Comparative Assessment of Weather Index Insurance Strategies

Literature Review commissioned by Vuna | May 2016

Please cite this publication as follows:

Arce, Carlos. 2016. Comparative Assessment of Weather Index Insurance Strategies. Vuna Research Report. Pretoria: Vuna. Online: http://www.vuna-africa.com

Project Team

Project Team Leader	David Rohrbach
Project Manager	Vimbai Chasi
Editor	Mark Essig

Date: May 2016 | **Lead Author:** Carlos E. Arce | **QA'd by:** Vimbai Chasi

Vuna is a DFID-funded regional Climate Smart Agriculture Programme. The British Government's Department for International Development (DFID) financed this work as part of the United Kingdom's aid programme. However, the views and recommendations contained in this report are those of the consultant, and DFID is not responsible for, or bound by the recommendations made. This material is not to be reproduced, altered, contents deleted or modified in any way without written permission from Vuna.

UKaid
from the British people

TABLE OF CONTENTS

Acronyms iii

1 Introduction 1

2 Background 2

3 Mechanics of WII 4

3.1 Design 4

3.2 Levels 4

3.3 Basis risk 6

3.4 Data sources 6

4 Demand 7

5 Bundling with credit 8

6 Profitability 9

7 Impact 9

8 Agriculture WII and Climate change 10

Bibliography 11

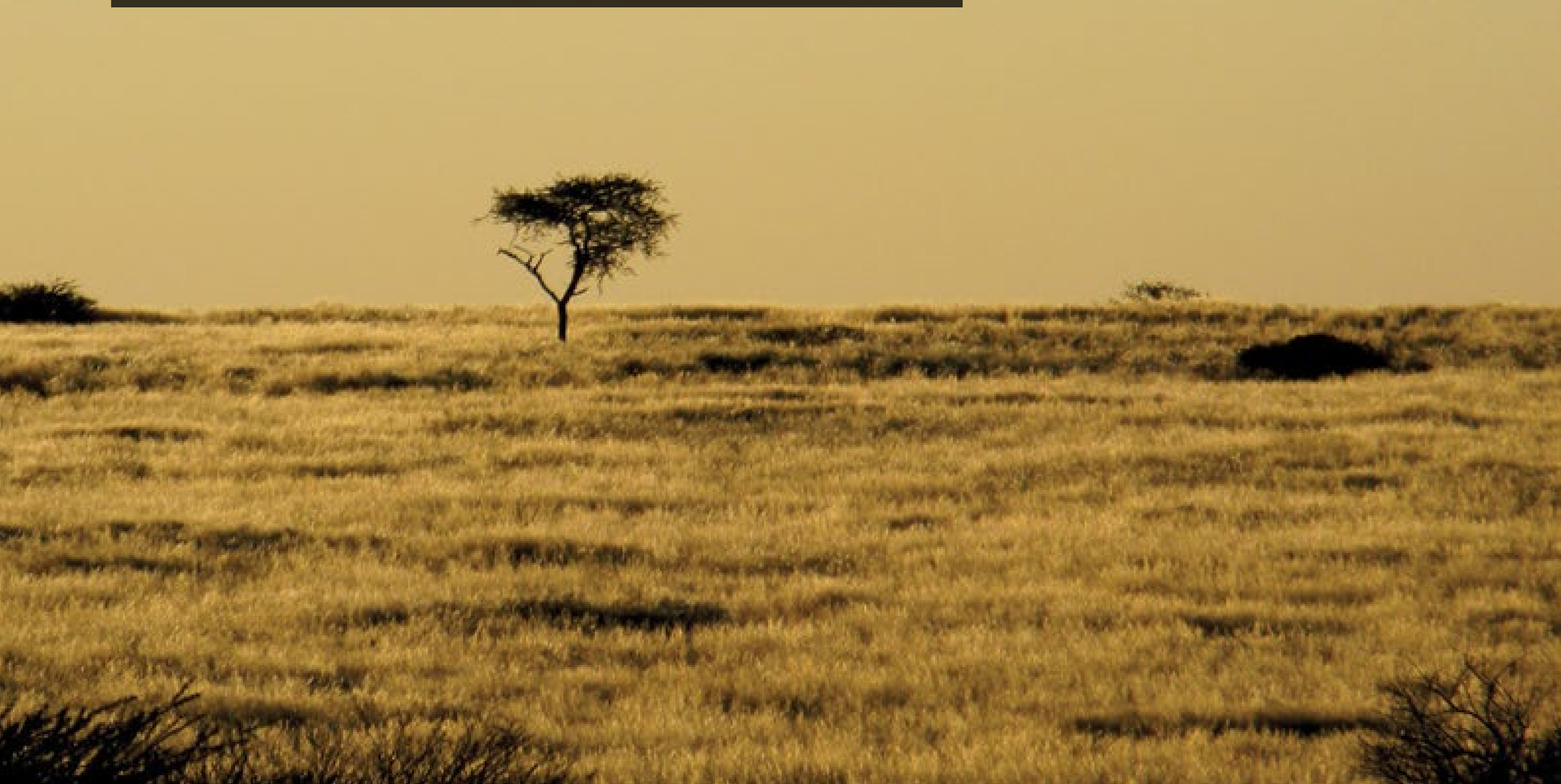
List of Tables

Table: 1: Recent Weather Index Insurance pilots in sub-Saharan Africa by level and type 5

Acronyms

CSA	Climate Smart Agriculture
Vuna	Climate Smart Agriculture Programme
DFID	Department for International Development
ACRE	Agriculture and Climate Risk Enterprise
GIFF	Global Index Insurance Facility
NDVI	Normalised Difference Vegetation Index
ARC	African Risk Capacity
WBCIS	Weather Based Crop Insurance Scheme
IBCI	Index-based Crop Insurance
IBLI	Index-based Livestock Insurance
FSD	Financial Sector Deepening
WII	Weather Index Insurance

This Literature Review is the first step towards a comparative assessment of Weather Index Insurance (WII) in the agricultural sector in East and southern Africa.



