Indirect protection: the impact of cotton insurance on farmers' income portfolio in Burkina Faso*

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Abstract

While there is ample evidence of the toll that uninsured risk imposes on farmers by discouraging profitable but risky investment, we still know little on the mpact of new insurance possibilities on household investment strategies. This paper examine this quesiton in the context of an area-yield index insurance sold to cotton farmer groups in Burkina Faso. Insurance access was randomized, and in the treatment area, sales were encouraged through premium subsidies (between 25% and 75%) randomly distributed to farmer groups. We find no impact of the program on cotton prodcution but substantial and significant impacts on several other assets or activities such as sesame cultivation, livestock herding and field investments. First-hand qualitative evidence suggests that various implementation gaps help explain the pattern of results. Overall, the findings suggest a promising role of index insurance for stimulating ex-ante investments, but also draws attention to important challenges which currently threaten this type of intervention.

Keywords: Index insurance; Burkina Faso; productive investments; randomized evaluation; mixed-methods.

JEL classification: D91, G22, I38, O12, O13, O22, O33, Q12

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1 Introduction

An increasing amount of evidence suggests that the lack of instruments for risk management (saving, credit and insurance) plays a major role in limiting poor households' ability to accumulate assets and improve their future well-being. Uninsured risk prevents household from perfectly smoothing consumption (Kazianga and Udry, 2006; Dercon, 2002), and causes adverse shocks to have harmful lifetime consequences (Alderman et al., 2006; Hoddinott and Kinsey, 2001). Besides the impact of realized shocks, exposure to risk also discourages investment in profitable but risky activities. Farmers in Sub-Saharan Africa for example have been shown to adopt low-risk, low-return portfolio strategies, such as cultivating "safe" crops (Stoeffler, 2016; Zimmerman and Carter, 2003). This situation is striking in the Sahel in general and in Burkina Faso in particular, where levels of risk are high and overall levels of investments in input and productive assets are low.

In this context, insurance constitutes a promising poverty alleviation tool by helping farmers overcome the pervasive ex-post effects of risk and generate higher revenue. However . However, delivering contingent transfers in case of individual shocks is very challenging in rural areas of sub-Saharan Africa and index insurance has emerged as a promising alternative to traditional insurance contracts. By making indemnity transfers contingent on an index (such as the level of rainfall) rather than on an individual outcome, insuranceare immune to moral hazard and can be made more affordable. The drawback is that insurance payments based on the index are not perfectly correlated with farmers' losses, which means that the value of the protection provided may be relatively low (Clarke, 2011; Miranda and Farrin, 2012). In practice, only a few pilot projects have been implemented so far in Sub-Saharan Africa (De Bock and Gelade, 2012; Jensen and Barrett, 2015) and we know remarkably little on the impact of index insurance on household investments (Jensen et al., 2014b; Elabed and Carter, 2015a; Karlan et al., 2012). Research has focused mostly on demand for index-insurance, and on the factors explaining the low take-up observed in most projects (Karlan and Morduch, 2010; Binswanger-Mkhize, 2012; Carter et al., 2015; Cole et al., 2013; Jensen et al., 2014c) (Barré and Stoeffler, 2017; Clarke et al., 2012; Jensen et al., 2014a). Finally, existing studies do not assess the impacts on insured households after a shock occurred (one exception is (Janzen and Carter, 2013))

This paper studies the impacts of an index insurance contract designed for cotton farmers in Burkina Faso. Cotton farming in Burkina Faso, as in other West African countries, is a highly profitable but risky activity, given the crop's vulnerability to the region's variable weather patterns and the lack of insurance mechanisms for these farmers. Small-scale farmers often forgo this profitable opportunity (or limit the area they plant to cotton) in order to minimize their exposure to risk. This "risk rationing" strategy (Boucher et al., 2008) has adverse effects on the entire farming system, because cultivating cotton is often the only channel for Burkinabe households to obtain inputs for their other crops. In this context, insuring cotton has the potential to impact not only cotton production but the whole household portfolio and farmers' long-term well-being.

We exploit a randomized control trial that involved 80 farmer groups of the Houndé region, half of them being randomly selected and offered the insurance product for purchase. The insurance is based on a area-yield index and was sold as part of the cotton credit package by the cotton company (Sofitex). We collected data among 1000 households twice: at baseline before the intervention in January 2014, and one year later in January 2015. In addition we collected extensive qualitative data through focus

groups and farmers' interviews in 2016.

Take-up was very high compared to other index insurance pilots: approximately 45% of the farmer groups purchased the insurance in our research area. In terms of investments, we find no direct impact on cotton cultivation for insured households. In contrast, insurance stimulated substantially (and significantly) investments in other activities or assets such as sesame cultivation, livestock or field infrastructure. For instance, sesame cultivation among insured households increased by 17.3 percentage points compared to non-insured households. Furthermore our qualitative field work reveals that insurance has enabled farmers hit by a drought to avoid depleting their productive assets and continue cotton cultivation. In terms of mechanisms, we argue that the lack of impact of insurance on cotton production is likely driven by implementation gaps. In particular the insurance was sold too late for farmers to adjust their input demand and area cultivated. Our qualitative investigation also suggests other implementation gaps and continuing challenges for index insurance in similar contexts.

The paper is organized as follows. Section 2 describes the insurance product as well as context of the research. Section 3 presents the data, the research design and the empirical strategy. Section 4 reports quantiative and qualitative results on the impacts of the project. Section 5 discusses challenges and opportunities for index insurance and finally, Section 6 concludes.

2 A cotton index insurance : context and intervention

2.1 Risk & cotton production in Burkina Faso

The pervasiveness of risk and its consequences have been well studied in Burkina Faso. Based on the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) survey, research has shown that food shortfall were common for the poorest households (Carter, 1997), and that contrary to popular belief, livestock was not widely used as a buffer against adverse shocks (Fafchamps et al., 1998). As a consequence, droughts impact negatively poverty (Reardon and Taylor, 1996), as poor households are far from perfectly smoothing consumption (Kazianga and Udry, 2006). Extreme variability in agricultural production pushes households to diversify income in-farm and off-farm, but the poorest households remain trapped in low-return activities (Reardon et al., 1992; Stoeffler, 2016). Nevertheless, in the presence of shocks, poor households tend to smooth assets to protect future income from catastrophic collapse, as shown theoretically (Zimmerman and Carter, 2003) and empirically (Carter and Lybbert, 2012). . This suggests that better understanding risk alleviation mechanisms and their impact is crucial for improving farmers' living conditions in Burkina Faso and in many other parts of the developing world (Townsend, 1994; Udry, 1994; Rosenzweig and Binswanger, 1992).

The cotton sector in West Africa in general, and in Burkina Faso in particular, is very well suited for the development of index insurance product for several reasons. First while cotton is a profitable crop, farmers bear numerous risks surrounding cotton production and do not have access to formal risk mitigating instruments. Second very good quality data is available that allow to design area-yield contract (which are better correlated with cotton production than rainfall indexes). This is because the sector is very centralized with parastatal companies enjoying local monopolies in large regions. These companies purchase the entire production to farmer groups to which they also offer credit to finance cotton inputs. As a result, companies have detailed information on production and yields at

the group level. Finally the financing scheme also entails risk for farmers who are jointly liable for the group cotton loan: if the production of one farmer in the group is not sufficient to cover her debt, other producers' revenues are de facto reduced to reimburse the entire group loan. This situation has a negative ex-ante impact on cotton production at the intensive and at the extensive margin: it pushes some cotton farmers to take smaller loan to decrease their exposure to defaults, and it prevents some farmers to enter the cotton sector at all.[1] In case of group default, the entire group may be forbidden access to future loans (and thus to cotton production). In this context, when a group experiences a bad year and a low production, it generates great tensions in its local community (Gelade and Guirkinger, 2017). As a result, financial instruments that would reduce the group exposure to covariate risk are in high potential demand.

