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Effect of Village Savings and Loan Associations on adoption of index-based crop insurance under limited liabilities

Marcien Ndagijimana [a,*], Marcel van Asseldonk [b], Aad Kessler [a], Jean Ndimubandi [c]

[a] *Wageningen University and Research, Soil Physics and Land Management Group, The Netherlands*
[b] *Wageningen University and Research, Wageningen Economic Research, The Netherlands*
[c] *University of Burundi, Rural Economics Department, Burundi*

Abstract

A household survey and focus group discussions were conducted to quantify the general determinants of an index-based crop insurance adoption under limited liabilities in Burundi, and specifically the effect of existing Village Savings and Loan Associations (VSLAs). The survey sample comprised of 40 crop insurance adopters, 40 non-adopters and 40 drop-outs in Bukirasazi and Makebuko communes of Gitega province. The results indicated that saving money (by VSLAs) for upcoming premium payments and regularly VSLA meetings attendance increase insurance adoption with relative risk ratio (RRR) = 0.21, $p \leq 0.001$) and (RRR = 0.01, $p \leq 0.01$), respectively. In addition, VSLAs' members with more knowledge in land management (RRR = 0.07, $p \leq 0.05$), crop management (RRR = 0.05, $p \leq 0.001$) and integrated farm planning (RRR = 0.03, p<0.05) were more likely to adopt the crop insurance. Furthermore, smallholders being aware and less appreciative limited liability were more likely inclined to adopt crop insurance with RRR = 0.12 ($p \leq 0.01$) and RRR = 0.01 ($p \leq 0.001$), respectively. Given the importance of VSLA in fostering crop insurance adoption, we recommend strengthening VSLAs in their operation, save for upcoming premium payments as jointly agreed and set in their constitution, and encourage smallholders to run their farms with integrated farm planning. Due to limited knowledge of smallholders about the mode of crop insurance operation, a more extensive capacity building coupled to a coaching by experts in this domain is more than a necessity.

Keywords: Burundi, community savings and credit associations, index-based crop insurance, integrated farm planning, risk management

1 Introduction

Smallholders must make complex financial decisions, and often exploit only a limited range of financial instruments available to them, to address their varying needs. The available formal financial instruments, such as banking facilities or micro-finance, are often expensive and risky, or lack necessary flexibilities (Karlan *et al.*, 2017). When formal financial institutions are not available, smallholders use more informal and flexible mechanisms instead.

The widespread use of informal financial networks, mostly savings-led village groups (of which the rotating savings and credit associations (ROSCAs) is a typical example), is a testament to this (Conning & Udry, 2005, Karlan *et al.*, 2017). A Village Savings and Loan Association (VSLA) is a group of people who save together, take loans (credits) from the deposited savings, and share generated interests by loans according the rules and regulations made by and for the members of the group. The main objective of VSLAs is to assess the savings made, analyse the loans to give to applicants and exchange information related to the organisation. A VSLA may have an additional social or solidarity fund, which is a fund managed by the group that can be accessed by members in the form of an interest-free loan or cash grant in case of an emergency (Karlan *et al.*, 2017).

Emergency can manifest itself following high crop yield losses or reduced quality or a combination of these (Roth & McCord, 2008). A multi-peril crop insurance can play an important role in hedging against these implications of adverse weather and climate change (Mahul & Stutley, 2010).

* Corresponding author – ndagijimana1980@gmail.com

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However, stand-alone crop insurance may attract little demand and may not be seen as a scalable value proposition (Falco *et al*., 2014). Index-based micro-insurance products offer a more financially sustainable mechanism by tackling adverse selection and moral hazard, and reducing the risk faced by agricultural households. While there are some examples of success, by and large smallholders have been reluctant to hedge substantial amounts of risk with this instrument (Cole *et al*., 2012). However, there is increased interest in risk management and bundling crop insurance to promote agricultural investments and access to credit, and to provide financial stability to smallholders and other actors in the agri-value chain (Dick & Wang, 2010).

In the rural area smallholders are often disconnected to potential insurance companies. Although demand for micro-insurance solutions for smallholders in developing countries is (relatively) substantial, the supply side faces several constraints and challenges which prevent the private sector from becoming involved in these solutions on a large scale (Levin & Reinhard, 2007). Therefore, many input suppliers (such as those selling seeds and fertilisers) could sell on credit, but they have limited capacity to handle the covariate risk associated with agriculture (Hazell *et al*., 2010). Most of the banks are also reluctant to finance agricultural activities, only some micro-finance institutions are beginning to become involved in granting credits to farmers organised in cooperatives (i.e., aggregated demand). However, if smallholders are not safeguarded against the unforeseen weather hazards, they prefer to invest less in agriculture, instead of running the risk to lose it all. In general, risk and uncertainty impede innovations and induces risk-averse and low-return investments (Zimmerman & Carter, 2003).

