Ex-ante Impacts of Agricultural Insurance:

Evidence from a Field Experiment in Mali

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Abstract

Anticipating a negative income shock, uninsured households may refrain from undertaking profitable, but risky activities. This ex-ante risk coping strategy is costly in terms of forgone income. Therefore, insuring households so that they are objectively (and subjectively) less exposed to risk can prevent them from adopting these welfare decreasing ex-ante behaviors. To test this hypothesis, we randomly distributed the possibility of being insured and feeling insured to a group of cotton cooperatives in Mali by giving them access to a microinsurance contract. In a first step, we estimate the average treatment effect of the intervention by comparing the outcomes of households belonging to treated cooperatives to their counterparts in the control group. We find that our randomization instrument had a significant impact on households' ex-ante behaviors at the extensive margin. These intention to treat estimates show that offering insurance resulted in a 15% increase in the area in cotton, and a 14% increase in the expenditure on seeds per ha. In addition, as a result of our randomization 22.5% of the treated farmers and 10% of the non-treated farmers felt that they are insured. We measured Perceived Risk Reduction (PRR) at the individual level using the treatment status as an instrument for feeling insured. We find that households who felt insured increased their area in cotton by 75%.

1 Introduction

Uninsured risk remains a serious impediment to poverty reduction in developing countries. It disproportionally affects the poorest within a population, potentially impeding their ability to participate in growth. When facing a negative income shock, uninsured poor households protect their assets at the cost of reduced consumption, with potentially irreversible losses in child human capital. In addition to this ex-post effect of shocks, there is an ex ante impact. Anticipating a negative shock, uninsured households refrain from undertaking profitable, but risky activities. They instead invest in traditional technologies that have a low rate of return, which makes them even poorer.

In developing countries, policy makers have promoted micro insurance as a tool to stabilize household's incomes, mitigating the pernicious ex-post and ex-ante effects of uninsured risk. Despite the rapid spread of microinsurance pilots around developing countries, there is little empirical evidence on their effectiveness as a tool to reduce poverty. The goal of this paper is to evaluate the efficacy of an innovative index insurance intervention that targeted cotton farmers in Mali. Unlike conventional indemnity insurance in which payouts are based on individual outcomes, index insurance insures an index. The index is measured objectively and is designed to be highly correlated but not identical to individual outcomes (for example rainfall insurance, area-yield insurance).We focus on the ex-ante impacts of insurance, including agricultural production decisions.

The cotton industry in Mali is a monopsony, and production takes place in cooperatives. The pilot project was designed around this cooperative structure; out of the 87 cooperatives in the area, two thirds (59) of the cooperatives were allocated into treatment group and one third (28) of the cooperatives were maintained as a control group. The treatment cooperatives were then offered the option of purchasing the insurance contract. To increase the likelihood of substantial take-up, we adopted an encouragement design: treatment cooperatives randomly 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 such a discount in subsequent years.

In the first year of the program, 16 out of the 59 treatment cooperatives (30%) agreed to purchase the index insurance contract. This uptake rate is well above up-take rates in some other pilot projects.

We estimate the average treatment effect of the intervention by comparing the outcomes of households belonging to treated cooperatives to their counterparts in the control group. We find that our randomization instrument had a significant impact on households' ex-ante behaviors at the extensive margin. These intention to treat estimates show that offering insurance resulted in a 15% increase in the area in cotton, and a 14% increase in the expenditure on seeds per ha. In addition, as a result of our randomization 22.5% of the treated farmers and 10% of the non-treated farmers felt that they are insured. We measured Perceived Risk Reduction (PRR) at the individual level using the treatment status as an instrument for feeling insured. We find that households who felt insured increased their area in cotton by 75%.

The remainder of the paper is structured as follows. In Section 2, we present a literature review of the studies of the impact of insurance. We then present the context of the intervention in Section 3. In Section 4 we describe the sample. In Section 5 we present our main findings. We conclude with policy implications.

2 Impact of microinsurance on risk coping and risk mitigation mechanisms

To better understand the impact of microinsurance on households's welfare, it is helpful to study the household's behavior in the absence of insurance. The literature has established two channels through which uninsured risk affects a poor household. The first channel takes place after the shock occurs (ex post), and consists of two complementary mechanisms. When a household faces an income shock, it can cope with it by liquidating its assets such as livestock to maintain a critical level of consumption. This behavior is called consumption smoothing, and is the most common type of coping strategies among the rural poor. It leads to a suboptimal accumulation of capital, and therefore a lower level of long term income.

A growing body of evidence shows that poorer households perform another type of smoothing called asset smoothing, which is complementary to consumption smoothing. They do so by destabilizing their consumption to protect their assets (Hoddinott 2006, Carter et al. 2007, Carter and Lybbert 2012,Kazianga and Udry 2006Jalan and Ravallion 1997Townsend 1994). Not only does this type of behavior have immediate short term impact on households 'nutritional status, but it also leads to potentially irreversible losses in child health, nutrition and education [Carter et al., 2007]).

The second channel through which uninsured risk affects households' well-being occurs before the realization of the shock or ex ante. For an agricultural household, this channel takes place primarily through their production decisions. Anticipating a negative income shock, a household chooses to adopt a risk averse production behavior by investing in lower risk and lower return production method, instead of profitable but riskier alternatives [Rosenzweig and Binswanger, 1993]; [Carter et al., 2007]).

Empirical studies of the impact of microinsurance[1] on household production decisions in developing countries are scarce, mainly because of a low level of uptake of these products. The demand side reasons are ad hoc such as liquidity constraints [Cole et al., 2013a, Giné and Yang, 2009], lack of trust and poor understanding ([Cai et al., 2009, Dercon et al., 2011, Cole et al., 2013a] as well as behavioral such as ambiguity aversion [Bryan, 2010], compound risk aversion ([Elabed and Carter, 2014]), and prospect theory considerations ([Petraud, 2014]. The supply side reasons for the low uptake are primarily driven by a poor contract design, involving high level of uncovered residual risk, called basis risk.

By protecting households against shocks and therefore reducing income variability, microinsurance allows households to avoid the costly asset smoothing and consumption smoothing behaviors. To date, only Janzen and Carter [2013] study the ex post impact of micro insurance on households' welfare. Their study is based on a drought induced insurance intervention in Kenya. Using households' reported risk coping strategies, they find that insured farmers were less likely to smooth their consumption and their assets.