In our area of study each cotton farmer has to belong to a farmer group (GPC or *Groupes de Producteurs de Cotton*) of ten to forty members (but sometimes up to eighty members *de facto*). The cotton company provides all inputs on credit (seeds, fertilizer, pesticide, etc.) using the group's cotton production as a collateral. In fact, the company is the only source of formal credit for input , and consequently, the main source of input purchase. In theory, farmers are not allowed to use these inputs on other crops, and input diversion is monitored by the company's agents (*Agents Techniques de Coton, ATCs*). In practice, it is widely know that part of the inputs purchased is applied to other crops (in particular fertilizer, which is used to produce maize), which makes cotton production central for farmers' entire crop portfolio.One of the costs of this well structured input credit system is the rigidity of the input provision chain. Indeed, credit demand is expressed many months in advance, before the current year crop is harvested.[2] .Furthermore, uncertainty is high: besides the weather uncertainty, other factors affect each farmer's production capacities such as her own health, her family labor supply, her productive assets (livestock for ploughing). [3] The rigidity of the system combined to its uncertain context pushes farmers to be conservative in their input requests, and limits their capacity to invest when conditions change in the short term (e.g. when insurance is provided).[4]

2.2 Index insurance project

The pilot project analyzed in this paper started in Burkina Faso in 2014 in the Houndé region, and was implemented by the NGO Planet Guarantee and several partners. The cotton company Sofitex participates actively to the project by providing excellent historical data, and by selling the insurance: its local agents conducted information sessions and the marketed the insurance product.[5]

The contract was sold to farmers' group, on credit (on the terms as cotton inputs). A farmer group had to collectively decide to purchase the insurance, and the entire surface cultivated was insured in

[1] Some farmers are indeed excluded from a group and/or not able to join any group. In addition, when an entire group is not able to reimburse its loan, it is usually suspended until the loan is reimbursed- preventing its members to produce cotton in the meantime.

[2] Credit demands are made as early as September, (y_{-1}) for sowing in June (y_0), harvesting in January and being paid as late as April (y_{+1})

[3] There is also a certain price uncertainty, reinforced by the length of the production timeline described above: Sofitex guarantees a minimum price at the beginning of the cotton season, but this "floor price" is low and the final price fluctuates.

[4] These features have been well described theoretically and empirically by Malan et al. (2015) and Theriault et al. (2013).

[5] Other partners include Ecobank, the institution that finances farmer loans; HannoverRe, the re-insurer of the insurance product; and I4 researchers, which contributed to the design of the index insurance product.

that case.

The insurance contract provides three levels of payment. When yields are below 20% of the yield distribution (a one in five years event), farmers receive a "small payout" of 11,200 FCFA per hectare insured.[6] This insurance payment was designed to correspond to the value of the insurance premium (so that the premium is reimbursed to farmers in case of small shock). When yields fall below 8% of the yield distribution, the insurance provides a "medium payout" of 34,000 FCFA. Finally, in case of yields falling below 4% of the distribution (a 1 in 25 years event), the farmers receive a "big payout" of 90,000 FCFA per hectare, which corresponds approximately to the value of the input loan.

Farmer groups were grouped in five categories, depending on their yield historical average: the yield distribution was estimated for each category, and each category was offered a different contract based on this distribution. The index insurance is built on a double trigger mechanism (Elabed et al., 2013). This means that farmers receive payments under two conditions. First, the group yield needs to be below a given threshold corresponding to its category of yields (e.g.: yields below 800 kg / ha). Second, the other farmer groups in the neighborhood of the insured group need to have somewhat low yields as well: there is a "neighborhood" threshold as well, which is higher than the own farmer group threshold (e.g.: yields in the neighborhood needs to be below 1000 kg / ha). This neighborhood condition was designed to avoid potential moral hazard issues, while still conditioning the payment on each group's yield. Indeed, since farmers of a group live in the same village and are usually members of the same family, ethnic group or religious community, there were concerns of potential coordination within one group. The neighborhood condition prevents such coordination by ensuring that yields are not particularly good in other groups in the area as well. For more details regarding the design and the quality of the index insurance product, see Elabed et al. (2013) and Barré and Stoeffler (2017).

3 Research design and data

3.1 Research design & quantitative survey

Our research area includes 80 farmer groups of the Houndé cotton region. Among these groups, the intervention was randomized in two manners. First, half of the farmer groups were randomly selected to be offered the insurance for purchase. Thus, the treatment area comprises 40 farmer groups, whereas the 40 farmer groups in the control area could not purchase the insurance (it was not offered in their villages). Second, an encouragement design is generated among the treatment group by randomly distributing subsidy coupons. These subsidies covered 25%, 50% and 75% of the premium cost for 10 farmer groups each and a last group of 10 farmers received no subsidy.Farmers groups decided whether or not to subscribe to the insurance during a general assembly of the farmer group. In practice however not all farmers were present during the assembly (we come back to this point in Section 5.1).

Around 13 farmers per group were randomly selected to participate to a baseline and a follow-up survey. A total of 507 and 508 households were thus surveyed first in January 2014, before the first insurance sales of May-June 2014. The follow-up survey was conducted in January 2015. Attrition was kept very low (only 5 households out of 1015, or below 0.5%). The main purpose of the survey was to measure the ex-ante impact of the insurance: no farmer group knew whether it would receive an

[6] For reference, 656.07 FCFA = 1 euro (fixed exchange rate).

insurance payment at that date. Questionnaire modules included detailed information on agricultural production and investments at the plot level. In addition to the household survey, group leaders answered a separate questionnaire on the functionning of the farmer group.

3.2 Qualitative data collection

In addition to the quantitative data collection effort in 2014 and 2015, we conducted a qualitative fieldwork in the study area in June 2016. A first purpose of this fieldwork was to better understand our quantitative results. We explored in particular the details of the project implementation in the ground and the timing of farmers' investment decisions. A second objective was to explore the *ex-post* impact of the program on groups which were affected by shocks. Our household survey was conducted *before* the first insurance payments and therefore does not allow to measure the effect of shocks and the potentialmitigating effect of the insurance. Besides, shocks being rare events by definition, a new wave of quantitative surveys would not have been able to identify the *ex-post* effect of insurance payments given our sample size. [7] A final objective of thequalitative work was to better understand demand and supply dynamics, in order to assess the practical viability of the insurance program.

In practice, we conducted fourteen focus groups: two focus groups with farmers who were never insured, two focus groups with small producers, two focus groups with women, four focus groups with producers who received an insurance payment and two focus groups with farmers who renewed their insurance (without having received a payment). [8] We also made semi-structured individual interviews with farmers, farmer groups leaders, and Sofitex employees. Each focus group or interview was conducted by one or two local enumerator, in the presence of one author, and then transcribed. The qualitative report that summarizes these transcriptions is available upon request.

3.3 Empirical specifications

Our two main empirical specifications rely on the double randomization design . A first specification measures the Intention to treat (ITT) effect by taking the difference-in-difference (DID) between our treatment and control groups, before and after the intervention. As the take-up is 45%, the ITT provides a conservative estimate of the impact, with low precision. Formally, the estimation takes the form:

$$y_{it} = \beta_0 + \beta_1 * T_i + \beta_2 * D_{it} + \beta_3 * T_{it} D_{it} + \epsilon_{it} \tag{1}$$

where y_{it} is the outcomes of interest for farmer i in year t, $T_i = 1$ in if farmer i belongs to the treatment farmer groups, $D_t = 1$ when $t = 2015$, and ϵ_{it} represents an error term. The main coefficient of interest isβ_3 which captures the effect of being offered the insurance in 2015. Standard errors are clustered at the farmer group's level.

The second, and mainm specification allows to estimate the Average treatment effect (ATE) on the

[7] Indeed, in our treatment group, only 3 farmer groups out of 40 received a "large" insurance payment (and one group a "small" payment), thus not providing the required statistical power to measure the impact of insurance payments. Besides, implementation issues also affected insurance payments (see below).