1 Introduction

This Literature Review is the first step towards a comparative assessment of Weather Index Insurance (WII) in the agricultural sector in East and Southern Africa. The second step involves visits to four countries (Kenya, Tanzania, Zimbabwe, and Zambia) covered by the Climate Smart Agriculture Programme (Vuna) funded by DFID, which have weather index insurance programmes. The visits will allow collection of information on the recent performance of those programs and obtain the perceptions of key stakeholders on lessons learned, constraints, sustainability, and potential of those insurance programmes to address issues related to strengthening the resilience of agricultural systems to weather risk. The findings from both stages will be summarised in an Evidence and Learning Report focussing on the determinants of success or failure of the programmes under implementation.

This paper summarizes the main findings of the global experience on the implementation of WII specifically the lessons learned on the mechanics of the index, profitability, bundling, impacts, and potential role in climate change adaptation. It also discusses the challenges of current pilot projects in East and Southern Africa, wherever secondary information is available.

2 Background

The origins of WII are from the international weather derivative market, where major corporations hedge weather risks. The interest in investing in WII applications for agriculture grew in the late 1990s from a belief that traditional insurance products (especially MPCI)[1] were not viable for developing countries, where limited commercialization and small average farm sizes are a major hindrance to the development of sustainable commercial agricultural insurance products (See Skees *et al.,*,1997).

Since the late 1990s, there has been a lot of discussion and debate about the promise and potential uses of agriculture weather index insurance. As the theoretical discussion of the advantages of an index over traditional insurance turned to a need for practical examples, a 2005 World Bank publication "Managing Agricultural Production Risk" set out, in some detail, the potential benefits of index insurance and some early examples of its application in developing countries.

World interest on WII was particularly triggered after the launching by Mumbai-based insurance company ICICI Lombard of a weather insurance pilot program for groundnuts. Since its inception in 2003, the product has undergone some drastic changes. Currently, the contract is not tied to specific crops but offers a generic contract for three phases of the growing season for specific rainfall thresholds; it has become compulsory for those farmers applying for a credit loan from public credit funds and it is heavily subsidised by the government.

Since 2005 the World Bank motivated by the recent design of weather index insurance in India and the availability of crop models developed by FAO[2] started promoting WII to protect the rural poor against weather risk. Arguably, WII was conceived as low cost, commercially sustainable, individual protection, with no moral hazard and reduced adverse selection for small farmers in developing economies (World Bank, 2005). During the last decade, there have been a plethora of pilot projects in different parts of the developing world attempting to deliver the promises, and an equally significant number of scholars analysing and assessing the results. Over 15 developing countries have introduced index insurance pilot programs for the protection of individual farmers' weather risk, mostly on a limited experimental basis.

This exceptional effort, funded with over $40m over a decade (in the form of technical assistance, infrastructure, risk pooling, and co-financing of certain products, provided mainly through the GIIF by the European Union, the Swiss and Dutch Development Cooperation, via the World Bank) has maintained the momentum of research on how to apply a great innovation in the agricultural sector of developing nations. Likewise, USAID has applied serious efforts into piloting innovative WII initiatives, coordinated by leading US agricultural universities.

However, despite this effort, there has been no successful commercially sustainable scale-up at the farmer level, despite the various modalities supported by policy or financial tools by governments and / or substantial financial support from donors.

In fact, the findings are very disappointing in many respects, particularly the puzzlingly low uptake by farmers in developing countries, and less than a handful of pilots are today still being tested. Recently, the Agriculture and Climate Risk Enterprise (ACRE) claims to have scaled to reach nearly 80,000 farmers within a number of different modalities of pilot projects in Rwanda, Tanzania, and Kenya. ACRE's most relevant pilot regarding uptake is bundling weather index insurance with the provision of seeds through agro-dealers (using cell phone mobile banking for collecting premiums and delivering payouts). In Ethiopia and Senegal, the R4 Rural Resilience Initiative (former ARITA project by OXFAM) uses a very different model by protecting around 20,000 poor smallholder farmers with a subsidised index product against weather risk, used mainly to trigger food aid as part of a larger comprehensive social protection strategy. Another example is the partially subsidised, NDVI-based, Index Based Livestock Insurance (IBLI) project in Kenya with an uptake of around 8,000 pastoralists insured in 2016, which will be extended by the government in a totally subsidised modality to protect a large number of vulnerable households against drought, as part of the government social protection policy.[3] Most of the other WII piloting in Sub-Saharan Africa supported by GIIF for small farmers (i.e. two different modalities of insurance for cotton farmers in Tanzania (ginneries as distribution channel) and Mozambique (through the Mozambique

1 Multi-peril crop insurance.

2 FAO introduced the concept of Water Requirement Satisfaction Index (WRSI), which has the potential to estimate yields based on rainfall patterns.

