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Short communication

Jan DUCHOSLAV*¹ and Marcel van ASSELDONK**²

Adoption and impact of credit-linked crop index insurance: a case study in Mali

Linking insurance with credit is a promising approach towards overcoming the main difficulties of scaling up crop insurance in Africa. The current research revealed that credit-linked crop insurance adopters in Mali were on average larger households than non-adopters, were living more often from subsistence agriculture, were less patient and less likely to produce maize, while operating on smaller farms. However, propensity score matching revealed that changes in terms of production decisions or wellbeing were limited compared to credit-users. To achieve scaling, linking crop insurance with credit should not only be beneficial for banks to limit their exposure (on a mandatory basis), but should become beneficial as well for smallholders (in terms of better access to credit, lower interest rates or less required collateral).

Keywords: crop insurance, credit, adoption, impact

JEL classifications: Q14, Q18

* Wageningen University, Development Economics Group, Hollandseweg 1, Wageningen, the Netherlands & International Food Policy Research Institute, Malawi Strategy Support Program, P.O.Box 31666, Lilongwe 3, Malawi (jan.duchoslav@wur.nl)

** Wageningen University, Development Economics Group & Wageningen Economic Research, Hollandseweg 1, Wageningen, the Netherlands (marcel.vanasseldonk@wur.nl)

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Introduction

Micro-insurance can be an effective approach to smoothening income in adverse times, for example during and after droughts, and potentially a way to achieve financial inclusion of vulnerable smallholder farmers. Giving smallholders access to micro-finance enables them to invest in improved agricultural inputs to enhance farm production and ultimately household income (Karlan *et al.*, 2014). However, its uptake remains quite low in developing countries (Carter *et al.*, 2014). Being usually offered at the beginning of the growing season when farmers have least access to cash and most need for the capacity to invest, stand-alone insurance products are difficult to sell. Bundling insurance with credit is a logical strategy to address the farmers' lack of capacity to pay, but limited access to financing and the high costs of agricultural credit complicate this approach. There is a lack of understanding and little trust in insurance products, and the financial literacy of smallholder farmers is very limited. Many act out of necessity on short-term needs as opposed to long-term business strategy, with insufficient attention and means to employ risk mitigation strategies, which include, but are not limited to, insurance, that could help them to break out of the cycle of low income and low production.

In order to be financially viable, crop insurance has to be low-cost and thus at large-scale. Key to success is for providers to streamline claim handling and marketing efforts in order to minimize transaction costs. Emerging index-based insurance across Africa has proven to enable efficient claim handling. However, direct sales to individual smallholders remain a challenging task without an easily scalable solution. To reach the necessary scale, it is essential to cooperate

with aggregators in the agricultural value chain who have a shared interest. Such organizations include the financial service industry (e.g., insurers, brokers, banks and MFI's), input providers (e.g., seeds and fertilizers), traders, processing industry, as well as farmer-based organizations.

Limited adoption and impact studies in the field of crop (index) insurance go beyond a one-off field experiment, and mostly focus on stand-alone insurance products. See for example a systematic review by Marr *et al.* (2016). Yet those insurance programs that are currently running are frequently marketed as bundled products (linked with input purchases and/or credit). The current research seeks to find the determinants of adoption of a credit-linked insurance bundle in Mali, and to gauge its contribution in enhancing the agricultural productivity of smallholder farmers (i.e., income smoothening and income enhancement). Mali is proving a particularly challenging context to develop the agricultural insurance market. It is the least developed insurance market in the region, with very limited capacity in the sector to develop and scale agricultural insurance products. With relatively high operational cost, agricultural insurance remains expensive. Within this institutional framework there is an increasing recognition for the potential of insurance towards building a more resilient agricultural sector, but there is little supporting policy, such as tax waivers or premium subsidy, that could help in reducing the cost of insurance.