[8] Most focus groups had ten participants (the maximum that we allowed), but women groups and groups which never purchased the insurance had fewer participants.

treated. It relies on the randomization of the subsidy level, which is used as an instrument in the first stage to predict insurance take-up. The predicted insurance purchase decision is then used in a second stage, in a first-difference (FD) specification to measure the change introduced by the purchase of the insurance compared to baseline outcomes (identical in essence to the DID specification in Equation 1). The addition of covariate increases the precision of the estimation. Formally, the first stage is written:

$$Ins_i = \gamma_0 + \gamma_1 * T_i + \gamma_2 * S_i + \Gamma * X + v_i \tag{2}$$

and the second stage is:

$$\Delta y_i = \beta_0 + \beta_1 * \hat{Ins}_i + B * X + \epsilon_i \tag{3}$$

where $Ins_i = 1$ when the farmer i purchases the insurance and $S_i = \{0, 0.25, 0.5, 0.75\}$ is the level of subsidy, X is a vector of covariates. In the second stage equation, Δy_icorresponds to the first difference between follow-up and baseline outcomes and $\hat{Ins}_i$ denotes the predicted insurance purchase, . The covariates include baseline differences between the treatment and the control groups. .

3.4 Descriptive statistics

Table 1 and Table 2 present descriptive statistics for household characteristics and agricultural activities respectively and reports the balance between the treatment and the control groups. Households are large (more than 10 members on average) and household heads have a low education level on average (1.2 years). The average surface cultivated is about 10 ha, with approximately 4.5 ha devoted to staple food crops (maize, sorghum, millet and rice), 4 ha of cotton and 1.5 ha of diversification food or cash crops (sesame, groundnut, bean, etc.). Average cotton yields are relatively low (829 kg / ha) and fertilizer usage is below the level recommended by the cotton company (farmers use on average 115 kg / ha instead while the recommended level is 150 kg / ha)2 Most households raise animals, with an average livestock size of 6.4 Tropical Livestock Units (TLU).[9] The t-test results indicate that the sample is well balanced between the treatment and the control groups. However, the share of households cultivating genetically modified (GMO) cotton is much higher in the control group, .

Table 3 shows the occurrence of shocks affecting cotton and cereal plots in our sample for the 2013-14 and 2014-15 agricultural seasons. The share of households affected by shocks is very high in both years, but is much higher in 2014-15.[10]

Take-up was high in the research area: 18 out of the 40 groups purchased the insurance product. This corresponds to 233 out of the 506 households to whom the insurance was offered in our sample (46.05%), which is much higher than usually observed in small index insurance pilots (Binswanger-Mkhize, 2012; Hazell, 2010). Table 4 reports the number of group purchasing the insurance for each level of subsidyand reveals that the coupon had a strong impact on index insurance demand. While only 2 groups out of 10 purchased the insurance at commercial price, this number rises to 8 groups out of 10 at 75% subsidized price. This confirms that the level of subsidy is a relevant instrument for

[9]The TLU formula used in this study is: TLU = 0.7 * cattle + 0.35 * calves + 0.1 * (goats + sheeps) + 0.01 * (chicken + other poultry) + 0.2 * pigs + 0.5 * horses + 0.3 * donkeys.

[10]While these 2014-15 numbers may also be inflated by the fact that we asked questions about shocks during the 2015 survey only. Thus, the 2013-14 shocks are reported retrospectively.

	No insurance offered	Insurance offered	Significance level
Age of household head	44.0	43.6	
	(12.4)	(13.5)	
Household size	10.4	10.4	
	(6.38)	(6.09)	
Household size, members above 15	5.76	5.66	
	(3.72)	(3.54)	
Maximum education level in the household (years)	5.17	4.94	
	(3.40)	(3.41)	
Education level of the household head (years)	1.15	1.22	
	(2.45)	(2.52)	
Progress out of Poverty Index	36.3	36.8	
	(12.8)	(12.0)	
Roof of dwelling is solid	0.47	0.51	
	(0.50)	(0.50)	
Floor of dwelling is solid	0.28	0.32	
	(0.45)	(0.47)	
Household Diet Diversity Score (HDDS) (0-12)	7.83	7.84	
	(1.57)	(1.55)	
Number of food coping strategies (0-4)	0.47	0.40	
	(0.96)	(0.87)	
Number of different crops / products cultivated	4.02	3.97	
	(1.36)	(1.39)	
Surface of sesame (ha)	0.21	0.17	
	(0.57)	(0.51)	
Surface of groundnut (ha)	0.22	0.24	
	(0.41)	(0.47)	
Surface of bean (ha)	0.22	0.22	
	(0.43)	(0.44)	
Rent fields	0.34	0.27	*
	(0.48)	(0.45)	
Chicken	24.8	20.7	*
	(30.3)	(22.2)	
Goats	6.48	6.77	
	(8.42)	(8.45)	
Sheeps	4.38	3.82	
	(8.65)	(7.14)	
Cows	7.60	6.13	
	(14.4)	(10.8)	
Tropical livestock unit (TLU)	6.90	5.85	
	(10.6)	(7.79)	
Observations	508	507	1015

Mean coefficients, standard deviation in parenthesis. T-test of equality of mean between treatment and control groups.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1: Test of balance: household characteristics & assets

	No insurance offered	Insurance offered	Significance level
Total surface cultivated, cotton (ha)	4.03	3.77	
	(3.77)	(3.06)	
Total surface cultivated, all cereals (ha)	4.59	4.43	
	(3.63)	(2.84)	
Total field surface cultivated	10.1	9.81	
	(8.18)	(6.53)	
Total production, cotton (kg)	3646.6	3316.3	
	(4399.2)	(3307.8)	
Yields, cotton (kg)	829.4	829.3	
	(350.8)	(338.5)	
=1 if cultivated OGM in 2013	0.63	0.42	***
	(0.48)	(0.49)	
Yields, Maize (kg)	1555.8	1563.8	
	(818.1)	(776.0)	
Yields, Millet (kg)	469.5	609.7	
	(321.1)	(1108.3)	
Yields, Rice (kg)	1605.4	1196.7	
	(1008.5)	(951.7)	
Yields, Sorghum (kg)	642.2	627.9	
	(439.7)	(465.5)	
NPK for cotton, bag per ha	2.29	2.38	
	(1.05)	(1.05)	
Uree for cotton, bags per ha	0.93	0.98	
	(0.49)	(0.46)	
Total cotton credit by ha	95437.0	96556.0	
	(38687.2)	(41150.6)	
Hired labor (men-day) per ha, cotton	17.8	22.8	
	(41.1)	(59.2)	
Observations	508	507	1015

Mean coefficients, standard deviation in parenthesis. T-test of equality of mean between treatment and control groups.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Test of balance: agricultural activities

	Cotton 2013-14	Cereal 2013-14	Cotton 2014-15	Cereal 2014-15
Shock: drought	0.150	0.153	0.277	0.322
Shock: flood	0.038	0.048	0.103	0.104
Shock: weeds	0.040	0.119	0.052	0.262
Shock: crop disease	0.006	0.019	0.025	0.050
Shock: pest	0.029	0.023	0.103	0.062
Shock: farmer ill	0.000	0.002	0.013	0.008
Shock: lost labor	0.000	0.002	0.000	0.010
Shock: lost input / assets	0.000	0.006	0.000	0.010
Shock: damaged by livestock	0.043	0.044	0.087	0.076
Shock: elephants	0.004	0.005	0.002	0.005
Shock: fire	0.009	0.000	0.005	0.003
Shock: other	0.009	0.008	0.034	0.032
Shock: any	0.288	0.333	0.545	0.631
Observations	932	1006	932	1006

Share of households who received a shock on one of their plot by crop type and year. Recall data from January 2015.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Shocks

	Premium subsidy level				
GPC bought the insurance	**0%**	**25%**	**50%**	**75%**	All
No	8	5	7	2	22
Yes	2	5	3	8	18
Total	10	10	10	10	40

Table 4: Take-up at each level of premium subsidy

predicting insurance purchase.