The main finding of the ex-ante impacts of microinsurance is that it induces farmers to take more profitable but riskier activities. When studying agricultural decisions in Ghana, Karlan et al. [2012]show that uninsured risk is the binding constraint to farmer's investment decisions. They randomly distributed cash grants, the possibility of purchasing insurance, or both. They showed that insuring against the main production risk enable farmers to spend more resources on their farm. Cole et al. [2013b]randomly distributed insurance contracts to a sample of Indian farmers. They find that farmers intensify the production of their main cash crop, which is risky relative to other land and labor uses. They do so by allocating more fertilizers, seeds and land to that crop.Mobarak and Rosenzweig [2012] randomly offer households the opportunity to purchase a rainfall insurance contract. They find that insured households are more likely to plan a variety of

[1] Cole et al. [2012]and [De Bock and Darwin Ugarte, 2013] do a systematic review of the effectiveness of index insurance in developing countries.

rice that has a significantly higher yield but is less drought tolerant. Cai et al. [2009] randomly distributed the opportunity to purchase an insurance contract to Chinese farmers in Southwestern China. They find that increased insurance adoption leases to an increase in sows. Cai [2012] uses a natural experiment and a household level panel data set in rural china to study the impact of government weather insurance program. She finds that insurance results in a significant increase in the production area of the insurance crop, a decrease in the production diversification. [Vargas Hill and Viceisza, 2010] designed framed field experiment in rural Ethiopia. In the games, farmers were asked to decide between whether to purchase a fertilizer and if so how many bad. Fertilizers represent the high risk high return activity in those experiments. Introducing a hypothetical insurance contract induces farmers to take more risk by purchasing more fertilizers than their non insured counterparts.

3 Context and evaluation

3.1 Background on cotton production in Mali

Cotton is the main cash crop in Mali. It participates by up to 1% of the country's GDP and 15% of export revenues AFRICAN OUTLOOK . Moreover, it plays a crucial role in rural development: between 10 and 13 million Malians depend directly on the cotton sector for their livelihood IFDC (. Most of the production takes place in Southern Mali in the regions of Sikasso, Bougouni, Fana, Sikasso and Kita.

Cotton is an annual crop, and grown on an average of 2 ha in rotation with other staple and cash crops such as maize. Its planting season coincides with the rainy season, which starts in late May or early June. The harvest takes place during the months of December and January.

Cotton has an important food security component. It is main source of cash for the household. In addition, it acts as collateral to get input loans for the staple crops such as maze. Cotton producers are eligible for fertilizer loans from the BNDA, with the obligation to repay at harvest time. In a setting where individual credit is nonexistent, this is very a very important attribute.

The cotton sector in Mali is characterized by four main features. First, it is characterized by a high degree of vertical integration. The CMDT, the company Malienne des Textiles, is a national company that controls the cotton sector in Mali. Upstream, it acts as a monopsony by providing farmers with inputs and technical assistance. Downstream, it acts as a monopoly by purchasing all the cotton harvest from the farmers. In addition, CMDT divided the cotton growing area in several Secteurs (there is a total of xx Secteurs in South of Mali). As shown in the graph in the appendix, each sector is divided into Zones de Production Agricole (ZPA), and each ZPA is in turn divided into cooperatives comprised of 25-30 farmers each.

An individual farmer has no access to credit to finance cotton production inputs. This is due to the usual problems that guarantee the failure of individual microcredit in rural areas of the developing world. To solve the problem of lack of access to credit, cotton production in Mali takes place in cooperatives. In a given village there are from 1 to 2 cooperatives with an average of 20 farmers. The main role of a cooperative is to give its members an access to input loans, mainly seeds, urea and the complexe cotton – the main fertilizer used in cotton. The Banque National de Developpement Agricole (BNDA) is the primary source of input loans for the cotton sector. It passes loans to the CMDT, which on-lends the funds to individual village cooperatives. Every cooperative has a bank account at the BNDA.

The input loan comes with a joint liability clause. If at least one producer is unable to pay back his loan, all the other members of the cooperative have to pay back the difference. Therefore, productive cotton farmers bear the burden of less productive farmers, which creates tensions within the cooperatives. There is evidence that joint liability is enforced in the area. Members who were not able to pay back their loans are forced to sell their productive assets.

At the beginning of the growing season, each member of the cooperative lists his needs in terms of production inputs. The secretary of the cooperative gathers the list from all the members and get an input loan in kind from the BNDA. Then the cooperative distributes the inputs in kind among its members. After the harvest, The CMDT sends trucks to the villages and publicly weighs the cotton production, then transport it its processing facilities. Then, the amount of the loan is deduced from the CMDT payment to pay back the loans. Then it distributes the profits to the village cooperatives, which are responsible for distributing the profit among their members.

Farmers do not face a price risk since the CMDT announces the price long before the onset of the growing season. However, they face a substantial production risk. Since cotton is entirely rain fed in the study area, its production is vulnerable to weather shocks. The household survey we conducted highlights the extreme poverty and vulnerability of these farmers to adverse shocks: more than three quarters of the households were hit by a drought during the year preceding the survey (i.e. in 2011). The average reported cost of this drought is equal to almost 348, 000 CFCA (approximately 696 USD). Furthermore, droughts account for more than half of the costs of the shocks experienced by the households in 2011.

Households unable to pay back their input loans suffer a loss of their productive assets, and go through costly risk coping mechanisms. While insurance is a potential solution to the effects of these adverse shocks, it is widely absent in Mali. In this context, the Index Insurance Innovation Initiative launched in 2010 a pilot in the sector of Bougouni, in Southern Mali.

3.2 Design of the cotton insurance contract

The study area consists of the Secteurs of Dogo and Bougouni located within the region of Bougouni. There are a total of 270 cooperatives in these two Secteurs. Since the cotton industry in Mali is controlled by a monopsony/monopoly, and the production takes place in cooperatives, we decided to make the cotton cooperative as the insured unit.

The contract we designed is an innovative area-yield index insurance contract. Unlike traditional insurance that pays individual farmers based on the losses they experience in their fields, a conventional index insurance pays based on an index that is designed to be highly correlated but not identical to farmer's losses.

A conventional area yield index insurance contract pays a cooperative if the average yield in an aggregate area falls below a predetermined historical level.

