Building resilience through climate risk insurance:

Insights from agricultural research for development

Working Paper No. 287

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Berber Kramer
Jon Hellin
James Hansen
Alison Rose
Mélody Braun

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CGIAR

CCAFS

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Correct citation:

Kramer, B., J. Hellin, J. Hansen, A. Rose and M. Braun (2019). Building resilience through climate risk insurance: Insights from agricultural research for development. CCAFS Working Paper no. 287. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Titles in this series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is led by the International Center for Tropical Agriculture (CIAT) and carried out with support from the CGIAR Trust Fund and through bilateral funding agreements. For more information, please visit https://ccafs.cgiar.org/donors.

Contact:

CCAFS Program Management Unit, Wageningen University & Research, Lumen building, Droevendaalsesteeg 3a, 6708 PB Wageningen, the Netherlands. Email: ccafs@cgiar.org

Abstract

Scaling insurance to transfer climate risk from the rural poor to financial markets is vital to enhance agricultural risk management in developing countries, but insurance programs need to address several challenges in order to improve resilience at scale. A mix of stakeholder expertise is required to design, evaluate and scale insurance programs with the potential to enhance resilience among the rural poor. We highlight the contribution that agricultural research for development can play by providing data, methods, impact evaluations and other research products that can help strengthen and verify the impacts of insurance on resilience at scale. These outputs are made available to the insurance industry as public goods in order to overcome challenges around, among others, data availability, targeting and design of insurance, distribution channels and use of technology, bundling with risk-reducing technologies and practices, enabling environments and smart subsidies, and capturing the full value chain.

Keywords

Climate change; Agricultural risk management; Insurance; Resilience.

About the authors

Berber Kramer is a Research Fellow in the Markets, Trade and Institutions Division of the International Food Policy Research Institute (IFPRI) and a Project Leader in the CGIAR Research Programme on Climate Change, Agriculture and Food Security's Flagship on Climate Services and Safety Nets. B.Kramer@cgiar.org.

Jon Hellin is the Sustainable Impact Platform Leader at the International Rice Research Institute (IRRI) in Los Baños, the Philippines. J.Hellin@irri.org

James Hansen is a Senior Research Scientist at the International Research Institute for Climate and Society (IRI) at Columbia University in Palisades, NY, USA.

Alison Rose is the Science Officer for the CGIAR Research Programme on Climate Change, Agriculture and Food Security's Flagship on Climate Services and Safety Nets. She is based at the International Research Institute for Climate and Society (IRI) at Columbia University in Palisades, NY, USA.

Mélody Braun is a Senior Staff Associate at the International Research Institute for Climate and Society (IRI) at Columbia University in Palisades, NY, USA.

Acknowledgements

Funding support for this study was provided by the CGIAR Research Program on Climate Change and Agricultural Food Security (CCAFS), which is carried out with support from the CGIAR Trust Fund and through bilateral funding agreements. For details please visit https://ccafs.cgiar.org/donors. This work was undertaken as part of CCAFS and the CGIAR Research Programs on Policies, Institutions, and Markets (PIM) led by the International Food Policy Research Institute (IFPRI). This paper has not gone through IFPRI's standard peer-review procedure. The opinions expressed here belong to the authors, and do not necessarily reflect those of the CGIAR or the authors' institutions.

Contents

Introduction: Insurance and climate risk management

In much of the developing world, climate change is expected to increase the risk from extreme weather events such as drought, flooding and heat waves (IPCC 2014). Climate shifts and extreme weather already threaten tenuous agricultural-based livelihoods. The associated damage to livestock, crops and other assets induces farmers to resort to traditional risk avoidance mechanisms and costly coping strategies, such as liquidating productive assets, borrowing at excessive interest rates or defaulting on existing loans, withdrawing children from school to work on-farm, reducing nutrient intake and forgoing health care (Barrett and Carter, 2001; Carter and Barrett, 2006; Carter et al., 2007; Dercon, 2004; Dercon and Hoddinott, 2005; Hoddinott, 2006; McPeak and Barrett, 2001; Wood, 2003; Alderman et al., 2004; Dercon et al., 2005; Victora et al., 2008). Anticipating the possibility of such losses, farmers also forgo profitable yet higher-risk investment opportunities, and incur significant costs trying to diversify their livelihoods (Morduch, 1995).

As a result, the mere anticipation of climate risks can trap already vulnerable households in poverty, impeding the kinds of transformation that smallholder agriculture needs to adapt to climate change. Studies of drought-prone areas in India and Burkina Faso suggest that farmers may sacrifice 12-15% of average income to reduce risk (Gautam et al., 1994). Elbers et al. (2007) estimate for farmers in Zimbabwe that this *ex ante* effect of risk on investments is twice as large as the effect of shocks *ex post*. Reducing risk, for instance by promoting improved agricultural technologies, can improve investments in modern inputs, cultivation practices and wage labour during normal years, enhancing both productivity and agricultural employment (Emerick et al., 2016). As such, the effects of weather shocks are not limited to households for whom farming is their main livelihood; production losses have effects more broadly on rural economies by reducing local agricultural employment, wages and non-farm income (Hazell and Hess, 2017), and by increasing local food prices.

Agricultural insurance is an important tool in adapting to climate change. By providing monetary compensation after a shock, insurance not only prevents farmers from resorting to costly coping strategies that could trap them into poverty, but it can also unlock investments in higher-risk yet productive agricultural and non-agricultural opportunities before a shock occurs, because the mere existence of risk hampers investments. As such, agricultural insurance can help increase farmers' incomes and resilience. Yet, agricultural insurance markets have generally failed to provide smallholder farmers with insurance coverage at scale, and where scale has been achieved, programs were not necessarily designed to impact resilience and adaptation. In this light, leveraging both the power and flexibility of the markets alongside the insights of science can help agriculture adapt to the growing risks of climate change. This paper discusses how insurance industry can work with agricultural research-for-development (AR4D) institutions to leverage the insights, methodologies and research products that have their origin in science.

