that index insurance can resolve the problems of risk rationing and underinvestment. Even if purchased, insurance with a high FNP is unlikely to encourage additional risky investment by the farmer.

## GROUP LOANS AND DEFAULT RISK FOR COTTON FARMERS IN MALI

In Southern Mali, most farmers grow a mix of subsistence crops and cotton. Cotton is their main, and often only, source of cash. It is also a

## *KEY POINTS*

*Reducing the index scale to bring it closer to the farmer reduces basis risk, but increases moral hazard issues. One solution to this conundrum is to design multi-scale contracts.*

*A two-scale contract can, at the same premium rate, radically reduce the probability that a village is not paid when their yields are low (from 45% under the single scale contract to only 7% under the multi-scale contract).*

*In the first year of the program, 16 of the 58 treatment cooperatives (30%) agreed to purchase the index insurance contract.*

profitable, but risky crop. Due to erratic rains and pests, cotton yields tend to fluctuate substantially from year to year. Low yields translate to low farm revenue and financial difficulties as farmers rely heavily on credit to finance their cotton production.

In a sample of 505 farming households surveyed in 2006/07, all cotton growers had received an input loan as a part of an exclusive contract with Compagnie Malienne des Textiles (CMDT), the government cotton company, which also distributes the inputs and purchases the crop. A state bank provides loans to groups of cotton growers with a joint liability clause. The bank has an agreement with CMDT stating that a group's cotton revenue is directly transferred to the group's account. As a result, the joint liability clause is enforced and a group's revenue is first used to pay back its loan. If a group defaults, it will not be given future loans.

While groups do not present collateral to the lender, they internally collateralize loans, allowing compensation of good, or perhaps lucky, producers who effectively pay the debts of poor or unlucky producers. The 2006/07 survey of Malian cotton farmers provides a window into the operation of this internal loan collateralization. Conducted on the heels of a bad cotton season, it shows that even if a group's revenue is greater than its total debt, individual farmers face adverse consequences when their production does not cover their individual share of the loan.

> *"Of the 240 farmers who grew cotton, 79 declared having difficulties in repaying their loan. More than a third (38%) had to sell farm assets (most often animal) to pay back their farm, three senta child to work on another farm for debt relief , and two pledged part of their land."*

Of the 240 farmers who grew cotton, 79 declared having difficulties repaying their loan. More than a third (38%) had to sell farm assets (most often an animal) to pay back their loan, three sent a child to work on another farm in exchange for debt relief, and two pledged part of their land. Other farmers obtained loan refinancing through their group by agreeing to pay back the group the following year. These indebted farmers may also see their credit line reduced and face exclusion from the group. When the joint-liability clause is binding and a group member's debt is paid by other members' cotton production, the defaulter's debt is not forgiven. Group members may enforce immediate repayment. Farmers repeatedly mentioned the "tensions" that the joint liability created within villages.

Thus farmers not only dread the consequences of defaulting on their loan, but also fear their responsibility for the debts of other farmers. This specific feature of group loans may discourage investments, leading to a special type of credit rationing. In addition it opens the door to morally hazardous behavior. When a farmer expects his cotton production to pay other farmers' debt, he has few incentives to work hard. This type of behavior is all the more likely as the number of potential defaulters increases.

## PROBLEMS WITH SINGLE SCALE CONTRACTS

Given this loan liability structure, index insurance, which protects against default, should be able to have a very large impact on the investment and productivity of cotton farmers in Mali. As conventionally constructed, index insurance is based on a single index measure. However, reliance on a single sindex creates an irresolvable tension between the interests of the insurer and the insured. In Mali, individual production data collected by the CMDT as part of its usual business practice makes it possible to define an area yield index insurance contract. Under an area yield contract, insured farmers are indemnified if the average yields in their area fall below a critical level. But at what geographic scale should the insurance index (average yield) be defined—average yields for the village, average yields across all villages in a micro region or even average yields at a district or provincial levels? Insured farmers, of course, would prefer to have a more local index, such as village level average yields, as such an index will offer less basis risk (a small-

er FNP) than average yields at a district level. Insurance companies, on the other hand, are wary of a village level index, as they fear that a small group of villagers can easily band together and collude to depress their yields and collect insurance payouts.

This precise issue arose during the insurance design phase in Mali. The research team presented cotton cooperative leaders a draft insurance contract under which payouts would be based on the zone de production agricole (ZPA), a grouping of approximately ten village cotton cooperatives typically within 10km of each other. The leaders objected that yields in their individual villages could be quite poor even when average ZPA-level yields were near normal. These cooperative leaders intuitively recognized that the high variability in Sahelian rainfall patterns would result in large basis risk and FNP under a contract scaled to ZPAs.

To solve this basis risk problem, the leaders proposed reducing the index scale to the village cooperative. The research team explained that it was quite unlikely an insurance company would offer a contract at that scale, given that village cooperatives are made up of about 20 to 30 individuals with numerous family and social interconnections. Such a closely connected group could easily collude to underreport yields, deliberate sabotaging yields through mismanagement, or sell inputs such as fertilizer for cash. An insurer would not risk insuring producers when such severe moral hazard conditions exist.