The contract is a double-trigger lump sum indemnity contract. Compared to conventional single trigger contract, this contract has the advantage of reducing uninsured basis risk faced by cooperatives. The first trigger is the cooperative average yield, and it varies between 264 and 913 kg/ha. The second trigger is the ZPA yield and is equal to 900 kg/ha. We adjusted the level of the first trigger to keep the price of the insurance contract constant across cooperatives. Payoff occurs only if both the cooperative yield and the ZPA yield are below their triggers. Thus a cooperative with a yield of 740kg/ha would receive a payoff if the ZPA yield is 780kg/ha, but not if the ZPA yield is 1000kg/ha.

The triggers were set based on an estimation of the statistical distribution of the yield data at both levels. The CMDT provided cotton yield data at the ZPA level for all the ZPAs of Bougouni Region for 7 years (from 2001/2002 to 2007/2008). In addition we obtained cooperative level yields for nearly all the cooperatives in the Secteurs of Dogo and Bougouni for the last 5 or 6 years. The probability of getting a payment is set at 7%, and the insurance payment is equal to a lump sum of 95000 CFA/ha (or about 190 $US per-hectare). It corresponds approximately to the amount of the loan taken by the farmers at the beginning of the growing season from the BNDA.

The upside of these contracts is that they reduce the basis risk for the cooperative while avoiding the moral hazard that would occur if payments were made only based on cooperative level yields. Under this dual trigger contract, insured cooperatives have no perverse incentives to reduce their yields, since payoffs are made only if the greater area of the ZPA has a low average yield. For more details about this contract see [Elabed et al., 2013].

Since the insured unit is the cotton cooperative, cooperative members decide to purchase the contract with a consensus process. The decision has to be made before the beginning of the growing season, i.e. before end of May. If the cooperative decides to buy the insurance contract, then the CMDT will sign a formal insurance agreement with the insurance company, naming the covered cooperative and the appropriate number of hectares insured. The CMDT will pay the insurance company directly and then deduct the premium charges from the cooperatives using the same mechanism it uses to recover loan repayment (that is, loan and insurance changes will be deducted from the value of cotton sales which are made directly to the CMDT).

3.3 Experimental Design

The final set of cooperatives that were priced by the reinsurance company contains 87 cooperatives. We randomly allocated two thirds (59) of the cooperatives into treatment group and we maintained one third (28) of the cooperatives as a control group. We then offered the treatment cooperatives the option of purchasing the insurance contract. To increase the likelihood of substantial take-up, we adopted an encouragement design: treatment cooperatives received randomly distributed discounts that reduced the price to 50%, 75%, or 100% of the actuarially fair premium. The actuarially fair premium of the insurance contract is equal to 7125 CFA. The insurance company charged a 50% mark-up, which results in a premium of 10716 FCFA/ha. The contracts are identical from an actuarially point of view. They have the same probability of payment, and differ in terms of the triggers set at the cooperative and ZPA level. Overall there are three categories of prices, implying three levels of subsidy. The first category corresponds to a price of 7125 FCFA, the actuarilly fair price, which implies a subsidy of 3591 FCFA/ha. The second category corresponds to a price of 5344 FCFA/ha, which represents 75% of the actuarially fair price. The third price is 3563 FCFA/ha, which is 50% of the actuarially fair premium.

The implementation of the randomization was complex and consisted of three steps. We organized a workshop in Bamako to train a group of local extension agents about the insurance contract and the implementation of the randomization. During the months of April and May 2011, these agents organized group trainings with the secretaries of the cooperatives from the treatment groups to inform them about the intervention. The idea was that the secretary would then train the members of his cooperative about the insurance contract. During the training, the agents emphasized that the encouragements are temporary and being offered for the first growing season. Cooperative secretatrires were told that their cooperatives were selected at random to receive these temporary discount subsidies as a way to encourage them to try out and learn about the insurance contract. In the final stage of the implementation process, the extension agents were supposed to visit each cooperative from the treatment group to hold a general meeting with all its members. The outcome of the meeting would be a decision of the farmers of whether they want to subscribe to the insurance contract or not.

We administered a follow-up survey in December 2011 and January 2012, after the harvest. We sampled the households to survey in one wave in 2011/2012. There was no baseline survey and we relied on recall data over a short period of time instead. To draw the sample, groups of enumerators were assigned a certain number of cooperatives in the study area. Then, each group coordinator asked the chief of the cooperative to list the name of the cooperative members. Using a randomization table, the survey coordinator identified 12 household heads to survey. The final sample frame consisted of 312 household members from the control group, and 669 households from the treatment group.

The questionnaire included demographic, wealth, production and food consumption modules. There was also a module about insurance purchases. In every household, we surveyed the household head, the woman in charge of preparing the meals (the food queen), and the woman who has the youngest children in the household. We also measured the heights and weights of children aged from 6 months to 5 years.

To make sure that the implementation of the intervention complies with the procedure we established, we included an audit question in the impact survey. Specifically, we asked the surveyed cooperative member whether he knew that his cooperative had access to an insurance contract or not. Surprisingly, 9 cooperatives out of the 59 initially allocated to the treatment group have a high percentage of negative answers. We further investigated this issue by talking to the extension agents who implemented the intervention. We found out at that at least 3 cooperatives were not offered the possibility of purchasing the insurance contract. The reason behind this imperfect implementation is primarily the deadline we imposed on the collection of the insurance subscriptions by the extension agents. In fact, since we are also interested in studying the ex-ante decisions of farmers, we imposed the deadline of May 31st to guarantee that farmers made their insurance choice decisions before starting to make their planting decisions. To account for the high level of negative answers within the 9 cooperatives, we decided to reclassify them in the control group. The rest of the paper carries the analysis using both the original treatment variable and the audit-based reclassification. In the appendix, we carry robustness checks with a more conservative approach in which we reclassify to the control group only the three cooperatives with a 100% negative response rate.

4 Sample and balance tests

We targeted 12 household from each of the 88 cooperatives in the study area, for a total sample size of 1056 households. We completed the survey of 981 households for an overall response rate of 93%.

Table 1 provides the descriptive statistics for the households belonging to the control group. The average household head is approximately 56 years old, and has limited formal education (four years of schooling). The total area in cotton per household is around 2 ha, with a yield of 1070 kg/ha. Overall, the study sample is made by really poor small scale cotton farmers.

We did not implement a baseline survey, but included recall data in the survey following the intervention. Hence to check the balance between treatment and control groups, we look at recall variables related to the 2010-2011 growing season, which preceded the season with the randomized distribution of the possibility of purchasing the insurance contract. Although the period of recall was relatively short, 60% of the surveyed household members were not able to remember the area of land they allocated to cotton and the value of their cotton productions in 2010. Therefore, the differences in these two variables that we observe at the baseline between the treatment group and the control group are only true for the subsample of farmers who remembered their production decisions in 2010.