3 The normalised difference vegetation index (NDVI) is a simple graphical indicator that can be used to analyse remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not.

Cotton Institute), and other minor initiatives have not progressed beyond the initial piloting of less than a handful of thousand farmers).

The reality is that WII so far has been tested in a considerable number of countries under different modalities, and there are no clear signs of the commercial sustainability of those products when developed to protect small farming in developing countries, despite the considerable donor support in terms of know-how, insurance platform, marketing, and scientific applied research.

The latest serious scholarly assessment of WII initiatives worldwide considers that while impacts have typically been positive where some uptake has occurred, uptake has generally been low and in all cases under conditions that were not sustainable. There has been a high degree of experimentation that has ended up in failure once the piloting stage is over and no program so far in sub-Saharan Africa has proven to be sustainable. Some scholars consider that WII is thus still very much work-in-progress (at the stage of Research & Development), and the jury is still out on how to make it work (Carter *et al.*,2014), the task being made more pressing by the need to provide a risk transfer solution to the risk management toolkit (mitigation – transfer – coping) for the agriculture sector in developing countries.

3 Mechanics of WII

The innovation of weather index insurance was triggered by the shortcomings demonstrated by traditional agricultural insurance that base indemnity payments on verifiable losses. One of those factors, among many, is moral hazard; it is extremely difficult (and costly) for an insurer to monitor large numbers of small plots against false declarations. The second shortcoming is adverse selection, where asymmetrical information on risks leads only farmers with higher risks to contract insurance. Raising the premiums only attracts even riskier farmers, leading to still higher costs. And the last such shortcoming is the high transaction costs of contracting large numbers of dispersed smallholders. There seems to be a consensus on the conclusion that conventional indemnity-based insurance simply does not work for smallholder farmers in developing countries (Hazell, 1992).

3.1 Design

An index-based weather insurance policy links possible insurance pay-outs with an index, which is based on estimates of the weather requirements for an insured crop/livestock to develop satisfactorily. These requirements are summarised in a simple crop model relating a weather index (either rainfall, temperature, wind speed, solar radiation, etc.) to crop growth and losses. An indemnity is paid whenever the realised value of the weather index exceeds a pre specified threshold (for example, when protecting against excessive rainfall) or when the index is less than the threshold (for example, when protecting against too little rainfall). Although the index is based on the use of data and complex modelling technology, the problem remains that one is trying to use mathematics to reflect a series of natural processes (that is, the growth of living plants across a wide area) occurring in a small plot of land, which is extremely complex. The main challenge of weather-based approaches to agricultural insurance is therefore the issue of basis risk (weather damage occurs to an insured crop but the insurance contract does not trigger a payment). An important part of basis risk is whether the index itself (even given accurate representation of weather) accurately captures the crop development stages (for example in maize, planting, vegetative growth, tasselling, cob formation, ripening) of the individual plants on the insured field.

Theoretically and empirically it has been shown that basis risk depresses the value and demand for these products (Clarke 2011), and Dercon *et al.,* (2014). Clarke (2011) for instance, makes the point that index insurance contracts characterised by high basis risk may find low acceptance amongst highly risk averse farmers. The basic insight is the simple but important one that, when a contract fails (premiums are paid, losses occur, but no indemnity payments are forthcoming), the individual is left worse off than if the insurance had not been purchased at all. Highly risk-averse individuals would be expected to be especially sensitive to this increase in tail-end risk that results from high basis risk insurance. In addition, when basis risk is high, index insurance will also fail in its fundamental development objective of crowding in additional investments in remunerative but risky technology, a point developed in detail by Carter *et al.* (2014).

3.2 Levels

The recent practical applications of weather index insurance can be summarised in the following table, as they were designed to protect the agriculture sector in Sub-Saharan Africa.

Table: 1: Recent Weather Index Insurance pilots in sub-Saharan Africa by level and type