Methodology

Bundled insurance product

We consider a typical form of a credit-linked index-based drought insurance designed and monitored by EARS (Envi-

¹ <https://orcid.org/0000-0001-5745-4183>

² <https://orcid.org/0000-0001-7097-2663>

ronmental Analysis & Remote Sensing). The services are brokered by PlaNet Guarantee and delivered through a consortium of aggregators in Mali. The sales strategy towards financial organizations has been an inclusive approach by bundling insurance with credit directly (through MFIs) or indirectly via credit for input purchases (input providers also offering financial services). Participating aggregators made crop insurance mandatory for all clients requesting an agricultural loan. The amount of insurance premium is integrated into the loan amount, and eligible claims (i.e. index pay-outs) are deducted from the clients' debt.

The index insurance is based on Relative Evapotranspiration (RE). In principle evapotranspiration consists of two components, namely water loss from bare soil (e.g. run off) and water loss through plant leaves (i.e. transpiration). RE is a better predictor of crop growth than precipitation, and as such the explanatory value of an RE index is higher for credit risks than that of a precipitation index (Von Negenborn *et al.*, 2018).

In our case in Mali, three alternative RE-based drought indices were distributed. Insurance coverage included a generic drought index policy (marketed from 2016 onwards), and crop-specific drought indices for maize and sesame (marketed from 2015 onwards). The maize coverage had a three-phase structure (i.e. germination, vegetative and flowering) with a flexible start (i.e. early start or late start). Sowing period of maize ranges from 11th to 31th of July, while harvest is typically at the end of October. The generic and sesame coverages were both based on a "single-phase" design with a fixed start. Sowing sesame starts on the 11th of August while harvest starts on the 11th of October.

In 2015 and 2016, 7,282 and 6,102 smallholders respectively were insured. Initially, maize coverage was most popular (54% maize versus 46% sesame insurance policies), but after launching the generic product sesame insurance became more prominent (28% maize versus 44% sesame versus 28% generic policies). The average insured plot size and insured (input) amount per smallholder was approximately 1 hectare and 50,000 CFA franc (76€). Average premium per farm amounted to 5,535 CFA franc (8.41€) and depended on the geographical zone, for which premium ranged between 10% in the least drought prone climatic zone (south) up to 14.8% in the most drought prone climatic zone (north).

Adoption and impact design

The current adoption and impact research would cause minimal interference with the initiatives that would normally be undertaken by the broker and aggregators in Mali. Impact was assessed by means of a cross-sectional double-difference design by sampling adopters in the access villages and non-adopters in both access villages and control villages. In total, 15 villages with access to the credit-linked index-based insurance product were randomly sampled from a list of all targeted villages. Since the total number of insured villages per aggregator was limited, several aggregators which offered identical terms and conditions of credit-linked index insurance were included. For each access village, a control village was randomly selected from non-access villages within the same circle (administrative unit) and climatic zone (as defined by

EARS). In each access village, 8 insured farmers were randomly selected from the list provided by the aggregator, and 8 non-insured farmers were selected at random from a village census provided by local authorities. In each non-access village, we interviewed 16 farmers selected at random from a village census provided by local authorities. The Android-based survey was conducted after the harvest season in March 2017 by an independent contractor (GREAT).