Table 1 presents the baseline characteristics of households by treatment status using the orginal classification and the audit-based recalssification, and the p-values of tests that the differences between treatment and control are equal to zero. It shows that the randomization achieved balance across a range of baseline observables for both classifications.

	Original			Audit-based reclassification		
	Control	Treatment	Difference	Control	Treatment	Difference
Cotton area 2010(ha)	2.20	2.41	0.21	2.19	2.44	0.24
($N = 586$)	[1.39]	[1.70]	(1.15)	[1.33]	[1.77]	(1.34)
Cotton harvest 2010 (kg)	2339.19	2288.47	-50.73	2316.60	2291.20	-32.23
($N = 584$)	[1822.26]	[1879.20]	(-0.23)	[1741.26]	[1939.37]	(-0.15)
Cotton yield 2010 (kg/ha)	1070.20	926.68	-143.52**	1053.11	914.59	-140.02***
($N = 584$)	[440.65]	[345.69]	(-3.01)	[422.87]	[342.68]	(-3.31)
Maize area 2010 (kg)	2.12	1.77	-0.35	2.00	1.79	-0.21
($N = 969$)	[5.33]	[1.94]	(-0.96)	[4.72]	[1.96]	(-0.71)
Rice area 2010 (ha)	0.20	0.21	0.01	0.26	0.16	-0.10
($N = 969$)	[0.55]	[0.68]	(0.18)	[0.78]	[0.51]	(-1.24)
Sorghum area 2010 (ha)	1.20	1.37	0.17	1.20	1.40	0.20
($N = 969$)	[1.63]	[1.84]	(0.78)	[1.64]	[1.86]	(1.01)
Fonio area 2010 (ha)	0.04	0.04	0.00	0.04	0.03	-0.01
($N = 969$)	[0.29]	[0.23]	(0.18)	[0.33]	[0.17]	(-0.51)
Mil area 2010 (ha)	0.54	0.43	-0.11	0.49	0.45	-0.03
($N = 969$)	[1.28]	[1.12]	(-0.92)	[1.22]	[1.14]	(-0.31)
Millet area 2010 (ha)	0.03	0.05	0.02	0.03	0.06	0.03
($N = 969$)	[0.26]	[0.33]	(1.02)	[0.25]	[0.35]	(1.14)
Age of the hh head	55.85	55.33	-0.52	55.19	55.71	0.51
($N = 971$)	[14.49]	[15.02]	(-0.43)	[14.61]	[15.00]	(0.44)
Education of the hh head	3.50	3.98	0.48	3.89	3.77	-0.14
($N = 948$)	[6.10]	[7.39]	(0.80)	[6.44]	[7.37]	(-0.23)

[a]

[a]Columns (1) and (2) show means with standard deviations in brackets. Column (3) shows the coeffcient on treatment from regressions of each characteristic on treatment clustering standard errors at the cooperative level with t-statistics in parenthesis. ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

5 Insurance take- up

5.1 Descriptive results

A total of 16 cooperatives out of the 59 treatment cooperatives (30%) purchased the insurance contract. This corresponds to 184 households out of the 669 households in the treatment group, or an uptake rate of 27%. The total area of cotton in 2010 in the treatment group was 970 ha. The insured area is equal to 229 ha, or 23% of the total area eligible for the insurance product.

The encouragement design allows us to examine the demand of this product. Recall that the intervention targets cooperatives since they are the insured units. Therefore, we ended up with 87 discrete decisions of whether a given cooperative participates in the program or not. Figure 1 shows the number of cooperatives purchasing insurance as a function of the price of insurance. Demand slightly dropped when the price went from 100% of the fair premium to 75% of the fair premium. Then it slightly increased when the price went down to 50% of the fair premium. As Table 2 shows, correcting the misclassification does not change the pattern of the demand.

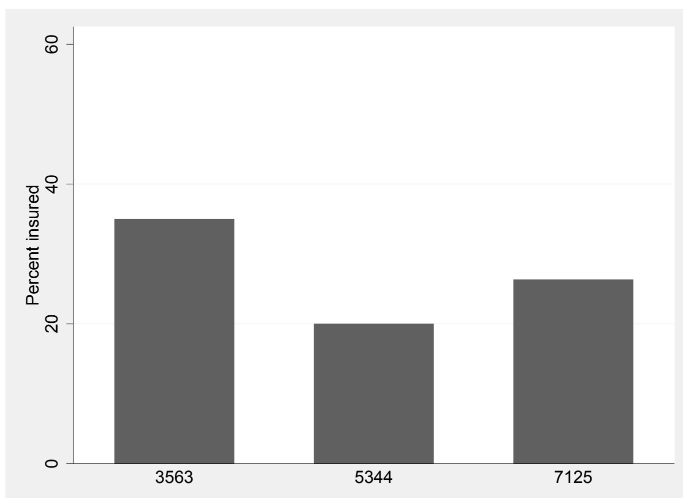

Figure 1: Insurance Take up by Price per ha (CFA)

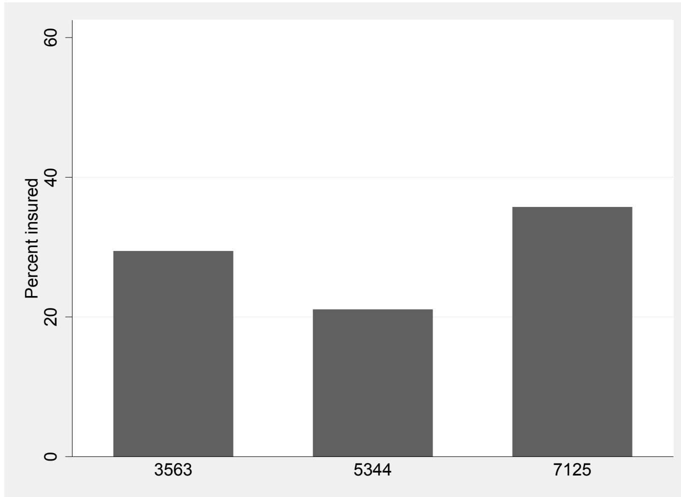

Figure 2: Insurance Take up by Price per ha (CFA)

5.2 Empirical estimation and results

We estimate the up-take of insurance using the following specification :

$$I_c = \alpha_1 + \beta_1 T_c + \varepsilon_{1c} \tag{1}$$

where I_c is an indicator of whether cooperative c decided to purchase the insurance contract, T_c is cooperative c treatment status (original or audit-based), and is equal to 1 if cooperative c belongs to the treatment group. Since the treatment $T_c = 1$ was randomly assigned, we should expect $E(\varepsilon_{1c}|T) = 0$ and the ordinary least square estimate of β_1 is unbiased.