Index insurance is often promoted as a solution to many barriers that are thought to limit the supply of formal insurance coverage to smallholder farmers and livestock owners in developing countries (Jensen & Barret, 2016). However, in the presence of basis risk, a risk averse and/or ambiguity averse individual can still have no or limited appetite in index-based insurance (Belissa *et al*., 2019).

In 2017, an index-based insurance program was implemented in Burundi. This index-based insurance was preferred by smallholders and insurers since it deals with asymmetric information (manifesting itself in adverse selection and moral hazard) and pay-outs are based on an index whose degree of occurrence and magnitude cannot be influenced by insurers (in addition to the advantages of low transaction costs). Advocates of index insurance argue that it can overcome unfeasible loss assessment by conventional means, particularly where there are many small-scale farmers or where insurance markets are underdeveloped (World Bank, 2015; Fisher *et al*., 2019).

Smallholders opted for a mutual approach (owned by themselves) with limited liability meaning that in the case of excessive systemic climate shocks, which influence the majority of the insured at the same time, the compensation should be less than the agreed conventional pay-out. Limited liability was socially considered to be valuable by the members of the VSLA because it reduced the need for excessive levels of retention and reinsurance, and associated transaction costs, compared to unlimited liability (Harrington & Niehaus, 1999).

The main objective of this study was to explore the determinants of index-based crop insurance adoption under limited liability with particular attention to the effects of VLSAs on adoption, as the crop insurance was implemented through these social and financial structures. Three groups of respondents were considered for this study namely adopters, non-adopters and drop-outs.

In terms of achievements, the insurance continues to operate although the underwriting rate is not as high as at the beginning of the program. An insurance management committee has been set up and two farmers per rainfall station (i.e. 12 farmers for the six stations) have been trained and therefore have the capacity to collect daily rainfall data that serve as a reference for the indemnification in case of excessive or deficit rainfall.

2 Crop insurance in Burundi

The crop insurance in Burundi is organised via a mutual structure named Micro-insurance and Finance Cooperative (MAFICO). MAFICO is an independent mutual which promotes agricultural insurance, health insurance, micro saving and credit schemes. It is owned and managed by local smallholders, also represented in the executive board (Ndagijimana *et al*., 2017). Burundi smallholders preferred to set up a mutual agri-insurance company themselves based on mutual solidarity and limited liability principles, hence without involvement of an external (re-)insurance company. As this insurance is developed under a mutual approach, the insured are responsible of any change regarding the terms and conditions. MAFICO is technically supported by a private Income Security Expertise Company (ISECOM) which delivers technical assistance in terms of management, program development, awareness raising, and all aspects related to the monitoring and evaluation. ISECOM's support is essential since farmers have limited competencies to manage a complex program like a crop insurance. All aspects related to the crop insurance are managed by a crop insurance commit-

tee which reports to MAFICO's executive committee. The committee works in close collaboration with the manager of MAFICO who is the person in charge of all MAFICO's daily activities.

A crop insurance pilot study was conducted in 2017 in cropping season B (March - June) with 257 participants from selected VSLAs in four communes (Bukirasazi, Makebuko, Butihinda and Giteranyi) in two provinces in Burundi, namely Gitega and Muyinga. Piloted VSLAs were participatory selected based on a certain number of criteria such as a high adoption level of integrated farm planning (PIP) and a subscription to the health insurance scheme. The latter was only required for famers from Gitega Province. After the analysis of these criteria, 17 % of VLSAs were selected among 200 existing VSLAs in the two provinces, that is 13 VSLAs from Gitega and 21 from Muyinga. In their mode of operation, VSLA members agreed that 50 % of their savings and generated interest would be used for a credit fund (investment), 30 % progressively put aside to pay the insurance premium and the remaining 20 % would be shared among the members to be used for family needs. However, some VSLA members preferred not separating the savings as set in their constitution meaning that this 30 % for premiums was not saved by all VSLAs.

