

Bundling weather index insurance and credit in Senegal: contributors and constraints to take-up

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Summary

Bundling weather index-based insurance (WII) with credit and other services as a package is considered as a possible pathway to address low insurance take-up by farmers in developing countries. Bundling may help farmers to overcome liquidity constraints they face for the insurance premium at the beginning of the rainy seasons and is also expected to reduce the risk of default as the pay outs could be used for loan reimbursement. Though there seems to be a widespread agreement on the potential advantages of bundling, the way it is best implemented to stimulate take-up and maximise benefits is less definite. In Senegal, the national agricultural insurance company (CNAAS) works with microfinance institutions and farmer's organisations to sell index insurance to farmers through their pre-existing channels. These intermediaries then decide whether they will offer insurance either as a mandatory complement to credit or as a voluntary add-on for their clients or members.

In this formative evaluation, we test these assumptions around the constraints to insurance take-up and compare three possibilities for bundling WII with credit in a context of liquidity constraints and limited availability of/access to financial services. To address these challenges, two of the three possibilities also entail an incentive for bundling, which considers WII as a partial supplement of collateral. This increases access to loans for farmers with a lower asset base and reinforces credibility for repayment.

The study includes 346 farmers who applied for credit through the microfinance institution of a cooperative network (COOPEC/RESOPP) in the regions of Kaolack and Fatick in Senegal. A randomised controlled trial (RCT) experiment, together with a survey, key informant interviews (KII) and focus group discussions (FGD), was used to identify the preferable bundling option that would increase WII take-up and to assess correspondence of the product with the needs and preferences of farmers, intermediaries and the insurer.

During the study, the following options were randomly allocated and offered to credit applicants:

- Mandatory insurance with incentive
- Voluntary insurance with incentive
- Voluntary insurance without incentive

Farmers had therefore to decide whether they would purchase WII or not at the moment of applying for credit, knowing that it could be beneficial for their access to financing. Insurance offers were implemented by COOPEC agents, who usually collect and manage demands for credit and would be in charge of insurance sales also in the absence of the study.

Our results suggest that whether WII is a mandatory or a voluntary addition to credit is not relevant for overall take-up in a context where farmers depend on external financing for agricultural activities, as farmers expect the bundling to support credit applications and facilitate re-payment even after a bad rainy season. Average WII take-up by COOPEC credit-applicants was 72.5%, with no statistically significant difference between the three groups of bundling options but a statistically significant preference for voluntary

incentivised bundling in the follow-on survey suggesting that the absence of difference between treatment groups can be driven by spillovers. When bundling provides the possibility of pre-financing the premium through credit to avoid cash premium payments, most farmers appear to purchase WII. From a perspective focused exclusively on insurance take-up, WII could therefore be included systematically in an indivisible package of services in contexts of financial exclusion where people struggle to acquire the needed inputs to start their agricultural activities.

Nevertheless, even if take-up indicators are promising, the perception of high basis risk seems to play a significant role on the decision of people to not purchase WII. In addition, 23.3% of people who were offered mandatory incentivised bundling were willing to opt out, i.e. to forego their loan application, and results show that for women, take-up was lowest when WII and credit were tied together. Though the latter is not statistically significant, it implies the need to consider potential adverse effects of mandatory bundling on financial inclusion more broadly. Furthermore, a statistically significant preference for voluntary incentivised bundling in the follow-on survey suggested that the absence of difference between treatment groups can be driven by spillovers. From an estimation of the spillover effect it appeared that if the members of a participant's social network received a homogeneous treatment (one treatment/ control only) or a very heterogeneous treatment (three treatments/controls), we observed no significant spillover, whereas it did occur when the network received a rather heterogeneous treatment (two different treatments/controls).

This study contributes to the debate on what integrating WII with credit provision implies for insurance take-up. Whether bundling was mandatory or voluntary did not seem to matter for take-up, but it could have others important implications, As the only presently operating agricultural insurance company in Senegal is proposing that more microfinance institutions and farmers' organisation include insurance in the package of services they provide to their clients and farmers, there is an urgent need for an evaluation of the net impacts that WII, in combination with other services, has on resilience and well-being in the long run. Finally, there is a need to monitor the development of take-up rates for bundled products over time:

- In the long run, will people continue to purchase WII as a mandatory add-on to credit or will they prefer to opt out?
- As mandatory insurance is expected to lead to a decrease of the premium rate (due to economies of scale), what would be the consequence on farmers' decision?

Only answers to these questions will enable the validation of the use of mandatory bundling systematically when it comes to offer WII through microfinance institutions and farmers' organisations as aggregators.

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Abbreviations and acronyms

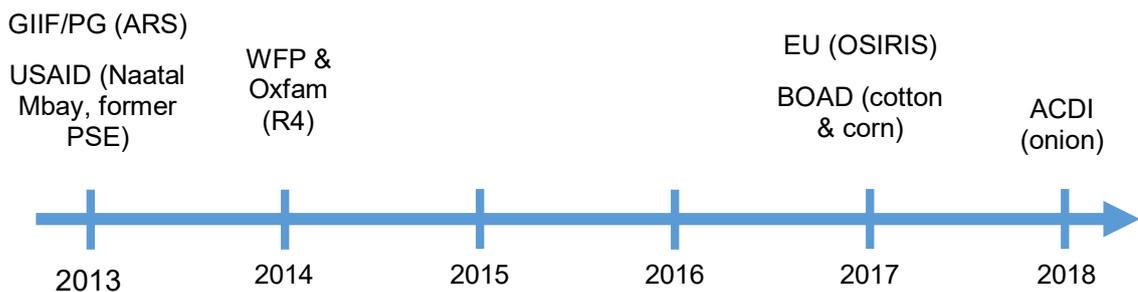
ACDI	Agence Canadienne de Développement International (Canadian International Development Agency)
ARS	Assurance Récolte Sahel (Sahel Harvest Insurance)
BOAD	Banque Ouest Africaine de Développement (West Africa Development Bank)
CNAAS	Compagnie National d'Assurance Agricole du Sénégal (National Agricultural Insurance Company of Senegal)
COOPEC	Cooperative d'Epargne et de Crédit (Savings and Credit Cooperative)
EU	European Union
FGD	Focus group discussion
GIIF	Global Index Insurance Facility
KII	Key informant interview
OSIRIS	Offre de Services Intégrés en Milieu Rural pour l'Inclusion Sociale (Offer of Integrated Services for Social Inclusion in Rural Areas)
PG	Planete Guarantee
RESOPP	Réseaux des Organisations Paysannes et Pastorales du Sénégal (Network of Farmer and Pastoral Organisations in Senegal)
USAID	United States Agency for International Development
WFP	World Food Programme
WII	Weather index-based insurance

1. Introduction

Since the beginning of the century, pilots for weather index insurance (WII) for crops (Box 1), have been implemented in many developing countries – starting in Asia and South America before arriving in West Africa in the years 2010. In the Senegalese case, we are currently witnessing the multiplication of programmes that are either directly dedicated to WII or include a WII component as part of a larger rural intervention.

There are presently six projects that implement WII in specific areas of the country: Assurance Recolte Sahel (ARS) managed by Planete Guarantee (PG) and supported by the Global Index Insurance Facility (GIIF), Naatal Mbay funded by USAID, R4 managed by the World Food Programme (WFP) and Oxfam, OSIRIS funded by the European Union (EU), Index insurance for the cotton and the corn sector funded by the West African Development Bank (BOAD) and finally, index insurance for onion producers supported by ACDI (Figure 1). All these pilots provide WII through the only presently operating agricultural insurance company in the country, the Compagnie Nationale d'Assurance Agricole du Sénégal (CNAAS), which is a public private partnership created in 2008.

Figure 1: Weather index insurance pilots in Senegal



Source: Authors' figure based on data provided by CNAAS.

The intervention for which this evaluation is conducted is the WII component within the OSIRIS¹ project. It is implemented through a savings and credit institution, COOPEC which is the financial branch of the farmers' organisations network RESOPP. COOPEC and RESOPP as a union of 9 rural cooperatives are legally recognised and have been funded by the European Union to execute the OSIRIS together with their partners, including CNAAS. The overall purpose of the project is to strengthen economic and social inclusion of rural populations and to reduce vulnerability and chronic poverty in a context where small-scale agriculture is at the core of rural livelihoods.

OSIRIS aims to cover 12 500 farmers with agricultural insurance generally, of which 1500 are intended to be crop WII contracts. While the programme itself has started in January 2015, the WII component was delayed and started only in the rainy season of 2017. It is the first effective experience in Senegal of bundling WII with credit through using a micro finance institution as an intermediary. The product covers peanut harvests

¹ Offre de Services Intégrés en milieu Rural pour l'Inclusion Sociale au Sénégal (*offer of integrated services in rural areas for social inclusion in Senegal*). For more details on OSIRIS, see Chapter 3.

by transferring risks related to rainfall deficits to CNAAS. This aims to protect farmers by compensating them for rainfall-related harvest losses, to secure the loans which COOPEC/RESOPP provides to customers, and to stimulate investment in agricultural activities. Though these theoretical links are widely acknowledged, empirical evidence on impacts and the preferable way for bundling insurance with credit or other financial services is less conclusive (Zimmerman et al., 2016; Banerjee et al., 2014; Karlan et al., 2011; Gine and Yang, 2009).

Box 1: Weather index-based insurance

Index insurance definition

Weather Index-based Insurance (WII) for crops is an insurance mechanism whose pay-outs are triggered by an index. This index is calibrated and triggered through rain gauge measurements on the ground. Next to WII, two other index insurance approaches are being used in different contexts: satellite-based indices, capturing remote sensing of vegetation levels, and yield indices, assessing historic trends and yield data. The weather-based index is used as a proxy for actual weather-related damage on the area covered by insurance. Given that the correlation between damage and rainfall is imperfect, basis risk, meaning the probability for the index to differ from actual events on a farmers' field and therefore the potential to either falsely trigger or miss to trigger pay-outs, presents a continuous challenge for WII mechanisms.

WII in Senegal

In Senegal, only satellite and rain gauge based weather indices are developed so far. For the specific case of rainfall-based products, a rain gauge installed in a village chosen as a reference is used for the calibration of the index that triggers the pay-outs. A radius of 5 kilometres is covered by each rain semi-automatic or automatic gauge, which measures rainfall development. So far, all WII products offered in Senegal cover rainfall-deficits and delays, but not excess or other hazards. The produce covered so far are rain-fed rice, groundnut, millet, maize and cotton.

Insurance provision channels have involved farmers' organisations since the first pilots started in 2013 and microfinance institutions more recently. Both take on a role of aggregators and report the demand of their members or clients to a broker, Planet Guarantee (PG), who manages the design of the index and the delivery of the product on behalf of the only agricultural insurance company (CNAAS) in the country. A particularity of the Senegalese context is the fact that the government is a stakeholder in the public-private insurer and subsidises 50% of all WII premiums in order to support insurance development, which reflects an important commitment from the public sector.

WII in this study

The insurance product that is the object of this study is a crop WII product for groundnut, using an index based on rain gauge measurements on the ground. It is supplied by CNAAS through the broker PG, who is responsible for the design and the calibration of the index, as well as for the management of sales through the aggregator, in this case COOPEC/RESOPP, a microfinance institution linked to a country-wide network of farmers' organisations.

The produce covered by the WII product is two different types of groundnut: groundnut 90 days (90 days required for maturation) and groundnut 110 (110 days required for maturation). The average level of premium paid was 8524 FCFA (about 17\$) and 11856 FCFA (about 21\$) respectively. These premium values were derived from a premium rate ranging from 9.5% to 11.5% depending on the location of the rain gauge and the type of groundnut cultivated. The average surface covered was 1.4 hectares for groundnut 90 and 1.7 hectares for groundnut 110.

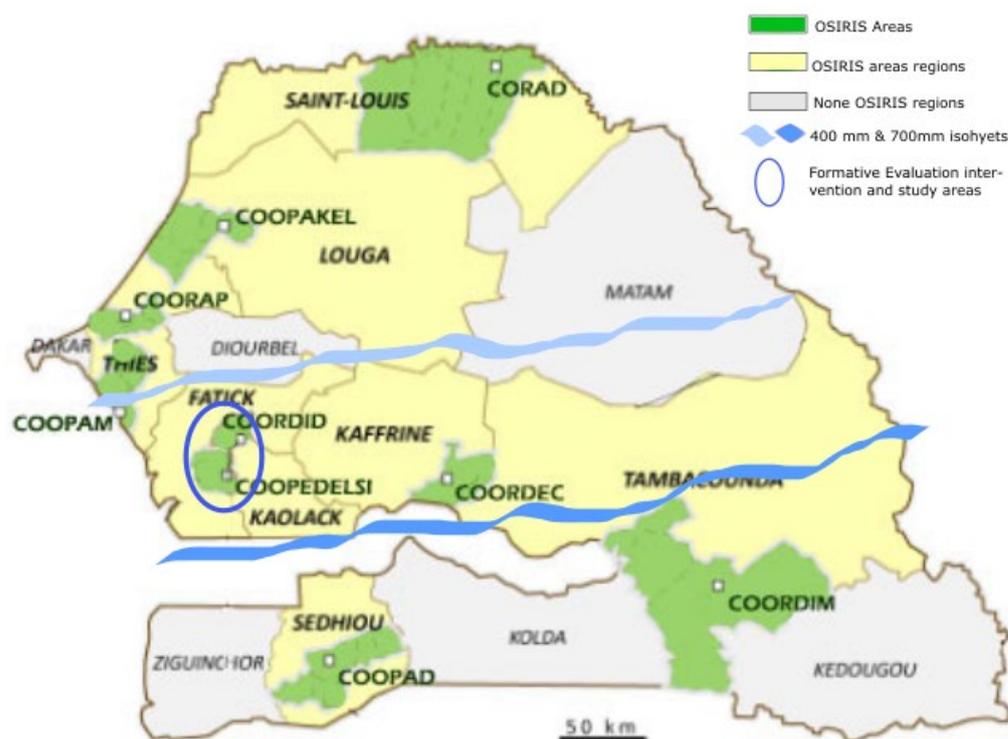
For the payment options, farmers had the option to pay premiums in cash or to pre-finance them through credit, so that the total amount could be paid at the moment of loan reimbursement. In that case, the interest rate applied to the principal credit also applies to the insurance premium.

This formative evaluation explores livelihood risks, along with farmers' needs and preferences for financial mechanisms to manage these risks in the Senegalese peanut basin. Using a randomised controlled trial (RCT), we compare three sales protocols offered to three randomly composed groups of loan applicants to assess the effects of product bundling on WII take-up. Finally, we test assumptions and additional contributors and constraints to insurance take-up in Senegal through a mixed methods approach. The targeted knowledge gap this study addresses concerns the role that microfinance institutions have with regards to WII take-up in Senegal. While working with intermediaries, who can facilitate integration of different financial products and services, is one of CNAAS's key strategies for boosting insurance demand, no independent studies have so far been conducted in the country to assess how much this approach potentially raises WII take-up and what effects it has on financial inclusion.

2. Context

The key focus of this formative evaluation study is on WII take-up by rural farmers in Senegal. Related to the nature and aims of WII, this concerns producers practicing rain-fed agriculture. Given that WII in the OSIRIS project intervention is channelled through COOPEC/RESOPP as an intermediary, all participants are also network members who applied for credit in the 2017 agricultural season. Among the eight regions where the nine offices (and cooperatives) of the COOPEC/RESOPP system are established, only five feature rain-fed agriculture as the main economic activity. These regions are located in the centre of the country with the COORDID (in Fatick), COOPEDELSI (in Kaolack) and COORDEC (in Kaffrine) cooperatives; the southeast with the COORDIM cooperative (in Tambacounda), and the south with the COOPAD cooperative (in Sedhiou) (Figure 2).

Figure 2: OSIRIS project areas and location of formative evaluation study



Source: Adjusted from OSIRIS updated areas map

Next to the predominance of rain-fed agriculture, selection criteria for the specific study location included:

- Exposure of the agricultural sector in the area to high levels of rainfall variability
- Existence and effective availability of a bundled crop WII with loans
- Proposition of WII for the first time to the beneficiaries of the intervention
- Practical feasibility and relative homogeneity within the study population

Based on these criteria, Fatick and Kaolack were chosen as focal areas for the formative evaluation. Since OSIRIS started its WII intervention in these locations in the rainy season of 2017, this provided an opportunity to accompany activities in their initial steps and to inform the standard protocol for bundling WII with credit in the coming years. Traditional agricultural insurance products had been made available by OSIRIS in 2016, targeting areas not suitable for WII and farmers who have their cultivated land outside of rain gauge reach (i.e. are located at more than 5 km distance from the nearest rain gauge). However, indemnity insurance take-up in the study areas was marginal and participants had previously not had access to WII through the network.

Farmer households in the central Senegalese regions are highly exposed to the impacts of drought and rainfall deficits on rural livelihoods (Sène, et al., 2006). This is related to their position within the 400-700 mm isohyets. Whereas the 400 mm isohyet divides the country into a predominantly rain-fed agricultural area in the south and a predominantly irrigated agricultural area in the north.

Despite their high exposure to rainfall-related risks, the regions in the centre represent the main contributors to Senegalese agricultural production (Jalloh, et al., 2013). In Fatick and Kaolack, the principal activity of the population is small-scale rain-fed agriculture with a relative preference for cash crops as compared to the south of the country where subsistence rain-fed agriculture is more widespread (Agence Nationale de la Statistique et de la Démographie, 2013). The most important cash crop in the study area is groundnut, which is grown in two varieties with short vegetative cycles: groundnut 90 days and groundnut 110 days. Table 1 below gives an insight on the characteristics of agricultural households in those regions and how they compare with the national average.

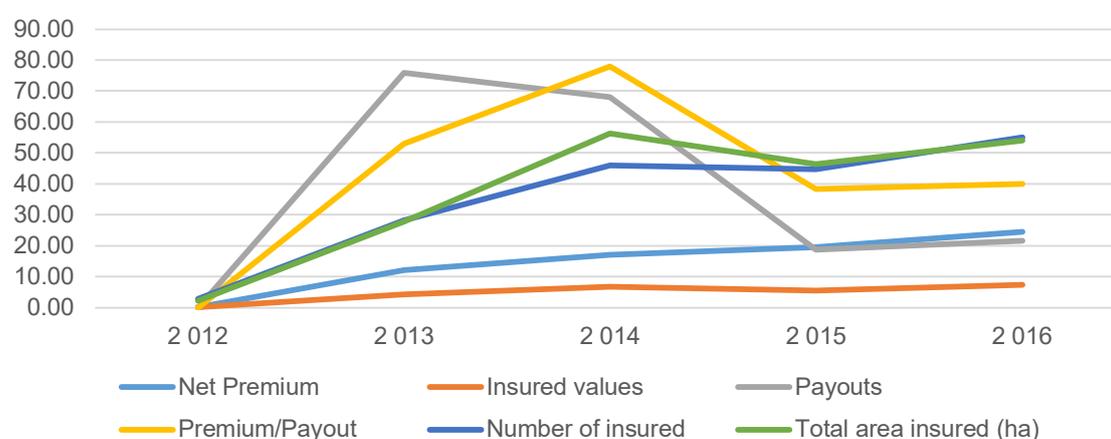
Table 1: Agricultural household statistics in the study regions

	Kaolak	Fatick	Senegal
Affiliated to a cooperative or farmer organisation	15,0	20,3	11,4
With total area under cultivation less than 6ha	59,1	72,3	69,8
Located in rural areas and practicing rain-fed agriculture	85,38	87,68	79,45
Headed by a woman	10,4	16,5	15,3

Source : Agence Nationale de la Statistique et de la Démographie (2013)

Agricultural insurance as a means to better manage weather-related risks and to support rural development has been attributed an increasing role in sectoral legislation and policy-making in Senegal over the past decade². The national agricultural insurance company CNAAS is currently the only supplier of agricultural insurance products in the country. The company operates as a public private partnership (PPP), with shares held by the government, private insurance companies and farmers' organisations. It provides both indemnity-based and index-based products, with the latter specifically targeting smaller-scale farmers. For this purpose, all WII premiums are subsidised at 50% by the government – an exceptionally high rate for West Africa and developing countries more generally (Sandmark, et al., 2013). The role of WII within CNAAS has been constantly growing since its introduction in 2012, though the shares of insured value and net premiums play a more minor role in the overall portfolio (Figure 3).