Level	Recent pilots (examples in sub-Saharan Africa)	Type
Micro The policyholders are individuals (i.e. individual farmers)	Ethiopia- Senegal: R4, formerly HARITA (OXFAM)	Type: Social protection. Protection of smallholders against droughts, conceived as social protection for vulnerable households. Subsidised premium payments with modality of "work for insurance" and satellite rainfall indexes. Ongoing.
	Kenya, Tanzania, Rwanda: ACRE/Syngenta/ Kilimo Salama	Type: Insurance of seed. Designed to protect weather risk during sowing (20-26 days). It covers the value of purchased seeds. Distribution channel is through mobile phones. Satellite-based observations. Ongoing.
	Malawi: Opportunity international	Type: Insurance of a loan. To cover credit of maize and groundnut smallholders against rainfall risk for the duration of the crop cycle. Weather station observations. Stopped
	Kenya: ILRI/Ministry of Agriculture	Type: Stand-alone yield protection. To protect individual herders against drought. NDVI observations. Stopped
	Mozambique: Mozambique Cotton Institute (IAM) -Guy Carpenter	Type: Insurance of inputs. To protect the value of inputs of cotton farmers against drought. Premiums paid by the cotton institute (IAM) for the first year. Weather station observations. Stopped.
	Zimbabwe: Econet / SeedCo.	Type: Insurance of seed. Designed to protect farmers against weather risk during sowing (20-26 days). It covers the value of purchased seeds. Distribution channel is through mobile phones. Weather station observations. Stopped.
	Zambia: Musika	Type: Insurance of inputs. To protect the value of inputs of cotton farmers against drought. Premiums paid upfront by the agro-dealer to recover them at harvest together with credit. It uses financial intermediaries as distribution channels charging premiums as part of the loan. Ongoing.
Meso The policyholders are "aggregators" (i.e. financial intermediaries with rural portfolio, input suppliers)	No cases known of WII subscribed by aggregators to protect their own credit portfolio weather risks. The cases where aggregators participate are mostly as distribution channels for individual farmers to protect their credits.	The objective would be to cover the weather exposure to business operating with individual farmers, usually providing credit or inputs.
Macro The policyholders are institutions at national or regional level against government exposure (Sovereign insurance).	• In 2006, WFP facilitated a drought index coverage deal between the government of Ethiopia and AXA Re. • Since 2012 the African Risk Capacity (ARC) as a risk pooling and transfer mechanism for food security. • In Kenya, Ministry of Agriculture and ILRI are launching in 2016 a transfer product to protect pastoralist livestock against severe droughts. This is designed as part of the government social safety net. • Malawi macro level drought risk protection.	The main objective of these transfer vehicles is to protect the fiscal risk of the State faced with catastrophic events. Rather than insurance, some of these products are more correctly qualified as a derivative (but are not locally regulated as such). These reinsurance facilities are usually part of a layered-risk financial protection, covering the catastrophic end tail of the risk spectrum. Risk events of less intensity are usually covered with government budget, donor emergency aid, or contingency finance. The Kenyan livestock insurance will cover fiscal risk of the government against catastrophic level droughts. For the Malawi sovereign protection the objective was quick access to reliable source of contingent financing available in case of drought.

Some recently launched pilot projects being tested in Kenya, Zimbabwe, Tanzania, and Zambia will be assessed more in detail in a separate comparative assessment report.

However, the weather index insurance market in India is the world's largest, having transitioned from small-scale and scattered pilots to a large-scale weather based crop insurance program covering more than 9 million farmers. As might be expected, the introduction of a largely compulsory, heavily subsidised program by states for farmers applying for agricultural loans, led to a substantial increase in premium volume and number of farmers insured from 2007-8 onwards, with between-year uptake fluctuations mostly caused by large states changing their decision about whether to opt in to Weather Based Crop Insurance Scheme (WBCIS) or not (Clarke *et al.,*2014).

3.3 Basis risk

The main challenge of weather-based approaches to agricultural insurance is that, by offering payments based on the measurements of weather variables (e.g. mm of rainfall) at a referenced weather station, there are cases where farmers might have losses due to insured weather events (i.e. rainfall deficit) but the contract does not trigger payments. This can be due to the imperfect correlation between the index and a farmer's loss, the presence of microclimates, or simply the long distance between the farmer's plot and the weather station. This can result in the farmer receiving no payment, despite having experienced crop loss.

Indeed, a common assumption (which is, perhaps quite problematic for WII design) is the reliance on a single weather station representing an area of 20– 25 km radius. Households and villages within this radius are expected to have homogeneous topography and farming systems. However, this simplified assumption of homogeneity of farming systems in index development is problematic for countries with variable topography, soil conditions and more diverse agro-ecologies (Gommes and Gobel 2013). One of the potential solutions to avoid the problems of basis risk is obviously to design contracts only for big shocks as argued by Turvey 2008, and Hazell and Hess 2010, but then the contract might lose it attractiveness for not covering potentially large monetary losses at farm level that are not necessarily at the catastrophic level. WII contracts covering only the catastrophic layer might be instead more attractive tools for social protection strategies to cover the sovereign fiscal risk.

3.4 Data sources

The lack of relevant and reliable long-term yield and weather data has been one of the key technical constraints in designing weather index insurance in developing countries (Osgood *et al.,*2007; Kapphan 2011). Contract design requires a time series of reliable, historic weather and yield data, covering at least 20 years, with less than 5 percent missing observations. In the absence of such data, the pricing of the product is raised to cover the uncertainty.

In some cases, the level of aggregation of yield data is also a problem. Some researchers argue that it is more accurate to include yield or input use data (for calibrating indices) derived from plot level information/surveys than taking regional or national average yield or input use. For instance, Laajaj and Carter (2009) quoted in Tadesse *et al.,*2015, find that basis risk could be minimised using the village level area-yield index derived from plot and household level survey data. However, the availability and/or reliability of such village level data can also represent a challenge.

The use of satellite observations data sets (satellite-based observations calibrated with readings from field observations), also known as "synthetic" data, whenever available tends to solve the problem of scarcity of weather data for pricing and for triggering payouts, but it does not solve the issue of basis risk. It might increase it.