The index-based crop insurance product covered both drought and excessive rainfall, as they were selected by smallholders as the major weather stresses that hamper agricultural production. It was decided by smallholders' representatives to measure rainfall using ground-based stations. Six rain gauges were installed and twelve smallholders, i.e. two smallholders per rain gauge site, appointed to collect rainfall data each day at 8.00 AM for the covered seasons. The selection criteria for collectors was to be literate (able to read and write) and have at least primary education. Another criterion was the attitude of the collector such as being intrinsically motivated, participating in different meetings organised by MAFICO, and being responsible with exemplarity in the village. Before rainfall data collection, the 12 collectors were trained on how these data should be collected. The training was offered by the Institut Géographique du Burundi (IGEBU). The reason to appoint two smallholders per rain gauge was to share the work load and as a back-up in case one of them was hindered (e.g. due to illness, travel, and other social commitments) at the time of data collection. The two collectors agreed on the collection timeline and if one was not available, he should inform his colleague to do the recording in his place to avoid missing data. Every month, the collected data were submitted to IGEBU for verification and validation. During the verification process, data were compared to those from IGEBU reference stations to check coherence. The differences noticed were automatically corrected. After the verification, IGEBU validated the rainfall data and allowed their use as reference to determine the pay-outs.

The implemented crop insurance program in Burundi operated under limited liabilities meaning that in case of extreme systemic climate shocks, which affect the majority of insured at the same time, the insurer will set a limit on pay-outs (Ndagijimana *et al*., 2017). Given this limited liability, in case of extreme shocks are incurred at portfolio level (i.e., losses exceeding retention level of MAFICO), the insurer pays each affected smallholder only 80 % of the premiums received (the rest is allocated for transaction cost). In years without (or limited) losses, the insured remain the owner of (part of) their contributions not used for pay-outs. A part of the remaining amount, determined by the crop insurance members' general assembly, may be used building a reserve (i.e. retention) or premium discounts for those who continue the insurance cover in the subsequent year.

The premium and pay-out are calculated based on the recurrence interval of drought and excessive rainfall (i.e. the trigger value), the agreed percentage of pay-out (i.e. tick value) and the invested amount. As such the insurance coverage is input based and not yield based. Climate studies were carried out in each of the pilot zones to determine the recurrence interval of the two perils. Recurrence intervals were based on 30-year historical rainfall data analysed by the Information Processing Centre of the Department of Hydrometeorology in IGEBU. Based on the smallholders' preferences elicited at focus group meetings, the original design was refined in terms of coverage based on recurrence interval per peril per season. In Burundi, smallholders grow crops in three seasons, namely season A (September-February), season B (March-June) and season C (June-September). The crop insurance only focused on the two first cropping seasons which are alternatively affected by the two perils (drought and excessive rainfall) covered by the insurance program. During season C, farmers grow crops in marshlands or swampy areas. In Muyinga province, the recurrence interval for drought and excessive rainfall, in Season B, was set at 20 % and 23 %, respectively. In Gitega province, the probability of recording a drought was set at 13 % and at 43 % for excessive rainfall. Smallholders agreed that premiums were to be paid 5 days preceding the concerned season and pay-outs (if any) 30 days after the covered period.

Prior to launching the pilot program an awareness raising campaign was organised to explain how the crop insurance works, how to set up a board committee, and how to assign the rainfall data collectors. Initially, smallholders' participation in the first crop insurance campaign (season

B 2017) was relatively high due to these awareness campaigns. Two years later the crop insurance program ceased in Muyinga province but continued in Gitega province, managed by the farmers themselves with support from MAFICO. In Muyinga province MAFICO is not yet implemented. Therefore, this study only includes smallholders from two communes of Gitega province, namely communes of Bukirasazi and Makebuko. Gitega province is geographically located in the central part of Burundi. During the insurance piloting stage, the total premium and pay-out for the four relevant seasons in Gitega were estimated at 740,190 BIF[1] (404.93 USD) and 504,400 BIF (275.94 USD) respectively, resulting in a loss ratio of 69 % (Table 1). On average, 10 % of the premiums were reserved to account for incurred transaction costs. In addition, in 50 % of the seasons, liability was limited meaning that the expected pay-outs were capped in accordance with the smallholders' agreement as set in the insurance policy.

However, even at the end of support, 162 farmers (75 %) continued the program for the next season which indicated the commitment to crop insurance program. Fortunately, after three seasons, impressive results are still noticed since the crop insurance program extended without support, and 96 smallholders (45 %) are still involved in the crop insurance which is a promising situation for insurance implementation in Burundi, particularly in Gitega province. Furthermore, a crop insurance board committee is operating, 12 smallholders acquired skills in rainfall data collection, smallholders are aware of the benefits of crop insurance, and local government officers appreciated this innovative approach of addressing climate related risks.