Figure 3: Share of WII in CNAAS portfolio



Source: Authors' figure based on data provided by CNAAS.

CNAAS delegates the design and the management of WII products to the broker Planet Garantie (PG). Since 2013, PG has been working with Farmers' Organisations (FO) and in some instances with community saving groups as aggregators to promote and sell the products. So far, WII is channelled mainly through the FO networks and solely to their effective members. This provides an institutional platform for insurance provision, but also points to limitations for scaling-up, given that, in 2013, only 11,4% of the farmers across the country were affiliated with an FO (Table 1).

Microcredit institutions can play a role similar to that of FOs in offering insurance to their members/clients. Indeed, since 2016, CNAAS is multiplying the agreement with microcredit institutions in order to develop a new network of aggregators for the provision and sale of WII next to the already existing FO networks. However, another hurdle to providing risk transfer and investment in agricultural production more generally is the low access to microfinance loans for poorer and more vulnerable small-scale farmers. The vast majority of farmers in the study locations are small producers (Table 1), who have less options for accessing financial services (International Bank for Reconstruction and

² See the official version of the national programme for the acceleration of agricultural development, Programme d'Accélération de la Cadence de l'Agriculture (PRACAS). https://www.ipar.sn/IMG/pdf/pracas_version_finale_officielle.pdf

Development / The World Bank Group, 2016). According to the World Bank's financial capability survey of 2015, the average financial inclusion rate in rural area was at 13.4% vs 21.7% for urban areas and 21.9% for men vs 13.4% for women. When it comes to the usage and knowledge of insurance products, the survey reports that 12% of the population know about it, while 5% have ever used it and only 2% were using it at the time of the survey. In rural areas, the results are 11%, 4% and 1% respectively. This outlines important work to be done to raise awareness around credit and insurance mechanisms, strengthen financial literacy in rural areas and enhance the utility of and access to products in order to increase financial inclusion.

3. Intervention description and theory of change

The formative evaluation presented in this study focuses on the OSIRIS project, which aims to (1) contribute to poverty eradication, (2) enhance social inclusion of rural vulnerable populations, and (3) strengthen social and economic protection of rural vulnerable populations who depend on the informal economy by offering services through cooperatives and mutuals in Senegal. OSIRIS has been active since 2015 and is ongoing until December 2018. The project builds on a partnership between Aide au Développement Gembloux (ADG), the Réseau des Organisations Paysannes et Pastorales du Sénégal (RESOPP), the Coopératives d'Épargne et de Crédit (COOPEC), the Groupe de Recherche et d'Appui aux Initiatives Mutualistes (GRAIM), the Groupe de Recherche et d'Échange Technologique (GRET) and the Compagnie Nationale d'Assurance Agricole du Sénégal (CNAAS). It is funded at 80% by the European Union for a total budget of € 5 090 000³.

The specific intervention we are evaluating concerns WII provision and bundling of WII with credit through a microfinance institution. While this was initiated as part of the OSIRIS project, the intervention will continue through ongoing collaboration between CNAAS and COOPEC/RESOPP after OSIRIS ends in 2018⁴.

Developing and delivering a WII product to cover crop production is one component, next to other activities such as technical support to farmers, indemnity crop insurance or the provision of life/disability insurance, through which the OSIRIS project aims to achieve its objectives outlined above. This operates in the context of pre-established relationships between COOPEC/RESOPP and farmers in the intervention areas. Through COOPEC, members of the network have access to credit in the form of agricultural inputs, including fertiliser, seeds and equipment. More specifically, RESOPP buys inputs in bulk in order to provide its members with quality products below the market price, especially at the beginning of the rainy season. COOPEC agents then collect applications for credit from farmers in terms of expression of needs for inputs and decide about their provision based on credit history and available collateral, before distributing the withdrawal orders. Since the price and availability of inputs is a big concern for poorer farmers, they have a vested interest in the services offered by the COOPEC/RESOPP system, but are also vulnerable to accumulating debt when failing to repay the loan at the end of the season.

³ For more information on the OSIRIS project and the specific roles of all involved partners, please consult <http://www.ong-adg.be/docs/Fiche%20OSIRIS.pdf?PHPSESSID=266910a8c8b8bc9c2b85f5e2810243d9>.

⁴ This means, the TW13 1073 Phase I formative evaluation operates entirely in the context of the OSIRIS project, while a potential Phase II impact evaluation will continue after OSIRIS ends.

Agricultural insurance is one mechanism through which OSIRIS intends to address this challenge

Despite the envisaged start of WII provision under OSIRIS in 2016, the commercialisation of the product was delayed. Initial meetings were held to inform and train COOPEC credit agents and other COOPEC/RESOPP local staff on index insurance concepts and procedures in 2016 and farmers were granted initial access to indemnity insurance that year, though take-up was negligible in most areas covered by OSIRIS. In 2017, installation of additional rain gauges and the timely preparation of commercial premium prices allowed for the start of index insurance provision in certain locations. Channelling index insurance transactions through COOPEC, which already offers credit services and life/disability insurance to member farmers, is intended to support continued stability and sustainability of take-up after the end of the OSIRIS project. Pre-established relationship between farmers and the network provide an initial basis of trust. In addition, cooperative member structures offer channels of communication which can be used to pass on information about WII products and coverage.

The Theory of Change (ToC) used as a basis for the formative evaluation was derived from a combination of OSIRIS project documents and existing literature around pathways to insurance impacts and related assumptions. Though recognising that the OSIRIS project contains additional components, the formative evaluation (and consequently ToC) focuses on index insurance and its role in contributing to the outlined objectives. The following sections introduce key components of the ToC (see Annex for graphical representation).

3.1 Objective:

Contribute to reducing chronic poverty and vulnerability in rural areas by helping farmers to better manage climatic risks and strengthen their resilience to rainfall-related shocks and stresses.

3.2 Potential constraints to index insurance take-up:

As existing literature highlights, pilot studies in most developing countries where they have been undertaken have reported a low uptake of index-based insurance compared to the initial expectations (Giné, 2008; Cole et al., 2013; Gine and Yang, 2009). Hill et al. (2011), underlined the fact that, on average, only about 10% of potential index insurance clients actually buy them and Matul et al. (2013) add that, even for widely subsidised insurance schemes, the subscription is rarely above 30% with renewable rates exceptionally modest.

Among the determinants of take-up are the level of trust towards (Dercon et al., 2011), and understanding of insurance (Takahashi et al., 2016) with a positive effect. Furthermore, liquidity constraints and affordability (insurance premiums are to be paid at a time when farmers hold little cash), lack of supply (infrastructure is not in place or product is not on offer), lack of demand (availability of alternative risk management mechanisms; basis risk/high premiums make the product unattractive or unreliable to farmers), or other behavioural explanations beyond trust and understanding (farmers are risk averse towards new products or underestimate the likelihood and severity of rainfall-related hazards) can negatively influence take-up. Concerning the influence of credit access on insurance take-up, findings are mixed: access to credit can have a negative effect in insurance take-up when it is a substitute (Gine and Yang, 2009; Banerjee et al., 2014; Zimmerman et al.,

2016) or a positive effect when it eliminates liquidity constraint for premium payments and functions as a complement to insurance (Carter et al., 2011; Jensen et al., 2014). The latter relationship represents a rationale for bundling insurance products with credit in the context of poverty and vulnerability in which many farmers in low income countries live.

However, the literature has also discussed the benefits and costs of bundling on WII and credit take-up with mixed results (Karlan et al., 2011). Regarding benefits, Matul et al. (2013) provide evidence from a bank in Ghana that experienced increases in insurance demand through savings linked to the insurance product. Zimmerman et al. (2016) in a study in Columbia found that overall take-up of crop insurance can reach 23% when bundled, which compares favourably to take-up with of similar products in other countries. Nevertheless, Banerjee et al. (2014) have pointed out the willing of borrowers to forego a microfinance loan in order to avoid mandatory health insurance, losing at the same time the lead products and the associated advantages. Gine and Yang (2009) also found that rainfall insurance contracts drive down the demand for credit if bundled. Taken together, existing research seems to imply that bundling may drive insurance take-up, but can have negative effects on credit use⁵.

3.3 Inputs:

The main input to the intervention entails designing, supplying (CNAAS/PG) and selling (COOPEC-RESOPP) index insurance to producers who apply for credit through the network in selected locations⁶. This requires the purchase and installation of rain gauges, training of financial service officers and the setup of product provision mechanisms.

3.4 Outputs:

At the end of the OSIRIS project, 1500 farmers will have access to rainfall-based index insurance through COOPEC-RESOPP. Established products and supply channels should guarantee ongoing provision of index insurance beyond the duration of the project.

Achieving these outputs is based on the assumption that the intervention will address constraints to index insurance take-up on both the supply and the demand side. On the supply side, OSIRIS will facilitate product design and delivery and set up sustainable provision channels. To address demand side challenges, the intervention will reduce liquidity constraints as the costs of index insurance is integrated with loans, so that farmers will repay the initial loan and the premium with interest at the time of loan reimbursement after the harvest. The intervention will neither directly address behavioural reasons for low insurance take-up, nor will it alter existing informal insurance mechanisms, though indirect effects on both components are expected and to be monitored. This entails, for instance, risk perceptions, trust in the insurance product over time and the use

⁵ A more exhaustive review on the effects of bundling on take-up and impacts of insurance and credit can be found in the recent paper by Marr, et al., (2016), though but most of the included studies focus on the effect on the supply side in terms of credit rationing and willingness of borrowers to lower their interest rate.

⁶ Locations selected for the intervention considered in this formative evaluation need to be part of the OSIRIS project area and lay within a 5 km radius of suitable rain gauges.

of alternative informal risk management mechanisms through social networks⁷.

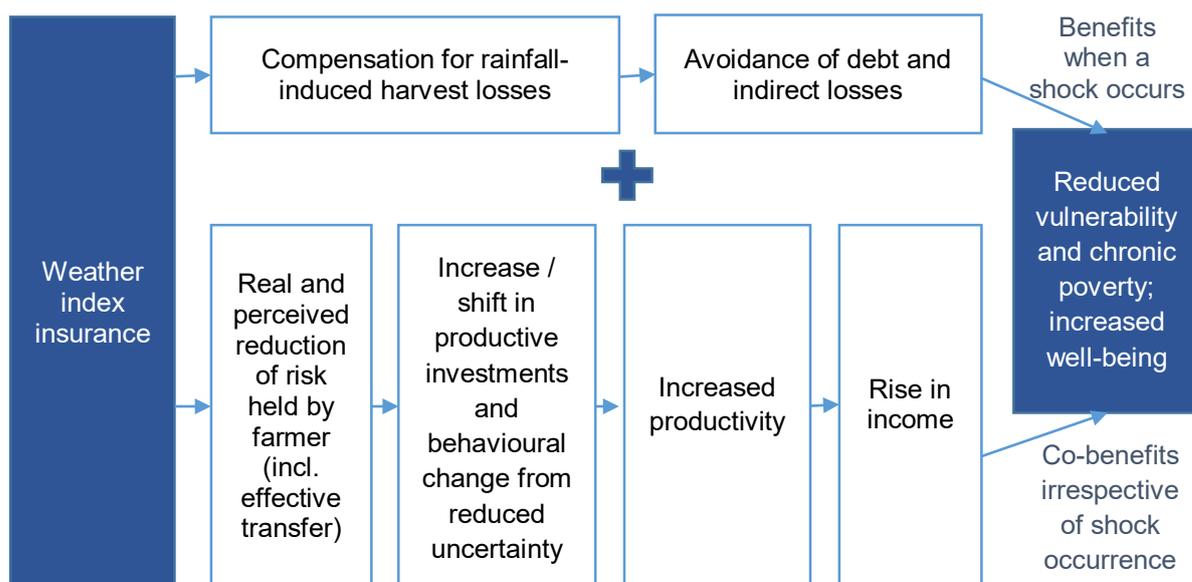
3.5 Outcomes:

In the short term, there will be a high effective take-up of WII. To poorer farmers, insurance will provide a possibility to reduce collateral requirements and enhance access to credit by using insurance as a partial subsidy to collateral. In the longer term, insurance will (1) compensate policy-holders for rainfall-related harvest losses covered by the insurance contract when a shock occurs and (2) stimulate agricultural and off-farm investments through risk transfer irrespective of a shock, resulting in increased productivity and higher levels of resilience (Figure 4).

Crucial assumptions underlying the achievement of longer term outcomes include reliability of the insurance product, especially under consideration of basis risk, and the expectation that farmers effectively re-invest unlocked funds in productive activities. Without insurance, and in the context of rural poverty, farmers' strategies to manage rainfall-related risks often consist of growing low-risk low-return crops or relying on harmful post-shock coping strategies. Weather index insurance, on the contrary, is expected to incentivise high-risk high-return crop cultivation, since it ensures compensation when a shock occurs (International Fund for Agricultural Development and World Food Programme, 2010). In this regard, it is imperative that farmers understand the mechanism of the WII product: a difference between actual risk transfer and what a farmer perceives can have negative impacts on well-being from the WII, when assets or income a policy-holder thought were covered are not indemnified after a shock occurs. In turn, risk transfer which is not perceived by the insured can cut the links with positive outcomes on investment and productivity.

Figure 4: Theoretical channels towards achieving welfare benefits from weather index insurance

⁷ Trust in the insurance provision channel is expected to be high, as all study participants are COOPEC-RESOPP member farmers and have previously requested credit through the network. However, this evaluation will not allow for a quantitative assessment of the relationship between trust in the institution and take-up, as the experimental stage does not entail a non-member control group.



Source: Adapted from Weingärtner, Simonet, & Caravani (2017)

3.6 Impacts:

The expected impact of the OSIRIS programme is a reduction in chronic poverty, to which weather index insurance contributes through preventing debt and increasing incomes – on-farm via the outlined productivity channels and off-farm via re-investments in additional income-generating activities. Impacts will depend on reliable and sustainable insurance mechanisms, farmers’ use of pay-outs in a way that increases their welfare and the realisation of economic co-benefits from insurance coverage even in the absence of a shock. Finally, building adaptive capacity to larger processes of climatic change, for instance through the integration of insurance with other services, will be crucial for ensuring impacts in the long run. If insurance were to incentivise maladaptive outcomes, resilience processes, and eventually well-being impacts could be undermined.

In the context of this ToC, the formative evaluation aims to help identify the sales protocol that is most likely to boost take-up of weather index-insurance and to assess what knock-on effects bundling may have on financial inclusion, thus focusing on outputs, immediate outcomes and related assumptions. We expect that farmers will prefer voluntary incentivised bundling, because it partially lowers collateral requirements and offers freedom of choice. Through stakeholder engagement and knowledge exchange at national level, evaluation results intend to inform wider strategies around the provision and take-up of weather index insurance in Senegal.

4. Monitoring plan

Monitoring of the WII and credit intervention has been carried out as part of OSIRIS general monitoring activities by ADG. In addition, CNAAS and COOPEC collect and monitor WII and credit take-up rates and will continue to do so after the end of OSIRIS in 2018. Even though OSIRIS project activities had started in 2015 for all areas of intervention, actual provision of WII started only in June-July 2017 - at the same time as field activities for this evaluation.

We provide here a list of core indicators used to follow the take-up of insurance. More details on input, output and outcome indicators of both the OSIRIS project more generally and components relevant to the specific intervention studied in this evaluation are presented in the table of monitoring indicators in Annex 6: OSIRIS monitoring indicators and study.

4.1 Inputs:

4.1.1 Trainings on WII functioning and subscription procedures

Since 2016, the OSIRIS project has been conducting training programmes for the COOPEC/RESOPP system to increase the understanding of WII, other agricultural insurance and ex-ante risk management mechanisms among their staff. This entailed (1) training of farmer's representatives and COOPEC/RESOPP's staff on the functioning of agricultural insurance products and (2) training of delegates and local people of influence on the procedures and details for subscription.

4.1.2 Awareness raising and advertising in villages where there are members of COOPEC/RESOPP

In all regions where OSIRIS is present, advertising and awareness raising campaigns were held in collaboration with the section of FO operating in each village that recorded at least 15 members. When the number of members was less than 15, the villages were regrouped in one section. The representatives and head of each village section were playing the role of intermediaries, sharing information with members. They were also delegated to explain the product to any new farmer who wanted to become members of COOPEC/RESOPP.

4.1.3 Access to WII through the installation of new rain gauges

To improve access to WII, 2 new rain gauges were installed in collaboration with CNAAS in the COOPEC/RESOPP intervention areas in 2017. In combination with the 2 already existing rain gauges installed in earlier years, this meant that 4 operating rain gauges were available in the area, each of them covering a radius of 5 km. Unfortunately, the 4 rain gauges were not enough to cover the entire study population as 5 rain gauges were originally expected to be in place at the beginning of the rainy season, but the installation of the last gauge was postponed at the last minute.

4.2 Output:

4.2.1 Knowledge of risk coping/transfer mechanisms available for agriculture activities

In the localities of the intervention, 122 villages were visited by COOPEC/RESOPP and OSIRIS staff in order to raise awareness for adhesion to the products. This was open to all village residents, not only to members of COOPEC/RESOPP who were initially targeted.

4.2.2 Understanding of the agricultural insurance products and the subscription procedures

Overall, 26 farmers' delegates were trained (22 men and 4 women) on the procedure and details for subscription. Besides these delegates, 7 local people of influence (6 men and 1 women) also received trainings. This entailed heads of villages or political representatives who were respected locally. Regarding the characteristics and functioning of insurance, especially for WII, 19 farmers' delegates were trained (9 men

and 10 women). Mostly were representative and head of villages sections. 7 COOPEC/RESOPP staff members also received trainings (5 men and 2 women). These trainings aimed to enable participants to explain the products to any farmer who is interested in insurance and had further questions of understanding. Head of village sections could then provide answers and explanations at the village level and COOPEC/RESOPP staff could give more precision at the booking office level.

4.3 Outcome:

4.3.1 Effective take-up as the number of farmers who paid a premium (either cash or by credit)

This is directly measured by the number of farmers who actually paid for the insurance premium after expressing their interest in obtaining WII. As WII was bundled with credit, only farmers whose application for credit was accepted could access to the insurance through the COOPEC/RESOPP. Other farmers for whom the credit was refused had the option of purchasing insurance directly from the insurer (with higher transaction costs and no possibility of pre-financing the premium through credit) if they were interested. To our knowledge, however, there was no independent insurance take-up outside of the COOPEC/RESOPP system in the intervention area.

As explained in the input section, only 4 rain gauges were installed amongst the 5 expected, which led to a shift from WII to traditional insurance for people who wanted to take the WII and whose localities were not covered by rain gauges. Thus, amongst the 253 farmers who decided to take insurance, 158 farmers actually purchased WII, while 96 purchased traditional insurance. 61 other members of COOPEC/RESOPP who applied for credit but were either not in a locality covered by a rain gauge or changed their mind after they had initially declared that they were not interested in the insurance product also decided to purchase traditional insurance. In total, 315 insurance contracts were sold in the intervention area in the 2017 season.