## TWO TRIGGER CONTRACT AS A SOLUTION TO BASIS RISK-MORAL HAZARD TRADEOFF

Given that a standard single index insurance contract presents a severe tradeoff between moral hazard and basis risk, researchers proposed a multiple scale index designed to mediate this tradeoff. Under this multi-scale contract structure, the primary insurance index and trigger are set at the village level, as farmers wanted. As proposed by the research team, farmers would become eligible for insurance payments when village yields fall below 750 kilograms/hectare. However, to control moral hazard, insurance payouts would only be made subject to a secondary audit rule based on a second index measured at the multi-village, ZPA level. The payout trigger at the ZPA level would be set at a higher level, such as 900 kilograms/hectare. This secondary audit trigger tells farmers that a low village yields will only trigger payment if ZPA yields are sufficiently low to make it likely that low village yields reflect misfortune and not opportunistic behavior. This second feature re-

*"Analysis...shows that a two-scale contract can, at the same premium rate, radically reduce the FNP, the probability that a village is not paid when their yields are low."*

assures insurers that the contract will not be torpedoed by collusion and morally hazardous behavior within the village.

The effectiveness of this multi-scale design ultimately depends on the statistical properties of village and ZPA yields. Analysis by the research team revealed that the proposed multi-scale contract greatly reduces basis risk as compared to a single scale contract at the ZPA level. Figure 1 shows the results of that analysis, revealing that a two-scale contract can, at the same premium rate, radically reduce the FNP, the probability that a village is not paid when their yields are low. In fact, the FNP decreases from 45% under the single scale, ZPA contract to only 7% under the multi-scale contract.

## BASIS RISK & THE DEMAND FOR INDEX INSURANCE?

The multi-scale contract has the ability to reduce basis risk increase the quality of the insurance, making it more likely that farmers will both demand it and increase their investment and productivity under its protection. In addition, the radical reduction in basis risk should have a further knock-on effect, given emerging evidence that farmers are not only adverse to risk, but they are also adverse to ambiguity and compound lotteries. To appreciate this second point, note that the farmer who buys index insurance faces two layers of risk. First, her future yields are unknown. Second, the index, which will determine whether she gets a payment or not, is also unknown at the time when the insurance must be purchased. If there were no basis risk (i.e., if the FNP were zero), then this second risk would disappear. However, in the presence of basis risk, index insurance appears to the farmer as a compound lottery.

Under standard economic expected utility theory, whether the index insurance contract is perceived as a compound lottery or not does not matter for its demand because farmers are assumed to be compound-risk neu-

tral. Attitudes towards the overall risk are the only factor that determines the impact of basis risk. However, our research uses insights from behavioral economics to show that another phenomenon called compound-risk aversion might exacerbate the impact of basis risk. A farmer who is averse to compound risk perceives index insurance as an ambiguous and risky investment. Thus, she is willing to pay less for index insurance than her compound-risk neutral counterpart. Equivalently, expected utility overestimates the desirability of index insurance. If this perspective is correct, contracts (such as standard, single scale rainfall contracts) that present farmers with a high FNP are unlikely to meet with any demand and will have limited development impacts.

To explore the impact of compound-risk aversion on the demand for index insurance we conducted a series of experiments with 331 cotton farmers in Bougouni, Mali. The experiments were incentive compatible meaning that farmers earned real money for making decisions about their cotton crop as a part of the game. Each participant played two games that allowed us to derive her risk aversion and a compound-risk aversion coefficient. Before playing the first game, participants learned how to determine their yields and the resulting revenue. Then participants, endowed with one hectare of land, had to choose among different hypothetical insurance contracts. Using a theoretical model of risk aversion, we were able to derive the coefficient of risk aversion by observing the participant's choice. In the second game, the participant provided us with her willingness to pay to get rid of basis risk, or how much she is willing to pay to switch from an individual contract (basis risk free) to an index insurance contract. Combining the findings of the two games allowed us to derive a coefficient of compound risk aversion for every participant. A full 57% of game participants revealed themselves to be compound risk averse of varying degrees, in contrast to the predictions of expected utility theory.

Using these results, we then simulated what the demand would be for the single-scale versus a multi-scale contract. Because of the direct effect of improved contract quality and because of the indirect effect via compound risk aversion, we found that uptake of the multi-scale contract would be 40% higher than under an equivalently priced single-scale contract.