3 Methodology

3.1 Sampling frame and data collection

The sampling consisted of 120 smallholders selected from 13 VSLAs from Bukirasazi and Makebuko communes (Gitega province). These 120 smallholders consisted of 40 current crop insurance adopters by the time of study (i.e., season A 2019), 40 non-adopters and 40 drop-outs. Information was collected through a household survey with a structured questionnaire, which was administered by enumerators who were fluent in Kirundi (the local language in Burundi). The questionnaire was divided into two main modules focusing on VSLA participation and on crop insurance adoption, respectively. For the module on VSLA, data collected were related on savings deposited and credits received, the appreciation of VSLA activities by its members (in terms of knowledge learned in land management and crop management), the use of the integrated farm plan (PIP) in the farming system, the role of VSLAs within the insurance adoption (savings for the insurance premium) among others. For the module related to crop insurance adoption, questions captured constraints preventing crop insurance adoption and scaling-up, benefits of insurance and knowledge of crop insurance management (from premium payment up to claim handling). For closed questions in the survey, different Likert-scales were used to quantify data and categorize answers (nominal, ordinal and interval) (Schroeder *et al*., 2013).

In addition to the household survey, focus group discussions (FGDs) were used to gather information related to how the VLSA could be re-organised to increase the level of crop insurance adoption and scaling-up. Particularly, the index design and the limited liability of the mutual approach were discussed in-depth during the FGDs. In total, three FGDs (of 10 participants each) were conducted, i.e. one per group (adopters, non-adopters and drop-outs).

3.2 Empirical framework and data analysis

One-way analysis of variance (ANOVA) was used to compare means for the three different categories of survey respondents (i.e. adopters, non-adopters, and drop-outs). In addition, crop insurance adoption was fitted using a multinomial logistic regression model with variables associated to VSLAs, index design and limited liabilities, and those specific to the respondent as predictors.

We tested the hypothesis that smallholders' commitment to VSLAs is positively associated with the crop insurance adoption (H1), in terms of saving collectively for premium payments, meeting attendance frequency, farming with the integrated farm planning approach (PIP), and the change in knowledge due to received trainings. It is important to note that the PIP approach was rolled-out through each of the villages involved in this study, with a high level of participation also among the VSLA members. Having been trained via the PIP approach implies that families have made a visionary integrated farm plan (the PIP) which is developed for the whole farm by the farmer family and drawn on a map, and which aims at transforming small-scale subsistence farms into more productive and sustainable farms, based on sound natural resource management (land, water and the crops/vegetation). Changing smallholders' mind-sets and making them aware that they can transform their reality by conscious collective action is at the core of the PIP approach (Kessler *et al*., 2016).

Moreover, we tested the hypothesis that the index design and limited liability approach hamper crop insurance adop-

[1]BIF: Burundian Francs, 1 USD = 1,827.929 BIF (https://www.brb.bi/, exchange rate on 18^{th} of June 2019)

Table 1: *Key indicators of the crop insurance performance in the study area (Gitega).*

Season	*Number insured*	*Total amount insured (BIF‡)*	*Average amount insured per farm (BIF)*	*Total premium (BIF)*	*Average premium per farm (BIF)*	*Total pay-outs (BIF)*	*Pay-outs limited due to limited liability*	*Loss ratio (%)†*
During the pilot study								
Season B 2017	215	2,535,940	11,795	959,500	4,463	1,012,898	Yes	106
Post-pilot study								
Season A 2018	162	2,677,360	16,527	856,966	5,290	267,736	No	31
Season B 2018	148	933,968	6,311	909,786	6,147	549,357	No	60
Season A 2019	96	250,140	2,606	234,515	2,443	187,612	Yes	80
Average*		1,599,352		740,192		504,401		69

* Average over Season B 2017–Season A 2019; ‡ BIF = Burundian Francs
† The loss ratio is the ratio between the pay-outs and collected premium by season. In this study, the loss ratio for the season B 2017 exceeding 100 percent means that farmers from Gitega were paid-out from premium collected in Muyinga and Gitega (joint participation) because the trigger 'excessive rainfall' occurred in Gitega exceeded the normal precipitation. For the season B 2017, the loss ratio in Gitega was 106% (41% in Muyinga), and the loss ratio for the two pilot areas amounted to 91%. In addition, in the first crop insurance campaign high transaction costs were incurred including additional expenses, among others, the opening of a bank account dedicated to crop insurance and frequent awareness training.

tion (H2), both in terms of awareness and appreciation. We estimated determinants of crop insurance adoption by referring to Heyi-Damena & Mberengwa (2012). Therefore, the distribution function for the probability of adoption (ρ_i) is given by:

$$\rho_i = \frac{1}{1 + e^{-A_i}}$$

where ρ_i is the probability of adopting crop insurance for i^{th} smallholder (1-ρ_i, otherwise) and A_i is a function of n exogenous variables and for this study is expressed by:

$$A_i = \alpha + \mu_i X_i + \psi_i \Delta_i + \gamma_i K_i + \epsilon_i$$

Where A_i is the dependent variable which is a categorical variable with a value of:

- 1 – if the smallholder reported to use the crop insurance, hereafter 'adopter',
- 2 – if the smallholder reported to have never used the crop insurance, hereafter 'non-adopter',
- 3 – if the smallholder reported to have used the crop insurance but gave up using it after a given period, hereafter 'drop-out'.