5. Evaluation questions and primary outcomes

Our intervention builds on the premise that a sustainable increase of WII take-up should pass through the intermediaries and aggregators, such as FOs or microfinance institutions. This allows to benefit from and strengthen embedded structures that can continue WII provision after pilot projects terminate and therefore deepen financial inclusion in the long run. This, eventually, should enhance the resilience of rural livelihoods and agricultural production and ensure access to markets more generally. As outlined in Chapter 3, bundling insurance with credit is expected to overcome liquidity constraints and increase the access to financing. This enables poorer farmers to bypass the collateral problem, while credit reduces the barriers to insurance take-up that may result from premium prices and liquidity at the time of premium payment. Unclear, however, is whether the bundled product is perceived as a valuable product by farmers, how it corresponds to their specific needs, whether liquidity issues and a lack of collateral are actually the main constraints to WII take-up and financial inclusion, and whether making bundling a mandatory or a voluntary option drives take-up more. Thus, the questions we seek to answer in this evaluation include:

- 1) What sales protocol (voluntary or mandatory bundling) is more likely to help reach the objectives of poverty and vulnerability reduction through increasing

insurance take-up?

- 2) To what extent is take-up of the bundled product increased by using index insurance as a complement to collateral for credit?

We recognise that take-up may be influenced by additional factors that are not inherent to the financial product. The following questions thus aim to further guide the formative evaluation by assessing additional possible hurdles to take-up beyond liquidity and collateral and by checking the underlying assumptions to the intervention (see Theory of Change):

- 3) What factors beyond those addressed by the bundled product (liquidity and collateral) may support or inhibit insurance take-up by farmers in the study areas and how can these be addressed by the intervention?
- 4) How do the suggested products and intervention processes adhere to farmers' needs with regards to managing agricultural risks and providing adequate financial services?
- 5) How may the intervention support farmers' risk management and deepen financial inclusion?

Primary findings that are of interest in the study therefore entail most importantly the identification of the sales protocol that represents the most favourable way for bundling WII with insurance in terms of enhancing insurance take-up. Though take-up is the key outcome of interest here, we also consider other potential co-benefits and adverse effects that may result from bundling, such as a possible decrease in access to credit when bundling is mandatory (see Chapter 3). Results related to sales protocols will be discussed with relevant stakeholders of the OSIRIS project and the national agricultural insurance company CNAAS, to inform bundling strategies in the study context and to review implications on a national level. Further findings of interest include a better understanding of farmers' needs for (risk) financing, additional constraints and contributors to WII take-up that are not addressed by bundling and the perceptions and expectations of farmers with regard to how WII can meet their financial needs and support their livelihoods.

6. Evaluation design, data and methods

The design of the evaluation follows a mixed-methods approach, consisting of four steps: (1) key informant interviews, (2) a randomised controlled trial (RCT), (3) a survey and (4) focus group discussions. Initial impressions from each of the steps fed back into the following steps. This iterative process allowed for complementation and triangulation throughout data collection and analysis.

6.1 Key informant interviews

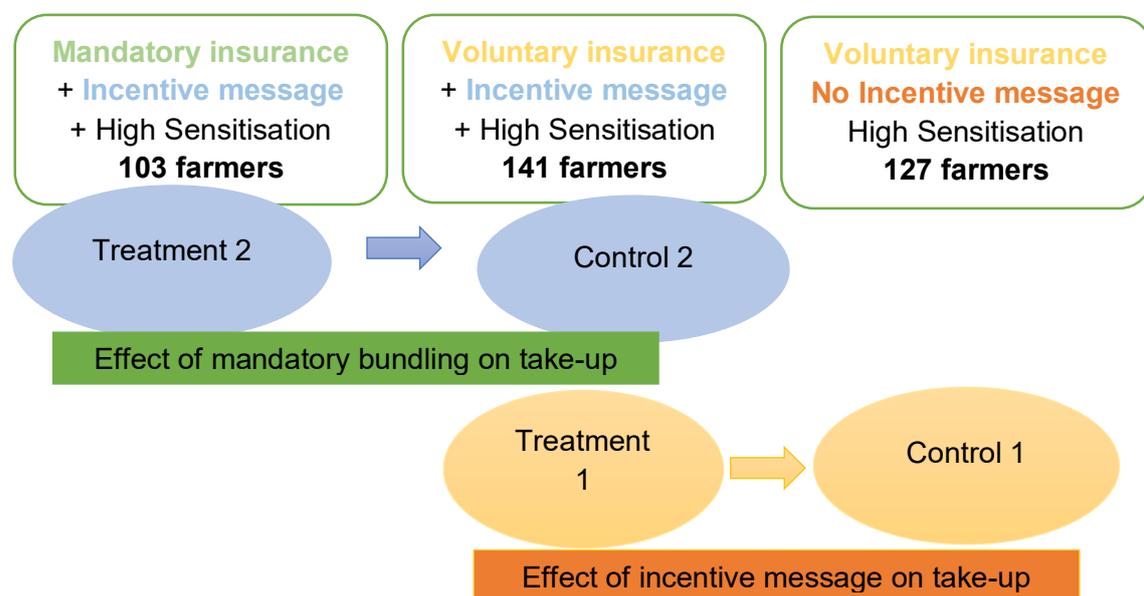
Key informant interviews (KIIs) were conducted with leading figures in the OSIRIS project partner organisations at the outset of the data collection process. This was important to check some key underlying assumptions, to better understand the study context and to get a better picture of the technical side of the intervention. KIIs entailed four oral semi-structured interviews and one written exchange with main partners and implementers in the OSIRIS project: ADG, RESOPP, COOPEC and CNAAS. Interviews served to inform further data collection and yielded insights about OSIRIS project

strategies, activities and challenges.

6.2 Randomised controlled trial

The comparison of different sales protocols was undertaken through an experimental step in the evaluation, using an RCT design. Based on stakeholder engagement and secondary data screening, we assumed relative homogeneity in the study population, which allowed us to conduct an RCT without a full baseline survey⁸. The unit of treatment is at individual level. As previously highlighted, all study participants were COOPEC/RESOPP members in the Fatick and Kaolack regions and applied for credit before the beginning of the 2017 rainy season. Participants were randomly assigned through one of the three control and treatment groups, which are summarised in Figure 5.

Figure 5: RCT group comparison - control and treatment sales protocols



Source: Authors' own figure

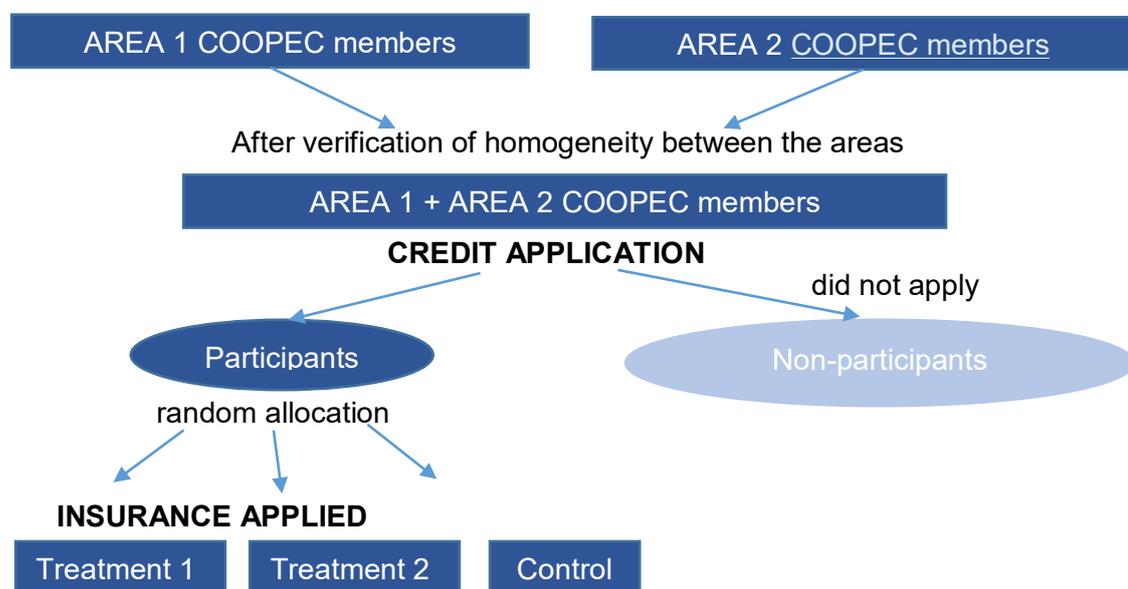
Since the product of interest in the study was WII, only farmers who were located in an area already covered by rain gauges already installed or whose installation was ongoing could participate. Because of the WII and credit bundling aspect, participants had to be chosen among COOPEC/RESOPP credit applicants. Credit applications were conducted according to standard COOPEC procedures before the beginning of the rainy season. Combining applications and rain gauge coverage in Kaolack and Fatick resulted in a total of 425 potential participants. The power calculation based on the design of the study indicated a minimum of 322 required participants⁹. For additional buffer, and given that the difference between these two figures was not too large, all 425 eligible farmers were considered in the study.

⁸ Homogeneity tests after full data collection confirmed this assumption. See the Kruskal-Wallis test results in Annex 7: Statistical tests.

⁹ The sample size required for the study was 246 farmers. Please see **Erreur ! Source du renvoi introuvable.**, for the calculation formula and details on the sample size.

After credit applications were completed, the eight sale agents presently working at the booking offices in the study area participated in a 3-day training on WII products (in addition to training they already received as part of the OSIRIS project) and the specific design and implementation of the study. Working with these agents has the particular advantage of creating realistic scenarios, as they would be the primary contact providing insurance to farmers even in the absence of the study. After having completed the training, agents engaged a second time with the 425 identified farmers, offering them to purchase WII coverage according to the specific sales protocol to which they were assigned. All agents used a tablet-based application during this interaction, which was designed specifically for this study to randomly allocate participants to the different treatment and control groups after they had confirmed their participation. Figure 6 graphically displays the study population, sampling and allocation to sales protocols.

Figure 6: Description of RCT sampling and design



Source: Authors' own figure

As described in Chapter 2, Kaolack and Fatick were chosen as the study areas based on their coverage by the OSIRIS project, their specific environmental and livelihoods context, and the relative social, economic and ecological homogeneity. The number of COOPEC credit applicants, i.e. potential study participants, per rain gauge in each of the two regions is displayed in Table 2.

Out of these 425 farmers that applied for credit, 371 finally participated in the study intervention. The remaining farmers were either absent at the time of contact with sales agents, withdrew their application for credit because they had found another alternative in the meantime, or refused to participate to the study. Among the 371 participants, 31.46% ended up in the control group, while 39.61% were allocated to treatment 1 and 28.93% to treatment 2 (see Figure 10 for the statistics of the participants in both the intervention and the survey of the study).

Table 2: Repartition of the study population across areas

Location of the study Rain gauges	Study rural commune	Members to the RESOPP in the study commune	Number of the study villages	No. of Applicants for credit from the study villages
FATICK				
1. Thilla Keur Khalifa	Niassène	517	8	167
2. Ndiobène	Diossong	420	7	148
3. Diagane Barka	Diagane Barka	315	6	61
KAOLACK				
4. Thialapp	Dya	212	8	42
5. Thioupane Diakhamène	Thiomby	569	1	7
TOTAL		1096	30	425

Source: Authors based on monitoring data from OSIRIS project

6.3 Survey

A survey complemented the RCT by providing detailed information related to the individual and household socio-economic characteristics of participants. The questionnaire was also used to explain farmers' decisions to take or leave the insurance product and to evaluate their thoughts on the specific sales protocol they were assigned to¹⁰. Control questions were also asked to investigate whether the farmers would change their decision if they were shifted to a different group and were offered insurance in other ways.

The survey was instrumental for assessing additional contributors and constraints to take-up and for generating an understanding about farmers' perceptions and preferences related to WII. Eight experienced interviewers were recruited for the survey. Each of them received one tablet to conduct the survey. All 371 farmers that had been offered WII and bundling with credit in step 2 were approached to take part in the survey. As interviewers were unable to meet some of the initial participants and others refused further participation in the study, a total of 346 farmers were interviewed during the survey. Table 3 shows the total number of participants per group throughout different stages of the study.

Table 3: Repartition of study participants by RCT, survey and actual WII take-up

	Treatment 1	Treatment 2	Control	Total
Applicants for credit	-----	-----	-----	425
RCT participants	141	103	127	371
Survey	133	96	117	346
Actual insurance¹¹ take-up	92	73	88	253

Source: Authors' own table

¹⁰ For the latter, the survey needed to be implemented after the RCT step instead of serving as a baseline beforehand.

¹¹ Both index-based and traditional indemnity-based agricultural insurance. Because of the delay in the installation of the last expected rain gauge in the study area, farmers who decided to take the WII in the villages that were supposed to be covered by that rain gauge received traditional insurance.

6.4 Focus group discussions

Instead of administering individual interview questionnaires with all credit agents and local COOPEC-RESOPP staff, they were invited to participate in a FGD after implementation of the field experiment. This allowed agents to reflect on the insurance sales processes, to share feedback on interactions with farmers and to discuss constraints to WII take-up.

Table 4: Repartition of the FGD participants

Insurance take-up	Sex	Treatment 1	Treatment 2	Control	Mix	Total
Yes	Men	2 (24)	2 (19)	2 (23)	--	6 (66)
	Women	1 (8)	1 (7)	1 (10)	--	3 (25)
No	Men	1 (8)	1 (7)	1 ()	1 (4)	4 (19)
	Women		1 (5)	1 (4)		2 (9)
Total		5 (40)	5 (38)	4 (37)	1 (4)	15 (119)

Source: Authors' own table¹²

In addition, a total of 15 FGDs were conducted with farmers who participated in the study, i.e. who had also been part of the field experiment and the survey. The objective was to gain a deeper understanding of how farmers perceived the different treatments and how this influenced their decision about insurance take-up – both from people who purchased insurance coverage and from those who decided not to subscribe. We therefore undertook a stratification by treatment, acceptance/refusal of take-up and gender. The justification of the gender stratification was twofold: (1) women may respond differently to insurance as compared to men because of differences in their livelihoods, implications related to economic and social structures or variation in how they understand and address risks; (2) when pooled with men in a same discussion groups, women may be reluctant to speak out especially if their position is different to those of men. We also included one mixed group (with people from different control/treatment groups), which was necessary due to the low number of participants who did not purchase an insurance policy in area 1.

Participants for the focus group discussions were randomly selected from the list of people fulfilling the respective stratification requirements and their number was proportional to the size of the group (gender/response to take-up/treatment) to which they belonged. When pools of potential participants consisted of 6 people or less, all of them were invited to participate in the discussion but people who declared that they would not be able to attend could not be replaced in these groups as was the case in other groups.

6.5 Secondary data from COOPEC/RESOPP and OSIRIS

In addition to primary data collection, we relied on secondary data from COOPEC/RESOPP and OSIRIS partner institutions throughout the study. At the loan application stage, secondary data provided by the COOPEC/RESOPP informed the identification of credit applicants, their location, the amount of credit they applied for, the type and level of collateral they intend to provide, and information related to their

¹² The first number of the cells is the number of groups and the second number is the total number of participants. For example, two groups "Men/Yes/Treatment1" were constituted for a total number of 24 participants in that category.

agricultural activities (surface of the farm, type of crop etc.). Those data were completed with the OSIRIS monitoring data provided by its coordination team and the insurance company CNAAS in order to recruit only those credit applicants located in areas where WII would be available.

6.6 Quality management

To ensure quality of the primary data, a day by day follow up plan of all activities undertaken as part of the RCT, survey and FGDs was undertaken. To support questionnaire design, a survey monitoring specialist was recruited to code questions in CsPro, load them onto tablets and link each tablets with a Dropbox account. Subsequently, eight experienced interviewers received training conducted by the survey specialist in presence of the coordinator of the study and the research assistant. All questions were reviewed and discussed for a standardisation of their meaning amongst the interviewers. Finally, the interviewers were sent to the field with two assistants for supervision and coordination. The first survey day was used to test questionnaires and the apps for correction of errors and bugs. Throughout the survey, the coordination team was circulating between the interviewers and collected data were loaded in the Dropbox accounts for verification on a daily basis. The survey specialist could then check their accuracy and provide comments for each interviewer.

Regarding qualitative data, more specifically the focus groups, a facilitator familiar with the study areas administrated the questionnaires. All FGDs were held in a neutral place without the presence of any member of COOPEC staff in order to make sure that people could speak freely and response bias would be kept to a minimum. As part of the data collection processes, compensation was provided to participants in those cases where their participation required that they come from their home location to another village. This was the case only during the focus group stage.

7. Study timeline

Main activities as part of this formative evaluation were undertaken between February and October 2017 (Figure 7).

The timeline required only minor adjustments throughout the year. The most crucial shift concerned the credit application period, which began two weeks ahead of schedule due to earlier availability of funds and the beginning of the rainy season. Originally, it was envisaged to record demand for the weather index insurance products together with farmers' applications for credit from COOPEC. The earlier credit application period meant that capacity building of credit agents on index insurance products and provision could not be carried out as planned. Instead, it was decided to adjust the timeline, conducting training of agents after they had collected credit applications and carrying out awareness raising and demand assessment activities (as part of the field experiment) after credit applications were completed. Flexible management of the timeline and study activities – in coordination with stakeholders – allowed the research team to adapt plans while avoiding major delays of subsequent activities.

Figure 7: Study timeline



Source: Authors' own figure

8. Analysis and findings from the evaluation

8.1 WII contributions to risk management and financial inclusion

This chapter addresses how the intervention adheres to farmers' needs with regards to managing agricultural risks and providing financial services and, consequently, how it may support risk management and deepen financial inclusion.

8.1.1 Perception of shocks and losses

Farmers in the study area face unfavourable climatic conditions for agricultural livelihoods. In a context where agriculture is rain-fed, rainfall variability is a challenge that is expected to often become even greater if climate trends persist. Moreover, the perception of interviewed farmers suggests a situation that has put them under increasing stress: 54% of them say that rainfall has declined during the last three years and more than 35% believe that it has become more erratic (Figure 19).

As for the experience and perception of shocks, we note that climatic and hydrological conditions are a major concern. More than 40% of the producers interviewed said they had suffered either flooding or drought. Around 37.5% of producers were affected by poor harvests (Figure 20), of which a good proportion may additionally be attributed to these rainfall conditions. It is surprising that the decision to insure does not appear to be motivated by previous experience of rainfall-related shocks in a very obvious way. But disentangling this relationship shows a clearer correlation, which is rather based on the magnitude of the losses induced by the shocks. Although WII subscription rates are generally high, we note that producers who decided to take out insurance are not the ones that have lost the most after a shock. Thus, amongst people recording no losses from a shock, 26.51% decided not to take the insurance product. For those whose losses are between 0 and 500 000 FCFA, 36.52% did not purchase insurance coverage. But among those who lost the most during shocks, i.e. 1,000,000 FCFA or more, 17.02% decided not to subscribe (Figure 21). In the interpretation of this relationship, it is important to consider that the wealthiest farmers also have the most to lose, while their losses in relation to income may not actually have as much of an impact as the same absolute amount would have for a less wealthy person¹³.