Traditional indemnity-based crop insurance relies on an assessment of physical loss and, hence, requires farm visits to verify insurance claims. Although effective for large-scale farms, adverse selection (the tendency for insurance to be purchased preferentially by farmers with greater risks, increasing premiums and payouts), moral hazard (the incentive for farmers to neglect good risk management in order to receive payouts), and high transaction costs associated with verifying claims have made this type of insurance generally unfeasible as scalable solution for smallholder farmers. Index-based insurance, on the other hand, has gained attention as a promising tool for adapting agriculture to climate risk. Index-based insurance triggers payouts based on an index that is correlated with agricultural losses, for instance rainfall during a defined period or average yield sampled over a larger region. Such insurance can reduce the costs of administering and delivering insurance while eliminating adverse selection and moral hazard.

Since its introduction to the agricultural sector in the mid-1990s, index insurance has overcome some of the major obstacles to insuring smallholder farmers in the developing world. It is a promising approach for underwriting the costs of government and relief agencies, providing a fast and reliable source of funding once an insured catastrophe has occurred. Based on a recent review of documented index-based agricultural insurance programs in the developing world, Hess and Hazell (2016) estimated that about 198 million farmers are insured, divided into approximately 650,000 in Africa, 3.3 million in Latin America and the Caribbean, and 194.2 million in Asia–of which 160 million are in China and 33.2 million in India. Although risk reduction can play a part in stimulating the entrepreneurship and innovation needed for agricultural development, until recently, the private sector has played only a minor role in insuring farmers in the developing world against agricultural risks. Responsibility for providing insurance was largely in the hands of government, relying on public funds to address market failures. This is changing with a growing emphasis on climate insurance in the United Nations Framework Convention on Climate Change (UNFCCC) processes under the Loss and Damage track. While it is important to highlight that insurance is not a silver bullet nor a stand-alone solution, index insurance is now recognized as a risk management tool with significant potential to reduce climate risk and improve welfare for smallholder farmers by protecting livelihoods and promoting investments.

At the same time, as we will argue in this paper, insurance faces several challenges that impede the ability of affordable index insurance to strengthen resilience and foster climate change adaptation at scale. Scaling introduces for instance the challenge of having to provide clients with an understanding of often complicated indices, and of designing products that are adequality tailored to local contexts, minimizing basis risk. Basis risk means that the index and associated payouts do not correlate adequately with actual crop losses. As a result, farmers may end up paying the insurance premium without receiving a payout when experiencing crop damage ('downside' basis risk). Alternatively, they may receive payouts during good years when they did not suffer actual losses ('upside' basis risk). Both reduce potential welfare impacts of insurance for a risk averse farmer, and thus rational demand for index insurance (Clarke, 2016).

This paper argues that deeper collaboration among experts from insurance, agriculture and climate science is required to address these challenges. To that end, we will describe AR4D methodologies and research outputs that can help address the challenges faced by the insurance and climate change sectors. The paper is structured as follows. We first describe existing evidence and gaps in our knowledge on how insurance can both support farmers in protecting their livelihoods from catastrophic losses and promote investments in income-enhancing opportunities, enabling farmers to become more resilient. Based on a review of secondary literature, interviews with key informants and the authors' experience, the next section highlights challenges that warrant concerted multi-stakeholder attention and action in order to realize the potential of agricultural insurance as a key component of climate change adaptation. The final part of the paper discusses how experts from across the insurance, agriculture and climate change sectors can work together to overcome these challenges. We thereby focus on applying insights and innovations from AR4D that can be fundamental in overcoming the challenges to scaling of agricultural insurance.

Pathways for welfare impacts of agricultural insurance

Climate risk insurance can improve resilience and welfare through at least three channels. First, when coping with catastrophic losses from extreme weather events (*ex post*), insurance payouts provide farmers with an alternative source of income, reducing their reliance on costly coping strategies. Payouts can help avoid having to sell off one's livestock or enable farmers to re-invest in their fields for the next agricultural season. For example, in northern Kenya, insurance payouts for livestock following a drought reduced distress sales by 64% among better-off pastoralist households and receiving an insurance pay-off reduced the likelihood of rationing food intake by 49 percentage points among poorer households (Janzen and Carter 2018). In Ethiopia, payouts from the Horn of Africa Risk Transfer for Adaptation (HARITA) project, now known as the R4 Rural Resilience Initiative, increased farmers' savings (Madajewicz et al., 2013). A similar program in Senegal protected farmers' food security from drought (Dalberg Global Development Advisors, 2016).