X_i is the vector of covariates affecting crop insurance use/adoption including variables linked to VSLA such are:

- Saving collectively for premium payments (1= smallholders allows VSLA to put aside money for insurance, 0 otherwise),
- Meeting attendance (1= not one, 2= attended 25 % of planned meetings by respective VSLA, 3= 50 %, 4=75 %, 5=100 % of planned meetings)
- Change in knowledge due to the trainings received through VSLAs which was expressed by three variables namely:
  i. knowledge in land management (1 = much decreased, 2 = less decreased, 3 = no change, 4 = increased, 5 = much increased),
  ii. knowledge in making a business plan (1 = much decreased, 2 = less decreased, 3 = no change, 4 = increased, 5 = much increased),
  iii. knowledge in crop management (1 = much decreased, 2 = less decreased, 3 = no change, 4 = increased, 5 = much increased).
- Having created a PIP for the farm (1= household created a PIP for the farm, 0 otherwise).

Δ_i is the vector associated to index design and limited liabilities (LL). The index design was determined by:

- the smallholders' awareness of pay-out-based index (1 = smallholder is aware that the pay-out is index - based rather than incurred losses, 0 otherwise),
- smallholder's appreciation of the pay-out-based index, by asking them if the pay-out based on index rather than incurred losses is a problem (1 = like, 0 = dislike).

The limited liability (LL) was elicited by:

- the smallholder's awareness of LL(1 = smallholder is aware that the insurance is an index based limited liability, 0 otherwise) and

- smallholder's appreciation of LL (1 = not at all appreciated, 2 = not appreciated, 3 = indifferent, 4 = appreciated, 5 = much appreciated).

Finally, K_i is a vector associated to variables related to the respondents:

- The sex of the respondent (1 = male, 2 = female) and
- Education of the respondent (0 = illiterate, 1 = primary, 2 = secondary, 3 = university)

μ_i, ψ_i and γ_i are respectively the corresponding vectors of parameters (slopes) and ϵ_i is the error term. We interpreted data from multinomial logistic regression by using the relative risk ratio (RRR) which is obtained by exponentiation of the multinomial logit coefficient (e^{coeff}).

4 Results

4.1 Relationship between variables linked to VSLA members and crop insurance adoption

The community-based financial structures referred to as VSLAs were the entry point of the implemented crop insurance scheme in the study area. A one-way ANOVA group was performed to compare the differences in key VSLAs membership variables between crop insurance adopters, non-adopters and drop-outs (Appendix 1).

Results indicated that the mean difference (MD) in saving collectively for premium payments was statistically different between the adopters and non-adopters (MD = 0.675, $p \leq 0.01$) and between the adopters and drop-outs (MD = 0.225, $p \leq 0.05$). This means that for farmers who consent with their VSLAs to collectively save for premium payments were more likely to adopt the crop insurance. In addition, results also indicated that regular attendance to VSLAs' planned meetings was found statistically different between the adopters and non-adopters (MD = 0.550, $p \leq 0.01$), meaning that farmers who regularly attended planned VSLA meetings were more likely to adopt the crop insurance (compared to those participating more irregularly), even if they discontinued the crop insurance program after one or more seasons. For instance, 65 % of the adopters participated in all planned VSLA meetings against 32.5 % drop-outs (Appendix 2).

Next, a significant difference was found in knowledge of land management between the adopters and non-adopters (MD = 0.500, $p \leq 0.01$), meaning that the knowledge level of land management might influence crop insurance adoption. For the same variable knowledge of land management also the non-adopters and drop-outs differed significantly (MD = -0.650, $p \leq 0.01$), but also for knowledge in crop management (MD = -0.350,$p \leq 0.05$). Hence, even if farmers drop-out from the crop insurance, the trainings received through VSLAs play a big role in initial crop insurance adoption, with their focus on integrated and effective solutions to cope with low production including risks associated to farming. For the variable having a working PIP, the adopters were found to be significantly different from the non-adopters (MD = 0.500, $p \leq 0.01$) and from the drop-outs (MD = 0.350, $p \leq 0.01$). The PIP approach, with its focus on transforming small-scale subsistence farm households into more productive and sustainable farms, thus triggers farmers to adopt the crop insurance.