In focus group discussions, participants outlined the different types of risks related to their livelihoods in the study areas. Agricultural production, according to respondents, represents the most dominant source of income across households and rainfall deficit, excess and variability throughout the plant growing phases were described as the most impactful hazards. At the same time, however, other common livelihood activities include livestock rearing, as well as gardening, groundnut transformation and commerce, with the latter three being especially relevant amongst women. In addition to rainfall-related risks, respondents were also concerned by pests and insects, destruction of agricultural produce by livestock and related conflicts between herders and farmers, livestock theft and market-related risks, including access to agricultural inputs and prices for outputs.

8.1.2 Relevancy, intervention fidelity and compliance

In focus group discussions, respondents generally judged the WII product relevant to support their livelihood risk management based on the information they had received from COOPEC credit agents and exchanges with peers. In the survey, only 8.53% of the interviewed farmers thought that index insurance could not help them manage rainfall deficit risks. Farmers' expectations towards the WII product, however, were dispersed and sometimes linked to a limited understanding of the product. Despite a general notion that insurance would somehow provide compensation for a bad harvest, misconceptions about what the specific WII contract covered were prevalent. Some farmers, for instance, assumed that a policy would allow them to receive an indemnification in case of flood, while others linked the product to bad harvests in general, without specifying a sufficiently large and specifically timed rainfall-deficit as the condition¹⁴. Overall, the majority of FGD participants appeared to judge the WII product as generally relevant and valuable to their specific financing needs.

¹³ Such an analysis would be more pertinent if relative losses were considered. However, this was not possible as part of this study, because of the relatively short timeframe taken into account for assessing losses and the missing losses for many households, which would introduce a bias on the results.

¹⁴ After each FGD, facilitators provided an opportunity to ask questions and clarified some of the misconceptions where these were evident from the discussion.

However, the large variety of risks outlined in the previous paragraphs also point to one of the crucial limitations of WII. Unlike indemnity insurance or more comprehensive risk financing approaches, WII only covers a very confined set of hazards. This was highlighted as an important limitation to the relevancy of WII by FGD respondents. While only 15% of survey respondents stated that receiving insurance pay-outs after a bad rainy season and the option to pre-finance premiums through credit were not sufficient as an incentive to purchase WII, many FGDs revolved around the need to also take into account and manage other risks. This appeared to be a concern not only for farmers, but also for the insurer (CNAAS) and intermediary WII provider (COOPEC/RESOPP). KII respondents and local agents regarded WII as a mechanism to enhance overall stability of COOPEC/RESOPP activities, a way to secure loans and an incentive for increasing investments in agriculture. In this context, they also recognised the variety of additional natural and non-natural hazards which could result in a farmer's default on credit provided by the cooperative. Some of the related risks were already as part of the OSIRIS project, including for instance the provision of life and invalidity insurance, but others such as price fluctuations and uncertainty around the timely provision and quality of agricultural inputs remained. These findings strongly resonate with recent literature, which highlights WII as a complement rather than a supplement to informal and other formal risk financing mechanisms (Mobarak & Rosenzweig, 2012; Berg, Blake, & Morsink, 2017; Takahashi, Barrett, & Ikegami, 2017).

8.1.3 Index insurance and credit matching: Producers' financing needs, an opportunity to increase underwriting of index insurance

Potential beneficial links between insurance and credit include facilitated access to credit because insurance can function as a complement or (partial) substitute for collateral and credit releases the liquidity constraints for paying insurance premiums through pre-financing (see Chapter 3). Next to the expected compensation of losses from the insurance payout in case a rainfall deficit occurs, bundling may therefore provide further economic co-benefits to producers. Whether these co-benefits will incentivise insurance take-up, however, is expected to depend on farmers' financial assets and preferences. Someone who can provide sufficient collateral to take out a loan and relies on savings to cope with harvest losses, for instance, may not be interested in the bundled product.

Data collected and analysed in this study sheds light on these specific financing needs of producers. Concerning the need for credit, we find that 66.47% of the surveyed producers declare that they do not have the capacity to finance an agricultural season on the basis of their own capital. In addition, almost than 70% of those who have subscribed to index insurance are producers who have difficulties financing productive activities with their own funds (Figure 13) and 93% of those who have taken the insurance say that bundling is a sufficient motivation to subscribe. Thus, one of the main problems faced by farmers is the relatively high level of need for financial resources. The solution of linking insurance with credits can, in some ways, be beneficial at two levels. Firstly, on the supply side, credit institutions' confidence in applicants may increase, as there is some securitisation of their loans thanks to the transfer of rainfall-related risks to the insurer. On the demand side, this measure reduces the risk of farmers failing to pay back loans in the event of poor production due to lack of rain, thus preventing debt traps. However, it must be recognised, as the results showed earlier, that, in practice, the specific way in which insurance and credit are bundled does not have a significant impact on the

propensity to subscribe. An exception to this is the option for pre-financing premiums through the bundled loan. Though the RCT did not measure this effect directly, it was a key feature of bundling that many FGD respondents highlighted as being essential for facilitating access to WII coverage. Next to this advantage, however, more investigation is needed on potential strains introduced by the additional amount of credit for WII premiums taken out by farmers. For example, if a harvest is worse than expected due to circumstances not related to a rainfall deficit, re-paying the premium along with credit and interest, can represent an additional burden for farmers after the rainy season. Welfare impacts of pre-financing over time should therefore be more closely examined in longer-term evaluations.

The question of how insurance take-up relates to invested capital was also explored during the field investigation. It turns out that the specific variety of groundnut planted imposes different levels of financial needs on producers: groundnut 110, which is harvested 110 days after planting, requires far more financial resources than groundnut 90, which takes 90 days to mature. On average, for a producer of groundnut 110, around 117 490 FCFA are mobilised per season, whereas this amount is 94 330 FCFA for groundnut 90. When connecting this to the insurance take-up rate, the average capital invested by those who actually subscribe to index insurance is relatively high (125 273 FCFA) as compared to those who did not take out insurance (83 285 FCFA) (Figure 15). Thus, this shows that the greater the exposure in terms of financial investment, the greater producers' willingness to subscribe to insurance.

8.2 The effects of mandatory and voluntary bundling on WII take-up

Now, if we refine the analysis by looking at the take-up rate within each group of the RCT stage - i.e. voluntary without incentive (control), voluntary with incentive (voluntary) and mandatory with incentive (mandatory) - we find that in all groups the acceptance rate is much higher than the refusal rate with 74.11%, 68.79% and 76.7% respectively (Figure 12). However, bi-variate analysis and the comprehensive estimation in Chapter 8.2. show that these differences between groups are not statistically significant¹⁵, i.e. we do not find that mandatory bundling of credit and WII results in lower insurance take-up rates as compared to the other tested options, when offered to credit applicants. Contrary to expectations, this finding implies that the strength of the insurance take-up rate does not depend on the specific way of bundling insurance with credit (from the options tested in this study) or even on an explicit integration of both products (beyond the option of pre-financing premiums through credit) in the first place.

In relation to findings from previous literature, our results are original in the sense that, to our knowledge, no study has yet directly compared the impact of mandatory and voluntary bundling of loans and crop weather index-based insurance on take-up and few have empirically explored other aspects of bundling. Among them are Zimmerman et al. (2016), who studied the effect of 'responsible' bundling in comparison to self-standing products and found that overall take-up of crop insurance can reach 23%. This compares favourably to take-up of similar products in other contexts. In the literature on demand for

¹⁵ To assess significance, a Kruskal-Wallis H test was conducted (for results, see Annex 7: Statistical tests). This is a non-parametric test that estimates the significance of the difference between two or more groups on a dependent variable that can be continuous or discrete.

health, Banerjee, Duflo, and Hornbeck (2014) have pointed out the willingness of borrowers to give up a microfinance loan to avoid mandatory health insurance in India, losing at the same time the lead and the additional product. Our findings on relatively high rates of take-up of the bundle across treatment groups and the adverse effect of mandatory bundling on credit applications confirm both studies in the context of weather index-based insurance linked to loans in Senegal.

Regarding the comparison between stand-alone credit or insurance and take-up of the interlinked products without differentiation of the bundling methods, Giné and Yang (2009) showed in one of the first studies on the topic that simply offering credits and loans together without additional advantages or links between the products does not increase the take-up of index insurance. Carter et al. (2011) enriched these results, refining the analysis by distinguishing farmers in terms of level of collateral they possess. They showed that interlinked contracts can stimulate technology adoption for both farmers with low levels and high levels of collateral while stand-alone insurance does not provide additional advantages to farmers with low collateral. These results are consistent with our findings on the potential positive effect of incentivizing insurance take-up as a partial supplement to collateral (see Figure 8: Verification of take-up in the survey), but the impacts of bundling on technology adoption, as well as on farmers' well-being more generally, remain to be established through an impact evaluation in the Senegalese context.

Nevertheless, mandatory bundling of insurance with credit led to 23.3% of credit applicants in the mandatory treatment group opting out of taking the credit. Though more information and discussion with peers about insurance appeared to decrease the opting-out rate over time, results imply that the effect of mandatory bundling on credit take-up can be relatively strong (given that the two other sales protocols implemented had no effect on credit take-up), whereas it has no significant impact on insurance take-up. Assessing the characteristics of farmers who opt out of credit when insurance is a mandatory add-on helps to understand this effect¹⁶.

Assessing take-up according to sex of the COOPEC member farmer who applies for credit reveals clear similarities between men and women, as overall insurance take-up rates are over 75% for both. The refusal rates are equally similar at nearly 25% on both sides (Figure 7). When further disaggregating this across control and treatment groups, however, the trend seems not to apply to those offered the mandatory bundling option. Women in the mandatory incentivised bundling group had a lower take-up rate than those in the two other groups, whereas for men in this group the take-up rate was higher than for men in any of the other two groups (Figure 17 and Figure 18). Though this difference is not significant in our results, the literature more generally points towards differences in the use of financial services according to sex. Potential reasons why this may be the case with regards to bundling WII and credit might be that (1) women applicants are less reliant on the credit than men, which means their threshold for pulling out in the case of mandatory bundling would be lower, (2) they are more resource-constrained, i.e. their opportunity costs for purchasing insurance are higher, or (3) they are more risk averse to the insurance product than to rainfall-related risks. Women's higher levels of risk aversity towards innovative financial products have been described

¹⁶ See Annex 3: Characteristics of farmers who decide to leave the bundle when it is mandatory

in other contexts in the literature (Akter, et al., 2016). However, given that insurance take-up rates in the other two groups (voluntary incentivised and non-incentivised bundling) are similar for men and women, our findings lend more support to the two alternative explanations presented above. Disaggregating take-up by sex thus highlights the potential negative implications of mandatory bundling on women’s access to, and use of, credit.

8.3 WII as a complementary collateral for credit

The question of whether WII as a complementary collateral for credit can incentivise insurance take-up is assessed by comparing treatment 1 (voluntary incentivised bundling) and control 1 (voluntary no incentive bundling). From the RCT, we find no significant difference in insurance take-up between farmers who received the incitation message and the ones who did not. Nevertheless, when people were asked during the survey whether they would take the insurance in each control and treatment scenario we noted a net difference.

The decision to take out WII falls drastically when people receive repeated information that take-up will have no effect on the treatment of their loan application. This suggests that people in the control group (voluntary no incentive) initially interpreted the introduction of the WII product itself as a pre-condition for access to credit, even though the conditions were laid out by credit agents according to the allocated group during the RCT phase. Indeed, as the FGDs highlighted, due to low access to credit and agricultural inputs (seeds and fertiliser more specifically), people did not take the risk to decrease their chance to get funded, even if they did not fully grasp the concept of the WII or the bundled product. Therefore, most of them decided to take out WII irrespective of other considerations.

Figure 8 and Figure 9 present these results in terms of decision-making during the experiment (Figure 9) and the take-up decision when farmers were asked whether they would purchase the insurance if the random process assigned them to one of the two other groups instead of their initial one (Figure 8).

Figure 8: Verification of take-up in the survey

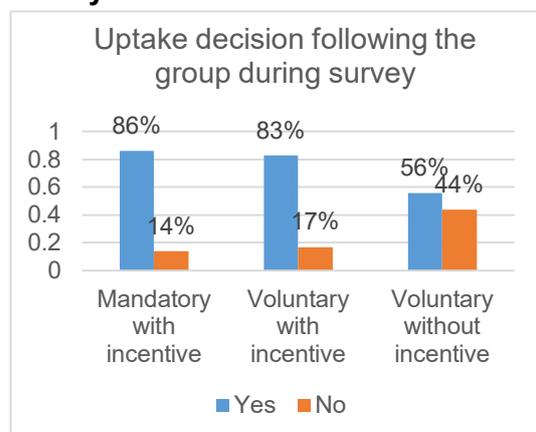
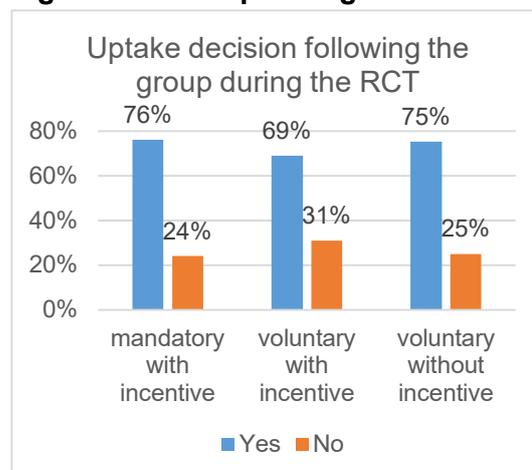


Figure 9: Take-up during the RCT



Source: Authors’ own figures

We would generally expect over-reporting of willingness for take-up in the survey, where external survey staff and framing of questions may result in satisficing or biased responses, as compared to the experimental stage where the cooperatives' agents collected actual demand. In addition, farmers had time to share information with others between the two stages, which may have led to a better understanding of the insurance product itself and the modalities of bundling, as was reported in the FGDs.

Remarkably, take-up dropped from 75% to 56% between RCT and survey for the control group which was offered voluntary bundling without incentive. This suggests that people in this group did not take their decision during the RCT according to the characteristics of their sale protocol only. From FGDs it became evident that some farmers in this group did not believe in the independence between WII and credit, which may have been related to spill-over effects, for instance when farmers heard about the implications from family or friends who may have been in one of the treatment groups. Most farmers in the control group then took their decision as if the insurance was bundled to the credit because they feared to reduce their chance to be granted a loan. Though the incentive did not make a significant difference for WII take-up during the experiment, the survey indicates that its role is actually more crucial, especially as farmers gather more information about the bundled product and its implications

8.3.1 Transparency and awareness - fundamental elements to influence the subscription rate

Overall, the observed changes in decision-making between the RCT and the survey went both ways and were stronger than anticipated. This indicates some sense of insecurity around the product and whether to purchase it or not, especially at the time of initial contact. This highlights the crucial need for the insurance company and intermediaries such as COOPEC/RESOPP to make sure that the index insurance product is well understood by potential subscribers, allowing them to evaluate the usefulness of incentivised bundling for their situation. Survey responses and focus group discussions revealed that some producers did not really understand the purpose of the product offered, the advantages of incentivised bundling and the conditions for compensation. Although the proportion of producers who changed their minds is relatively low (8% initially did not purchase the product but later expressed interest and 5.71% vice versa), good comprehension of the product and the conditions tied to it are crucial not only for immediate take-up but also continuous for renewal and eventually the sustainability of insurance provision. In a context where the introduction of index insurance is still very recent and where there is some mistrust tied to the insurance sector more generally, awareness and understanding in the early stages of market development are key. In addition, transparency and information around index insurance and its implications need to be provided to ensure consumer protection.

8.4 Determinants of WII take-up across the three sales protocols

The take-up rate for the WII product offered to farmers during the experiment is fairly high. Overall, 72.5% of producers who were network members and had applied for credit through COOPEC before the start of the 2017 rainy season decided to take the insurance, while 27.5% were reluctant to do so (Figure 11). The previous sub-chapters have already provided initial indications on some of the bilateral relationships between farmers' contexts and socio-economic characteristics and their decision to take out WII.

8.4.1 Towards a targeting of small producers

The farmers surveyed can be classified according to their level of production and the potential value of the production. First, we note that income from production is relatively low for a good proportion of the sample. Indeed, more than 36% have a production, all crops combined, whose valuation does not exceed 500 000 FCFA. For over half of the surveyed farmers (56.41%), the production value reaches 500 000 to 1 500 000 FCFA, whereas only less than 7% can be considered as "large producers", i.e. as having an estimated production of more than 2 000 000 FCFA (Figure 22). Interestingly, when linking production value with producers' decision on insurance, we note that small producers are the most willing to subscribe to index insurance. Thus, nearly 80% of the very small producers (production value less than 500 000 FCFA) made the decision to insure. In the same way, we find that more than 70% of producers with an estimated value between 500 000 and 1 000 000 FCFA also want to take the insurance. However, the higher the value of production, the lower the take-up rate seems to be. Among very large producers (production of more than 2 000 000), 45.45% of individuals decided not to take the insurance (Figure 23). These results indicate that small producers are very aware of potential losses and may be more vulnerable to climatic shocks than large producers, potentially because they have less alternative resources and mechanisms in place to manage risks. In this case, insurance could be an effective strategy to minimise the losses associated with rainfall-related extreme event. The smaller producers amongst the cooperative membership seem to be the most receptive to index insurance and the use it could provide them in a context where rainfall variability is a major concern and where agriculture is crucial for their survival.

8.4.2 Comprehensive estimation of determinants for take-up

To identify variables that may contribute to or constrain insurance take-up, we conducted a logit regression analysis. Three models were specified in order to better follow the effects of core variables. The first model (small model) includes only the variables related to the specific WII provision and the gender component. The second model (intermediary model) includes socio-economic characteristics and the last model (complete model) introduces the variables related to the insurance product, aspects of financial inclusion and a measurement for the spillover effect through treatment in respondents' social networks.

8.4.3 The dependant variable: decision to take out WII (1=yes; 0=no)

The dependant variable in our logit model is the decision by a farmer to take the insurance along with the loan or not between the moment he applied for the credit and the moment he received the result of his application. But, since the insurance product is bundled with credit, only farmers whose application for credit were approved could effectively get access to WII. Therefore, the signature of the insurance contracts which represent the actual take-up was possible only after the results of the credit application were released. While our dependent variable is instructive, given that it is based on an experimental setting, it is also important to note that it is different to actual take-up. The latter did not become effective for all farmers, since not all of them received the loan.

8.4.5 Independent variables and results from the estimation

Table 5 gives a description of the independent variables we considered as part of the econometric analysis. The selection of variables was made on the basis of the literature and bivariate analyses of correlation with the dependant variable. Independent variables which were documented in the literature but correlated strongly with one or more other

variables were dropped depending on which one of them most improved the model (see Annex 4: Bivariate analysis for the results of the bivariate analysis and Annex 5: Estimation of marginal effects and result of the exhaustive model).

Table 5: Description of independent variables

	Variables	Description
1	Sale agent's identity	The agent who sales the product to the interviewed farmer
2	Rain gauge	The rain gauge that trigger the pay-outs for a group of participants.
3	sex	The sex of the interviewed farmer
4	Sale protocol	The bundling protocol used to link the insurance with credit: Voluntary + incentive, mandatory + incentive, voluntary no incentive
5	Perception on relevancy	The perception on the relevancy and fitness of the product and the way it is bundled to the credit
6	Value of the past production	The value of the last year agricultural production (estimation by the farmers themselves)
7	Livestock wealth	The wealth in terms of importance of the livestock owned by the interviewed farmer
8	Liquidity constraint	The ability to pay the insurance premiums cash at the moment of take-up
9	Trust	Trust in the insurance product and in the aggregator (COOPEC/RERSOPP) when it comes to sell the insurance
10	Network	The number of people from whom information about agriculture and insurance more specifically is received and shared
11	Experience	The experience with agricultural insurance products
12	Access to credit	Access to formal credit only, informal credit only, or both.
13	Basis risk perception	The perception on the adequacy between the rain gauge records and the actual rainfall on the actual farm. ¹⁷
14	Wealth index	Index of wealth created on the basis of capital goods, housing materials (roofs, walls, floors) and source of cooking energy.
15	Shocks (index)	Index of shocks caused by rainfall in terms of the damaged caused.
16	Land owned	The number of hectares of lands in possession of the farmer
17	Network homogeneity ¹⁸	The number of different treatments or control in term of sales protocol (as defined above) that study participants that share a same network has received.