Second, when anticipating the mere possibility of losses due to extreme weather (*ex ante*), insurance can encourage prudent investments in agriculture, particularly in high-return yet higher-risk technologies and innovations. Climate variability reduces incentives and opportunities to invest in innovations such as improved seeds, fertilizers or other agricultural technologies. While improving incomes during years with good weather, these investments aggravate the losses associated with extreme weather events. In addition, climate variability has a negative impact on the development of rural financial services and supply chains, limiting the availability of credit for smallholder farmers in ways that further constrain investment opportunities and reinforce poverty at the farm level. Agricultural insurance transfers the risk from local actors in agricultural value chains to financial markets, which may help boost the investment confidence on part of both farmers and other actors in the agricultural value chain, including the financial sector (Carter *et al.*, 2016). Improved access to credit could help farmers take advantage of productive opportunities that can bring them higher income in most years.[1]

[1] For example, evaluation of the R4 Rural Resilience Initiative in Ethiopia showed that insurance allowed farmers to increase their savings, increase the number of draught animals, access more credit, and invest more in inputs such as

Third, index insurance should not be seen as a complete or stand-alone solution for all agricultural risks. It can be used to complement other risk management strategies. For example, a farmer can protect against yield losses from moderate droughts by using drought-tolerant seeds. In the likely scenario that these seeds are more expensive than regular seeds, a risk averse farmer may prefer not making this investment, even if profitable in expectation, because the seeds only protect them from moderate droughts; during years with an extreme drought, pest or disease attack, or other weather calamities, a farmer would lose the investment, and if the inputs were paid for through a loan, this would put them at risk of default. Index insurance can, hence, build resilience by not only providing a payout in bad years to help farmers protect their assets, but also by unlocking opportunities to increase investments in risk-mitigating technologies that protect farmers from the downside risks of more regular bad weather events, allowing insurance coverage to focus on only the most extreme events for which technologies are unable to offer protection.

Empirical evidence on the size of private and social benefits conferred by insurance through each of these three mechanisms is however generally lacking. Impact evaluations in several settings indicate that index insurance affects smallholder farmers' livelihood strategies, investments and technology adoption *ex ante*. However, these studies often evaluate smaller-scale pilot studies, and there is limited evidence that the impacts on productivity, profitability and incomes—if observed—are large enough to offset program costs. This suggests that farmers mainly experience benefits from insurance payouts *ex post*, by improving their ability to cope with extreme weather events. More research is needed on whether and how insurance generates adaptation benefits *ex ante*, that is, whether the increased investments due to risk reduction indeed help households build resilience and improve their incomes during years without insurance payouts, and if not, why this is not the case. It could be that improvements in income take more time to materialize than the time horizon of the typical impact evaluation. Alternatively, such impacts may require a more enabling environment in

fertilizers and improved seeds (Madajewicz et al. 2013). The ACRE (Agriculture and Risk Enterprise Ltd., formerly *Kilimo Salama*) initiative reported that insured farmers invested 19% more in farm productivity, resulting in 16% more earnings compared to their uninsured neighbours (IFC, 2013). Further evidence that index insurance enhances adoption of improved production technologies comes from evaluations and experimental studies with farmers in Bangladesh, India, Ghana, Mali, Burkina Faso, Senegal, Ethiopia and Zambia.

which insurance is not communicated and offered as a stand-alone solution, but as an instrument to provide farmers with access to credit, improved production technologies, high-value output markets, and agricultural advisories to guide investments. Impacts of insurance on coping *ex post* are important but the lack of income effects *ex ante* will undermine its potentially transformative impacts.

A second evidence gap in the literature is whether insurance reaches its full potential in enabling financial institutions, agro-dealers and other actors in the value chain to expand their businesses and provide improved services to smallholders, and whether this is a cost-effective strategy in creating resilience at scale. A few studies have examined impacts of insurance on access to credit and technology adoption, and on farmers' uptake of index insurance when bundled with technology (Carter *et al*., 2016; Carter *et al.*, 2017), but there have been very few evaluation studies to show the full impacts on resilience. In addition, evidence about demand and scaling potential remains mixed and controversial, especially when it comes to equity in terms of what types of farmers have best access to insurance and whether insurance diminishes or exacerbates inequalities in farming communities (Fisher *et al.*, 2019). Although many studies analyse how to increase adoption among the poor, uptake is not an indicator of welfare, leaving room for studies on distributional impacts of index insurance.

The next section describes challenges to achieving impacts at scale. Note that it is insufficient to analyse take-up and renewal alone as indicators of impact. Take-up and renewal, especially in meso- or macro-level programs, but even in micro-insurance programs, are not necessarily indicative of welfare-enhancing and cost-effective products. Instead, to track impacts of insurance, cost-benefit analyses and impact studies are needed, particularly those spanning a longer term and exploring welfare impacts of insurance offered at different levels (macro, meso and micro), along with complementary options. These would help guide decisions about when public financing might yield a positive net social return. It will be important to build more long-term monitoring and evaluation (M&E) components into future insurance programs, and this paper describes how the AR4D can contribute towards this goal.

Scaling impactful agricultural insurance: Challenges and opportunities

There are many challenges to making (index) insurance strengthen resilience at scale. Because of the complex nature of these challenges and the marginal contexts within developing countries in which the product is being rolled out, overcoming them requires concerted effort by stakeholders from across the insurance, agriculture and climate change sectors. We highlight these challenges and identify how the insurance and agricultural research communities can work together to turn them into opportunities. The next section will detail specific contributions that agricultural researchers can make. While we focus more on index insurance than insurance *per se*, they are also applicable to indemnity insurance not least because one of the added values of agricultural research is that it is improving how we measure yields and management practices, making it possible to come closer to indemnity insurance again (Ceballos and Kramer, 2019).

Data availability

A crucial factor determining the benefits of index insurance is the accuracy of the index: the greater the correlation with losses suffered by the insured, the greater the potential benefit. While it is impossible to fully eliminate basis risk in index insurance, it is critical to minimize it through careful index selection, cross-validating the index using several data sources, including farmers' input through participatory processes, and designing a contract that maps the index data to historical and anticipated patterns of losses (IRI 2013). To design and implement high-quality indices, index insurance needs place-specific data on historical yields, rainfall and other production hazards. However, these data are often sparse and of low quality, which is a key hurdle that needs to be addressed for index insurance to achieve scale.