Since the price at which the cooperatives were offered the possibility of purchasing the insurance contract randomly varied, we can also estimate another variant of specification 1:

$$I_c = \alpha_2 + \beta_2 T_c + \gamma_1 T_c P_{50} + \delta_1 T_c P_{75} + \varepsilon_c \tag{2}$$

Where P_{50} and P_{75} are the prices that corresponds to a 50% and 75 % discount in the actuarially fair price of the contract, respectively. The coefficients β_2, γ_1 and δ_1 are also unbiased (?) since the price discounts were randomly assigned to the cooperatives in the treatment group.

Table 1 presents the regression results using the original specification . Column (1) verifies that 27 % of the cooperatives in the original treatment group purchased the insurance contract. Column (2) shows the regression results of Equation 2. It is the regression analog to Figure 1. It shows that the pattern of the demand is not as predicted. While the demand at 50% of the actuarially fair premium is 8% higher than the demand at 100% of the premium, the demand at 75% of the fair premium is surprisingly 6% lower that the demand at 100% of the actuarially fair premium. However, the coefficients on the prices are not jointly different from zero, as shown by the value of the F-test.

	(1) Insurance takeup =1	(2) Insurance takeup =1
Treated	0.271***	0.263**
	(3.19)	(2.39)
Medium price		-0.0632
		(-0.53)
Low price		0.0868
		(0.73)
Constant	1.11e-16	1.11e-16
	(0.00)	(0.00)
Observations	87	87
F_stat	10.18	3.928

t statistics in parentheses

* p<.1, ** p<.05, *** p<.01

Table 1: Insurance uptake, cooperative level

6 Impact of the insurance on the production decisions

6.1 Descriptive results

Figures 3-5 summarize the impact of having access to insurance on the farmer's ex-ante decisions. We carry the analysis using the audit-based reclassification. Section H.1 of the Appendix carries the same analysis using the original treatment variable .

Figure 3 plots the cumulative probability distribution functions of the total area in cotton, separately by corrected treatment status. It shows that the CDF of the area in cotton if households in the treatment group is slightly shifted to the right of that of control group suggesting a slight increase in the area in cotton.

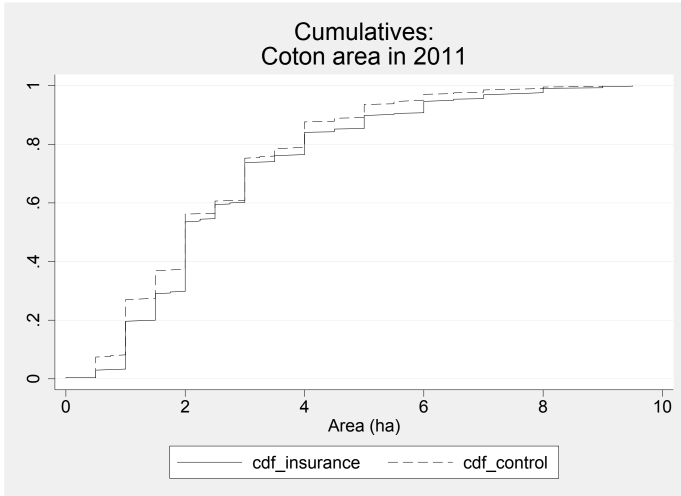

Figure 3: Effect of Insurance on cotton area in ha

Figure 4 plots the CDFs of the fertilizers used by the cotton farmers in CFA per ha, by treatment status. There does not seem to be an impact on this variable. A formal Kolmogorov Smirnov test of the equality of the different distributions does not reject the hypothesis that the two distributions are the same.

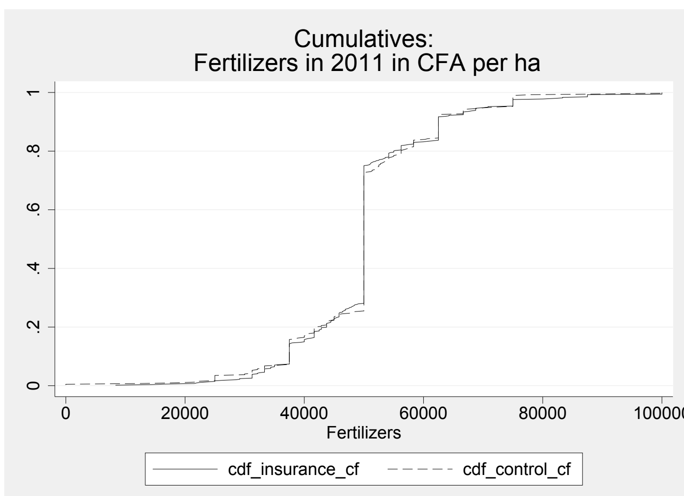

Figure 4: Effect of insurance on the use of fertilizers in CFA per ha

Figure 5 plots the CDFs of the cotton seeds planted in CFA per ha by the cotton farmers, by treatment status. The intervention seems to have an impact. A formal Kolmogorov Smirnov test of the equality of the different distributions reject the hypothesis that the two distributions are the same at the 5% level.

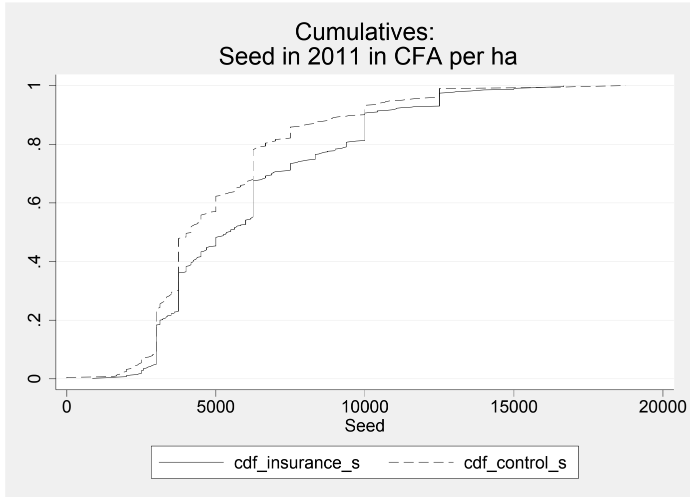

Figure 5: Effect of insurance on seeds in CFA per ha

6.2 Estimation strategy and results

This section estimates the effect of insurance on different *ex-ante* outcomes such as area devoted to cotton, input use and fertilizer use. For each outcome, there are two effects of interest: the intent-to-treat effect (ITT), the average effect of being assigned to the treatment group, and the average effect of those that purchased the insurance contract (the Treatment on the Treated or ToT effect).