Source: Authors' own table

¹⁷ To measure the basis risk perception, we proceed in two steps: (1) we verify first that the interviewee does know the exact site where the rain gauge that trigger payouts is located, (2) then we ask them to evaluate the adequacy between that rain gauge records (on the basis of the historic of rainfalls) and the actual rainfall on the actual site where their farm is located in the 5km area covered by the rain gauge. The farmers had to choose between these four answers: different, rather similar, similar and very similar.

¹⁸ The network homogeneity variable takes the value 1 (homogeneous treatment) if all the study participants that share a same social network were offered the same sales protocol (belong to the same treatment/control group); the value 2 (heterogeneous treatment), if there were two different sale protocols in the network; the value 3 (very heterogeneous) if all the three sale protocols (treatments and controls) can be found among the study participants of a respondents' wider social network.

Table 6 summarises the results of the estimation of the smallest model, i.e. the model which retains significant control variables (see Annex 5: Estimation of marginal effects and result of the exhaustive model for more detailed results from the estimation).

Table 6: Estimation results

<i>Uptake decision</i>	<i>Final model b/t</i>
Sale agent's identity	1.775*** (0.265)
Rain gauge of Diagane Barka	0.197*** (0.110)
Rain gauge of Thilla Keur Khalifa	0.153*** (0.104)
Rain gauge of Thioupane & Thiombly	0.0430*** (0.0478)
sex	4.156** (2.440)
Sale protocol 1 (mandatory insurance)	0.746 (0.339)
Sale protocol 2 (voluntary insurance)	0.748 (0.355)
Perception of relevancy (very relevant)	29.43*** (18.74)
Perception of relevancy (quite relevant)	3.304 (2.594)
Value of past production (very low)	4.043** (2.255)
Value of past production (low)	2.394* (1.206)
Value of past production (high)	2.064 (1.033)
Network (acceptable network)	1.433 (0.630)
Network (high network)	4.949*** (2.492)
Land owned (between 1,5 et 3)	0.232** (0.133)
Land owned (between 3 et 5)	0.400 (0.240)
Land owned (above 5)	0.341* (0.215)
Basis risk perception (rather similar)	3.468** (2.077)
Basis risk perception (similar)	4.884** (3.146)
Basis risk perception (don't know)	4.833* (4.010)
Network homogeneity (heterogeneous)	0.262**

<i>Uptake decision</i>	<i>Final model b/t</i>
	(0.140)
Network homogeneity (very heterogeneous)	0.811 (0.378)
Observations	303
Adjusted R	0.370
LR Chi2	125.6

Note: Exponentiated coefficients; Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01¹⁹

Source: Authors' own calculations

Variables were dichotomised for a better interpretation of the results. We note that treatment 1 and treatment 2 sales protocols (voluntary and mandatory insurance with incentive, respectively) are not significant. This confirms results presented in the descriptive analysis in Chapter 8.2.). The variables on sales agents and rain gauge facilitate a control for effect that influence take-up but are exogenous to the study. For sales agent, the level of performance in terms of contracts sold was significantly different, suggesting more training is required to ensure greater coherence amongst them. Sales agents for the insurance product are COOPEC credit officers and had little notion about WII before the intervention. Performance is generally expected to further increase over time as they gain more and more experience, but further training and supervision appear to be important.

The relevancy of the intervention can be used as a control to check whether interested people who seemed to understand and desire WII were actually taking it. Or, in other words, whether people were not taking the product only because of a need for credit. The level of significance at each stage of relevancy suggest that take-up in fact is positively influenced by people's perception of the relevance of the product for managing their livelihood risks.

The relevant socio-economic characteristics that have a significant influence on the uptake decision are the values of past agricultural production, which increases the chance to purchase WII for small values; the network which increases the chance to purchase insurance when the number of people from whom the information is received and with whom it is shared increases; and finally, an increase in the size of the land owned in terms of number of hectares seems to decrease the chance of a farmer purchasing the insurance. The negative relationships of production value and land size with take-up are somewhat surprising. The relatively high take-up of bundled products by smaller-scale farmers implies that bundling reduces liquidity constraints for accessing WII take-up and increases incentives for WII take-up because it facilitates access to credit, as expected from the ToC. Lower take-up by larger and higher income farmers,

¹⁹ The variables "rain gauge of Diagane Barka", "rain gauge of Thilla Keur Khalifa" and "rain gauge of Thioupane & Thiomby" refer to the name of the rain gauges, with the reference being the "rain gauge of the village named Ndiombene". The lowest level of relevancy perception represents the reference for interpretation. For past production, the reference reflects the highest value of production. For network, the category that represents individuals who share information about agriculture with the lowest number of people is taken as reference for interpretation. The number of hectares of land in possession goes from the highest to the lowest and the highest is taken as reference for interpretation purpose. The same applies to basis risk perception.

on the other hand, points to additional constraints to take-up that may not be addressed by bundling. This may be related to the larger range of financing options open to this group of farmers, which makes it easier for them to self-finance or access other funds better suited to their preferences when they opt out of bundled products.

The level of perception of basis risk influences also significantly influences the decision to take out WII. As the basis risk perception decreases, the chance to purchase the insurance increases. Despite the objective challenges related to basis risk and its implications on WII impacts, farmers understanding and subjective perception of basis risk can already constrain (where awareness and/or risk aversion is high) or facilitate (where awareness and/or risk aversion is low) insurance take-up.

Finally, the network homogeneity that we use to estimate spillover effects is significant at its second category (heterogeneous), meaning a spillover effect exists in this group, which may explain some of the absence of difference between the treatment and control groups. This highlights the importance of complementing the experiment with the follow-on survey and additional qualitative data collection. However, more detailed monitoring and comprehensive analysis will be required to monitor and better understand the influence of social networks on insurance take-up.

9. Implications of study findings

9.1 Implications for the intervention

This study provides a range of lessons on options for bundling WII with agricultural credit. The core of the studied invention consisted of providing to farmers who applied for a loan the possibility to include WII in the package together with credit. The implications of our results are particularly relevant in the Senegalese context, where a debate is ongoing about the preferred way to provide WII to farmers. Naturally, this differs between stakeholders – most notably between the insurer on the demand side, the intermediary bridging between the insurer and its farmer membership, and farmers on the supply side. In addition, there is a need to distinguish between the insurance market and the credit market as the implications of the different ways of bundling both products are not the same. Implications are summarised in Table 7.

9.1.1 Implications on WII take-up: voluntary and mandatory bundling have the same effect

Considering WII take-up, we see that whether provision is mandatory or voluntary has no effect in a context of high liquidity constraints and high need for credit. The level of WII take-up is similarly high for mandatory and voluntary bundling. Since the resources for providing credit through the cooperative are constrained, WII could help to protect loan repayments and increase security of the portfolio. However, in the specific case of WII, basis risk may undermine insurance impacts and eventually further reduce demand for insurance other products linked to it. On the supply side, WII was mainly expected to increase institutional stability in a context where loan default is high. This was a concern specifically with the insurer and with credit agents and COOPEC/RESOPP, who aim to increase business portfolios and their investments in agriculture. In addition, they have struggled with loan defaults and regard insurance as one mechanism helping to address this challenge. Though integrating credit and insurance products is already implemented

at scale with indemnity insurance in Northern Senegal, some stakeholders in the farmers' network, as well as farmers themselves, were adamant about their willingness to have the free choice of purchasing WII without mandatory integration with credit. Reasons for this view included that some judged the relevance of the product as unsuitable, had a lack of trust in the insurance mechanism, or access other financing mechanisms beyond COOPEC/RESOPP.

9.1.2 Implications on the credit market: Mandatory insurance means less financial inclusion for people who do not want to, or cannot, insure

For FOs and their related microfinance institutions, voluntary insurance can also be more preferred, because they want to give their members the freedom to choose. For independent microfinance institutions in which farmers are not members, complete integration is easier to implement, but its effect would be expected to depend on the level of competition they are facing in the credit market (mandatory insurance could be preferred in a context of low competition and voluntary insurance in a context of high competition). Other criteria such as level of default experienced are considered in intermediary's decision to bundle insurance with credit or not. As this evaluation has shown, mandatory bundling can result in a decrease in the demand for credit and may lead to the exclusion of people who do not want insurance or simply cannot afford to pay the added premiums, which would result in negative impacts on financial inclusion and economic opportunities. Voluntary insurance may then result in a larger but partially insured portfolio, while mandatory insurance may lead to a smaller but entirely insured portfolio, though other risks beyond the rainfall deficit are not addressed by WII.

Table 7: Bundling options and implications on take-up

	Voluntary bundling	Mandatory bundling
Incentive	High insurance take-up Facilitation of credit use without constraining access Consumer choice and more need to carry out awareness raising and training	High insurance take-up Facilitation of access to credit for some, but lower use of / access to credit through intermediary Reduced administrative costs for insurer and intermediary
No incentive	Lower insurance take-up when bundling conditions are clear No facilitated access to credit	n/a ²⁰

Source: Authors' own table based on study and stakeholder engagement workshop (Dakar, 21/09/17)

Given that the take-up rate is not significantly different between voluntary and mandatory bundling, but mandatory bundling constrains options and could negatively impact financial inclusion, the following steps are recommended for the evaluated intervention:

- **Provide voluntary incentivised bundling through COOPEC/RESOPP.** Based on the study findings, the option to facilitate access to credit is sufficient to incentivise insurance take-up in the study area. This achieves levels of take-up similar to mandatory bundling, but does not constrain credit access to farmers who do not wish to, or are not able to purchase WII coverage. At the same time,

²⁰ This option was not tested as part of the formative evaluation, but would also be expected to be the least preferable, especially for the demand side, since it does not facilitate access to credit and leaves the fewest choices for the target population.

this option requires a revised **strategy for cost-effective information campaigns to increase the levels of awareness and understanding of WII and credit bundling** amongst farmers. If respondents do not sufficiently understand what the WII product covers and perceive the transfer of risks where this is not in place, they risk being worse off. Awareness and information is thus crucial for consumer protection and for ensuring that the intervention meets its objective of increasing resilience and supporting well-being in the long run. The remainder of the OSIRIS project presents an opportunity to lay the ground work for insurance provision in the area more generally, but activities need to be implemented timely before the beginning of the season.

9.2 Implications for further research

Similar to the practical suggestions, implications of this formative evaluation for further research are different for the supply and the demand side. As discussed above, our results provide indications on the effect of mandatory and voluntary bundling on WII take-up, but the verification conducted during the follow-on survey (see Figure 8) also indicates that the absence of a statistically significant difference between the treatment and control groups can be driven by spillover effects. More evidence comparing the different sales protocols in a context in which the randomisation is clustered (instead of at individual level) are therefore necessary to support this conclusion. The results raise other important questions around the effect of bundling option on the demand for credit that require further investigation: What is the shortfall in terms of financial inclusion when WII and credit are inseparable? Would people stop applying for credit in the long run if they are bound to apply for insurance and what implications does this have for people's economic opportunities? At this stage, there is need to study the evolution of the eviction effect that mandatory bundling has on the demand for credit and the impact of WII farmers' well-being. In the long run, one could assume that if there is a positive impact of insurance on living standards for farmers who purchase it, this effect would eventually surpass the eviction effect of mandatory insurance. This would then justify a generalisation of mandatory insurance, which could be provided at lower cost and strengthen the portfolio of the credit institution.

Currently, the Senegalese national insurance company CNAAS has signed agreements with a range of microfinance institutions FOs for providing integrated, mandatory bundling of indemnity insurance and WII with credit while other institutions and FOs still prefer voluntary bundling. In stakeholder engagement workshops, representatives of these institutions and donors backing the different schemes highlighted the variety of contexts and approaches and the need for more evidence that spans across a larger spectrum of approaches. As partners of the current intervention, building on the OSIRIS project, are recommended to revise their intervention in order to provide voluntary incentivised bundled products in the coming year, an expansion of the scope of this study to include other aggregators who rely on mandatory bundling will facilitate a comparison of effects on take-up. A control that to be constituted of farmers who do not want purchase insurance can help to assess the impact of the insurance itself on farmers well-being and resilience in the context of shocks and stresses, as well as longer term climatic changes. This results in the following recommendations:

- **Monitor impacts of mandatory and voluntary bundling on WII take-up and credit default.** Given resource constraints and credit background checks, COOPEC/RESOPP is not able to grant a loan to every member applicant at the beginning of the agricultural season. Monitoring of credit default rates as compared between insured and non-insured farmers and the reasons for default should be monitored in order to trace whether WII would reduce defaults in the non-take-up group, or whether additional (financial) risk management strategies are required for this purpose.
- **Conduct an impact evaluation to assess WII and bundling implications on resilience and well-being.** Given the novelty of WII approaches in West Africa and the opportunity to work with a country-wide network of FOs as part of the OSIRIS project but also in CNAAS' wider insurance provision channels, presents an opportunity to assess impacts of WII and insurance bundled with credit where it is embedded in an institutional and sectoral structure. The evaluation should aim to assess the impact of:
 - Mandatory and voluntary bundling on demand for credit and financial inclusion in the long run
 - Take-up of WII and the different bundling mechanisms on well-being through supporting climate resilience and financial inclusion

10. Major challenges and lessons learnt

This chapter concludes with a summary of the key challenges we encountered during this formative evaluation and the lessons learnt throughout the process.

10.1 Challenges faced during the implementation of the intervention

In a context of rain-fed agriculture, all activities need to be prepared in very specific and externally established time windows, as some might not be possible after the first rainfalls of the season have begun. WII activities such as registration, preparation of the reporting of uptake decisions and signature of contracts are sensible to these time constraints. Therefore, a timely preparation of product and contracts needed to be carried out as part of the intervention simultaneously to preparations and activities such as training and sampling that were part of the formative evaluation. Close collaboration with implementation stakeholders and technical staff helped to ensure compliance.

10.2 Challenges faced during the evaluation

The main challenge faced during the evaluation concerned the operationalisation of the different treatments in terms of mandatory and voluntary insurance for the applicants of credit of one single membership-based microfinance institution. Stakeholder validation and repeated meetings to obtain authorisation and provide information on the study were held with COOPEC and RESOPP executive and elected leadership at national and local level. Transparency around the evaluation's conditions, processes and objectives thus helped to obtain buy-in and support from key actors. To address the ethical problem that was caused by that differential treatment of the three groups, the actual deliberation of the microfinance institution allowed farmers to revise their choice before actually signing the insurance contract²¹.

²¹ This procedure was approved by the Senegalese National Ethical Committee for Health Research.

10.3 Lessons learnt: Stratification at village or rain gauge level instead of individual level for study of insurance take-up when it is bundled to credit

This study was rich in lessons for the study team and the implementing agency regarding the implementation of an evaluation that entails different treatments and randomisation at individual level. As highlighted in Chapter 8.3., the sales protocol used as a control (voluntary bundling, no incentive) seemed to have not worked as well as expected. People seemed to decide to take the WII product because of fear to lose credit even though their sales protocol clearly delinked the two products. This may have been related to a lack of understanding and/or spill-over effects at village level. Though spill-over was to be expected, the limited scope of the formative evaluation and the low density of rain gauge coverage in relevant OSIRIS project areas did not allow us to conduct stratification on village or rain gauge level. Nevertheless, this should be considered for a potential follow-up impact evaluation and for similar studies implemented at a larger scale.

Regarding the weight of the intervention in terms of time it cost the farmers, FGD participants highlighted the fact that in the approaching of the first rainfalls, farmers are very busy with the preparation of the rainy season. They would not dedicate much time to the activities related to insurance products if it would lead to a delay of their main agricultural activities, which could eventually affect their decision to purchase WII in the first place. It would be more cost effective to link activities dedicated to WII provision with those of the credit application period and to sell both products at the same time. This had been the initial plan for the intervention, but earlier credit provision and delays in rain gauge installation and premium calculations prevented simultaneous credit and WII provision. As infrastructure and procedures will become more established, greater integration of provision processes should be pursued.

Appendix A: Figures and tables referenced in the report

Unless otherwise specified, all figures and tables presented in the annex are the authors' own.

Figure A1: Repartition of the participants in the intervention and the survey to RCT control and treatment groups