The household survey included both demand and impact indicators. Demand was hypothesized to be influenced by numerous explanatory variables including household characteristics, credit and liquidity constraints, preferences and individual characteristics, and farm characteristics. Household characteristics included education of household head (in years), gender and age of household head, whether household head was elder, number of household members, and distance to the nearest drinking water source (minutes). Credit and liquidity constraints were derived by means of a wealth index (a principal factor of assets owned by the household constructed following Sahn and Stifel (2003)), whether the household received income from a working family member, whether the main occupation of the household head was subsistence agriculture, and whether the main occupation of the household head was trading. Preferences and individual characteristics were elicited based on a series of hypothetical lotteries to deduct risk aversion level, and standardized measures of patience and cognitive ability following Falk *et al.* (2016). Finally, farm characteristics entailed information on maize production and total farm size (in hectares). Impact indicators comprised production and financing decisions in the last agricultural season, and wellbeing in the past 12 months. Production decisions focus on average organic fertilizer use (kg/m²), average chemical fertilizer use (kg/ha), average pesticide use (l/ha), use of improved maize variety, and percentage of total farm size dedicated to growing maize. Financing decisions captured total outstanding debt of the household (thousands West African CFA franc) and the percentage of total outstanding debt used for investment (as opposed to consumption). Binary wellbeing indicators classified whether households were faced with a situation of food shortage (i.e. a situation where there was not enough to eat), hunger (i.e. someone in the household went to sleep hungry at night) or money shortage (i.e. someone in the household faced shortage of money).

Using data from access villages, we obtained weights for the determinants of adoption, and used them to predict the likelihood of insurance adoption of each farmer (crucially including those without access to insurance). Furthermore, we estimated the effect of the insurance on the production decisions of comparable farmers by interacting the predicted probability with a variable indicating access to insurance (i.e. counterfactual by means of propensity score matching (Rosenbaum and Rubin, 1983)).

Results

Following the sampling design, and adjusted for practical limitations, in total 485 smallholders were surveyed, of which 247 in access villages, of which 104 credit-linked

insurance adopters. Balance tests along adoption determinants between villages with or without credit-linked insurance access revealed some selective attrition in our sample. A smaller proportion of households cultivated maize in villages with credit-linked insurance access (76.9% versus 86.6%, $P < 0.01$) in which the main occupation of the household head was more likely subsistence agriculture (84.2% versus 75.2%, $P < 0.05$).

By means of a multi-variate probit estimation, the probability of insurance adoption cases could be predicted 70.4% successfully (Table 1). Adopter households were on average larger than non-adopters (23.96 compared to 20.22 household members) at a significance level of $P < 0.01$. Adopters were more often living from subsistence agriculture ($P < 0.05$), were less patient ($P < 0.05$) and were less likely to produce maize ($P < 0.05$). Moreover, adopters operated on smaller farms ($P < 0.10$).

Table 1: Determinants of credit-linked insurance adoption.

	Marginal effects	
HH head years of education	0.014	(0.033)
HH head female	0.299	(0.985)
HH head age	0.001	(0.008)
HH head elder	-0.012	(0.294)
HH size	0.029***	(0.011)
Distance to water (remoteness)	0.007	(0.017)
Wealth	-0.035	(0.091)
Paid job	0.105	(0.192)
Subsistence agriculture	0.546**	(0.245)
Trading	-0.006	(0.187)
Risk aversion	0.071	(0.110)
Patience	-0.119**	(0.055)
Cognitive ability	-0.099	(0.065)
Total farm size ha	-0.011*	(0.006)
Grow maize	-0.321**	(0.157)
N	240	

Probit marginal effects. SE clustered at the village level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: own data

Impact of adopting the insurance on a range of adoption decisions is indicated by the coefficients in the first row of Table 2 ($\text{Access} \times \text{Pr(Adopt)}$) and indicated no measurable statistical impact. This is not surprising since the insurance, mandatorily linked with credit, was not arranged individually but by aggregators, and most of the insured respondents were even not aware (anymore) of being insured.

Table 2: Impact of credit-linked insurance on production decisions.