## SALES AND UPTAKE OF MULIT-SCALE INSURANCE

Armed with these insights, and working with partners from PlaNet Guarantee, Allianz and SwissRe, the research team launched a multi-scale contract in 2011 in the Bougouni region of southern Mali. The secondary audit trigger (ZPA-level yields) was set at 900kg/ha. The primary, village-specific triggers varied between 264 and 913 kg/ha. The level of the village triggers was adjusted to keep the price of the insurance constant across

**Figure 1**

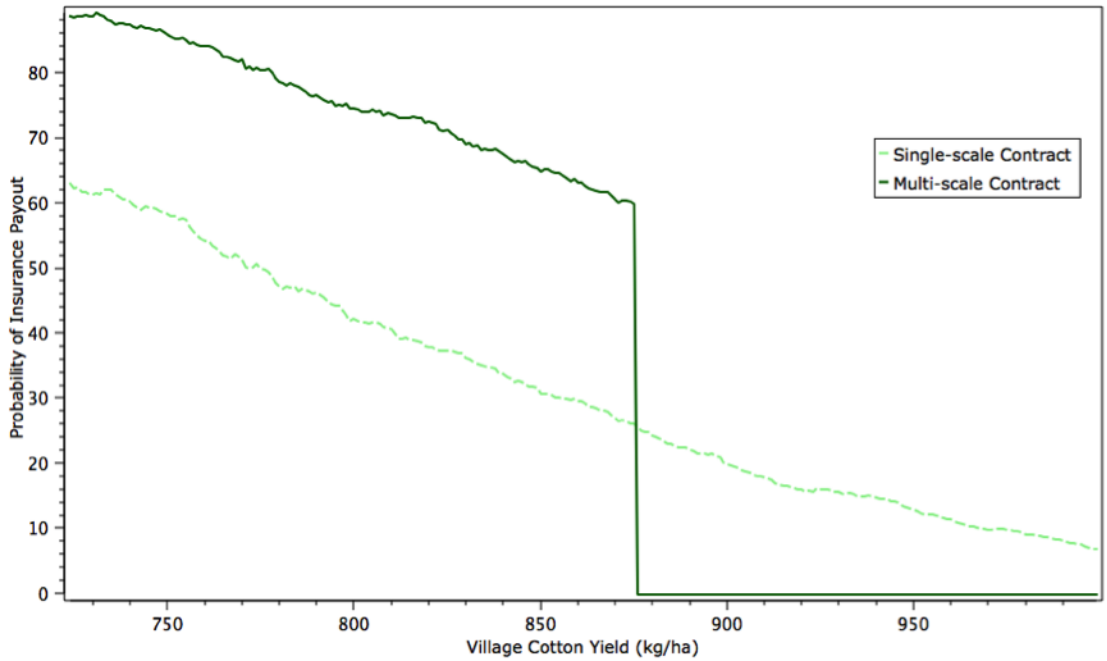


*Figure 1 represents the severity of the basis risk problem that would be confronted by the village cooperatives under the single scale contract and the multi-scale contract.*

villages. The pilot project included 86 cooperatives, of which two thirds were allocated into the treatment group and one third maintained as a control group. The treatment cooperatives were then offered the option of purchasing the insurance contract. In order to increase the likelihood of substantial take-up, treatment cooperatives received randomly distributed discounts that reduced the price to 50%, 75%, or 100% of the actuarially fair premium. Throughout this process, our implementing partner emphasized that the discount was temporary, and that cooperatives should not expect discounts in subsequent years.

*"In the first year of the program, 16 of the 58 treatment cooperatives (30%) agreed to purchase the index insurance contract."*

In the first year of the program, 16 of the 58 treatment cooperatives (30%) agreed to purchase the index insurance contract. This uptake rate is significantly below our prediction, but well above uptake rates in other pilot projects. For example, a similar project in Peru, which employed a single-trigger area-yield insurance contract, faced demand as low as 5%.

## POLICY RECOMMENDATIONS

Our findings suggest that to be effective, index insurance contracts must be structured to reduce basis risk. Thus, choosing the correct index is important, and, in principal, area yield contracts should strongly dominate weather-based contracts. Unfortunately, conventional area yield-based index insurance contracts face a severe tradeoff. Reducing the index scale to bring it closer to the farmer reduces basis risk, but increases moral hazard issues. One solution to this conundrum is to design multi-scale contracts.

While it is too soon to say that multi-scale contracts can work in the real world, results from the 2011 pilot in Mali are encouraging. Unfortunately, the March 2012 military coup led to the near collapse of many Malian institutions, cutting short this effort. The research project has since moved to neighboring Burkina Faso, where the cotton market structure and agro-ecological conditions are very similar to Mali's and a second version of the multi-scale contract was rolled out in 2013. Future data collection and analysis should allow us to better gauge the impact of improved contract design on insurance demand, especially for ambiguity averse individuals.

## FURTHER READING


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The BASIS AMA Innovation Lab is a virtual institute hosted at the University of California Davis comprised of researchers from around the globe that aims to improve the agricultural competitiveness and quality of life of the rural poor in the developing world through policy-relevant research that is dedicated to improving access to resources and enhancing the operation of markets.

I4 INDEX INSURANCE INNOVATION INITIATIVE

Hosted at the BASIS AMA Innovation Lab, the Index Insurance Innovation Initiative (I4) is a response to the overwhelming evidence that uninsured risk can drive people into poverty and destitution, especially thosei n low-wealth agricultural and pastoralist households. To rigorously test the hypothesis that by removing correlated risk from smallholder agricultural and pastoral systems we can reduce poverty and deepen financial markets in agricultural areas, the I4 team will design and implement a new generation of livelihood-optimized index insurance contracts.

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