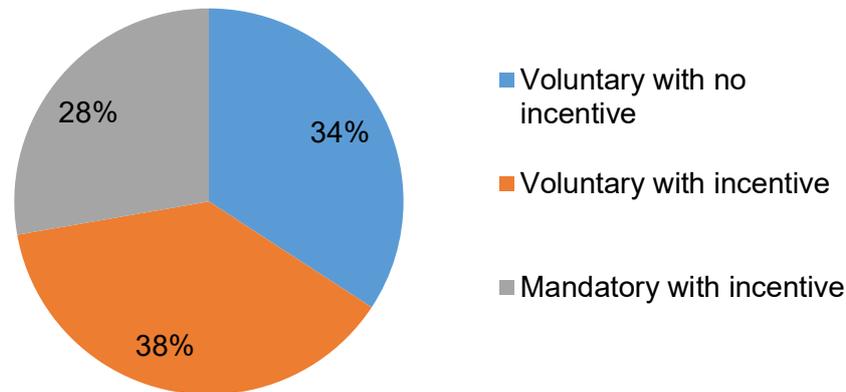


Figure A2: WII subscription rate

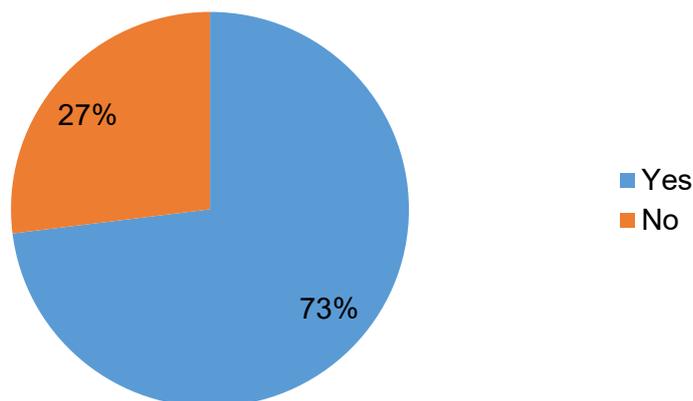


Figure A3: WII take-up by RCT control and treatment group

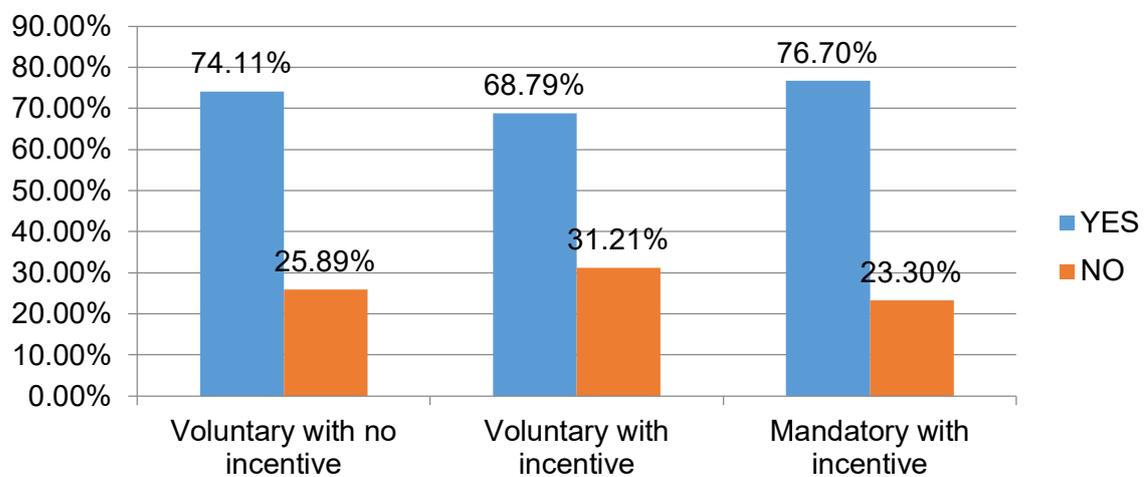


Figure A4: Index insurance take-up under constrained funds

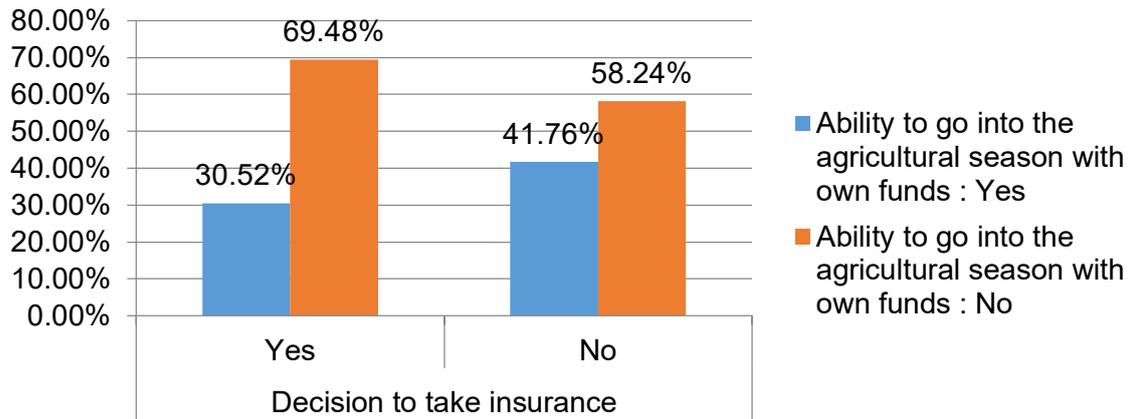


Figure A5: Opinion on bundling according to take-up decision

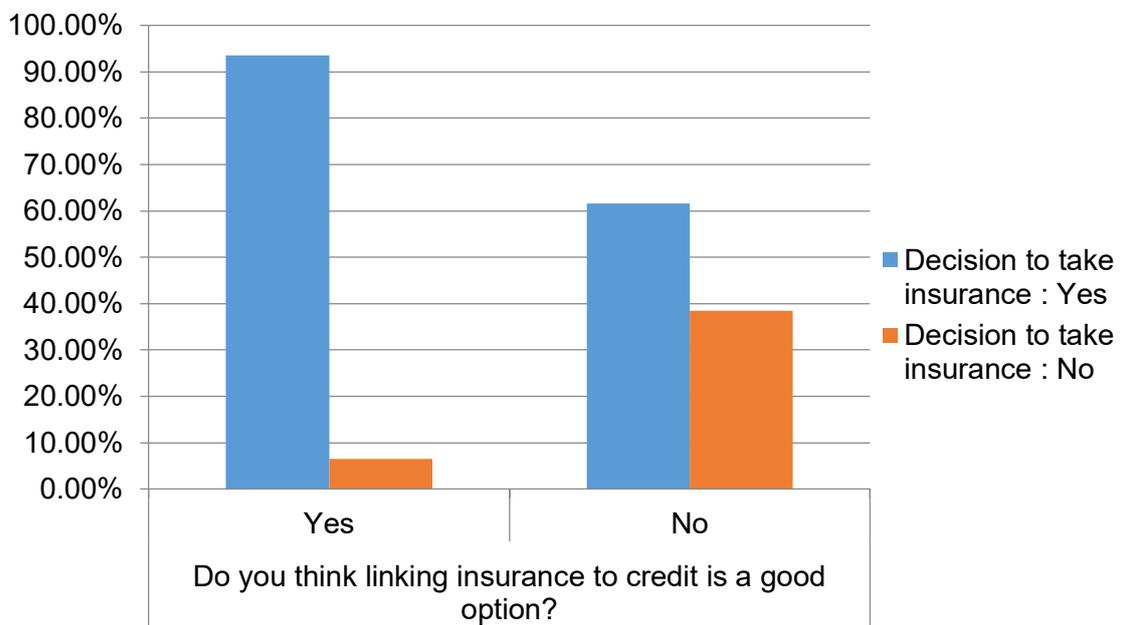


Figure A6: Average invested capital and insurance take-up rates

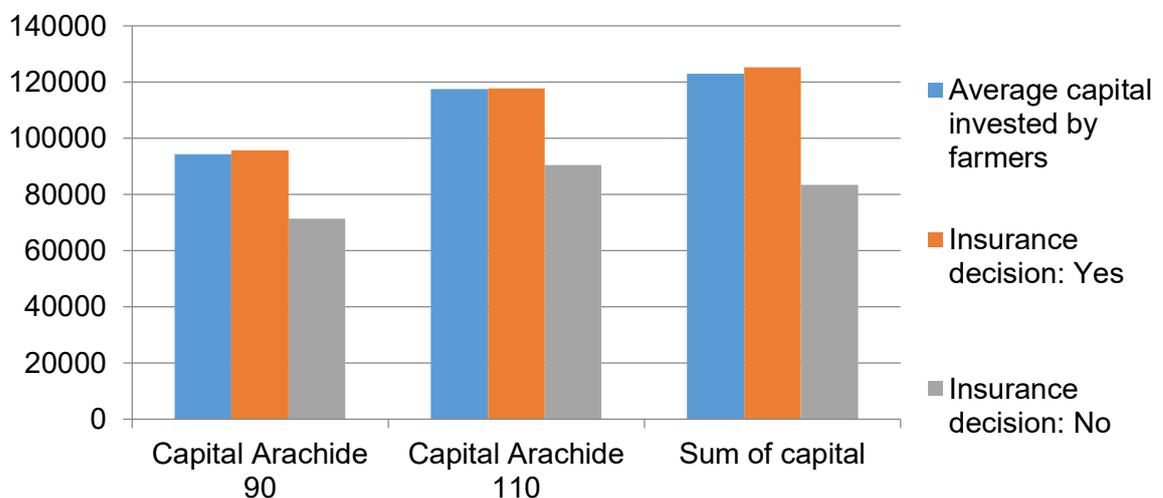


Figure A7: Overall take-up by sex

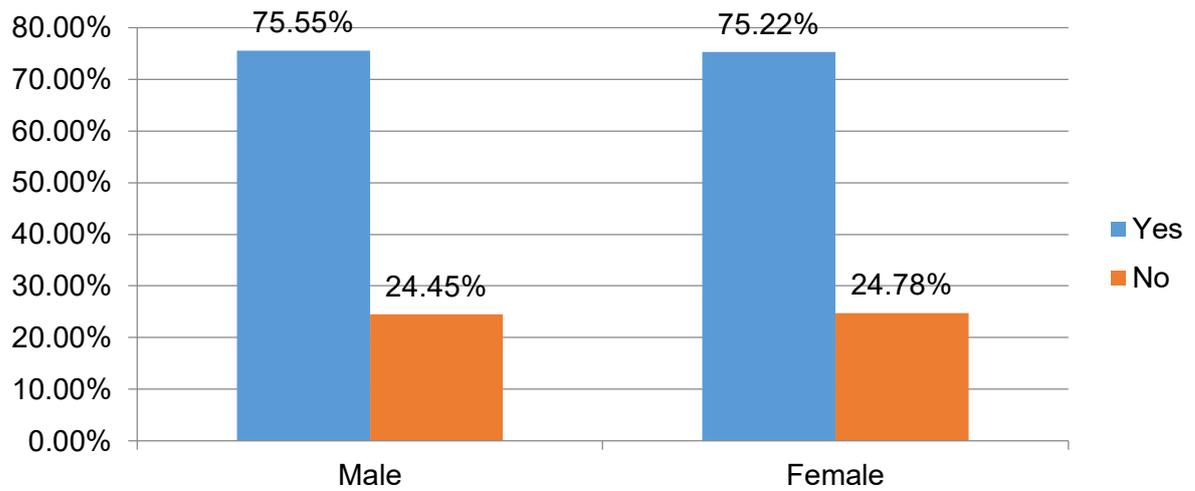


Figure A8: Take-up per RCT control/treatment group - women

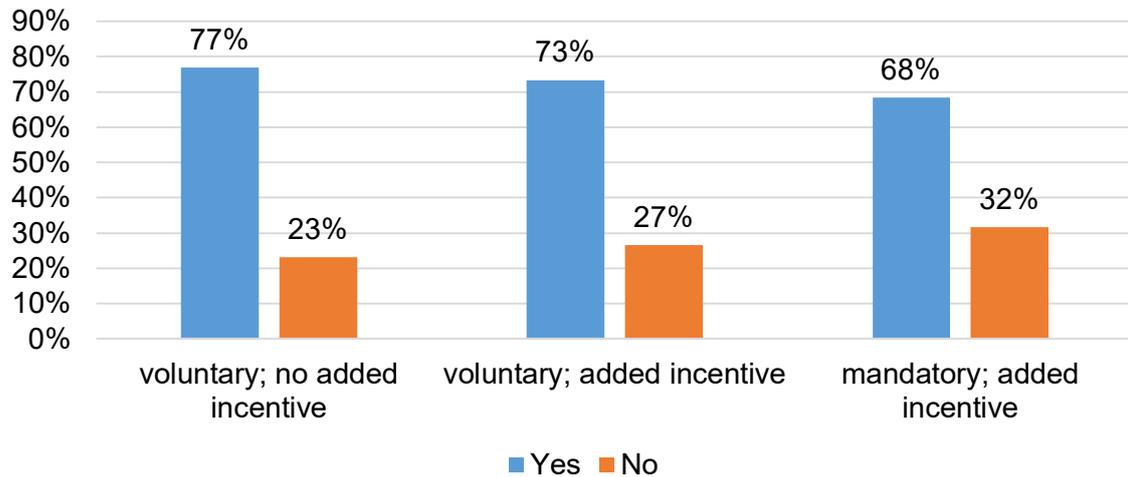


Figure A9: Take-up per RCT control/treatment group - men

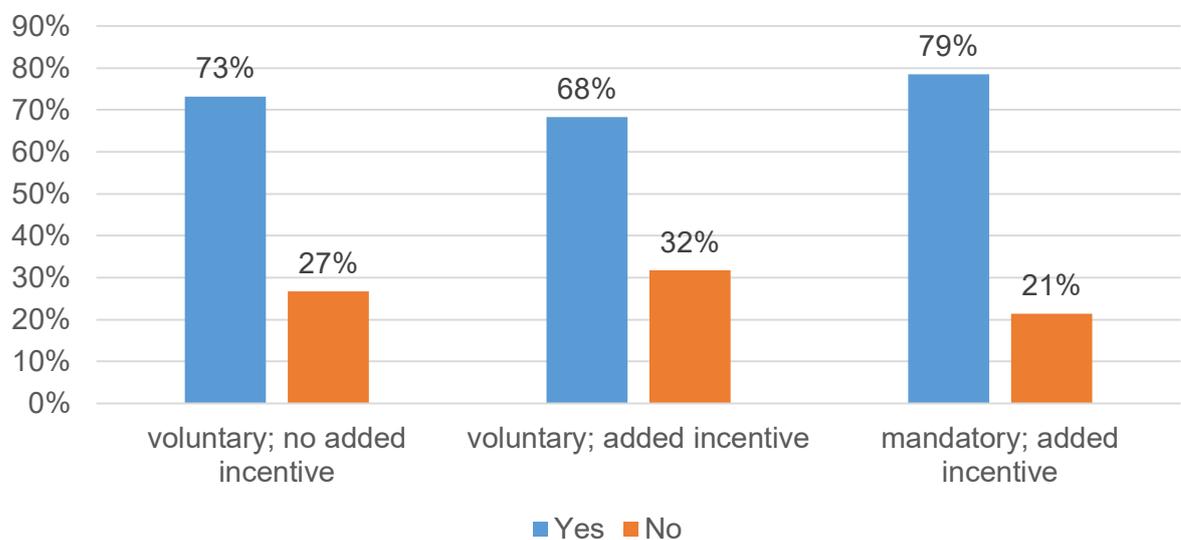


Figure A10: Farmers' perception of rainfall evolution in the study areas

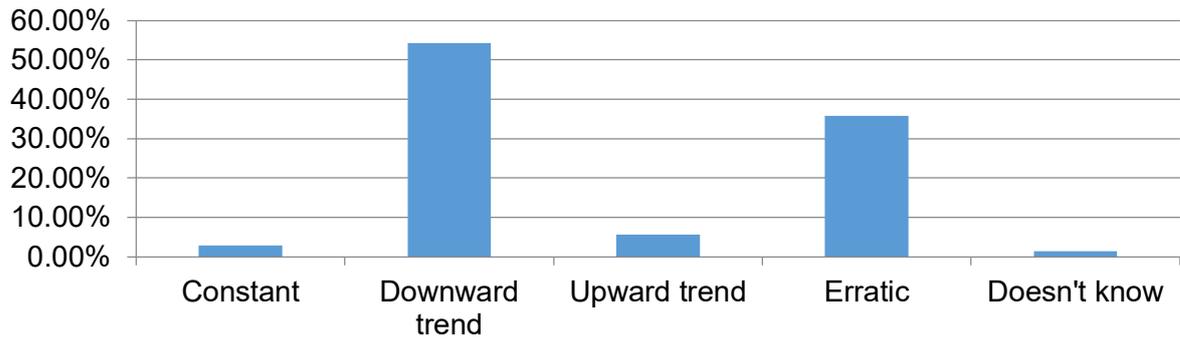


Figure A11: Shock perception and decision to take out WII

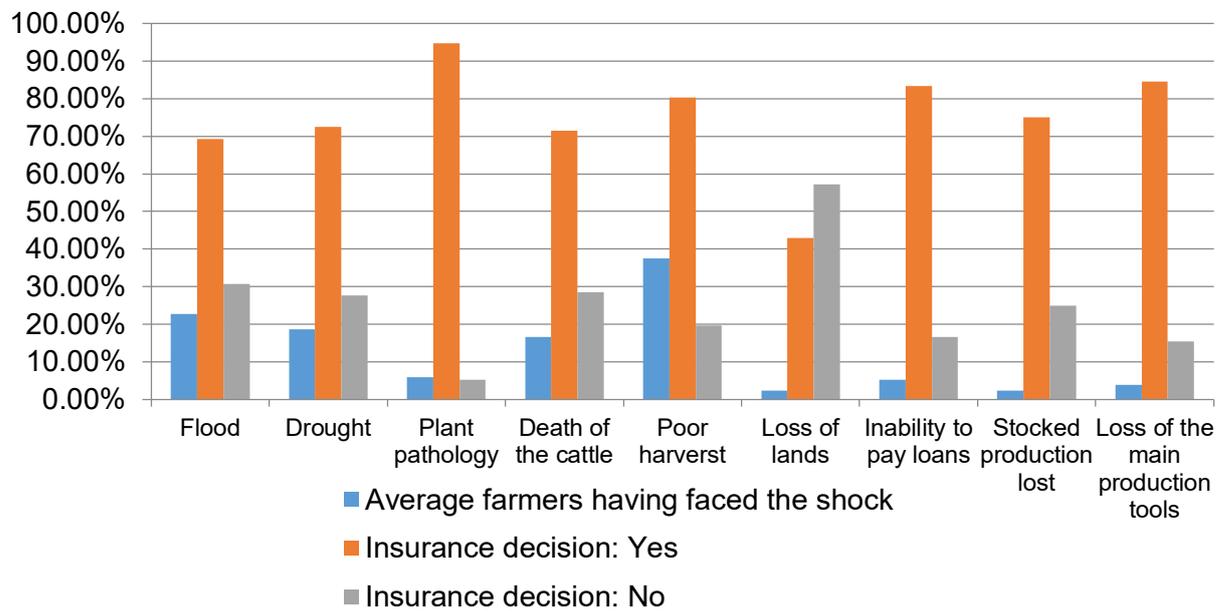


Figure A12: Take-up decision and estimation of previous losses

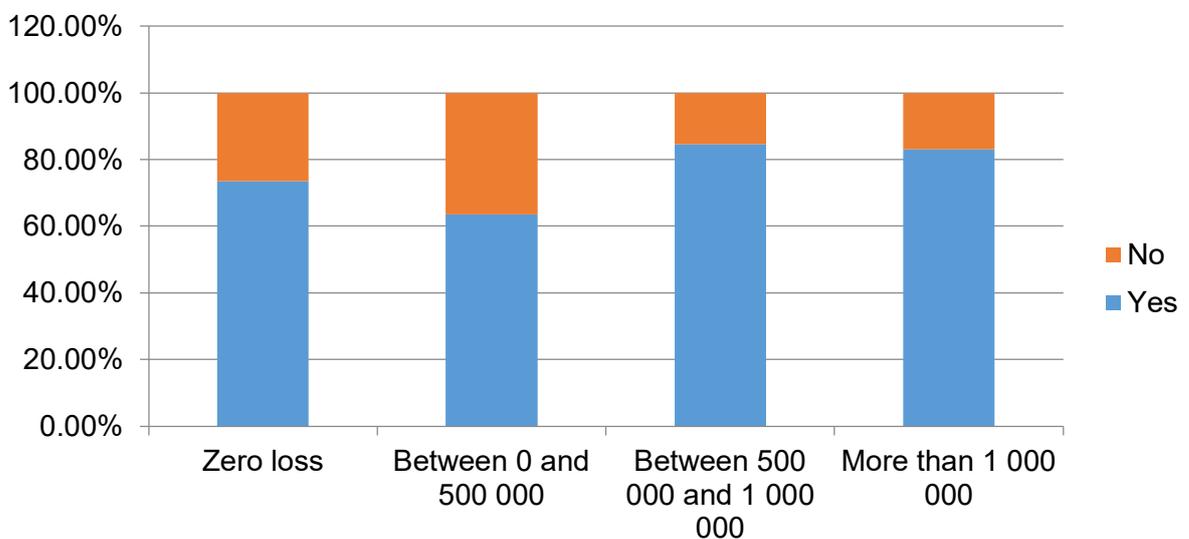


Figure A13: Repartition of production value amongst survey participants

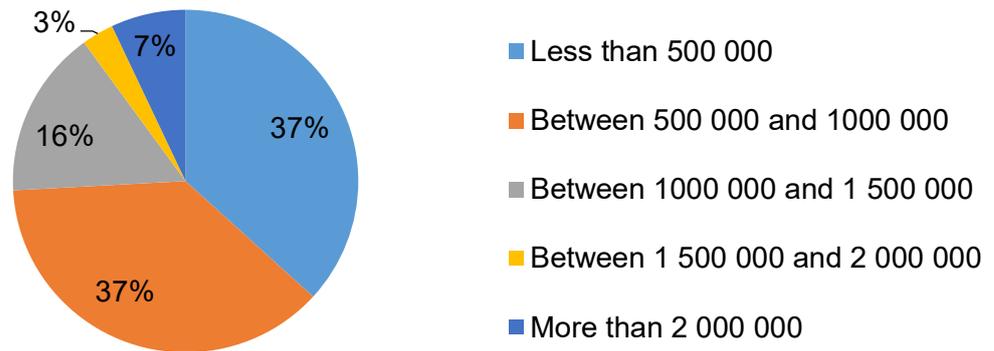


Figure A14: Take-up decision following production value class

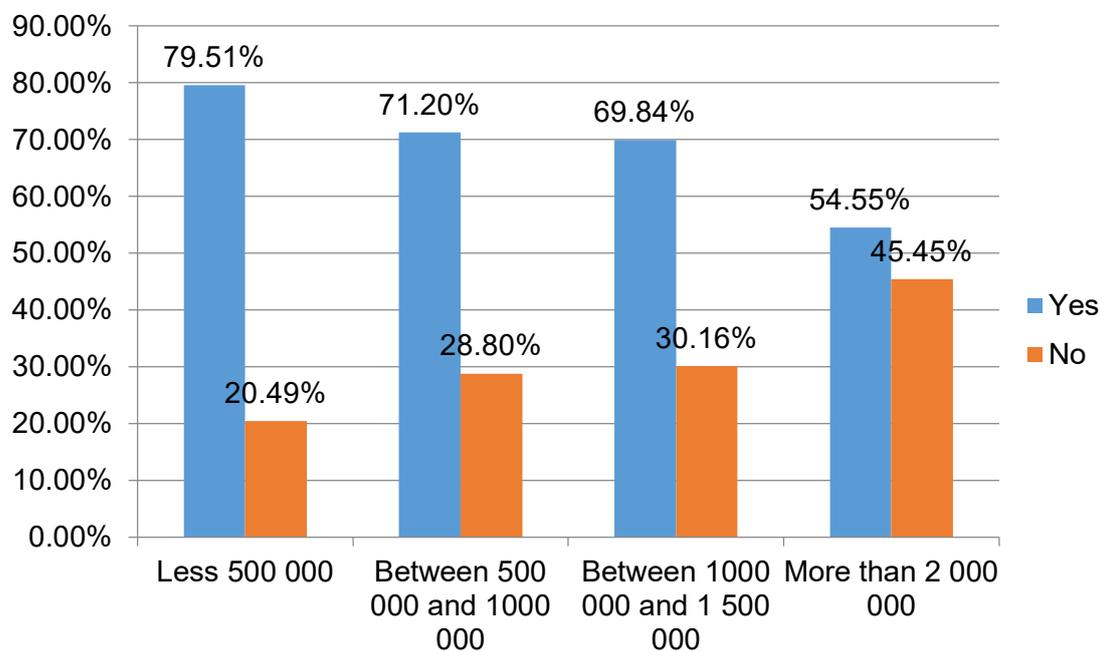
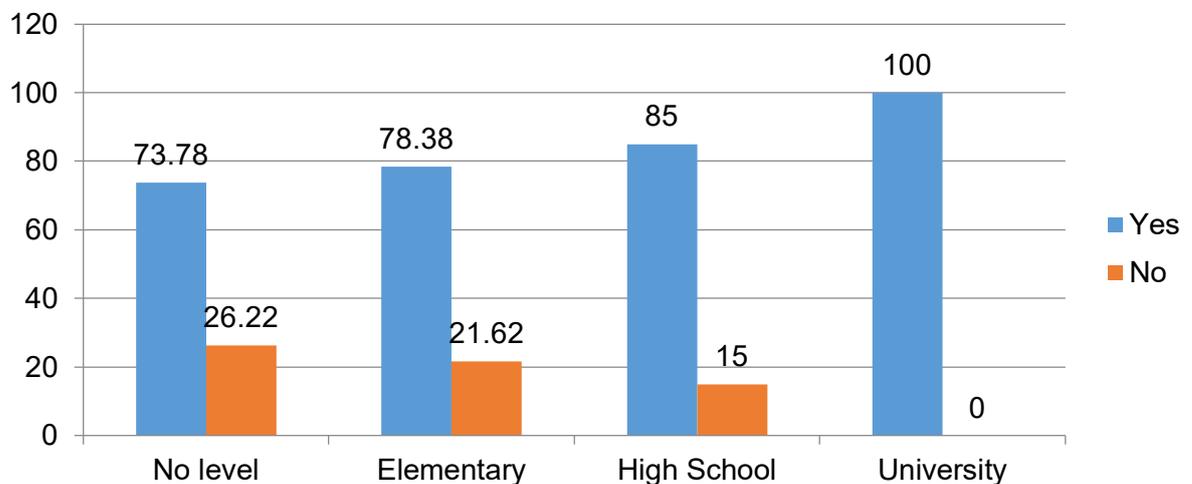


Figure A15: Insurance take-up by farmers' level of education



Appendix B: Socio-economic characteristics of survey participants