6.2.1 Reduced form estimation and results

We first estimate the overall average effect of being assigned to the treatment on a given outcome by ordinary least squares with clustering at the cooperative level. We use the following specification [2]:

$$Y_{ic} = \alpha + \beta T_c + \varepsilon_{ic} \tag{4}$$

Denote Y_{ij} the outcome of interest measured for individual i in cooperative c. T_c is cooperative c's treatment status, and is equal to 1 if cooperative c belongs to the treatment group. The average effect of being assigned to a treatment cooperative versus a control cooperative is captured by the parameter β. Since the treatment $T = 1$ was randomly assigned, we should expect $E(\varepsilon_{ic}|T) = 0$ and the ordinary least square estimate of β is unbiased. Standard errors are clustered at the cooperative level.

[2] We have also estimated the average effect of being assigned to the treatment on the area in cotton by estimating the following equation, using a fixed effect model:

$$Y_{ict} = \theta_{ic} + \beta T_c + \varepsilon_{ict} \tag{3}$$

where t is the year and θ_{ic} is the individual time invariant fixed effect. Using the original treatment assignment, the reduced form results imply an 0.08 ha increase in the area of land devoted to cotton compared to the baseline level. This number increases to 0.18 ha when we consider the audit-based treatment status. However, the point estimates are not precisely estimated because the sample size is reduced: only 40% of the respondents were able to remember their 2010 cotton production decisions.

	(1) Area (ha)	(2) Harvest (kg)	(3) Loans (kCFA)	(4) Seed (kCFA)	(5) Fertilizer (kCFA)	(6) Seed (kCFA/ ha)	(7) Fertilizer (kCFA/ha)
Panel A. Audit-based reclassification							
Audit-based treatment	0.39**	219.97	214.965	4.572***	15.288	0.772**	-1.423
	(0.18)	(209.18)	(170.518)	(1.423)	(10.066)	(0.386)	(2.394)
Constant	2.53***	2570.28***	302.114***	12.766***	133.250***	5.427***	54.006***
	(0.11)	(138.35)	(13.451)	(0.871)	(6.889)	(0.274)	(2.181)
N	954	942	968	952	952	952	952
R^2 (adj) Panel A	0.009	0.001	0.000	0.025	0.003	0.009	-0.001
Panel B. Original classification							
Original treatment	0.21	99.28	154.509	2.874*	10.047	0.503	-0.332
	(0.19)	(217.44)	(146.145)	(1.489)	(10.319)	(0.420)	(2.853)
Constant	2.61***	2630.10***	321.571***	13.453***	135.253***	5.531***	53.412***
	(0.13)	(167.51)	(15.117)	(1.087)	(7.891)	(0.341)	(2.681)
N	954	942	968	952	952	952	952
R^2 (adj) Panel B	0.002	-0.001	-0.000	0.008	0.000	0.003	-0.001

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p <0.01

Table2 : Reduced-Form Estimates of the impact of access to insurance on Cotton production

Panel A of Table 2 provides evidence on the average treatment impact of insurance on cotton production decisions using equation 4. The adjusted R-squared is provided at the bottom of the table. The regressions do not include co-variates. The estimation results are consistent with the hypothesis that the intervention had impacts on both the extensive margin and the intensive margin. Column (1) shows that compared to households from the control group, households from treated cooperatives significantly increased the area of cotton by 15%. In addition, the total expenditure on seeds per household significantly increased to 4,572 CFA from a base of 12,766 CFA, which represents a 35% increase. The amount of fertilizers used and agricultural loans did also increase but the point estimates are not significantly different from zero.

At the intensive margin, households from the treated cooperatives used seeds more intensively than their counterparts in the control group. In fact, the intervention resulted in 14% increase in the expenditure on seeds per hectare per household. The amount of fertilizer per ha decreased but the point estimates are not significantly different from zero.

Panel B of Table 2 shows that the point estimates do not change much when we consider the original treatment variable.

6.2.2 Instrumental variable estimation

Our impact evaluation is primarily concerned with households' ex-ante cotton production decisions. Our survey provided us with information about whether a given cooperative is insured or not. However, since we are interested in individual farmers 'decisions, it is their feeling of whether they are insured or not that matters for the analysis. Our main hypothesis is that if a farmer feels insured, then he will free the resources allocated as a coping mechanism against negative income shocks. At the intensive margin, he may choose to invest in cotton production. At the extensive margin, he may allocate a larger share of his land to cotton production. Insuring the farmer would then increase the overall farm revenue, protecting him from costly consumption and asset smoothing strategies. To take into account this feeling of being insured, we asked every surveyed member whether he thinks he is insured or not. The rest of the analysis in this paper studies the impact of feeling insured on the various outcomes. To do so we use an instrumental variable approach. Denote C_i the variable of interest, which is "feeling insured". Our strategy consists in instrumenting C_i with being assigned to the treatment group using the following specification[3]:

$$C_i = \alpha + \beta T_c + \varepsilon_c \tag{6}$$

We then estimate the impact of insurance on Y_{ic} with the following second stage regression:

$$Y_{ic} = \alpha + \beta \hat{C}_i + \epsilon \tag{7}$$

where $\hat{C}_i$ is the predicted value of the "insured" value using the first stage regression 6.

Panel A of Table 3 displays the average treatment impact on the farmers who felt insured using equation 6 and 7. The estimation results are consistent with the hypothesis that the intervention led to a change in the farmer's behavior at the extensive margin. In fact, farmers who think that they are insured increased their area devoted to cotton by 75%. They also increased the total expenditure on seeds by 190%. There are no significant impacts on the intensive margin.