A promising solution is being provided by Information and Communication Technology (ICT). Much can be gained from investing in national meteorological services' infrastructure, such as weather stations, rain gauges and gridded weather datasets, and harnessing these data to identify weather indices that capture the risks that are important to farmers. There is however a tension between the use of weather stations and rain gauges versus satellite data. Weather stations are increasingly established at lower cost but are often not equally distributed and introduce possibilities for technological and manual errors. They require investments are required in procurement and maintenance, and new weather stations come without site-specific historical records. Gridded satellite data are available for longer periods of time at a lower cost but provide estimates of weather conditions, potentially reducing accuracy. Merged datasets that calibrate satellite weather data with station data offer a potential solution to improve gridded datasets and reconstruct historical data gaps (Dinku *et al.*, 2018). Using such datasets requires capacity building on part of both insurers and farmers, due to a lack of familiarity and tangibility of these data.

Moreover, given challenges in designing weather index insurance, countries such as India and Kenya have shifted to area-based yield insurance for regions and crops where sufficient historical yield data has been available. As an index, these programs suffer because official yield measurements can be unreliable or biased, and are often reported late after the harvest, leading to delays in payment. Furthermore, collecting area-based yield insurance at a high spatial resolution within the short period before harvest, while the crop is still on the ground, is a daunting operation. In response to these challenges, recent innovations in ICT are focusing on indices that use satellite remote sensing to predict agricultural losses, for instance through cloud cover, vegetation cover, or soil moisture for a chosen region during critical agricultural periods. AR4D and climate science can help the insurance sector utilize this increased availability of quality data for the development of more robust indices.

Targeting and design of insurance

For index insurance to achieve scale it needs to be appropriately targeted. Farmers are not homogenous. The diversity of smallholder farmers' needs requires different insurance solutions. In some cases, insurance may not be an appropriate intervention. How do we understand better the demand for insurance as well as the welfare impacts among different types of farmers, and develop products that target men and women farmers' context-specific needs, packaged at the right scale (e.g., individual farmer, aggregator, national government)? How do we identify which farmers should be targeted for insurance while recognizing those for whom insurance is not appropriate? And how do we ensure that insurance is packaged in a way that complements men and women farmers' livelihood needs in ways that can be integrated into their on-going climate adaptation and climate service initiatives?

Agricultural researchers and development practitioners have developed various livelihood frameworks that can be helpful in targeting the sorts of farmers who are most likely to be receptive to insurance. These frameworks have been integrated into recent policy approaches to the agricultural sector (e.g. DFID, 2015). For instance, Oxfam, the UN World Food Programme and partners have been developing the R4 Rural Resilience program that allows very poor yet productive farmers to take out insurance in return for labour. Eligible farmers in Ethiopia, Senegal, Malawi, Zambia, Kenya and Zimbabwe can enrol in insurance coverage in exchange for their work on resilience-building activities in their community. At a macro-level, the African Risk Capacity (ARC) is providing insurance to members of the African Union in order to finance their humanitarian response operations when facing natural disasters such as drought, and ARC's Replica Coverage allows UN agencies and other humanitarian actors to match these country insurance policies. The aim of this initiative is to finance an expansion of food aid or social safety nets primarily for the extreme poor and vulnerable who would be unable to finance insurance premiums themselves.

Distribution channels

Farmers' demand for insurance and their capacity to access it will be weakened if there are lengthy forms to be filled out or special journeys to make to register or receive a payout. The power of technology and big data can be harnessed to make the payment and claim processes even more simple and timely. Some insurers are taking advantage of mobile phone and mobile banking technologies. A good example are the ACRE Africa insurance products in East Africa, which enable farmers to pay their insurance premiums and receive payouts via the M-PESA mobile banking system (Hess and Hazell, 2017). Using mobile money and objective triggers such as rainfall, measured near real-time, allows insurers to disburse payouts rapidly, which can make insurance a much more attractive proposition for farmers. One challenge of using mobile phones is to ensure that the technology reaches both men and women, considering that mobile phones are still mainly owned by the male head of the household in many rural cultures.

Few private insurers have the required distribution networks in rural areas so they often work through an intermediary with an existing network of their own (e.g., a microfinance institution, bank, input dealer, agro-processor, or NGO), or they work with groups of farmers who can be insured as single entities. Farmers may not understand or trust the insurance, especially when it is new, and this adds to the perceived risk of buying it. The existence of *basis risk* means that transparent communication is crucial for trust. But index technologies that reduce basis risk can be more complex and hence more challenging for farmers and other stakeholders to understand and trust. It is important to market the insurance through existing distribution channels that farmers use and trust, such as microfinance or input suppliers.

Even where farmers already trust the distribution channel, appropriate training and participation of farmers in the process from the start are crucial to building their trust in the eventual insurance products. Communicating index insurance, a potentially complex product, to farmers and other stakeholders requires large investments in consumer education and marketing. The process includes giving farmers a voice in insurance design as this can improve uptake and satisfaction. Participatory methods that have proven effective, however, are challenging to scale up. How can farmers' needs and realities be incorporated into the design of tailored solutions at scale, in a cost-effective manner? To what extent can ICT and especially mobile phones be exploited to enable farmers to play a greater role in product development at scale?

A focus on distribution channels also raises the issue of how the insurance is best marketed, and, whether to do so at a micro-, meso- or macro-level. There are distinct advantages to focusing at the meso-level. One of these advantages is that aggregating risk to the meso-level helps overcome basis risk arising from idiosyncratic risks in production. A relief agency, microfinance institution, agricultural input supplier or farmer group can pool farm-level variation and seek insurance for covariate risks that cannot be pooled at the meso-level. Basis risk is however not eliminated by underwriting risks at the meso- or macro-level. Index insurance offered at these aggregated levels can still suffer from inadequate index design, data quality issues, and covariate losses that are not directly tied to the index variable such as weather-sensitive pests.