Using satellite imagery, the Normalised Difference Vegetation Index (NDVI) is sometimes mentioned as a way to reduce basis risk. NDVI is capable of reporting a vegetation index at various resolutions and time intervals (Laajaj and Carter 2009). However, NDVI works mostly in homogenously grown fields, but is difficult to apply to multi-cropping systems that are typical in small farming in developing countries. Turvey and McLaurin (2012) found that NDVI should not be widely applied unless calibrated using location specific data. However, the same authors admit that some of the current imperfections in satellite imagery can be improved in the near future, however more experimentation will need to be made before there is evidence of reducing basis risk, as there are no NDVI applications for small farming. In the particular case of NDVI application for livestock in Kenya, it has proven to be rather difficult to correlate the index with livestock mortality, leading the designers to make various adjustments. There is no known, formal evaluation of basis risk.

The following subsections will summarize the findings that have recently been made regarding the key issues of demand, bundling, profitability, impact on agricultural investments, and the relationship between weather index insurance and climate change adaptation.

4 Demand

Despite continued pilot testing of many types of weather index insurance products in low-income countries for over a decade, its actual uptake has been far below expectations (Gine and Yang 2008; Binswanger-Mkhize 2012; Cole *et al.,* 2013). The few cases where index insurance has been implemented were either free or heavily subsidised, or offering insurance along with other benefits such as subsidised credit and heavy technical assistance. In extensively studied cases in Malawi (Giné, 2009) and India (Cole *et al.,*2013), take up was only 20-30%, with adopters insuring only a very small fraction of agricultural income. Take up among farmers not explicitly targeted in these programs was much lower (Carter *et al.,*2014). The low uptake has been the main factor of pilots' failure.

Low demand for WII has represented one of the most interesting puzzles in developing economics for the last decade. Scholars have found a fascinating area of research and they are not short of possible explanations, some of which are summarised below.

The high price (premium) and lack of trust in the index and its ability to properly predict the risk of loss as well as the credibility of the insurance providers are key factors negatively influencing the demand for weather index insurance (Brans *et al.,*2010; Cole *et al.,*2013).

Clarke (2011) shows that the low demand for weather index insurance by poor farmers is a rational response to basis risk. For higher uptake, weather index insurance should be cheaper than the current risk management practices of smallholders, such as reliance on social networks and self-insurance mechanisms by owning assets (Binswanger-Mkhize 2012). The World Bank agriculture risk assessments done in various African countries (Rwanda, Tanzania, Malawi, Kenya, Mozambique, Niger, and Senegal) argue that promoting access to productive assets (e.g. land, credit, improved seeds, better agronomic practices and rural infrastructure) are the key factors for the poor to build their own capital to self-insure and strengthening the resilience of agricultural systems.[4]

Likewise, for higher uptake, weather index insurance should be cheaper than the current informal risk management practices of smallholders, such as reliance on social networks and self-insurance mechanisms by owning assets (Binswanger-Mkhize 2012).

Mobarak and Rosenzweig (2012) provided some insights into the nature of demand for WII and informal risk sharing. They examined theoretically and empirically the impact of informal risk-sharing on the demand for index insurance, and the effects of index insurance purchase on subsequent risk-taking. In theory, informal risk sharing can crowd out demand for index insurance if the network indemnifies rainfall risk, but the authors argue that it could also be a complement to index insurance if the contract carries basis risk (i.e. mismatches between payouts and actual losses due to the remote location of the rainfall gauge). The findings of their randomised field experiments in India they found substantial support that the demand for index insurance is lower with greater basis risk, but indemnification of household-specific losses by the network mitigates this effect. Rainfall insurance enables households to take more risk even in the presence of informal insurance.

Kenya is one of the countries where both index-based crop insurance (IBCI) and Index-based Livestock Insurance (IBLI) pilots have been tested. A recent review of the Financial Sector Deepening Programme (FSD), supported by several donors in Kenya, provided important lessons and recommendations based on the performance of weather index insurance pilots in the country (FSD 2014). The FSD review recommends that FSD scale down the retail pilots and take a longer-term view by concentrating on meso- and macro- level cover, such as an agricultural lending portfolio or area drought cover for government agencies and others responsible for drought response (FSD 2014) which is quite interesting and pragmatic given the challenges of micro-level commercialization of the product using the existing delivery mechanisms and weather data for computing locally relevant indices to trigger payouts (Tadesse *et al.,,*2015). However, this would imply a safety net solution only.

In the end, designers of WII contracts for individual farmers have to choose and offer various options of coverage. The coverage is a trade-off between the desired frequency of payments (i.e. every 3 years, 5 years, 10 years, etc.) and the premium rate. The higher the frequency of payments, the higher the premium; and premium rates could be very sensitive to these return periods. Less frequency of payments results in lower premium rates, but it might not be considered enough coverage by farmers in drought prone areas.

4 Those risk assessments can be downloaded on: www.agriskmanagementforum.org.

Alderman *et al.* (2007) asserts that even if the use of weather-based indices can reduce costs and solve some of the information asymmetries that bedevil MPCI, in the absence of subsidies, it is not clear that low-income producers would be able to afford insurance. He then reverts to the issue of whether there may, therefore, be a role for the government in expanding the demand for individual insurance through premium subsidies both to address equity concerns and to address market imperfections. His assertion however, brings another set of questions regarding the economic and/ or social return of public investments on insurance, and moreover on the justification for public intervention vis-a-vis other agriculture risk management interventions related to good agricultural practice and strengthening resilience in agricultural systems.