Unless otherwise specified, all figures and tables presented in the annex are the authors' own.

Figure B1: Average household size of study participants

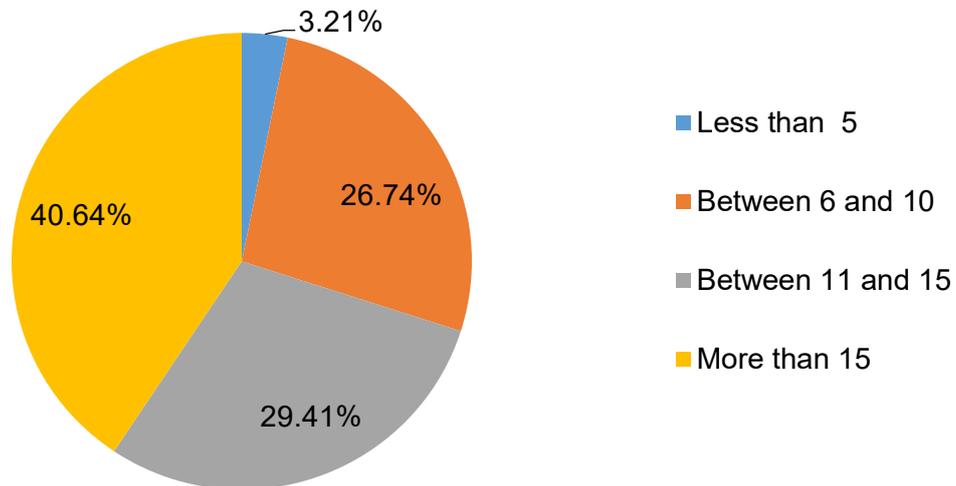
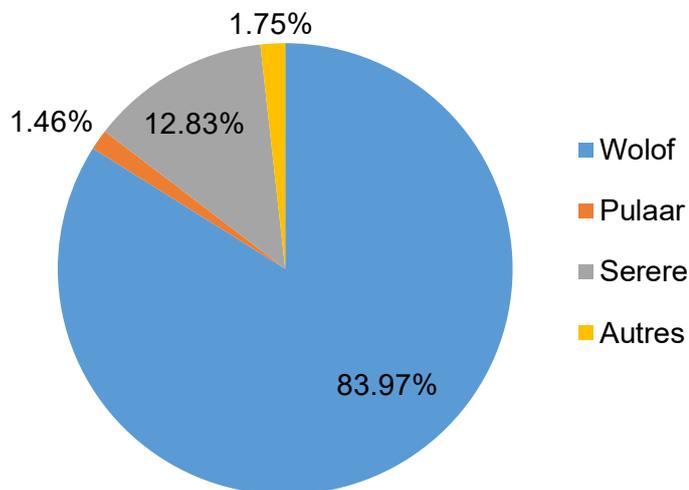


Figure B2: Ethnic repartition of study participants



Appendix C: Characteristics of farmers who decide to leave the bundle when it is mandatory

Unless otherwise specified, all figures and tables presented in the annex are the authors' own.

Figure C1: Opting out rate according to sex when insurance is mandatory (histogram)

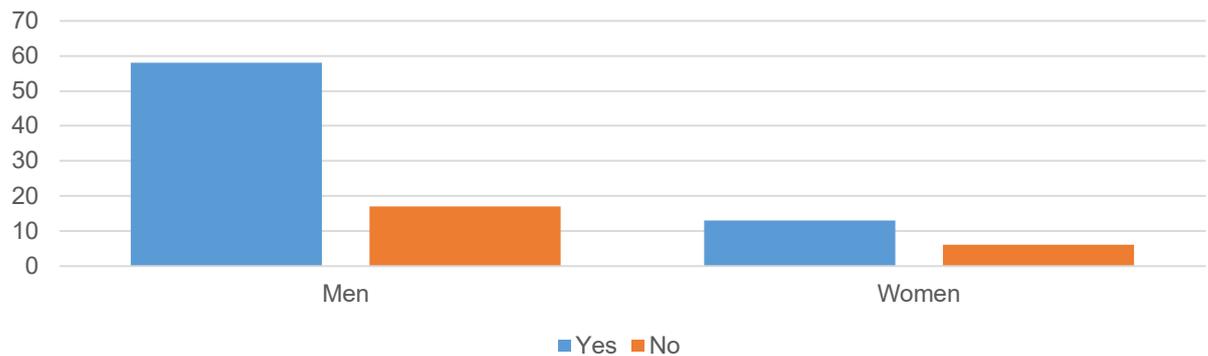


Figure C2: Opting out rate according to sex when insurance is mandatory (Pie Chart)

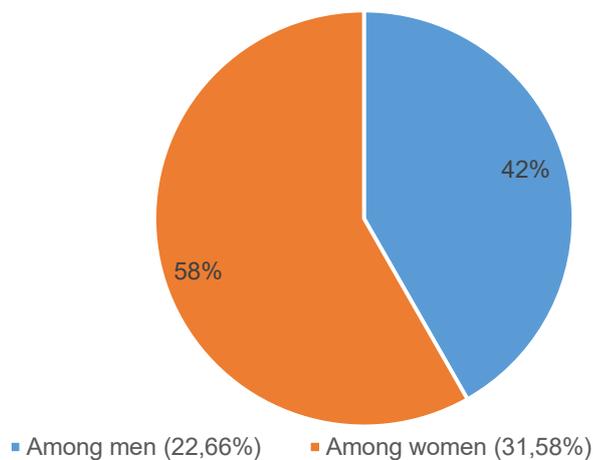


Figure C3: Opting out rate according to wealth when the bundle is mandatory (histogram)

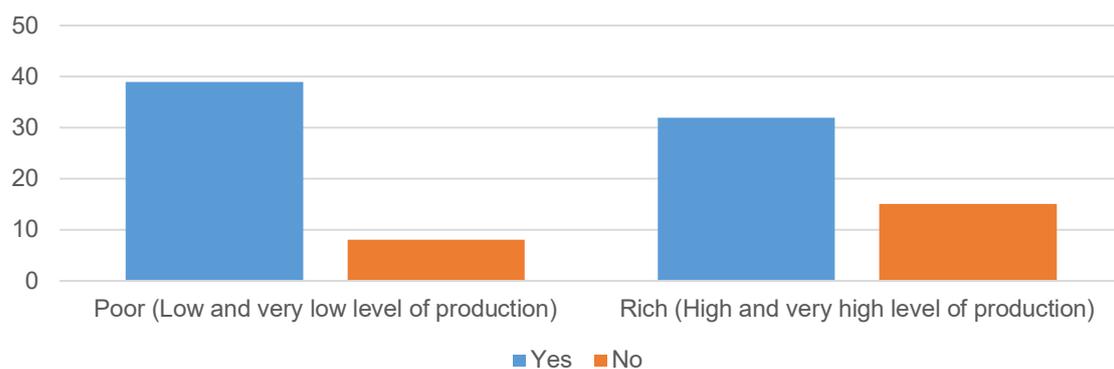


Figure C4: Opting out rate according wealth when the bundle is mandatory (Pie Chart)

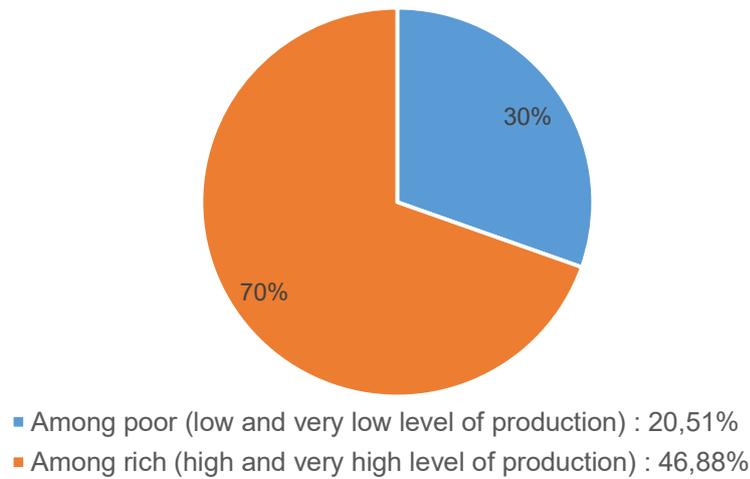


Figure C5: Opting out rate according education when insurance is mandatory (histogram)

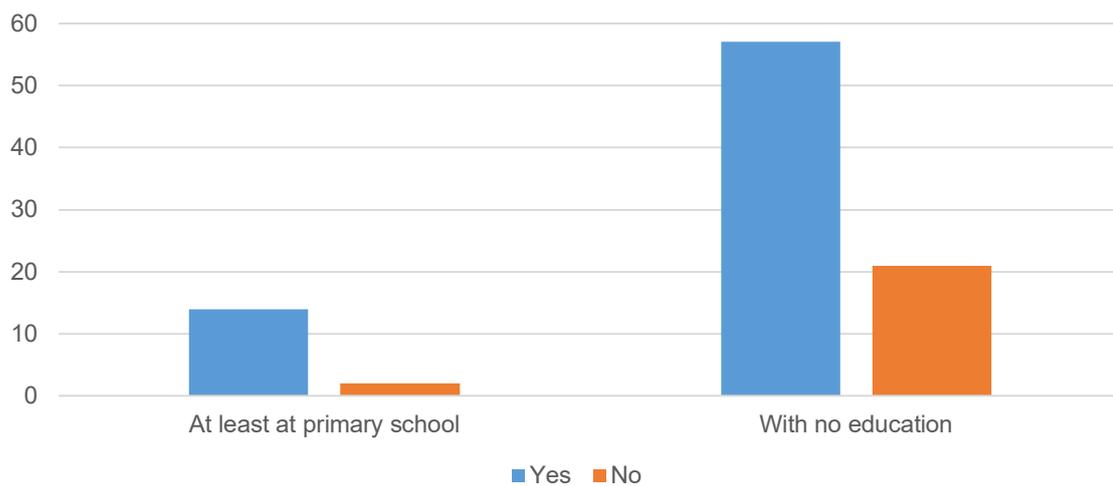


Figure C6: Opting out rate according education when insurance is mandatory (Pie Chart)

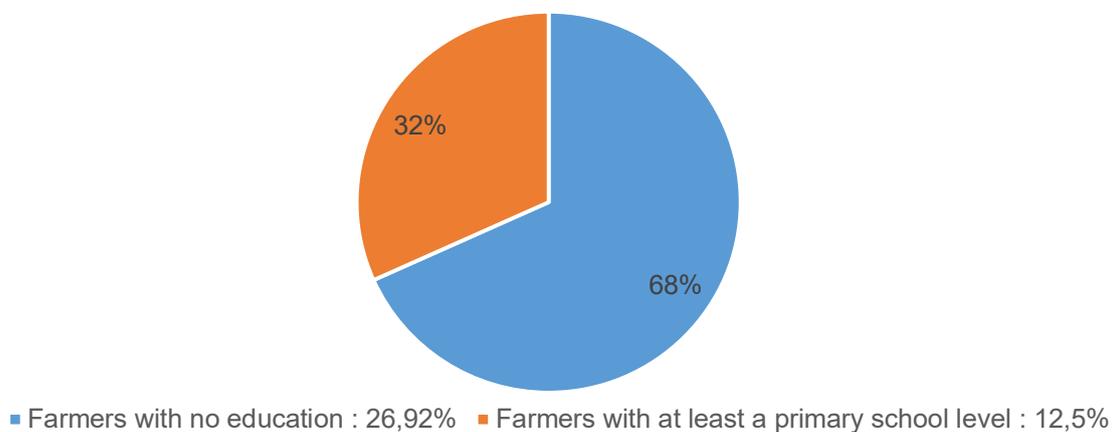


Figure C7: Opting out and ability to produce without credit (histogram)

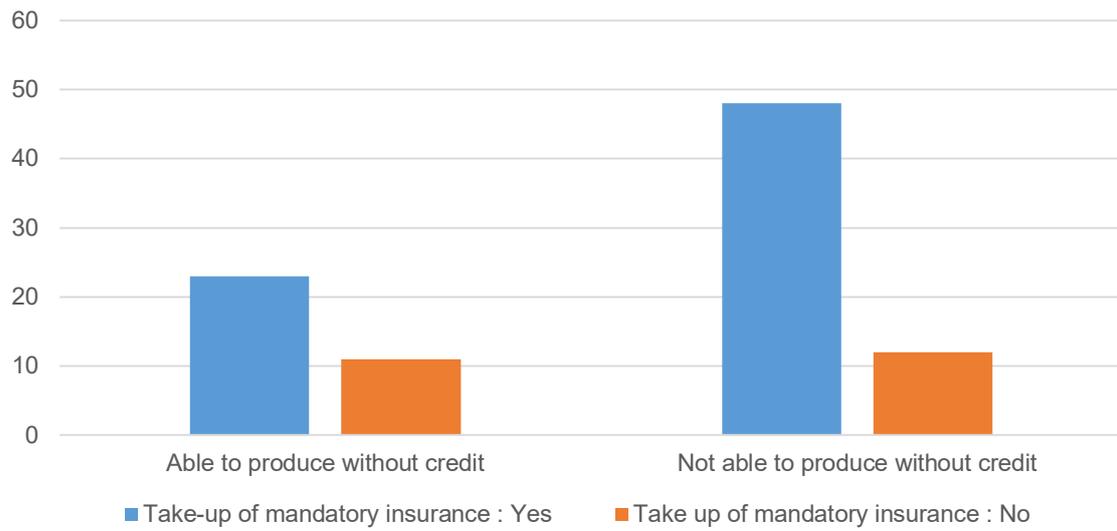
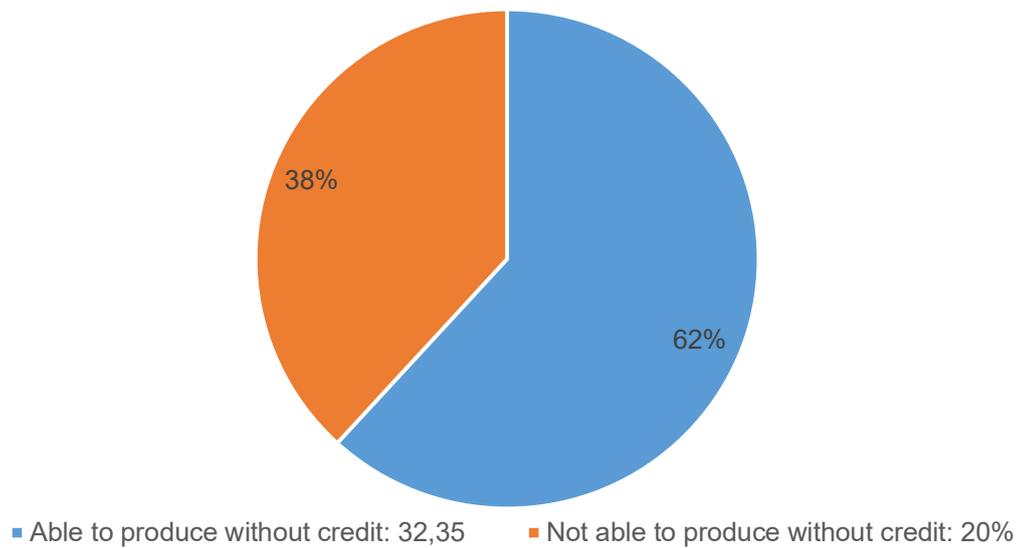


Figure C8: Opting out and ability to produce without credit (Pie Chart)



Appendix D: Bivariate analysis

Unless otherwise specified, all figures and tables presented in the annex are the authors' own.