While the group take-up is high, some farmers did not attend the meetings where insurance decisions were taken and did not learn about the outcome of this meeting. Thus only 52% of the households in groups which were offered the insurance stated that the group was indeed offered the insurance. Besides, only 53% of the insured household knew that they were insured.[11] Note however that these figures may be lower bounds: only household heads answered the survey and in some households they are not the ones in charge of cotton production. Still, this lack of awarness is harmfull to our impact evaluation because household who do not know that they have an insurance are particularly unlikely to make ex-ante changes in their production decisions.

4 Results

4.1 Quantitative results on production and investment outcomes

In this section, we present the average treatment impact of insurance on production and investment decisions as specified in Equation 3. For each outcome, we also report ITT impacts in appendix.

[11] Most of the others did not know that their group had a meeting to decide on insurance purchase. Among those participating at the decision meeting, most of them agreed with the insurance purchase. Formal vote was rare, but the decision was usually described as consensual during qualitative interviews.

	Cotton Surface	Cotton Production	Cotton Yields	Cereal Production	Cultivate sesame
insured	-0.0541	-536.2	-27.05	-463.7	0.173*
	(-0.16)	(-1.18)	(-0.39)	(-1.30)	(1.84)
GMO cultivation	-0.151	110.6	30.21	22.52	0.0283
in 2013 (=1)	(-1.01)	(0.70)	(0.90)	(0.11)	(0.62)
Constant	0.396**	851.2***	126.7***	302.1	0.142***
	(2.25)	(4.19)	(3.77)	(1.58)	(3.24)
Observations	928	928	928	923	928

t statistics in parentheses

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

Table 5: Impacts on cotton, IV model (ATE)

Cotton and cereal production

Table 5 reports the ATE estimates for cotton and cereal production outcomes as well as for the prevalence of sesame cultivation (Tables 15 in appendix report the ITT estimates) The results reveal that the insurance had no significant impacts on cotton and cereal production. There was no change in surface cultivated or input used for cotton and cereals among insured households. As a consequence, there is no significant change in yields or total production (Tables 10 and Table X report the ATE estimates for input use on cotton and cereals respectively). [12] It seems that the index insurance product failed to induce the ex-ante effect expected on cotton production and that cereal cultivation was not affected either by the new availability of insurance. We argue below that this results is explained by several implementation gaps (Section 2.2): the insurance was sold too late during the agricultural season. By the time farmers become insured, they had already made input commands from the cotton company, without straightforward options to purchase additional input and increase surface cultivated.

In contrast, insurance significantly increases the prevalence of sesame cultivation (we do not have continuous measures of sesame production) and the land rented from other households. Sesame is a cash crop that has developed rapidly in the last ten years in Burkina Faso, and is considered as the main competitor of cotton cultivation due to its low input costs and the rapidity of sales after harvest (Stoeffler, 2016). In contrast to cotton (and cereals), sesame does not require inputs other than seeds, which can be easily purchased, and land, which can be rented in. Since sesame is the only crop in which insured households appear to have invested in, it is reasonnable to assume that the impact on land rented in is driven by the increase in sesame cultivation.

[12]The ITT results suggest a an important (albeit not significant) decrease in cotton and cereal production among treated households. The decrease in yields is smaller and not significant. The ITT estimate for labor indicates a significant decrease in the number of paid labor employed in cotton fields. However, this variable is likely to be affected by shocks as well (less labor is required when there is less cotton to harvest). We believe that this is due to shocks affecting a small number of insured farmer groups. Because the insurance was sold very late (Section 2.2), there may have been some scope for adverse selection: farmers group experiencing a dry start of the campaign may have been more willing to take up the insurance. Luckily the ATE estimation strategy is not affected by this possibility as the instrument used to predict take-up (the level of subsidy) is exogenous to the weather conditions at the start of the campaign.

	Cattle #	Cows #	Goats / sheeps #	Chicken #	TLU	Investment field infrastructure (FCFA)
insured	1.635*	0.987*	0.889	6.830*	1.053	7824.4*
	(1.70)	(1.87)	(0.58)	(1.65)	(1.45)	(1.69)
GMO cultivation	0.235	0.0751	0.864	3.348*	0.186	4923.3**
in 2013 (=1)	(0.62)	(0.33)	(1.29)	(1.93)	(0.65)	(2.37)
Constant	0.0110	-0.0712	1.346**	-2.621*	0.219	-2901.2
	(0.04)	(-0.42)	(2.26)	(-1.67)	(1.05)	(-1.64)
Observations	928	928	928	928	928	928

t statistics in parentheses

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

Table 6: Impacts on livestock, IV model (ATE)

Livestock and field infrastructures

We now turn to the changes that the index insurance causes in other activities and assets. We present the ATE results for investments in field small infrastructure investments such as fences and small dams and irrigation in Table 11 (Table 18 in appendix presents the ITT results). Results show that the insurance generated a significant increase in household investments in fence and irrigation- and also in field total investments. The magnitude of the impact is modest (ATE of about 7,800 FCFA of investment) because only a minority of households conduct any field infrastructure investment in a given year.[13] However, the ATE estimate of the impact on the log of field investments indicates an average increase by 170% of the total amount invested by insured households.

Table 6 presents the impacts of the insurance on livestock owned (Tables 20 in appendix presents the ITT results). Insured households increased their level of livestock substantially. The increase is not significant for total livestock due to large standard errors . However, insured farmers increased significatively their total cattle stock, their number of cows (non-plowing ox) and of chicken . The ATE effect are also large in magnitude with1.6 cattle animals and 6.8 chicken on average.

We also measured the impact on durable goods and food security, for which we do not expect short term impacts, and on off-farm activities. Most of the coefficients are not significant for these variables. Detailed results are presented in Appendix B.

4.2 Investment and production impacts: qualitative evidence and mechanisms

Overall, the results indicate a relatively strong impact on assets and activities which were not directly insured by the cotton area-yield product offered to farmers. This is not necessarily surprising. First, if farmers' overall risk exposure is reduced with cotton insurance, they may be willing to increase their investments in other risky activities, even if these activities are not directly insured. Second, the revenue of these alternative activities is likely to be positively correlated with the cotton index: the

[13] About 10.2% of our sample households invested in any field infrastructure in 2014, 11% in 2015, and only 2.6% invested in both years. The ATE raises to about 52,800 FCFA when restricting the sample to those who invest.

main shock affecting cotton, namely drought, is also a shock for other crops and livestock, so that these activities may actually be partly insured by the cotton insurance. Finally, we know that farmers were actually very contrained in their possibilities to adjust cotton or cereal production to the availability of insurance (given the financing system and the late sales of the insurance), so that the changes in their portfolio concentrated on other activities.

Our qualitative interviews confirmed that most newly insured farmers were not able to invest in cotton because of the late sale of the insurance product, which made it very difficult for farmers to increase input credit and surface cultivated (see 5.1). Nevertheless, some investments that we termed "other activities" were mentioned as long term investment for cotton production, such as draft ox for plowing or the construction of stone barriers for better water management on fields. Furthermore, farmers explicitly linked these investments with the insurance program- and this, despite the concerns and disappointments that the insurance may have generated *a posteriori*:

> *I also invested in livestock and sesame thanks to the insurance, even though the insurance only regards cotton, because I felt that my cotton was protected* (II2)
>
> *We really thought that we were protected. This is why we increased the surface of our fields. But this was a big mistake* (7, FG12)
>
> *We really invested, but we did not get anything* (4, FG12)

The qualitative fieldwork also provided insights regarding the reason why farmers invested in sesame, livestock and field infrastructure. The timing of these investments is a key explanation. Indeed, sesame is cultivated later during the season, so that decision on sesame had not yet been taken when the insurance was purchased. The same applies to livestock and field infrastructure investment. Besides, SOFITEX loans are not necessary or even available for these investments (sesame does not require much chemical fertilizer), so that the calendar of the credit system did not constrain these investments.