5 Bundling with credit

In Tadesse *et al.* (2015) it is shown that Ethiopian households that participate in schemes in which subsidised index based weather insurance in linked with credit are more likely to use chemical fertilizer compared to those with standalone insurance schemes (McIntosh *et al.* (2013). Interlinking weather index insurance with credit seems to hold particular promise (Shee and Turvey 2012; Carter 2009; Hess and Syroka 2005; McIntosh *et al.,*2013), but there is not general agreement on this topic. Giné and Yang (2008) for example found demand for uninsured loans to be higher than for insured loans in Malawi. Similarly, Banerjee *et al.* (2014) see microcredit demand fall when interlinked with insurance. Nevertheless, one attractive proposition is that linking insurance with credit allows insurers to use financial institutions as distribution channel. Tadesse *et al.* (2015) argue that it could reduce administration costs such as through the use of innovative tools - e.g. mobile phone, and that it may also help to further reduce interest rates and insurance premiums. But there is no evidence that bundling insurance with credit reduces interest rates.

Although interlinking weather index insurance with credit may encourage rural financial institutions to provide credit to smallholder farmers (Carter 2009), it is important to develop products that could easily be interlinked with, and ease supply-side constraints such as, providing timely credit with the required amount (McIntosh *et al.,*2013). In addition, despite the theoretical justifications for interlinking insurance with credit (Farrin and Miranda 2015), there is lack of empirical evidence illustrating reductions in loan interest rates or insurance premiums due to the interlinkage.

McIntosh (2015) argues that in an experiment interlinking credit with insurance in Ethiopia, found that the credit contracts are difficult to establish, demand for both stand alone and interlinked loan were low.

Finally, as practical as it may seem in some cases, interlinking insurance with credit will need to be further researched, mostly due to the fact that weather risk, although a key risk, is not the only risk that financial intermediaries analyse while doing their due diligence for agricultural credit. A forthcoming publication by the World Bank (2016) maintains that the provision of financial services to agriculture, especially credit, is largely constrained by: the high transaction costs of serving clients located in remote, less densely populated areas with limited infrastructure; covariant risks in agriculture (including weather, price, pests, diseases); smallholders' lack of collateral (such as land and other fixed assets); and inadequate information on smallholders' credit history.

Moreover, agricultural risk assessments made by the World Bank identify that side selling in contract farming and failure to repay loans represent a high risk to banks. Given these, and that the presence of WII is only covering weather risk and adding to the costs of borrowing, we cannot expect an increase in lending by the sole presence of weather contracts in a context where many financial institutions are hardly present in remote agricultural areas and provide limited types of products, often requiring collateral.

6 Profitability

There is not much evidence published on the profitability of weather index insurance projects for participating insurers. However, the levels of uptake, the modest sums insured in the various pilots, and the number of firms that have dropped WII programmes suggest that WII has not been a profitable line of business for insurers. An exception could be in countries with heavy subsidies, like India and Mexico, but no evidence has been found. Additionally, in most countries WII represents only an insignificant portion of an insurer's portfolio, and most local insurers are retaining no more than 5-10% of the risk, leaving most of the business to the reinsurer. Some insurers in pilot projects in Nicaragua and Honduras also admitted that agricultural insurance carries an additional reputational risk, given the political nature of insuring smallholders with contracts that suffer from unknown basis risk. This is an area that needs further exploration to have a better sense of the insurers appetite for WII and the commercial sustainability of the product.

7 Impact

A good deal of field experiment by scholars has been conducted around trying to measure the direction and magnitude of potential impact of weather insurance around some of the pilot projects. The evidence shows there is some degree of correlation between the introduction of subsidised insurance and higher risk-taking of insured farmers. McIntosh (2016) summarizes the main findings as the following:

- In Andhra Pradesh, farmers who receive insurance were 6 percent more likely to plant cash crops (Cole *et al.* 2013).
- In Ghana, farmers increased their share of land planted to maize, and fertilizer use (Karlan *et al.,* 2013).
- In China, farmers given tobacco insurance in randomised field experiments increased production of this risky crop by 20 percent (Cai *et al.,* 2014).

Additionally, Mobarak and Rosenzweig (2012) use a randomised experiment where rainfall index insurance is offered to Indian farmers. Results show that insurance helps cultivators reduce self-insurance and switch to riskier, higher-yield production techniques. In another experiment, Mobarak and Rosenzweig (2012) show that existence of informal risk-sharing networks among members of a sub-caste increases demand for index insurance when informal risk sharing covers idiosyncratic losses, reducing basis risk. In this case as well, formal index insurance enables farmers to take on more risk in production.

Vargas-Hill and Viceisza (2010) use experimental methods to show in a game setting that insurance induces farmers in rural Ethiopia to take greater, yet profitable risks, by increasing (theoretical) purchase of fertilizer.

Finally, evidence from India in Gine *et al.* (2016) find that while insurance provision has little effect on total agricultural investments, it significantly induces farmers to invest more in riskier production activities. In particular, insured farmers under randomised experiments increased production of the main cash crops grown in the study areas, castor and groundnut. These crops produce higher expected returns but are also more sensitive to deficient rainfall. They find that insured farmers are more likely to plant these two cash crops, sow more land with them, and devote a larger amount of agricultural inputs to them, relative to uninsured farmers.