Embedding index insurance in the agricultural value chain

Many successful programs provide insurance as a bundled product with other services, including credit, modern inputs and better technologies, or to a better market outlet (e.g., contract farming), all of which can make the insurance part of a real value-adding proposition for insured farmers that extends beyond the value of its direct risk-reducing benefits (Hazell and Hess, 2017). This has led to successful cases where index insurance is packaged with other types of insurance that farmers find attractive, such as life or accident insurance. NWK AgriServices in Zambia has built weather and life insurance into its cotton farming contracts, in order to enhance farmers' loyalty and deliveries, and secure them against debt and livelihood problems in case of weather failures (Hazell and Hess, 2017). Bundling insurance policies with other financial services such as credit can also lower the costs of distribution and premium collection, since premiums can be deducted from loans and factored into interest rates. Meanwhile, reduced risk exposure could result in lower interest rates or expanded access to credit, if leading to a lower default risk.

Successful agricultural index insurance initiatives treat insurance as just one component of agricultural risk management, and some bundle insurance products within credit or technology packages. Hess and Hazell (2016) give the example of Zambia, where farmers emphasized the need for insurance to be embedded in the entire agricultural value chain. They expressed a strong need to increase their productivity and cope with production and post-production risks, which would require better access to quality farming inputs, irrigation, mechanization and other investments. These insights provide an opportunity to link index insurance with agricultural technologies and practices that help farmers reduce their exposure to risk, often without reducing productivity. The question, however, is to how to identify the most suitable climate-smart technologies and practices in a given context.

A related opportunity to increase the contribution of index insurance to agricultural resilience is to expand coverage beyond farmers, and beyond particular farm enterprises. These include financial institutions, agricultural traders and processors, landless workers, and village shopkeepers who are dependent directly or indirectly on local agriculture, and whom in turn can be adversely impacted by a drought and reduced agricultural production. One example of this broader insurance approach is the Livelihood Protection Policy (LPP) in the Caribbean. This insures non-salaried income earners against adverse weather events, such as high wind speed and/or excessive rainfall (Hazell and Hess, 2016). Insurance does not need to be tied to specific crops and can in principle be sold to anyone. This raises the possibility of insuring anybody in a region whose income is correlated with the insured event, including but not confined to farmers.

Regulatory environment

There are three types of agents that are active in providing agricultural insurance to smallholder farmers: the private for-profit sector, governments (public), and development organizations, including non-profits such as NGOs and international organizations. They have their own networks for distributing insurance to farmers. Since most of these organizations are not licensed to sell insurance, they inevitably partner with private insurers who provide and underwrite the insurance contracts. Other agencies help finance and initiate insurance programs, including bilateral donors, United Nations (UN) organizations and multinational development banks. Such agencies can play an important role since private insurers can face high setup costs and barriers to entry. For example, these agencies provide technical and financial assistance to help private insurers overcome high initial investment costs in research and development of index insurance products. Such costs might not be easily recouped if competitors can replicate products that prove profitable to sell.

Establishing a legal and regulatory environment for enforcing contracts that both buyer and seller can trust is a fundamental prerequisite for scaling insurance. This requires attention to incentives, monitoring product quality, support through public-private partnerships, and enabling regulatory frameworks. In low-income countries where index insurance is expanding, achieving these aspects can prove challenging. Sometimes insurers use their own networks to sell insurance directly to farmers, but more often they work through other players along value chains who sell directly to farmers. For example, they may link up with agro-processors, input suppliers, or seed companies that offer farmers insurance along with credit, seeds, fertilizer, or contract farming arrangements. These players typically do the marketing, servicing and subsidizing of insurance, with the advantage that such partnerships (facilitated by the aggregation of farmers in for instance farmer groups) establish linkages between private insurers and farmers whom would otherwise not be reached.

An enabling regulatory environment also means introducing minimum quality standards for insurance products, monitoring product compliance with these standards, and certifying those products that meet the standards. Farmers may lose their trust in insurance markets because they are worse off buying insurance compared to staying without coverage due to high premium rates, basis risk, poor product quality more generally, or a combination of these factors. Regulatory bodies can help build trust in insurance markets by monitoring whether products do no harm compared to not having insurance at all, and whether premium subsidies do in fact improve smallholder farmers' welfare in a cost-effective way, by comparing farmers' ex-ante welfare from a premium subsidy with the benefits from a similarly sized cash transfer (Carter and Chiu, 2018).

Additionally, laws and regulations need to be consistent with international standards to improve the chances of insurers gaining access to global markets for risk transfer. It is critical that insurers have access to appropriate reinsurance coverage. Assured and timely payments received from a reinsurer, when a disaster occurs, can help avoid some of the delays and uncertainties incurred in obtaining emergency funding from government and/or donor sources (Clarke and Vargas Hill, 2013). Reinsurance can also help smooth out the annual cost of a disaster assistance program to governments and donors in the form of a predictable and regular annual premium given that such a program aggregates any losses to a regional scale (Hess and Hazell, 2016). Laws and regulations must harmonize with international standards to improve the chances of insurers gaining access to global markets for risk transfer.