4.3 Ex-post impacts on insured farmers

Our follow-up quantitative survey was conducted before households received insurance payments (or even knew they would receive a payment). Furthermore, our sample size was too small to measure ex-post impact given the rare occurrence of payments. However, we explored ex-post impacts of the insurance during the qualitative study.

Three insured farmer groups of our research area received the "large" payouts after the 2014-15 seasons. They encountered important losses because their fields had been attacked by parasites in the middle of the season, after a "dry pocket" (relatively long period without rains). They spent additional time and money to try to save their crops from the worms but the products they used were inefficient.

> *In the entire village, only 10 people were able to reimburse their loan. The shock was huge. The lack of rain and the insects ruined all the cotton* (1, FG6)
>
> *We even wold our livestock to pay the insecticide to kill the worms* (6, FG6)

However, while their yields were very low, they did not receive payments immediately (nor were they promised payments). Instead, farmers were asked to reimburse their loans in June, since the production

of their groups were insufficient to cover their credit- which is precisely the catastrophic scenario that index insurance is supposed to prevent. Fortunately, insurance payments (that farmers did not expect anymore) were realized in August. There is no doubt that this implementation failure was damageable to farmers (see 5.1). From a research perspective, this disconnection between reimbursement of the debt and payout of the insurance made it straightforward for farmers to separately link debt repayment and insurance payments to given outcomes, thereby creating a sort of "qualitative counterfactual" (the same groups reported about the situation without insurance - in June - and the situation with insurance - in August). Thus, farmers' accounts reveal both the traumas caused by the negative agricultural shock and the positive ex-post impact of insurance payments.[14]

Debt repayment to Sofitex/Ecobank, due to the agricultural shock, caused serious economic and social stress on the communities of the three farmer groups concerned. Farmers had to deplete their productive assets to pay back their loan: they sold assets, but also food stocks. This situation threatened farmers prospects in the short and medium run.

> *We did not know that we would receive insurance payments. Since we had already sold our livestock, our cereals and other things to pay our debt, we were living in misery until the insurance payments arrived* (3, FG7)
>
> *I was working [as a day laborer] for other people in order to get food for my family. I had only a few goats so I did not want to sell them* (5, FG7)
>
> *[Without the insurance] we would not have been able to continue farming. We sold almost everything even the food [stocks]* (1, FG8)

In addition, the situation generated tensions and social conflicts in the affected villages, especially directed towards the groups' "elite" which decided to purchase the insurance in the first place.

> *It was very tensed, we sold our livestock to pay back the credit to Ecobank and Sofitex. Some refused and left the farmer group* (4, FG6)
>
> *The insurance prevented us from the worst, otherwise I would have left the village* (6, FG7)
>
> *When considering what happened in 2014-15, if the insurance had not been there, we would not be here to talk with you today* (5, FG6) [15]

The insurance payments, on the other hand, reverted the situation (both socially and economically). They allowed them to buy back the livestock that they had sold (although at higher prices), to feed their families for the year to come, and to continue farming. Farmers declared that they spent the insurance money to purchase livestock, food, agricultural input, durable (e.g. motorcycle), to pay school fees, cultivate new crops (e.g. rice), increase cotton surface, pay back credit and even marry.

> *With the insurance money, I bought an ox, a cart, and the tiles for the roof of my new house* (8, FG8)
>
> *We bought a plow and o few ox that we had to sell to pay back Sofitex and the bank* (3, FG8)

[14] Farmers, during our focus groups, were generally critical of the insurance project. This gives us more confidence in the (few) positive accounts. While the three groups which received payments were (understandably) more positive, they were also dissatisfied regarding the gap between credit reimbursement and insurance payments.

[15] Farmers also gave examples of serious individual conflicts, as well as risks of suicide.

Nevertheless, these farmer groups would have been better without the unacceptable delay observed between debt reimbursement and insurance payments. This gap is one among a long list of implementation issues, that the following section discusses.

5 Discussion: challenges and opportunities for index insurance

Despite some promising indirect and ex-post impacts, our quantitative results show that the insurance program was not successful in reaching its primary objective of fostering investments in cotton production and related food crops. In our opinion, this was mostly due to implementation gaps between the project plans and its realization in the field. This section discusses these gaps, as well as the other challenges and opportunities for future index insurance programs in developing countries.

5.1 Implementation gaps

Timing of sales

Ssales timing and logistics came up as an issue in 10 focus groups out of 11.[16] The sales occurred too late (end of May, beginning of June) for farmers to adjust their cotton input demand. It it the period of sowing and Sofitex does not accept modifications in loan demands at that time. Besides, the fact that insurance meetings occurred at the beginning of the agricultural period affected the demand for the insurance and possibly explains that some farmers were not even aware that they were insured as mentioned in Section 3.4.

> *For cotton, it is until June 30 [that you can change plans]* (5, FG6)
>
> *For me, it is April to May; after that, it becomes complicated [to change production plans for cotton]* (4, FG1)
>
> *[Late sales] are a problem because those who were at the [insurance] meeting were very few. We are in the fields.* (6, FG13)

Timing of payouts

As described above, another major implementation issue is related to the late insurance payouts (see 4.3). Indeed, the four groups that received insurance payments in 2014-15 received their payments... only after they had to reimburse their cotton credit. This means that farmers received a shock, were unable to reimburse their cotton credit, but had to do so (by using their savings or selling productive assets) before they received insurance payments. The Burkina Faso index insurance product has *actually* been designed to prevent this situation to arise. The failure of the insurance to pay farmers before they reimburse their debt defeats the purpose of the product.

[16] We indicate the number of relevant focus groups. All the questions were not relevant for all groups (e.g. groups which were never insured).

Lack of understanding of the insurance contract

The quantitative survey reveals that the level of knowledge and understanding of the insurance mechanism is not very high, with only 42% of farmers who are aware of (and understand) the double trigger mechanism (among those who know that they are insured). Furthermore several farmers expressed their frustration of paying the insurance while not getting anything in return when they did not have a shock.

> *It is good to be insured, but it is difficult for farmers to throw away money. We bought the insurance in 2014-15 but it did not bring us anything in return* (6, FG2)

Absence of complaint procedure

Another major implementation issue was related to the suspicion that farmers had been frauded by the insurance project. This suspicion suspicion of fraud arose in 2 focus groups out of 9. In one group, farmers suspected the Sofitex agents to have overestimated the size of their fields to make them pay more (since the insurance price is per hectare).

> *Me for example, I insured 4 hectares, but the insurance declared 6 hectares; however nobody measured my field. They deducted the price of 6 hectares (...). At first we felt protected and trustful, but the insurance did not do its job correctly regarding the surface of our insured fields.* (6, FG2)

Even more serious, in another group farmers suspected Sofitex and the insurance program to have cheated them in terms of the amount of insurance payment that they received.

> *When we joined [the project] we felt protected, but after the shock that we had (...) we received 500,000 FCFA instead of 790,000 FCFA, hence our anger.* (5, FG4)

Our research team had neither the mandate nor the possibility to assess whether these suspicions of fraud were justified or not. However, the fact that farmers had no doubt that they were cheated emphasizes the need for a well defined complaint procedure and an easier communication between farmers and insurance providers. Besides, these issues make the case for proper consummer protection in the index- and micro-insurance sector in developing countries.

Overall, these instances of implementation gaps definitely thwarted farmers' potential effort to increase cotton investments. But even more importantly, they discredited the insurance program and the willingness of farmer groups to continue purchasing the insurance product. We come back to this point at the end of the following section on challenges.

5.2 Challenges ahead

By providing a wealth of information related to the Burkina Faso cotton insurance project, the qualitative fieldwork can help us think about the overall challenges and opportunities for index insurance in such environments. Our discussions with farmers suggested three main types of challenges: the cost of insurance (9 groups out of 13); the trust and deception regarding the insurance product in a context of aggressive promotion (6 groups out of 6); and frustration related to the index nature of the product (9 groups out of 9).