These findings seem to suggest that insured farmers tend to undertake riskier agricultural activities than those uninsured under the same circumstances. Does this imply that farmers are underinsured? And that public policy needs to subsidised insurance arrangements to "fill in" missing markets with the potential to have positive effects on entrepreneurial production and risk-taking? As weather index insurance has not proven to be commercially sustainable, the answer for public intervention as to WII or not to WII is not all that simple. This is mainly due to the high costs of massively subsidizing agriculture insurance in order to have meaningful critical mass that could make some impact on productivity and poverty reduction. And most importantly, there is a pressing need to estimate the economic and/or social return and the total costs of WII (research, infrastructure, technical assistance, premium subsidies, etc.) compared to competing subsidies aimed at strengthening the resilience of small farming production in developing countries. This exercise is still pending.

8 Agriculture WII and Climate change

Since climate change is becoming a source of significant additional risk for agriculture and food systems, development practitioners look for the appropriate strategies to make agricultural systems resilient to changes in the climate. Agricultural index insurance is no exception to that trend and promoters of WII increasingly suggest that it can become a key intervention to boost resilience for smallholder agriculture. There is, however, not much evidence along these lines, probably because of the limited uptake WII has had during its implementation, and there is no analysis of its impact on resilience.

Factoring in climate change in WII contracts presents increasingly technical complexities in its design, mostly because insurance design is based on the probability estimates using historic yields, and climate change models, being long-term predictions, do not have the precise predictability needed in the short term for factoring in climate change in the pricing. However, it would be logical to assume that as WII relies on historic averages for assessing the risk, it will become increasingly difficult to price the product, adding cost to the premiums due to the inherent uncertainty.

However, it can also be argued that adaptation will take time, and WII could be deployed to provoke changes in productivity in the short term. But Surminsky *et al.* (2016) warn that utilizing insurance for adaptation and poverty reduction faces even more challenges: how can a scheme reach the most vulnerable, and how does it cope with and address changing risk levels? As the intensity and frequency of climate extremes increase, is it fair to shift responsibility on to those who are the least responsible for climate change, the least able to shoulder the premiums, and in many cases the least able to reduce their losses? Is the alternative to promote the subsidised safety net model?

Without substantial external support, insurance could shift the burden of climate-related impacts to the most vulnerable in society, by requiring vulnerable households to pay insurance premiums rather than offering them direct help and support. Subsidised premiums are one answer to this; other solutions include publicly funded reinsurance arrangements and technical support — each of which indirectly reduces premiums.

Finally, the introduction of stand-alone WII programs in the absence of any other measures for boosting resilience and adapt to climate change, resources and time might be lost that could have been invested in making agricultural systems more resilient. Worse even, it could lead to mal adaptation. Climate change requires a shift in agricultural risk management practices. As climate change will create new and often uncertain risks, increasingly sophisticated tools will be needed to understand and manage them (World Bank 2015). Adjustments to shifts in average conditions will involve the development of policy responses to medium –to long-term challenges.

However, in the short to medium term, weather risk are still significant and the World Bank agriculture risk assessments done in various African countries and elsewhere, as noted earlier argue that promoting access to productive assets (e.g. land, credit, improved seeds, better agronomic practices and rural infrastructure) are the key factors for the poor to build their own capital to self-insure and strengthening the resilience of agricultural systems, rather than relying heavily on WII products that have not provided signs of sustainability.

Bibliography

Alderman, Harold and Trina Haque. 2007. Insurance Against Covariate Shocks. The Role of Index-Based Insurance in Social Protection in Low-Income Countries of Africa. World Bank Working Paper No. 95. Washington, D.C.

Binswanger-Mkhize HP. 2012. Is there too much hype about index-based agricultural insurance? Journal of Development Studies. 48(2):187–200.

Brans MV, Tadesse M, Takama T (2010) Community-based solutions to the climate crisis in Ethiopia. In: Fujikura R, Kawanishi M (eds) Climate Change Adaptation and International Development. Making Development Cooperation More Effective. Earthscan, UK.

Cai, Jing, Alain de Janvry, and Elisabeth Sadoulet. 2014. "Social Networks and the Decision to Insure." American Economic Journal: Applied Economics.

Carter Michael, A. de Janvry, E. Sadoulet, and A. Sarris.2014. Index-based weather insurance for developing countries: A review of evidence and a set of propositions for up-scaling. Mimeo.

Carter, M. 2009. Intelligent design of index insurance for smallholder farmers and pastoralists. In: Hill RV, Torero M (eds) Innovations in insuring the poor. Focus 17, Brief No 6. 2020 Vision for Food, Agriculture and Environment. IFPRI, Washington, DC

CCAFS-CGIAR. 2015_. Scaling up index insurance for smallholder farmers: Recent evidence and insights. Report No. 14. 2015 CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Clarke, Daniel, O. Mahul, K. Rao, and N. Verma. 2014. Weather Based Crop Insurance in India. Policy Research Working Paper 5985. The World Bank, Washington, D.C.

Clarke, Daniel. 2011. "A theory of rational demand for index insurance." Series Working Papers 572, Economics Department, Oxford University.

Cole S, Giné X, Tobacman J., Topalova P., Townsend R., Vickery J. 2013. Barriers to household risk management: Evidence from India. American Economic Journal 5(1):104–35.