[3]We have also estimated the average effect of feeling insured on the area in cotton by estimating the following equation:

$$Y_{ict} = \theta_{ic} + \beta C_{ic} + \varepsilon_{ict} \tag{5}$$

where t is the year and θ_{ic} is the individual time invariant fixed effect. We used a fixed effect model and instrumented the variable "feeling insured" C_i by the treatment status. Using the original treatment assignment as instrument, the results imply a 0.41 ha increase in the area of land devoted to cotton compared to the baseline level. This number increases to 0.68 ha when we consider the audit-based treatment status. However, the point estimates are not precisely estimated because the sample size is reduced: only 40% of the respondents were able to remember their 2010 cotton production decisions.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed (kCFA/ ha)	Fertilizer (kCFA/ha)
Panel A1. IV Audit-based reclassification							
Feeling insured	1.77*	1054.25	1,009.390	20.202**	70.546	3.333	-6.504
	(1.01)	(986.32)	(886.286)	(9.500)	(51.046)	-2.136	(10.779)
Constant	2.34***	2447.87***	192.637*	10.598***	125.469***	5.067***	54.739***
Panel A2. First-stage, dependent variable is "feeling insured"							
Audit-based treatment	0.224***						
	(-0.0704)						
Constant	0.108***						
	-0.0397						
Observations	945	934	958	943	943	943	943
r2 first	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366
r2 second	-0.248	-0.071	-0.040	-0.687	-0.276	-0.007	-0.097
Panel B.1 IV Original classification							
Feeling insured	1.3	720.25	918.808	16.349	63.272	2.620	-2.006
	(1.19)	(1253.04)	(960.346)	(11.222)	(64.222)	(2.764)	(16.265)
Constant	2.45***	2527.98***	213.912	11.514***	127.196***	5.237*	53.670***
	(0.26)	(297.45)	(134.533)	(2.572)	(14.934)	(0.689)	(4.541)
Panel B2. First-stage, dependent variable is "feeling insured"							
Original treatment	0.175**						
	-0.0716						
Constant	0.118**						
	-0.0498						
Observations	945	943	958	943	943	943	943
r2 first	0.02	0.02	0.02	0.02	0.02	0.02	0.02
r2 second	-0.129	-0.032	-0.034	-0.450	-0.090	-0.176	-0.000

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p <0.01

Table 3 : Reduced-Form Estimates of the impact of access to insurance on Cotton production

Panel B of Table 3 displays the average treatment impact on the farmers who felt insured using the original treatment status. Although the point estimates are non-significant, they are not very different from the one obtained using the audit-based reclassification.

7 Conclusion

In the absence of formal insurance markets, poor rural households in developing countries may rely on costly risk-management mechanisms, including income smoothing strategies that entail avoiding riskier technologies with higher expected returns. In this paper we report results from a randomized field experiment that evaluates the effectiveness of microinsurance on agricultural production decisions among cotton farmers in Mali.

In the first year of the program, 16 out of the 59 treatment cooperatives (30%) agreed to purchase the index insurance contract. This uptake rate is well above up-take rates in some other pilot projects. The impact results imply that the intervention had impacts primarily on the extensive margin by increasing the area devoted to cotton.

The results have important policy implications. Policy makers showed interest in scaling up micorinsurance pilots to target a larger sample of vulnerable households in the developing countries. However, the evidence on the effectiveness of microinsurance interventions is scarce. The results of this paper show that an innovative microinsurance contract can overcome the negative ex-ante impacts of uninsured risk.

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A Appendix

A.1 Descriptive results, original classification

Figures 6-10 summarize the impact of insurance on the farmer's ex-ante decisions. Figure 6 plots the cumulative probability distribution functions of the total area in cotton, separately by audit treatment status. It shows that the CDF of the area in cotton if households in the treatment group is slightly shifted to the right of that of control group.

To improve the readability of Figure 6, the left panel of Figure 7 plots the CDF below the 80th (check) percentile, while the right panel of Figure 7 plots the CDGs above the 80th (check) percentile. It seems that the impact is concentrated in the right tail of the cotton area distribution. While the median area in cotton is actually 2 ha for both treatment and control groups, the 99th percentile increases by about is 2.5 ha, from a base of 8 ha. We observe a slighter impact on the 25th percentile: it increases by 0.5 ha from a base of 1.

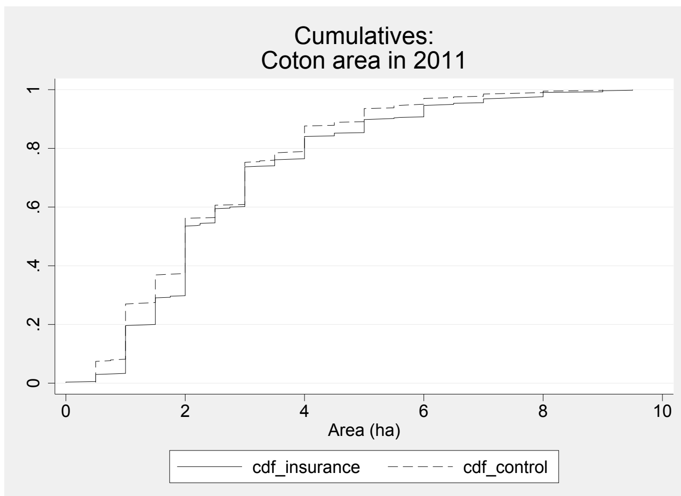

Figure 6: Effect of Insurance on cotton area

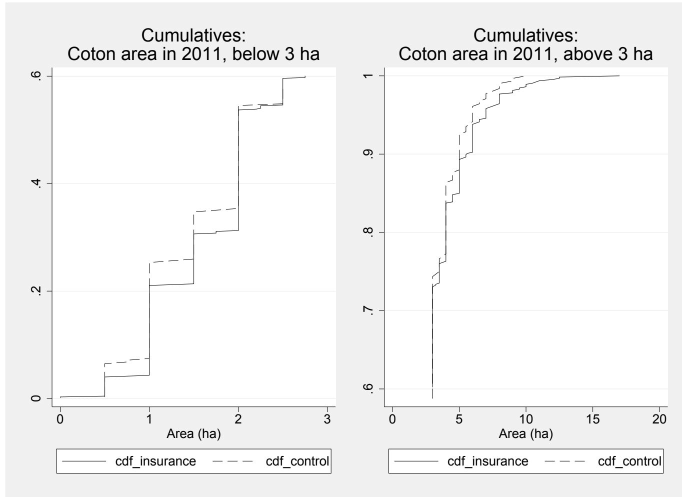

Figure 7: Disaggregated Effect of Insurance on Cotton Area

Figure 8 plots the CDFs of the different different fertilizers used for the cotton production, including urea, manure, and "complexe cotton", by treatment status. The intervention does not seem to a have an impact on these different variables. A formal Kolmogorov Smirnov test of the equality of the different distributions does not reject the hypothesis that the two distributions are the same.