Cost of insurance

The insurance proposed to farmers was expensive: the commercial premium was above the actuarilly fair premium by at least 75% (Barré and Stoeffler, 2017). Subsidies do increase purchase of the product significantly (see 4), suggesting that price has an important negative impact on demand. Moreover, when discussing with farmers, price is cited by most groups as one of the main drawbacks of the product. The loss of price subsidies was also felt sharply by farmers (subsidies were re-randomized in the second year). Yet, most insured farmers were not ready to trade a decrease in insurance payments for a decrease in price, suggesting that the problem was not one of calibration, but rather a gap between what farmers perceived as fair and the commercial price (which is not surprising with a mark-up of above 75%).

Trust and deception

As mentioned in the index insurance literature (Cole et al., 2013) , trust also plays a role in farmers' demand and production choices. The first year of the program is often a "pilot" for farmers as well, and insurance project managers are aware of the necessity to build trust:

> *We got insured but we did not expect much for the insurance* (4, FG8)
>
> *Since it was something new, we cannot say that we trusted it.* (1, FG8)
>
> *In addition, we did not have proofs that it would really pay people in case of shock* (1, FG9)

However, in the case of the Burkina Faso pilot, trust did not increase with time. While implementation issues had a major impact on trust, other factors played a role such as the lack of awareness of insurance payments (in other groups). Besides, the marketing campaign conducted by motivated (and incentivized) Sofitex agents was effective (high take-up in the first year) but also somewhat counter-productive (low renewal rates). Indeed, farmers felt that the aggressive marketing was misleading, and that the product was deceptive:

> *There were radio clips on the insurance which said that when you are insured, the insurance helps you in case of problem (...). But after the shock last year when we did not receive anything, it really discouraged us* (1, FG4)
>
> *We thought that individual cases would be considered. But it was not like that, so we stopped our collaboration [with the insurance]* (6, FG11)
>
> *Their attitude shows that they just want to make profit on us. It is not to help us* (8, FG12)

Index and basis risk

The index-based nature of the insurance was under attack during several focus groups. Yet, area-yield designs are considered as the best one can achieve in terms of index insurance compared to other proxies such as NDVI-based products or products offering only partial shock coverage such as rainfall-based schemes .

> *Wanting that all the GPC falls into debt is not normal. Why did they measure people's field individually, and now for the payouts they talk about the entire GPC?* (2, FG12)

They should also think about helping people individually. They should also come and discuss with us to know what happened in the fields (6, FG8)

In a so-called good season, low lands [bas-fonds] *are flooded but hill slopes produce good harvests. In a mediocre season, low lands produce good harvests whereas hill slopes generate poor yields. (...) People don't have the same production capacity and don't put as much effort. Thus, how can you compare productions?* (2, FG9)

In addition, farmers of 4 focus groups (out of 9) mentionned explicitely that they did not like the "double-trigger" mechanism of the insurance- the fact that yields of neighboring GPCs are taken into account as well to determine insurance payouts. This innovation has been shown to allow a decrease in basis risk compared to a single-trigger define on an area large enough to be immune to moral-hazard (Elabed et al., 2013). Nevertheless it makes the product more complex.

Your entire GPC has to have a low production and neighboring GPCs as well. Yet it does not rain everywhere in the same manner. (...) *Why this design for an agricultural insurance? I personally think that this is mostly to cheat us* (3, FG9)

The insurance wants to take into account the production of GPCs from here [Bereba] *and also those of neighboring villages, but we don't have the same rainfall patterns* (4, FG9)

Mechanisms related to this aversion for the second threshold are likely to be related to compound risk aversion, which have been elicited in a similar program and context in Mali (Elabed and Carter, 2015b). However, farmers' rationale is also related to classical risk aversion and the possibility, with index-*insurance* (due to basis risk), to end up worse-off than without insurance (Clarke, 2016). Farmers from 4 focus groups out of 6 referred to this issue.

the season was bad, we could not pay back our credit. We were forced to sell our goats and sheeps to pay our debt and the insurance (1, FG10)

the insurance worsened and increased the number of defaults. Because made some small profits but had to pay the insurance, which made them default on their credit (4, FG11)

the farmer who has a bad harvest and does not get insurance payouts still has to pay the insurance fees. This is a double penalty for him (3, FG9)

Related to the index-nature of the product, farmers strongly disliked the fact that nobody would come and check their shocks. One of the advantages of index insurance compared to traditional types of agricultural insurance is, arguably, its lower administrative costs (Miranda and Farrin, 2012). However, the absence of insurance agents and the fact that nobody assessed their actual agricultural losses was perceived by farmers as a reason for distrust.

You have discussed with us two years ago, then we never heard about you again (9, FG4)

[we consider buying the insurance again] under the condition that they come to discuss with us face to face. Otherwise there is no way that we work with them (8, FG13)

As a consequence of these cumulative elements of dissatisfaction related to the design and implementation of the index insurance product, renewal rates were very low. In the year following our study (2015

sales), only 6 groups purchased the insurance: among them, those who received insurance payouts (3) and some of those who received a 70% subsidy. This represents only about a third of those who purchased the product the first year- whereas most groups had stated the first year that they would "wait and see" before engaging with the insurance project.

5.3 Opportunities for index insurance?

In this context, what are the opportunities for index insurance products? There are reasons to believe that despite these implementations issues and these structural limitations, such an area-yield insurance scheme remain a potential impactful intervention to support poor farmers. The first reason rely in the ex-ante investment impacts and the ex-post shock alleviation observed in spite of the issues mentioned: all things considered, the insurance product party achieved its objectives during its first year of implementation.

Second, the high demand during the first year (also in spite of marketing and sale issues) shows farmers' interest in the product. This interest was also obvious in the high participation and engagement levels during our focus groups. The fact that most of the implementation issues we discussed could befixed is also a reason to remain hopeful regarding the potential of index insurance in such contexts. Indeed, in general, farmers remained interested in the product if its implementation issues (or what farmers perceived as a drawback of the project, such as the lack of visibility of insurance agents) could be addressed.

Third, the fieldwork confirmed that a group insurance may be particularly well-suited when farmers are jointly-liable for their credit.. Indeed, farmers from 7 focus groups out of 13 recognized that the insurance could help mitigate the tensions created by joint-liability (Gelade (2016)) They understood well the nuance between the joint-liability and the insurance, and the advantages provided by the latter in financial and non-financial terms:

> *The insurance is useful, because it avoids conflicts between the defaulter and its guarantors* [in the joint-liability group] (12, FG1)
>
> *Before the insurance, the guarantor used to pay. But in 2014-15, all the group members defaulted and the insurance saved us* (5, FG7)
>
> *The insurance motivates us because your money will not been used to solve other people's problems* (11, FG8)

Moreover, the qualitative study confirmed the limited availability of alternatives in terms of risk management. Focus groups revealed the quasi-nonexistence of informal social networks outside of the area which could provide assistance in case of shock. Besides, diversification outside of agriculture is extremely reduced, except for artisanal gold mining. This activity is obviously very risky- both in terms of income variability and potential accidents. Combined with the high levels of risk and the rare options to finance investments, insurance remains a promising option for improving their well-being for some of the farmers interviewed.

Altogether, these factors are likely to explain the continuing interest of some farmers in the insurance product despite a mixed experience in the first year of the product. While this pilot has proven how difficult it is to implement an index insurance product in a rural, Sahelian context (in spite of

careful design and testing), there are reasons to believe that such a product deserves further attention and investments to support farmers- and support them better.

6 Conclusion

This article studies the short-term impact of an index insurance project offered to cotton farmers in the Houndé region in Burkina Faso. The objective of the insurance project was to protect farmer and foster their investments in a risky but profitable cash crop. A randomized evaluation combining pure treatment and control assignment with an encouragement design (through insurance premium subsidies) is employed to identify the impacts of the insurance product. The relatively high take-up in the treatment group (approximately 45%) allows us to conduct analyses and measure impacts on insured households.