Dercon, Stefan, Ruth Vargas Hill, Daniel Clarke, Ingo Outes-Leon, Alemayehu Seyoum Taffesse. 2014. "Offering rainfall insurance to informal insurance groups: Evidence from a field experiment in Ethiopia." Journal of Development Economics 106(1): 132-143

Farrin, K. and Miranda M. 2015. A heterogeneous agent model of credit-linked index insurance and farm technology adoption. Journal of Development Economics. 116:199–211.

Gine, Xavi and D. Yang. 2008. Insurance, Credit and Technology Adoption: Field Experimental Evidence from Malawi. The World Bank Group, Ford School of Public Policy and Department of Economics, University of Michigan. September 2008. Accepted for publication in the Journal of Development Economics. Mimeo.

Gine, Xavi, James Vickery and Shawn Cole. 2016. How Does Risk Management Influence Production Decisions? Evidence from a Field Experiment. Update of World Bank publication in 2013. Mimeo.

Gommes R, Gobel W. (2013) Beyond simple, one station indices. In: Gommes R, Kayitakire F (eds) Proceedings of the challenges of weather index insurance for food security in developing countries. Organised by the EC Joint Research Centre (JRC) and the International Research Institute for Climate and Society (IRI, Earth Institute, Columbia University), Milan, 2013.

Hazell Peter, Hess U. 2010. Drought insurance for agricultural development and food security in dryland areas. Food Security 2(4):395–405.

Hazell, Peter. 1992. "The appropriate role of agricultural insurance in developing countries." Journal of International Development 4(6): 567-81

Hess U, Syroka J (2005) Weather-based Insurance in Southern Africa. The Case of Malawi. Agriculture and Rural Development Discussion Paper 13. The World Bank.

Kapphan I. 2011. Optimal weather insurance design- a quantitative exploration. Paper presented at modeling and simulation society of Australia and New Zealand, MSSANZ.

Karlan, Dean, Robert Osei, Isaac Osei-Akoto, and Christopher Udry. 2014. Agricultural Decisions After Relaxing Credit and Risk Constraints. The Quarterly Journal of Economics (2014), 597–652.

Laajaj R, Carter M. 2009. Using satellite imagery as the basis for index insurance contracts in West Africa. University of Wisconsin-Madison, Department of agricultural and applied economics. BASIS letter dated on March 7, 2009.

Leblois A, Quirion P. 2011. Agricultural insurances based on meteorological indices: realizations, methods and research challenges. Mete Applic. oi:10.1002/ met.303.

McInstosch, Craig. 2016. Weather Index Insurance, Risk, and Agriculture. Powerpoint presentation. The World Bank. Washington, D.C. mimeo.

McIntosh Craig, Sarris A, Papandopoluos, F. 2013. Productivity, credit, risk, and the demand for weather index insurance in smallholder agriculture in Ethiopia. Agricultural Economics 44(4-5):399–417

Mobarak, A. M., & Rosenzweig, M. 2012. "Selling formal insurance to the informally insured". Yale University. Mimeo.

OECD.2011. Risk management in agriculture. What roles for governments? Organization for Economic Co-operation and Development.

Osgood Dan, McLaurin M., Carriquiry M., Mishra A., Fiondella F., Hansen J., *et al.*,,2007. Designing weather insurance contracts for farmers in Malawi, Tanzania and Kenya. International Research Institute for Climate and Society, Earth Institute, Columbia University. Pallisades, New York.

Shee A, Turvey CG (2012) Collateral-free lending with risk-contingent credit for agricultural development: indemnifying loans against pulse price risk in India. Agri Econ 43(5):561–574

Skees, J. R., J. R. Black, and B. J. Barnett. 1997. "Designing and Rating an Area-Yield Crop Insurance Contract." American Journal of Agricultural Economics 79: 430-438.

Surminski, Swenja, Laurens M. Bouwer and Joanne Linnerooth-Bayer. 2016. How Insurance Can support Climate resilience. Nature Climate Change Vol 6, April 2016.

Tadesse, Million A., Bekele A. Shiferaw and Olaf Erenstein. 2015. Weather index insurance for managing drought in smallholder agriculture" lessons and policy implicactions for sub-Saharan Africa. Journal of Agricultural and Food Economics. (2015) 3:26.

Turvey C.G. 2008. The pricing, structure, and function of weather-linked bonds, mortgages, and operating credit. AgriFinance Rev 68(1):135–150.

Turvey CG, McLaurin M.K. 2012. Applicability of the Normalised Difference Vegetation Index (NDVI) in index- based crop insurance design. Wea Climate Soc 4(4):271–284

Vargas-Hill, Ruth, and Maximo Torero. 2010. Innovations in insuring the poor. International Food Policy Research Institute. Washington D.C.

World Bank. 2005. Managing agricultural Production Risk. Innovations in Developing Countries. Agriculture and Rural Development Department. Washington, D.C.

World Bank. 2015. Risks in Agriculture and Food Systems under the 'New Normal' of Climate Change. Implications of Climate Change driven volatility for agricultural risk management at production-, market- and enabling environment levels. Mimeo.

World Bank. 2016. Agriculture Finance Support Facility Lessons Learned. The World Bank, Washington, D.C. Mimeo.

Scan the code to read more on Vuna's work in East and Southern Africa

Contact Us:

T: +27 12 342 3819
E: contact@vuna-africa.com
W: www.vuna-africa.com

Search for **Vuna Africa**