	(1) Organic fertilizer	(2) Chemical fertilizer	(3) Pesticide	(4) Improved maize	(5) % land maize	(6) Total debt	(7) Debt for investment
$\text{Access} \times \text{Pr(Adopt)}$	-0.320 (0.237)	-42.536 (88.349)	2.150 (2.591)	-0.041 (1.111)	0.060 (0.528)	-35.069 (652.545)	-28.966 (21.552)
Access	0.150 (0.111)	37.451 (44.485)	-0.524 (1.333)	0.003 (0.542)	-0.111 (0.208)	0.609 (360.561)	9.438 (8.684)
Pr(Adopt)	0.063 (0.089)	46.407 (54.664)	-0.470 (0.780)	-0.503 (0.768)	-0.863* (0.459)	142.005 (516.010)	11.827 (11.546)
N	385	385	385	468	468	467	125

Tobit (1-3, 5-7) and probit (4) marginal effects. SE clustered at the village level in parentheses. * $p < 0.10$.
Source: own data

The direct impact of adopting the insurance on various indicators of wellbeing is shown by the coefficients in the first row of Table 3, and is somewhat mixed. Adoption of the insurance was correlated with lower probability of facing shortage of money, which is however likely to be due to its bundling with credit rather than to the insurance itself. There is no statistically significant effect on food security.

Table 3: Impact of credit-linked insurance on wellbeing.

	(1) Food shortage	(2) Hungry	(3) Money shortage
$\text{Access} \times \text{Pr(Adopt)}$	-0.690 (0.858)	0.283 (0.982)	-1.800*** (0.599)
Access	0.398 (0.379)	-0.210 (0.462)	0.890*** (0.238)
Pr(Adopt)	1.060 (0.673)	1.374* (0.715)	0.942** (0.470)
N	468	468	468

Probit marginal effects. SE clustered at the village level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: own data

Discussion

The full impact of adopting the insurance on wellbeing should truly manifest itself when drought hits. To estimate the effect of the insurance on farmers' wellbeing, we further interact access to insurance and the probability of being insured with a variable indicating a spell of drought during the last agricultural cycle (as measured and defined by the drought index used in the insurance). Outcomes suggest that crop insurance reduces the probability of food and money shortages in times of drought. However, when taking into account the intensity of the drought, the effects on food security become statistically negligible. When measuring drought as perceived by the respondents no significant effects are detected whatsoever. Adopting the insurance might nevertheless mitigate the severity of drought in other ways (or in a magnitude not detectable in our sample size), as it reduces the probability that the respondent perceives overall conditions as drought.

Crop insurance has a longer history in the EU than in Africa, and plays a significant role in compensating yield losses caused by climatic risks, with or without subsidies

at Member State level or by using Article 37 of the Risk Management Toolkit under the Common Agricultural Policy. However, the tools available in EU Member States to manage crop yield risks through insurance are very diverse (Meuwissen *et al.*, 2018). There are single-peril insurance tools (mainly hail insurance) and multi-peril risk insurance schemes that secure against a wider range of weather perils. Yet, drought is often excluded from most combined peril schemes or only partially included. Moreover, the insurance cover is generally not marketed as a credit-linked package (yet financiers might request to insure crops with a separate financial product). Although recent developments in index-based insurance products offer a potential for coping with crop losses, targeted index-based insurance products are offered only in a few Member States. Prominent examples of index-based drought insurance are marketed in Austria for some specific crops and grassland (Url *et al.*, 2018) and specific crops in Lithuania, while in France and Spain index-based insurance for deprived pasture yields is available. Other examples can be considered more as pilots to test product feasibility (e.g. drought index cover in Germany). The current paper serves as an illustration on index insurance, for which only few examples exist in Europe so far.

Good partnerships are essential in overcoming the main difficulties of scaling up micro-insurance in Africa. Micro-finance institutions and banks benefit from linking credit supply with mandatory insurance uptake directly. Financial institutions have a vested interest and the market power to enforce mandatory bundles that provides adequate coverage for climate related risk. Smallholders are less exposed to weather risks if they obtain insurance, which reduces their default risk. By reducing agricultural risk, financial institutions are able to increase their agricultural portfolio, absolutely and proportionally. Ultimately, this should result in a more competitive loan provision in the agricultural sector, manifested as better access to credit for producers, lower interest rates or less required collateral.

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