Role of the public sector

The public sector plays an important role in creating an enabling environment for index insurance. This includes investing in weather stations and agro-meteorological research and data systems, educating farmers about the value of insurance, building the capacity of the insurance sector on index insurance, and facilitating international reinsurance. There may also be a need for "smart" subsidies to correct initial market failures and externalities that hold back the development of markets for index insurance products (Hazell and Varangis, 2019). These subsidies should serve a well-defined policy objective, target a well-defined set of beneficiaries, be informed by monitoring and evaluation, and have either a clear exit strategy or a viable long-term financing strategy. For instance, subsidies directed at costs of developing and administering insurance to overcome initial program setup may be more cost-effective and less distorting than direct subsidies to premiums. If premiums are subsidized, the literature recommends providing subsidies on a per-farmer rather than proportional basis, to equitably support relatively poor smallholder farmers; and ensuring that farmers' portion of the premiums is not less than the long-term average expected payout, to avoid disincentives to managing risk through other available means.

Insuring against agricultural risks is expensive. In many countries, catastrophic events like droughts occur with such a high frequency that premium rates may need to exceed 10–15 percent of the total sum insured just to cover the amount that insurers expect to pay farmers in the form of claims (i.e., the average annual loss or actuarially fair premium rate). Subsidies will usually be less distorting if made directly to the insurer to offset administration, infrastructure, and development costs rather than subsidizing the premium rates paid by farmers. Premium subsidies for products that cover specific crops may encourage farmers to grow unsuitable crops in risky environments, leading to net social losses and adding to the future costs of insurance and the size of the subsidy.

There are other innovative ways to deal with farmers' inability to pay for a premium. Index insurance is designed to cover the most extreme risks that a farmer can face. Smaller risks are more efficiently addressed through a range of cheaper risk management strategies such as credit, savings and risk-reducing practices and technologies. Index insurance is expected to be the last recourse, but it can be expensive. Initiatives such as the 'work-for-insurance' strategies developed by the R4 Rural Resilience Initiative can help tackle this challenge by allowing farmers to pay the premium by providing labour to public works programs that help build the infrastructure to better manage risks. The requirement that farmers need to invest either some time or money in the insurance product gives the insurance providers an incentive to provide a high-quality product that responds to farmers' needs, while the option to pay the insurance premium through labour means that the product remains affordable for cash-constrained farmers.

AR4D for development and scaling of insurance

Given these challenges, the process of scaling up insurance to achieve resilience calls for a mix of stakeholder expertise. One area where we see tremendous and largely underutilized synergy is the contribution that agricultural research can make to overcome the aforementioned challenges to scaling insurance. As a leader in poverty-focused agricultural innovation, the CGIAR can offer a large knowledge base in this regard. The CGIAR, established in 1971, is a global network of 15 international agricultural research institutions and their partners, all working to advance agricultural science and innovation to reduce poverty, improve food and nutrition security, and to improve natural resources and ecosystem services. Researchers within the CGIAR network produce, in partnership with actors from both public and private sectors, global public goods including agricultural production technologies, data, methods, tools, analyses and evidence. These public goods can contribute to overcoming the challenges to scaling impactful agricultural insurance schemes.

Insights from CGIAR research

CGIAR research can contribute to the scaling of high-quality insurance schemes in at least four distinct ways. First, the CGIAR has worked since its establishment on developing and understanding context-specific viable production technologies and livelihood options that are available to smallholder farmers. Second, it has a deep understanding of the constraints and risks (beyond those targeted by insurance) that smallholder farmers face, and how they impact management decisions and smallholder farmers' welfare. Third, the network has established relationships with relevant institutions in the agricultural sector and can provide guidance on how to engage them to strengthen agricultural insurance. Fourth, the CGIAR offers independence from an insurance provider's financial interests, and it offers peer review that can help with quality control of good practice knowledge and evidence.

For instance, one of the potentially valuable contributions from A4RD and the CGIAR focuses on positioning insurance in a context of a broader resilience strategy, including other complementary climate risk management tools often developed or validated through research conducted by the CGIAR. Reviewing the evidence on climate risk management and rural poverty reduction, Hansen *et al.* (2019) argue that risk-reducing production technologies and practices originating from AR4D—including stress-adapted crop germplasm (used to make seeds more tolerant to risks such as drought, floods or disease), conservation agriculture and diversified crop and agroforestry production systems — stabilize agricultural production and incomes, and, hence, can reduce under certain circumstances the adverse impacts of climate-related risk. This is relevant to the design of index-based insurance since the latter plays a complementary role in enabling farmers to manage risk, overcoming risk-related barriers to adoption of improved technologies and practices, and protecting their assets against the impacts of extreme climatic events.

Moreover, AR4D offers insights into the roles that alternative climate-risk management interventions (technologies and practices versus index-based insurance and social protection through adaptive safety nets) can play in efforts to reduce rural poverty, particularly for different types of environments and farming populations. Targeting interventions to improve farmers' wellbeing in the face of climate risk requires distinguishing between different types of farmers (Barrett *et al.*, 2007; Hellin and Fisher, 2018; Hansen *et al.,* 2019). First, productive safety net interventions such as index-based insurance protect the vulnerable non-poor from falling into poverty when coping with shocks. Second, productivity-enhancing technologies and practices, complemented by improved climate risk management, or 'cargo nets' (Barret, 2005), enable those farmers just below the poverty line to escape poverty, allowing them to join the ranks of the vulnerable non-poor. Third, layered safety net interventions protect the poor with fewer assets, for whom production technologies are unlikely to be adequate, from destitution after a shock.

The AR4D community has also developed, tested and evaluated innovations in index insurance. Because much of this research was implemented through the CGIAR or with the CGIAR's partners, we conducted an inventory of recent insurance-related research projects undertaken within the CGIAR as a starting point. We reviewed these research projects to identify (potential) innovations delivered by these projects.[2] CGIAR research has aimed to address challenges to scaling insurance-driven resilience impacts through innovations such as weather securities, gap insurance, crop simulations and optimization, remote sensing, linking value chains stakeholders with the insurance industry, bundling insurance with climate risk-reducing technologies, as well as other formal and informal risk-financing strategies, impact evaluation and participatory approaches.