While the area-yield product sold to farmers is promising in terms of design and quality, the poor implementation of the project (especially the bad timing of the sale) most likely prevented any direct positive impact on cotton farming. However, it appears that insured farmers realized different types of investments in field infrastructure, livestock and sesame cropping. Such and indirect impacts of the insurance are consistent with the fact that farmers make portfolio decisions in a farming system where outcomes are highly stochastic and correlated with each other. These impacts suggest that index insurance can have a productive impact on poor farmers and support them in their income growth and asset accumulation strategies.

Although relatively promising, these results open several questions which require further investigation. What would be the impact of the insurance product on cotton farmer under a better implementation scheme: would farmers focus their investments in the insured crop by increasing surface cultivated and/or input use? Also, will the impact on indirect investments be sustained and initiate some positive dynamics among poor farmers, or is the impact found in the first year of the project only a short-term effect? How do these investments compare to alternative interventions- such as saving programs or cash transfers- in terms of cost-effectiveness? Given the implementation challenges specific to index insurance, these questions call for further empirical research with respect to index insurance impacts on productive investments.

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Appendix A

	(1) All offered	(2) Refused insurance	(3) Bought insurance
Heard about cotton insurance past year?	394 502	199 271	195 231
Was the insurance offered to your farmer group?	201 385	71 197	130 188
There was an information meeting	186 201	65 71	121 130
There was a purchase decision meeting	138 200	42 71	96 129
Were you present at this meeting?	116 138	33 42	83 96
There was a vote to decide on purchase?	48 132	9 40	39 92
Your group bought the insurance	124 200	2 71	122 129
Were some members reticent?	53 122	1 2	52 120
Were some farmers willing to buy it?	47 75	40 67	7 8
Did you agree with the decision?	152 200	37 70	115 130
Personnally, would have purcahse insurance	140 201	28 71	112 130
Insurance experience (excl. fire insurance)	6 199	2 71	4 128
Insured against fire in the past	54 200	17 71	37 129
Heard about insurance from research team	166 394	89 199	77 195
Heard about insurance from Sofitex/UNPCB	164 394	76 199	88 195
Heard about insurance from another farmer	56 394	29 199	27 195
Observations	502	271	231

sum coefficients; count in second row

$^{+}$ $p < 0.10$, * $p < 0.05$

Table 7: Insurance decision

	(1) All	(2) Refused insurance	(3) Bought insurance
Are you satisfied to be insured?	118 134	2 2	106 122
Discussed insurance purchase with someone	129 229	36 71	75 130
Feels very well protected for cotton	60 134	1 2	54 122
Feels somewhat protected for cotton	55 134	1 2	49 122
Feels not well protected for cotton	19 134	0 2	19 122
Insurance created tensions	28 134	1 2	27 122
Insurance decreased tensions	26 106	1 1	24 95
Understand insurance has double trigger	52 134	0 2	51 122
Knows the GPC had a subsidy	97 1010	19 273	78 233
Knows correct level of subsidy	54 94	12 18	42 70
Knows the price actually paid after subsidy	70 134	1 2	69 122
Knows the price actually paid before subsidy	95 134	2 2	89 122
Find the price way too high or little bit too high	162 229	54 71	92 130
Finds the price good	45 229	8 71	30 130
There are advantages being insured	198 229	57 71	116 130
There are drawbacks being insured	82 229	26 71	46 130
Group would buy insurance next year, same price	98 134	2 2	90 122
Group should buy insurance next year, same price	134 229	21 71	98 130
Would personnally buy insurance next year, same price	137 229	22 71	99 130
Farmer group would buy insurance next year, no subsidies	43 108	3 20	39 80
Farmer group should buy insurance next year, no subsidies	54 108	3 20	49 80
Would personnally buy insurance next year, no subsidies	55 108	5 20	47 80
Observations	1010	273	233

sum coefficients; count in second row

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

Table 8: Insurance perception and information

Appendix B : additional outcomes

	NPK/ha	Herbecide/ha	Input FCFA/ha	Labor (Man-Day)
insured	0.0259	-0.620	-1893.4	-36.07
	(0.14)	(-1.61)	(-0.47)	(-1.44)
GMO cultivation	0.157	0.213	9014.5***	-3.043
in 2013 (=1)	(1.61)	(1.47)	(3.75)	(-0.18)
Constant	0.0339	-0.246	-6071.9***	0.567
	(0.39)	(-1.46)	(-2.91)	(0.04)
Observations	928	928	928	927

t statistics in parentheses

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

Table 9: Impacts on cotton inputs, IV model (ATE)

	Surface	NPK/ha	Input FCFA/ha	Labor (Man-Day)	Yield
insured	0.0171	-0.0479	-833.5	1.732	-34.80
	(0.04)	(-0.19)	(-0.10)	(0.16)	(-0.29)
GMO cultivation	-0.0463	0.0841	2231.2	-0.580	29.33
in 2013 (=1)	(-0.24)	(0.50)	(0.41)	(-0.09)	(0.58)
Constant	-0.207	-0.108	-1014.9	-4.479	72.24
	(-1.05)	(-0.63)	(-0.18)	(-0.55)	(1.46)
Observations	923	925	923	927	923

t statistics in parentheses

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

Table 10: Impacts on cereals, IV model (ATE)

	Investment fence (FCFA)	Investment dam (FCFA)	Investment irrigation (FCFA)	Log invest field (FCFA)
insured	2470.9**	3318.6	2034.9*	1.703***
	(2.08)	(0.87)	(1.90)	(2.92)
GMO cultivation	1228.4**	3038.6	656.3	0.640***
in 2013 (=1)	(2.13)	(1.63)	(0.85)	(2.97)
Constant	-1265.8**	-577.3	-1058.2	-0.328*
	(-2.02)	(-0.47)	(-1.33)	(-1.73)
Observations	928	928	928	928

t statistics in parentheses

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

Table 11: Impacts on field infrastructure investments, IV model (ATE)

	Rent field(s)	Number crops	Surface cultivate (ha)	Sesame Peanut Bean (ha)
insured	0.213***	0.108	0.312	0.271
	(2.75)	(0.52)	(0.77)	(1.49)
GMO cultivation	-0.00713	-0.184**	0.0562	-0.0108
in 2013 (=1)	(-0.18)	(-2.09)	(0.25)	(-0.12)
Constant	0.00475	0.335***	0.0985	0.198***
	(0.15)	(3.49)	(0.48)	(2.89)
Observations	928	928	928	928

t statistics in parentheses

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

Table 12: Impacts on other crops, IV model (ATE)

	PPI index	Has cart	Has plow	Has motorcycle	Food items consumed	HDDS (Diet Diversity)	Food coping
insured	-1.735	0.157	-0.0599	-0.0896	0.895*	0.286	0.0681
	(-1.28)	(1.51)	(-0.20)	(-0.64)	(1.75)	(1.13)	(0.46)
GMO cultivation	-0.514	0.0445	0.147	0.0174	0.414	0.161	0.0355
in 2013 (=1)	(-0.93)	(0.97)	(0.96)	(0.26)	(1.37)	(1.16)	(0.61)
Constant	-0.814	-0.0503	-0.338**	0.0240	-0.651**	-0.291**	-0.215***
	(-1.39)	(-1.06)	(-2.41)	(0.43)	(-2.45)	(-2.32)	(-3.39)
Observations	928	928	928	928	928	928	928

t statistics in parentheses

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

Table 13: Impacts on household assets, IV model (ATE)