Figure **??** plots the CDFs of the insecticides and pesticides used by the cotton farmers, by treatment status. Again, there does not seem to be an impact on these two variables. A formal Kolmogorov Smirnov test of the equality of the different distributions does not reject the hypothesis that the two distributions are the same.

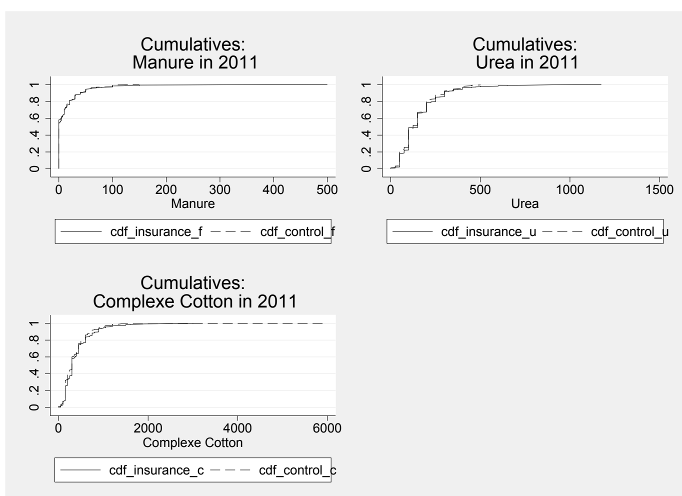

Figure 8: Effect of insurance on the use of manure

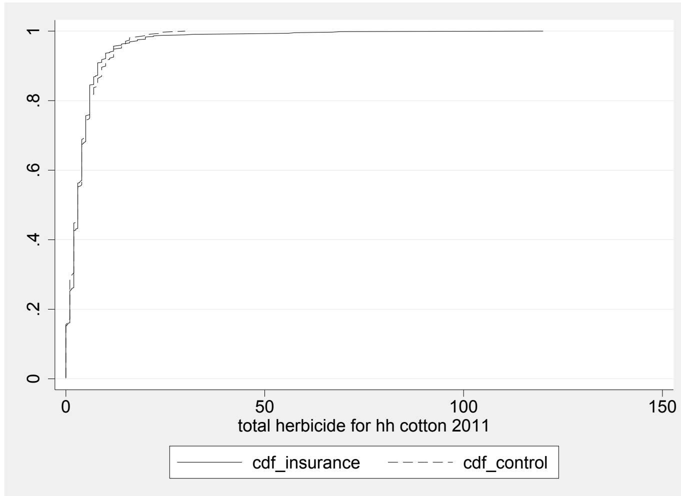

Figure 9:

Figure 10 plots the CDFs of the cotton seeds planted the cotton farmers, by treatment status. The intervention seems to have an impact. A formal Kolmogorov Smirnov test of the equality of the different distributions reject the hypothesis that the two distributions are the same at the 5% level. Figure 10 suggests that the impact is concentrated in the right tail of the seed distribution. The 75th percentile increases by about is 20 kg, from a base of 61 kg. The 95th percentile increases by about 25 kg, from a base of 150 kg.

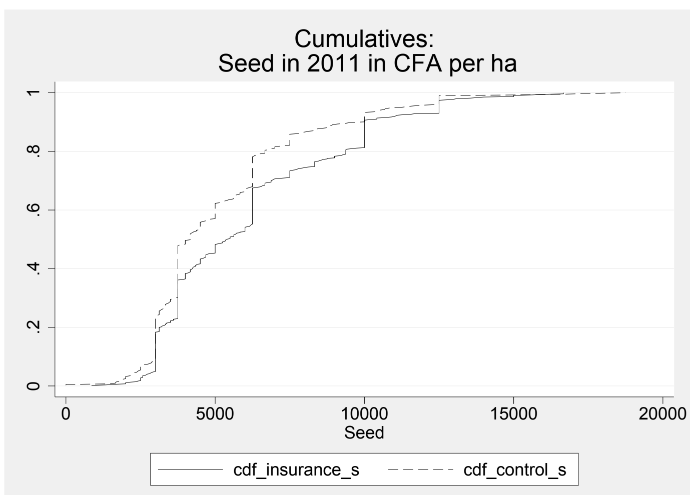

Figure 10: Effect of insurance on seeds

A.2 Reduced form impacts

In this section we investigate the reduced form impacts of being assigned to the original treatment group on different ex-ante indicators using three types of audit-based reclassification of the cooperatives. The first strategy consists in reclassifying only the three cooperatives for which we are certain that they were not offered the insurance contract. The second drops all these 3 cooperatives. The last strategy drops the 9 cooperatives with a high negative response rate to the audit question.

We begin by estimating the Intent to treat equation using the following specification:

$$Y_{ic} = \alpha + \beta T_c + \varepsilon_{ic} \tag{8}$$

Table 2 displays the estimation results.

	reclassify three	drop all three	drop all nine
Area			
treatment= 1 if offered insurance	0.184	0.210	0.310
	(0.183)	(0.191)	(0.198)
Constant	2.637***	2.611***	2.611***
	(0.123)	(0.134)	(0.134)
N	954.000	922.000	858.000
r2_a	0.001	0.001	0.004
Seed per ha			
treatment= 1 if offered insurance	717.594*	597.031	668.595
	(404.941)	(423.197)	(437.442)
Constant	5410.448***	5531.011***	5531.011***
	(318.720)	(341.573)	(341.746)
N	952.000	920.000	856.000
r2_a	0.007	0.004	0.005

Table 2: Reduced form impacts on cotton production decisions

A.3 Instrumental variable impacts

Table 3 shows the average treatment impact of the insurance intervention using the three reclassification strategies described in section H.2 .

	reclassify three	drop all three	drop all nine
Area			
Sub.Insurance	0.979	1.179	1.510
	(0.972)	(1.097)	(1.083)
Constant	2.529***	2.467***	2.428***
	(0.211)	(0.249)	(0.251)
N	945.000	913.000	850.000
r2_a	-0.071	-0.107	-0.190
Seed per ha			
Sub.Insurance	3341.907	2893.008	2937.440
	(2451.054)	(2636.509)	(2450.193)
Constant	5065.829***	5204.862***	5199.601***
	(608.233)	(680.169)	(655.616)
N	943.000	911.000	848.000
r2_a	-0.277	-0.221	-0.232

Table 3: IV impacts on cotton area and seeds