The results also revealed that the adopters were significantly different from the non-adopters (MD = 0.225, $p \leq 0.01$) and the non-adopters from drop-outs (MD = -0.175, $p \leq 0.01$) for the variable awareness of pay-out-based index. According to the drop-outs, they left the insurance program because of the pay-outs received being considered too low compared to the engaged investments. Similarly, awareness of limited liability was found significantly different between the adopters and drop-outs (MD = 0.300, $p \leq 0.01$) and between non-adopters and drop-outs (MD = 0.325, $p \leq 0.01$).For the variable limited liability appreciation, the adopters were found significantly different from the non-adopters (MD = 1.850, $p \leq 0.01$) and from the drop-outs (MD = 0.625, $p \leq 0.05$), meaning that appreciation of limited liability stimulated crop insurance adoption.

For the education of the respondent, the adopters were found significantly different from the non-adopters (MD = 0.550, $p \leq 0.01$) and from the drop-outs (MD = 0.350, $p \leq 0.05$) meaning that educated persons were more likely to adopt crop insurance. In general, most important differences in means were found between adopters and non-adopters, and between adopters and drop-outs. The group of non-adopters did not differ a lot from the group of drop-outs for most of the analysed variables.

The results from focus group discussion suggested that the main crop insurance limitations that hamper the adoption and scaling up are a lack of sufficient information on crop insurance in the community, lack of coaching by experts in the field, and lack of interest of crop insurance by some smallholders. In addition, the location of rain gauges does not favour all smallholders in the same way because drought or excessive rainfall can hit one colline (smallest administrative unit in Burundi) in the community and this is not accounted for at the time of pay-out analysis because only average of the whole season is considered.

Furthermore, the pay-out is always small compared to the incurred losses (used fertilisers, seeds, time and ultimately

Table 2: *Multinomial logistic regression analysis of factors influencing crop insurance adoption.*

Variables related to	*Variables**	*RRR*	*Robust Std. Error*	*P-values*
	Non-adopters			
VSLAs	1	0.21	-4.2	< 0.01
	2	0.01	-2.71	0.01
	3	0.07	-1.96	0.05
	4	8.67	1.02	0.31
	5	0.05	-2.92	< 0.01
	6	0.03	-2.37	0.02
Index design	7	0.32	-0.93	0.35
	8	116.81	1.51	0.13
Limited liability	9	15.99	1.19	0.23
	10	0.01	-3.6	0.00
Control	11	1.02	0.26	0.79
	12	0.07	-2.01	0.05
	13	102340	4.37	< 0.01
	Drop-outs			
VSLAs	1	0.08	-2.56	0.01
	2	0.21	-1.68	0.09
	3	4.88	1.7	0.09
	4	0.62	-0.74	0.46
	5	1.08	0.14	0.89
	6	0.07	-3.74	< 0.01
Index design	7	0.97	-0.02	0.98
	8	0.61	-0.48	0.63
Limited liability	9	0.12	-2.78	0.01
	10	0.83	-0.55	0.58
Control	11	1.02	0.51	0.61
	12	0.28	-1.64	0.1
	13	894.05	1.22	0.22
	Number of obs	120		
	Wald chi2(24)	82.31		
	Prob> chi2	0		
	Pseudo R2	0.6868		
	Log pseudo likelihood	-41.296443		

Reference category is Adopters; N=120 (adopters=40, non-adopters=40, drop-outs=40); RRR = relative risk ratio

* 1: Saving collectively for premium payments, 2: Meeting attendance, 3: Knowledge in land management, 4: Knowledge in business plan, 5: Knowledge in crop management, 6: Having a working PIP, 7: Awareness of pay-out based index, 8: Appreciation of pay-out based index, 9: Awareness of limited liability, 10: Appreciation of limited liability, 11: Sex of the respondent, 12: Education of the respondent, 13: constant

yield) and thus smallholders still have difficulties to manage climate-related disasters. In addition, participants in the group discussion suggested that there should be a national climate insurance fund where farmers and the government can contribute (i.e., blending insurance with public disaster relief). In terms of improving crop insurance adoption, respondents in the group discussions suggested that other actors such as non-governmental organisations involved in agricultural development, as well as ministries in charge of agriculture and in social protection should be involved in crop insurance management to improve its adoption and get tangible results.

4.2 *Determinants of crop insurance adoption in the study area*

Multinomial logistic regression was fitted to identify the factors that influence crop insurance adoption by comparing non-adopter and drop-out groups with the reference group of adopters (Table 2). The goodness of fit test was analysed by using, among others, the Chi-square coefficient (X^2). According to the results, $X^2 = 82.32$, $p \leq 0.001$ and R^2_{adj} to 68.68 % suggesting that the observed data were consistent to the expected one.