Table D1: Bivariate analysis between take-up and the variables considered in the estimation

Insurance take-up decision	Pearson Chi2
Sale agents	174.366*** (0.000)
Rain gauge	143.791*** (0.000)
Sex	10.02** (0.018)
Sale protocol	4.0510 (0.670)
Perception of relevancy	6.6759 (0.352)
Size of the household	14.0423 (0.121)
Network	48.6972*** (0.000)
Livestock Owned	8.6827 (0.467)
Land Owned (in hectares)	8.6827 (0.467)
Liquidity constraint	8.965 (0.176)
Trust	28.311*** (0.000)
Experience	122.998*** (0.000)
Access to credit	20.077** (0.017)
Value of the last production	16.764* 0.053
Perception of the level of basis risk	33.313*** (0.000)
Network homogeneity	4,8136* (0.090)
Observations	337

Note: Pearson Chi2; p-values in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Interpretation: The results of the bivariate analysis above suggest that there is an association between the decision of a farmer to take the insurance and the actual sales agents who offered the product to him, the rain gauge considered, the level at which he is networked, his level of trust, experience, access to credit, access to credit and value of past production.

Appendix E: Estimation of marginal effects and result of the exhaustive model

Unless otherwise specified, all figures and tables presented in the annex are the authors' own.

Table E1: Estimation of the marginal effects

Uptake decision	Marginal Effects
Sale agent's identity	0.0745*** (0.0181)
Rain gauge of Diagane Barka (d)	-0.293** (0.120)
Rain gauge of Thilla Keur Khalifa (d)	-0.289** (0.114)
Rain gauge of Thioupane & Thiomby (d)	-0.633*** (0.194)
Sex (d)	0.243** (0.119)
Sale protocol 1 (mandatory insurance) (d)	-0.0391 (0.0621)
Sale protocol2 (voluntary insurance) (d)	-0.0394 (0.0672)
Perception of relevancy (very relevant) (d)	0.659*** (0.105)
Perception of relevancy (quite relevant) (d)	0.109** (0.0494)
Value of past production (very low) (d)	0.142*** (0.0461)
Value of past production (low) (d)	0.0991* (0.0507)
Value of past production (high) (d)	0.0832 (0.0510)
Network (acceptable network) (d)	0.0447 (0.0527)
Network (high network) (d)	0.190*** (0.0573)
Land owned (between 1,5 et 3 ha) (d)	-0.236** (0.108)
Land owned (between 3 et 5 ha) (d)	-0.139 (0.104)
Land owned (above 5 ha) (d)	-0.169 (0.116)
Basis risk perception (rather similar) (d)	0.155** (0.0719)
Basis risk perception (similar) (d)	0.189*** (0.0717)
Basis risk perception (don't know) (d)	0.127*** (0.0406)

Uptake decision	Marginal Effects
Network homogeneity (heterogeneous) (d)	-0.232** (0.113)
Network homogeneity (very heterogeneous) (d)	-0.0284 (0.0660)
Observations	303

Note: Marginal effects; Standard errors in parentheses; (d) for discrete change of dummy variable from 0 to 1. * p < 0.10, ** p < 0.05, *** p < 0.01

Interpretation: It is not possible to interpret the marginal effect of the sale agent due to the nature of the variable (list of 8 sale agents) which is not dichotomised. For the rain gauges, they all present a negative probability to influence take-up compared to the rain gauge of reference. The higher the perception of relevancy, the higher the probability to decide to take the insurance, suggesting that the value of the product is crucial in take-up. The same applies for networks. For past production, the probability to take the insurance is the highest for farmers with the lowest values. The probability for people highly networked to insure is 19% higher than for people with the lowest level of network. Regarding land ownership, farmers who have the smallest size of land (the reference) have more than 23.6% probability to take out insurance than those who just come after them (between 1.5 and 3 ha). The probability to insure increases as the perceived basis risk decreases, jumping from 15.5% for farmers who perceive high basis risk to 18.9% for farmers who have low perception (rather similar) and 12.7% for farmers who consider that there is no basis risk (similar). Finally, farmers who belong to a homogeneous network (networks in which study participants have received one identical treatment/control) have more than 23.2 lower probability to insure than farmers who belong to a heterogeneous network (respondents' networks in which other study participants were in two different treatments/controls).

Table E2: Logistic regression analysis of determinants for insurance take-up: Extensive model with step by step estimation

Insurance take-up decision	Odds ratios	Odds ratios	Odds ratios
Sale agent's identity	1.484*** (0.172)	1.693*** (0.236)	2.040*** (0.369)
Rain gauge of Diagane Barka	0.185*** (0.0755)	0.270** (0.143)	0.216** (0.140)
Rain gauge of Thilla Keur Khalifa	0.226*** (0.114)	0.174*** (0.103)	0.121*** (0.0885)
Rain gauge of Thioupane & Thiomby	0.404 (0.338)	0.156* (0.176)	0.0147*** (0.0228)
Sex	1.848 (0.701)	2.908** (1.458)	5.321** (3.532)
Sale protocol 1 (mandatory insurance)	0.689 (0.252)	0.876 (0.358)	0.711 (0.355)
Sale protocol 2 (voluntary insurance)	0.802 (0.314)	0.769 (0.337)	0.682 (0.351)
Perception of relevancy (very relevant)	17.89***	26.24***	28.77***

Insurance take-up decision	Odds ratios	Odds ratios	Odds ratios
	(9.093)	(15.72)	(20.26)
Perception of relevancy (quite relevant)	2.804 (1.806)	3.280* (2.290)	2.885 (2.546)
Value of past production (very low)		4.531*** (2.486)	4.104** (2.662)
Value of past production (low)		2.410* (1.112)	2.761* (1.550)
Value of past production (high)		1.714 (0.807)	2.966* (1.716)
Network (acceptable network)		1.199 (0.491)	1.208 (0.595)
Network (high network)		6.366*** (3.212)	6.057*** (3.666)
Livestock wealth (poor)		1.864 (0.969)	1.721 (1.100)
Livestock wealth (intermediary)		1.915 (0.948)	1.020 (0.590)
Livestock wealth (wealthy)		1.464 (0.787)	0.856 (0.538)
Land owned (between 1,5 et 3)		0.296** (0.145)	0.247** (0.154)
Land owned (between 3 et 5)		0.558 (0.305)	0.546 (0.357)
Land owned (above 5)		0.419 (0.241)	0.469 (0.323)
Wealth index (weak)		0.688 (0.336)	0.597 (0.349)
Wealth index (high)		0.679 (0.339)	0.767 (0.489)
Wealth index (very high)		0.416* (0.214)	0.387 (0.246)
Shocks (level 1)		1.371 (0.750)	0.562 (0.390)
Shocks (level 2)		1.723 (0.970)	1.009 (0.730)
Shocks (level 3)		1.384 (0.780)	0.733 (0.526)
Liquid constraint low constraint			1.966 (1.101)
Liquid constraint high constraint			2.848* (1.706)
Trust (high trust)			1.253 (0.648)
Trust (acceptable trust)			1.629 (0.913)

Insurance take-up decision	Odds ratios	Odds ratios	Odds ratios
Experience			0.385 (0.356)
Access to credit (formal & informal)			0.526 (0.338)
Access to credit (formal only)			0.329** (0.178)
Access to credit (informal only)			0.923 (0.701)
Basis risk perception (rather similar)			3.868* (2.714)
Basis risk perception (similar)			6.013** (4.447)
Basis risk perception (don't know)			7.077** (7.022)
Network homogeneity (heterogeneous)			0.186*** (0.108)
Network homogeneity (very heterogeneous)			0.723 (0.370)
Observations	340	337	302
Adjusted R	0.254	0.340	0.411
LR Chi2	100.3	132.4	139.3

Note: Exponentiated coefficients; Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Interpretation: The first step of estimation concerns variables related mostly to the intervention. The second step includes socio-economic characteristics of the households and the third step the entails characteristics of the bundled product. We remark that most of the results remain when we shift from the first to the last step in terms of significance.

Appendix F: OSIRIS monitoring indicators and study

Principal monitoring indicators	Inputs	Outputs	Outcomes	Data
<i>Understanding of the agricultural insurance products and their subscription procedures</i>	Training of farmers delegates and stuff of COOPEC/RESOP on the Functioning of all agricultural insurance products available within the CNAAS	19 farmers' delegates trained (9 men and 10 women) & 7 COOPEC/RESOP P staff members trained (5 men and 2 women)	Ability by the COOPEC/RESOP P staff and farmer's representatives to explain the functioning of WII to simple members and clients;	Source: Primary + Secondary Mode of collection (for primary data): Interviews
	Training of delegates and some influential persons on the procedure and details of subscription	26 farmers' delegates trained (22 men and 4 women) & 7 influential persons trained (6 men and 1 women)	Less obstacles to take-up through a deeper and broader dissemination of the subscription procedures	
<i>Knowledge of risk coping/transfer mechanisms available for agriculture activities</i>	Awareness raising and advertising in villages with members of the COOPEC/RESOP P on the different products including agricultural insurance	122 villages were visited by COOPEC/RESOP P and OSIRIS staff in order to sensitize for adhesion to the products.	Number of farmers who have access to the insurance product and could subscribe: Farmers of 30 villages had access to WII.	Type: Quantitative and Qualitative
<i>Access to WII through the extending of the coverage radius of rain gauges</i>	Installation of new rain gauges in the COOPEC/RESOP P booking office areas	One new rain gauge is installed in all the OSIRIS intervention areas where rain fed agriculture is practiced.		
<i>Effective take-up as the number of farmers who effectively paid for the premium (either cash or by credit)</i>	Specific training of credit agents on the sales protocols of the bundled credit with agricultural insurance	8 sales agents and 7 COOPEC/RESOP P staff members trained on marketing and sales protocols	Number of effective take-up with actual payment for the premium in the study area: Results:	Source: Primary + Secondary

<i>Performance of sale agents</i>		Number of subscription per sale agents	<ul style="list-style-type: none"> • WII: 158 farmers (all participants of the study) • Traditional insurance: 157 (96 participants of the study, 61 non-participants). 	Mode of collection: Survey + Focus group Type: Quantitative + Qualitative
INDICATORS SPECIFIC TO THE INTERVENTION AND DESIGN AS PART OF THE STUDY				
<i>Mandatory bundling effect on take-up</i>	Mandatory insurance for 103 farmers + Incentive message High Sensitization 	Number of farmers who decide to take-up when insurance is mandatory vs when it is not. Result: 79 vs 24	Total: 315 sales	
	Voluntary insurance for 141 farmers + Incentive message High Sensitization 	Number of farmers who decide to take-up when there is an incentive message vs when there isn't Result: 97 vs 44		
<i>Positive incentive effect on take-up</i>	Voluntary insurance for 127 with No Incentive message High Sensitization			
<i>Trust, understanding and other socio-economic factors effects on take-up</i>	Detailing the insurance functioning and parameters such as premium pay-outs calculation to each participant of the study	Number of participants who said they would voluntarily take the insurance without incentive due to understanding, trust...	62% of the participants ready to take the insurance voluntarily without any incentive	Source: Primary Mode of collection: Survey + Focus group Type: Quantitative + Qualitative

Source: Authors from OSIRIS monitoring information.

Appendix G: Statistical tests

Unless otherwise specified, all figures and tables presented in the annex are the authors' own.

1. Kruskal Wallis test on the homogeneity of the different sales protocol groups

Kruskal-Wallis equality-of-populations rank test

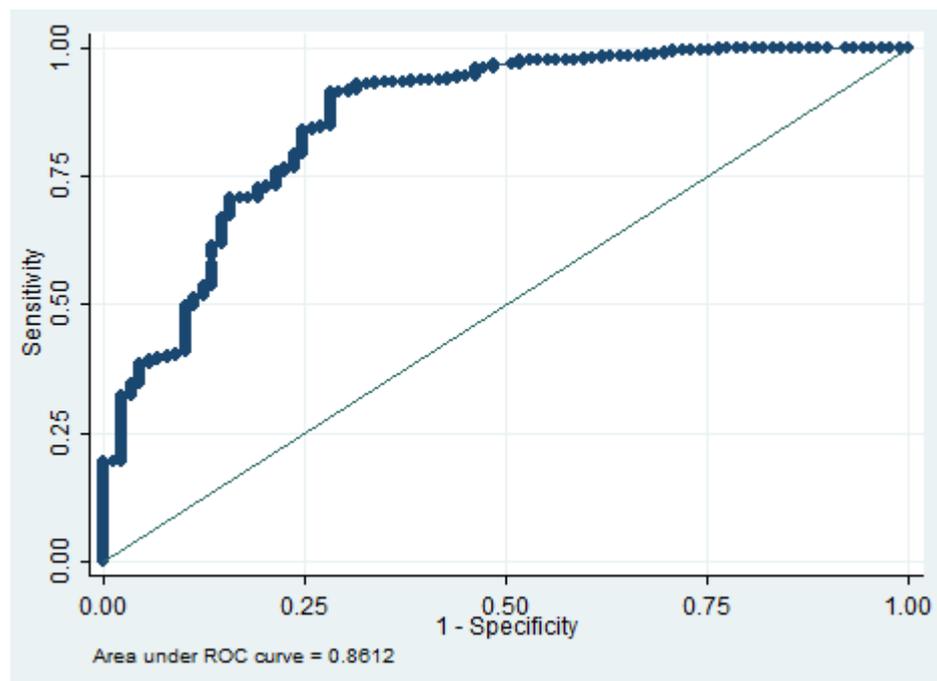
sale_prot~1	Obs	Rank Sum
volontaire	133	22167.00
obligatoire	96	17141.00
controle	117	20723.00

chi-squared = 1.018 with 2 d.f.
probability = 0.6010

chi-squared with ties = 1.727 with 2 d.f.
probability = 0.4217

The p-values is above 5%. Thus H0 hypothesis for differences in median is rejected and we can say that he groups are similar.

2. Quality of the adjustment of the model in Table 6: Estimation results



Interpretation: The area under the ROC curve is between 80% and 90% meaning that the adjustment is very good. This is confirmed by the GOF test below since the p-value is also above 0.05.

3. Fit of the model in Table 6: Estimation results

Logistic model for decision, goodness-of-fit test (Table collapsed on quantiles of estimated probabilities).

number of observations	337
number of groups	10
Hosmer-Lemeshow chi2(8)	7.76
Prob > chi2	0.4568

Interpretation: The p-value is above 5% suggesting that the data fits well the model.

Appendix H: Power and sample size

Assuming that the sampling distribution follows a Gaussian law, the formula for calculating size is:

$$n = \frac{Z^2 p(1-p)}{d^2}$$

n: Sampling size

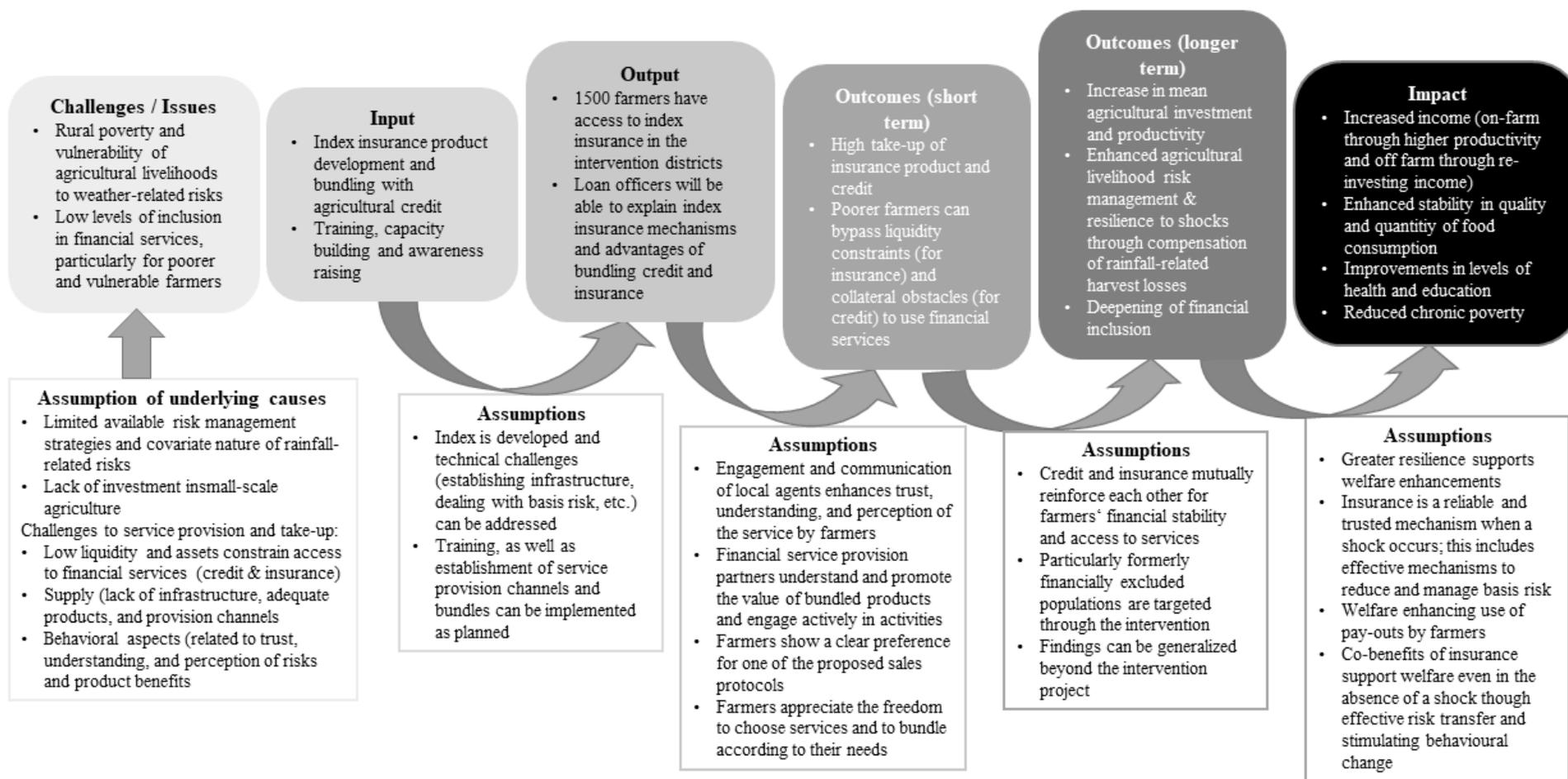
Z: standard error associated to a level of confidence of 95%: 1,96.

p: estimated proportion of farmers contracting index insurance: 20% (according to literature and stylized facts)

d: desired precision (margin of error): 5%

On that basis, the sample size required for the study was 246 farmers. In order to take in account non-responses risks and unusable data we added 10% of the initial proportion to the sample size. That gives a final minimum sample size of 270 farmers. Finally, all the population of applicants for credit, namely 425 farmers were considered as potential participants. 371 of them participated in the RCT and 346 participated in both the RCT and the survey.

Appendix I: Theory of Change



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