[2] It is important to note that this inventory is not meant to be exhaustive; there is a large body of research on innovations for agricultural insurance also outside the CGIAR but focusing on the CGIAR offered a starting point and hence the focus of this paper.

Reviewing these projects highlighted both the spread in regions and countries in which the CGIAR has implemented insurance activities, and the range of innovations being researched. In terms of geographic coverage, the CGIAR has conducted insurance research in Ethiopia, Kenya, Ghana, Tanzania and Mozambique in the Africa region; in Uruguay, Honduras, Nicaragua in Latin and Central America; in Syria and Egypt in the Middle East, and in India and Bangladesh in South Asia. Research has spanned a multitude of innovations, including aspects relating to the targeting and design of insurance, as well as projects addressing issues around distribution channels and the use of technology. A substantial number of projects aims to help improve data availability and bundling with other informal or formal financial services. The CGIAR has also conducted several rigorous evaluations to assess the impacts of these innovations on resilience. Research has looked less often into the regulatory environment; creating an enabling environment or using smart subsidies; and capturing the full value chain. These challenges provide areas for future research.

Weather security units

A first set of studies in Ethiopia, India and Uruguay (Hill and Robles, 2011; Hill, Robles and Ceballos, 2016; Ceballos and Robles, 2017) explores the demand for weather security units as a more flexible alternative to weather-based index insurance. The weather securities analysed in these studies are simple insurance units designed for smallholder farmers with strong heterogeneity in cropping patterns, for instance due to variation in crops or varieties grown, sowing dates, or risk exposure. The key idea is that farmers can choose from a menu of different insurance products, for instance with different coverage periods, different triggers (attachment points) or different coverage amounts (exhaustion points), to best suit their risk profile. As such, these products help improve the design of insurance as they offer farmers the flexibility to express heterogeneity in demand.

In addition, weather securities relax data availability requirements; instead of having to correlate historical weather indices with historical yield, and setting insurance parameters such as triggers, exit values and the sum insured based on those correlations, weather securities allow farmers to construct their optimal insurance portfolio themselves to match their expected yields under different weather realizations. Farmers may for instance know how much rain they need and when and, hence, can decide on what insurance product would best suit their needs. In this way, the weather securities relax data requirements by reducing basis risk in a temporal dimension (by allowing farmers to choose coverage for the period during which they are at risk) and from a design perspective (because farmers now use their own knowledge on the types of weather conditions required by their crops when purchasing their weather securities).

The studies in Ethiopia and Uruguay demonstrate that farmers mix and match the weather security units to construct an insurance portfolio based on personal risk exposure. Data collected during both an experimental game and real purchases of such insurance policies among farmers in southern Ethiopia suggest that the securities are well understood and can fit heterogeneous farmer needs. In Uruguay, farmers purchased insurance for different months, and with different triggers, depending on their crops and soil type, as well as cropping decisions. In other words, farmers construct their own risk management portfolios based on their perceived insurance needs, and the availability of more flexible insurance products allows doing so. Nevertheless, demand was strongly price sensitive, and an important area for future research is whether the flexibility of the weather units approach increases or decreases demand. Literature on menu effects suggests that the quality of decisions deteriorates as a decision-maker is presented with a larger number of options to choose from, and this may well be the case when farmers need to choose among a large number of flexible weather units (Ceballos and Robles, 2017).

However, from a more general perspective, farmers' significant heterogeneity in demand, which is correlated with heterogeneity in their farming practices, is important. It highlights that there is no one-size-fits-all weather-based index insurance product, and that the different needs that farmers have when managing their productions risks are important to consider in the design and targeting of climate risk insurance. Even if weather securities themselves might be challenging to implement, this finding offers an important motivation for the use of methodologies that design index insurance based on weather simulations and crop modelling, by using remote sensing, and/or through participatory approaches. Each of these methodologies acknowledges that is important to consider the heterogeneity across farmers in their exposure to weather risks, and the difficulties that insurance programs would face in capturing this heterogeneity by means of a simple one-size-fits-all weather-based index insurance product.

Gap insurance and fail-safe triggers

Another innovation aims to reduce downside basis risk in index insurance through so-called ‘gap insurance’, also referred to as fail-safe contract design (Carter *et al.*, 2017). This approach was introduced first in a pilot project in Ethiopia, where a failure-prone rainfall index was backed up by the possibility of conducting an area yield audit (Berhane *et al.*, 2015). Specifically, in case the rainfall index did not trigger a payout, but farmers reported that they had suffered severe damage, they could petition for the insurance provider to conduct a crop-cutting exercise in their village. Payouts would be made if the average yield measured was below a predefined threshold. This hybrid model in which the contract design combines both weather index-based insurance and area-yield index-based coverage reduces downside basis risk, thereby making insurance more attractive.

This approach was also adopted in an impact evaluation of weather index-based insurance in Bangladesh (Vargas Hill *et al.*, 2018), and the mechanism design behind this approach is further developed within the context of a pilot project in Tanzania (Flatnes and Carter, 2015). There, combining zone-level yields, predicted based on satellite observations of rainfall, with a crop-cut audit that is initiated at the request of farmers (if they indeed believe that yields in their zone are below 60% of normal yields), improves the accuracy of insurance payouts. This contract could be offered at a lower cost than an area-yield index contract if the rainfall index is sufficiently accurate, and if there is a penalty for farmers who call for an audit if they did not suffer severe damage in their zone, so that the insurance provider needs to carry out the costly crop-cut audits only in a limited number of scenarios. In that case, the cost of the insurance policy can remain well below those of area-yield index contracts, with a comparable accuracy, leading to increased welfare gains.