The independent variables *saving collectively for premium payments* (1 in table 2), *VSLA meeting attendance* (2), *knowledge in land management* (3), *knowledge in crop management* (5), *having a working PIP* (6), *appreciation of limited liability* (10), and *education* (12) were found statistically significant in distinguishing non-adopters from adopters ($p \leq 0.05$). Furthermore, by comparing adopters and drop-outs, the independent variables *saving collectively for premium payments* (1) , *having a working PIP* (6), and *awareness of limited liability* (9) were found statistically significant in distinguishing drop-outs from adopters ($p \leq 0.05$). Multicollinearity was checked by using the variance inflation factor (VIF) and correlation between aforementioned independent variables did not cause problems with the fit and the interpretation of the results.

The relative risk ratio (RRR) for non-adopters relative to adopters is expected to decrease by a factor of 0.21 ($p \leq 0.01$) given other variables in the model are held constant for the variable *saving collectively for premium payments*. For the same variable, the RRR for drop-outs relative to adopters would be expected to decrease by a factor of 0.08 ($p \leq 0.01$). In addition, for the variable *meeting attendance*, for one additional VSLAs' meeting attended, the RRR for non-adopters relative to adopters would be expected to decrease by a factor 0.01 ($p \leq 0.01$). In other words, smallholders who attended planned VSLA meetings are more likely to adopt the crop insurance. Next, smallholders who stated that their *knowledge in land management* improved due to the VSLAs' trainings were more likely to adopt the crop insurance (RRR = 0.07, $p \leq 0.05$) and are more likely to be in the group of adopters rather than in the group of non-adopters. Furthermore, the RRR for non-adopters relative to adopters would be expected to decrease by a factor of 0.05 ($p \leq 0.01$) for the variable *knowledge in crop management* holding constant other variables in the model. Smallholders who had a working PIP (*running the farm with PIP approach*) were more likely to keep adopting crop insurance rather than to never adopt it (RRR = 0.03). For the same variable, smallholders with a PIP were more likely to be in the group of adopters rather than in the group of drop-out. In other words, the RRR for drop-outs relative to adopters would be expected to decrease by a factor of 0.07 ($p \leq 0.01$).

For the *awareness of limited liability variable*, the RRR for drop-outs relative to adopters would be expected to decrease by a factor of 0.12, which means smallholders who are aware of limited liability were inclined to adopt crop insurance ($p \leq 0.01$). In addition, smallholders who appreciate limited liability were more inclined to adopt the crop insurance ($p \leq 0.01$). Finally, for one additional education level attended, the RRR for non-adopters relative to adopters would be expected to decrease by a factor 0.07 ($p \leq 0.05$). In other words, educated smallholders are more likely to adopt crop insurance. Other variables like *knowledge in business plan*, *index design* and *the sex of respondent* were not significant to distinguish adopters from non-adopters and drop-outs.

5 Discussion

This study explored the determinants that influence the adoption of an index-based crop insurance under a limited liability mutual approach. Data analysis consisted in comparing adopters, non-adopters and drop-outs. It was hypothesized that smallholders' commitment to VSLAs in terms of saving collectively for premium payments, meeting attendance frequency, farming with the integrated farm planning approach, and the change in knowledge due to received trainings through VSLAs are positively associated with crop insurance adoption.

Findings indicated that members of VSLAs who save money collectively for premium payments and who attended VSLA meetings regularly were more likely to adopt the crop insurance. VSLAs as financial structures could thus have a prominent role in crop insurance adoption: once a VSLA is structured with a better saving system and well-organised, it could pave the way for crop insurance adoption. Moreover, aggregating demand via VSLA's will likely reduce transaction costs for reaching smallholders. An alternative approach is to (re)insure the aggregate level, e.g. covering a crop credit portfolio at VSLA level or portfolio of VSLA's (Herbold, 2011).

Next, smallholders who stated that their knowledge in both land and crop management had improved due to the VSLAs' trainings (organised during the PIP approach implementation) were more likely to adopt crop insurance. These results are similar with those from India where the probability of crop insurance adoption was found higher for farmers with some formal trainings in agriculture (Aditya *et al.*, 2018). Trainings are considered as a crucial motivator in helping smallholders to improve their knowledge in terms of

risk management including the use of crop insurance. These results are consistent with those of Dercon *et al*. (2013) who indicated that trainings addressing on-farm risk-sharing increased insurance uptake in Ethiopia.