	Off-farm 7d	Off-farm 12m	Off-farm all	Off-farm members	Off-farm share	Off-farm: gold
insured	-0.0369	0.0325	0.0566	0.458	0.0314	-0.0279
	(-0.36)	(0.30)	(0.70)	(1.30)	(1.03)	(-0.31)
GMO cultivation	-0.00745	-0.0603	-0.0431	0.288**	-0.00368	-0.0464
in 2013 (=1)	(-0.16)	(-1.23)	(-1.19)	(2.02)	(-0.28)	(-1.21)
Constant	0.0847*	0.263***	0.130***	0.726***	0.0517***	-0.135***
	(1.93)	(4.67)	(3.89)	(4.38)	(3.69)	(-3.74)
Observations	927	927	927	927	927	927

t statistics in parentheses

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

Table 14: Impacts on labor, IV model (ATE)

Appendix C : Difference-in-difference estimates

	Cotton Surface	Cotton Production	Cotton Yields	Cereal Production	Cultivate sesame
Treated	-0.337	-428.8	-15.48	-241.8	-0.0492
	(-0.64)	(-0.82)	(-0.42)	(-0.33)	(-1.03)
2015	0.310*	990.6***	157.1***	429.3**	0.157***
	(2.01)	(5.32)	(5.48)	(2.51)	(5.52)
Treated 2015	-0.0179	-399.5	-40.03	-409.3*	0.0798*
(DID estimates)	(-0.10)	(-1.68)	(-0.92)	(-1.84)	(1.78)
Constant	4.237***	3877.3***	849.5***	5738.8***	0.207***
	(9.76)	(9.24)	(27.05)	(11.33)	(5.20)
Observations	1856	1856	1856	1850	1856

t statistics in parentheses

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

Table 15: Impacts on cotton, DID model (ITT)

	NPK/ha	Herbecide/ha	Input FCFA/ha	Labor (Man-Day)
Treated	0.0359	0.249	5597.1	21.71
	(0.31)	(1.06)	(1.49)	(1.38)
2015	0.131*	-0.138	-146.6	6.411
	(1.74)	(-1.02)	(-0.07)	(0.68)
Treated 2015	-0.0124	-0.265	-2912.1	-30.92**
(DID estimates)	(-0.13)	(-1.47)	(-1.08)	(-2.18)
Constant	2.312***	1.935***	67984.6***	71.86***
	(27.18)	(11.98)	(27.05)	(7.05)
Observations	1856	1856	1856	1855

t statistics in parentheses

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

Table 16: Impacts on cotton inputs, IV model (ATE)

	Surface	NPK/ha	Input FCFA/ha	Labor (Man-Day)	Yield
Treated	-0.167	0.0549	2583.4	-5.874	14.86
	(-0.42)	(0.31)	(0.56)	(-1.52)	(0.14)
2015	-0.220	-0.0648	581.5	-5.094	99.19**
	(-1.50)	(-0.75)	(0.21)	(-1.03)	(2.45)
Treated 2015	-0.00548	-0.0168	-1035.0	1.348	-32.86
(DID estimates)	(-0.03)	(-0.17)	(-0.33)	(0.25)	(-0.53)
Constant	4.717***	1.274***	38525.9***	24.66***	1222.4***
	(13.17)	(9.52)	(9.99)	(7.53)	(18.72)
Observations	1850	1852	1850	1855	1850

t statistics in parentheses

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

Table 17: Impacts on cereals, DID model (ITT)

	Investment fence (FCFA)	Investment dam (FCFA)	Investment irrigation (FCFA)	Log invest field (FCFA)
Treated	-432.0	-1162.3	-1069.1*	-0.205
	(-0.95)	(-1.54)	(-2.01)	(-1.03)
2015	-373.4	1452.1	-894.3**	0.128
	(-0.82)	(0.87)	(-2.03)	(0.79)
Treated 2015	668.7	743.6	1299.5**	0.553**
(DID estimates)	(1.20)	(0.37)	(2.63)	(2.26)
Constant	862.7**	1960.8***	1090.4**	0.702***
	(2.15)	(2.82)	(2.06)	(4.72)
Observations	1856	1856	1856	1856

t statistics in parentheses

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

Table 18: Impacts on field infrastructure investments, DID model (ITT)

	Rent field(s)	Number crops	Surface cultivate (ha)	Sesame Peanut Bean (ha)
Treated	-0.0713	-0.0522	-0.258	-0.0146
	(-1.35)	(-0.32)	(-0.24)	(-0.15)
2015	0.0131	0.190***	0.128	0.170***
	(0.36)	(3.10)	(0.73)	(3.34)
Treated 2015	0.0722	0.139	0.142	0.167**
(DID estimates)	(1.67)	(1.49)	(0.65)	(2.03)
Constant	0.342***	4.048***	10.85***	0.660***
	(7.63)	(35.45)	(12.33)	(10.39)
Observations	1856	1856	1856	1856

t statistics in parentheses

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

Table 19: Impacts on other crops, DID model (ITT)

	Cattle #	Cows #	Goats / sheeps #	Chicken #	TLU	Investment field infrastructure (FCFA)
Treated	-1.495	-0.727	-0.122	-4.460	-1.060	-2663.4**
	(-1.48)	(-1.41)	(-0.08)	(-1.58)	(-1.40)	(-2.18)
2015	0.133	-0.0501	1.813***	-0.969	0.326*	184.3
	(0.55)	(-0.36)	(2.90)	(-0.60)	(1.75)	(0.09)
Treated 2015	0.750*	0.485**	0.405	3.411	0.464	2711.7
(DID estimates)	(1.91)	(2.16)	(0.51)	(1.68)	(1.52)	(1.20)
Constant	7.736***	2.893***	10.91***	25.37***	7.025***	3913.9***
	(9.92)	(6.91)	(9.70)	(10.71)	(11.56)	(3.36)
Observations	1856	1856	1856	1856	1856	1856

t statistics in parentheses

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

Table 20: Impacts on livestock, DID model (ITT)

	PPI index	Has cart	Has plow	Has motorcycle	Food items consumed	HDDS (Diet Diversity)	Food coping
Treated	0.760	-0.0111	0.0278	0.0655	-0.00230	0.0514	-0.0674
	(0.49)	(-0.17)	(0.18)	(0.74)	(-0.01)	(0.35)	(-0.93)
2015	-1.050**	-0.0240	-0.216	0.0283	-0.266*	-0.109	-0.190***
	(-2.45)	(-0.83)	(-1.68)	(0.73)	(-1.77)	(-1.42)	(-3.99)
Treated 2015	-0.869	0.0666	-0.113	-0.0305	0.0867	-0.0595	0.0190
(DID estimates)	(-1.06)	(1.62)	(-0.67)	(-0.54)	(0.34)	(-0.45)	(0.28)
Constant	36.36***	0.719***	1.898***	0.730***	10.71***	7.791***	0.460***
	(32.49)	(15.63)	(20.26)	(13.96)	(76.35)	(83.77)	(9.82)
Observations	1856	1856	1856	1856	1856	1856	1856

t statistics in parentheses

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

Table 21: Impacts on household assets, DID model (ITT)

	Off-farm 7d	Off-farm 12m	Off-farm all	Off-farm members	Off-farm share	Off-farm: gold
Treated	0.00799	-0.0736*	-0.0380	-0.427**	-0.0406**	0.0723
	(0.17)	(-1.78)	(-0.91)	(-2.20)	(-2.29)	(1.08)
2015	0.0748**	0.210***	0.0876***	0.958***	0.0537***	-0.162***
	(2.40)	(6.01)	(4.14)	(6.38)	(5.05)	(-5.28)
Treated 2015	-0.00659	0.0518	0.0617	0.0504	0.00583	-0.00855
(DID estimates)	(-0.13)	(0.93)	(1.56)	(0.26)	(0.37)	(-0.19)
Constant	0.659***	0.413***	0.803***	2.199***	0.223***	0.371***
	(19.43)	(17.58)	(29.29)	(14.80)	(17.10)	(7.12)
Observations	1855	1855	1855	1855	1855	1855

t statistics in parentheses

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

Table 22: Impacts on labor, DID model (ITT)