In addition, VSLAs' smallholders who had a PIP and implemented it, were more likely to keep adopting crop insurance rather than to drop out or never adopt it. This relationship between having a vision and a plan and crop insurance adoption could be explained by the fact that smallholders with a working PIP invest in integrated land management including crop diversification and are likely aware of risks associated to farming; as a result, they are more receptive to risk management by adopting crop insurance. A risk-averse farmer would be more willing to buy agricultural weather index insurance (Jin *et al*., 2016). Through focus group discussions, respondents indicated that the implementation of the PIP approach improved the way of farming and enhanced investments in the farm (including the adoption of crop insurance).

Furthermore, smallholders who are aware of and less appreciate limited liability were more inclined to adopt crop insurance and thus limited liability hampers crop insurance adoption. According to the results from India, farmers' adoption of crop insurance is low mainly on account of lack of awareness about insurance products (Aditya *et al*., 2018). During the group discussions, farmers stated that they are proud of their mutual insurance because it is not only an innovation in their community but that they are also the first to have experimented this approach across the country. However, they regret that they do not have a good grasp of all the issues inherent to the functioning of the insurance, which limits its extension in the community. In addition, non-adopters and drop-outs stated that the limited liability associated to the index-based insurance is the main obstacle to crop insurance adoption since in most cases the insured receives less than losses incurred. Indeed, yield losses are never entirely correlated to what a weather index predicts (Turvey & Kong, 2010; Xu *et al*., 2018), and it is thus possible with the index based insurance that an insured farmer is paid-out without having losses or otherwise that a farmer is affected by a shock and not paid-out (because the pay-out is only triggered if the shock has occurred and the agreed threshold reached). Although index insurance lowers transaction costs compared to indemnity insurance, it introduces basis risk, which is the difference between actual loss and the pay-out on an insurance contract (Fisher *et al*., 2019). Index-based insurance in combination with limited liability compounds basis risk. Nevertheless, the index-based insurance as implemented in the study area is an innovative approach, since the insured farmers are at the same time insurers and can decide the insurance fund as they see fit (and making decisions on index design, retention level, reinsurance and limited liability).

Finally, the control variable education was found significantly associated to crop insurance adoption. In order words, educated smallholders are more likely to adopt the crop insurance. This result is similar to the results from Belissa *et al*. (2019) in a study on risk and ambiguity aversion behaviour in index-based insurance uptake in Ethiopia. Education enhances farmers' knowledge and skills related to risk associated to farming and might influence the understanding of the functioning of crop insurance. In addition, similar results were reported in a study on challenges, opportunities, and prospects for index-based insurance uptake in sub-Sahara Africa where literacy was found positively correlated with index-based insurance uptake (Ntukamazina *et al*., 2017).

6 Conclusion

Using data from a household survey, this study analysed the extent to which VSLAs influence index-based crop insurance adoption under limited liability. By analysing the findings, four main lessons were learnt.

Firstly, saving collectively for premium payments is crucial for crop insurance adoption. This study shows that smallholders who consent with their VSLA to save for premium payments are more likely to adopt the crop insurance. To increase the crop insurance adoption, VSLAs should endorse to save money as set in their constitution and approved by the VSLA members. Saving enables smallholders to pay premiums in lean periods coinciding with large family investments, namely the payment of agricultural inputs and school fees.

Secondly, regular attendance in the planned VSLA meetings was found as a positive driver of crop insurance adoption. The results from this study indicate that the level of participation in these VSLA meetings demonstrates the commitment that participants have towards the activities developed and those planned within the VSLA, including for this case the crop insurance program.

Thirdly, smallholders who run their farm with a PIP (i.e. who have a vision and a plan and implement this plan) are more likely to invest in integrated land management and therefore are more receptive to the innovative tools that reduce risk exposure, in this case the crop insurance program. In addition, knowledge in land and crop management is also key driver in crop insurance adoption.

Fourthly, according to the findings, smallholders who are aware of and less appreciate limited liability were more in-

clined to adopt the crop insurance that means the limited liability hampers crop insurance adoption.

Even though a proportion of the smallholders from the study area continue adopting the crop insurance, managing this program is not a concern of smallholders alone, and the contribution from the Burundi government and other stakeholders by subsidizing premiums is more than a necessity. VSLA structures should remain the entrance point of crop insurance implementation, but given the low knowledge level of its members in terms of crop insurance operation, capacity building coupled to a coaching program by crop insurance experts would be a great intervention of the public sector.

Supplement

The supplement related to this article is available online on the same landing page at: https://doi.org/10.17170/kobra-202002281031 .

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Conflict of interest

The authors declared no potential conflict of interests with the respect to the study, authorship, and the publication of this article.

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