Crop simulation and optimization

A second set of studies involve applications of crop simulation modelling to index insurance design, implemented for contract design in various contexts including Honduras, India, Nicaragua, Syria and Uruguay (Kost *et al.*, 2012; Ceballos, 2016; Shirsath *et al.*, 2019). The stochastic weather modelling that these crop simulations often use will help fill in missing weather data, thereby addressing challenges around the absence of reliable weather data for estimating probabilities of insurance payouts and thus premiums. In this way, crop modelling can be used to calibrate insurance triggers or attachment points and exits or exhaustion points, along with the associated insurance premiums, to existing heterogeneity in soil characteristics.

Heterogeneity in soil characteristics can be an important source of basis risk, and a challenge in targeting and designing index insurance products. In Nicaragua, researchers were able to overcome this challenge through a crop modelling approach. They interpolated monthly data on precipitation as well as temperature means and ranges from observed weather station data in the tropics and subtropics, and used these data, combined with farm plot-level characteristics, to simulate crop yields within crop models for how the biochemistry, physiology and agronomy determines crop water balance, photosynthesis, growth and development. These data were used to estimate a crop's minimum water requirements at fixed intervals during its growth and development, that is, for different time-blocks of the growing season. Triggers were based on the predicted probabilities that a crop would not meet its water requirements.

In India, a similar approach was applied to insurance contract design: combining agro-meteorological statistical analysis, crop growth modelling and optimization techniques, Shirsath *et al.* (2019) develop contracts that increased farmer satisfaction by 50 and 72 percent for soybean and pearl millet, respectively, while increasing the correlation of payouts with yield losses (i.e., reducing basis risk), and reducing the overall loss-cost ratio, lowering the required insurance premium subsidy per farmer insured. Similar approaches are underway in other contexts, and the tools to develop these improved contract designs are typically available for the insurance industry to use, free of charge.

Remote sensing

Each of the innovations mentioned above require weather-based indices to capture the risks that are important to smallholder farmers, and to be reliable predictors of crop yields, which is not always the case, resulting in basis risk. Advances in remote sensing and "big data" analytics are expanding the range of options for reducing basis risk but have yet to be fully tested and exploited. The European Union's new satellite system Sentinel-2A could be a game changer for the types of indices that can be developed and monitored around the developing world. Using such data however requires biophysical or statistical models that relate remotely sensed data to the agricultural losses to be insured. AR4D can play an important role in this regard.

The Index Based Livestock Insurance (IBLI) project is one of the better-known and successful applications of remote sensing to provide index insurance to smallholder farmers at scale. The IBLI project has developed a remotely-sensed vegetation index calibrated against mortality survey data to insure livestock mortality losses for pastoral households in northern Kenya and Ethiopia (Mude et al., 2010). Products have been shown to generate positive welfare impacts (Chantarat *et al.*, 2017), to be more cost-effective in comparison with cash transfers (Jensen, Barrett and Mude, 2017), and to improve coping strategies by allowing poorer households to limit food rationing when experiencing droughts (Janzen and Carter, 2018).

Vegetation indices are a good indicator of livestock mortality as pastoralists' livestock survival is largely dependent on forage, and reductions in forage availability are easily detected by vegetation indices. Measuring crop productivity is more difficult, especially in areas with intercropping, due to increased heterogeneity and smaller plots. In addition, remote satellites may not be very tangible to farmers, and available low-cost satellite imagery can be too coarse (either in terms of spatial resolution, or in terms of temporal resolution, especially in seasons with cloud cover) to accurately measure ground conditions at the localized level for which a smallholder farmer will need insurance. To overcome challenges related to cloud cover, the Remote sensing-based Information and Insurance for Crops for Emerging Economies (RIICE) project has used AR4D to pioneer a radar satellite data-based system that allows for accurate and timely measurement of planted areas and yields for rice in Asia (Hess and Hazell, 2016).

Another strand of CGIAR research on insurance is analysing the potential impacts of linking index-based insurance with picture-based insurance, which uses farmers' georeferenced ground pictures of the insured crops to measure crop damage for insurance purposes (Ceballos *et al.*, 2019). A mobile app collects data, including pictures and self-reported practices and input use, with high frequency, both pre- and post-damage. These pictures are sent to an online server, where experts identify the extent of damage. These data are used to build large training datasets for machine learning algorithms that can automate the process to rapidly trigger payouts.

Compared to traditional indemnity insurance, this will reduce the costs of loss verification; compared to index insurance products, this improves the tangibility of the insurance product, and potentially reduces basis risk if the pictures capture localized losses that cannot be measured through satellite imagery or weather stations. In a pilot implementation of this approach in the rice-wheat belt of India, nearly two-thirds of trained farmers took at least four pictures (roughly one per growth stage), which was considered sufficient for loss assessment; severe damage was visible from the pictures in 71 percent of affected sites; and this reduced basis risk significantly compared to alternative index-based products (Ceballos *et al*., 2019). Hufkens *et al.* (2019) find that the images also improve upon satellite measurements of NDVI when detecting crop growth stages or lodging events for winter wheat in India. An interesting avenue to explore is whether pictures can be used to expand agro-advisory services, and whether there are benefits from bundling advisory services with picture-based insurance (Ceballos *et al*., 2018). The innovation is currently being tested by several major insurance initiatives as a strategy to reduce basis risk in their index insurance products.

Bundling insurance with other climate risk management options

Bundling provides an excellent opportunity for the insurance industry to utilize outputs from AR4D. AR4D has over the last two to three decades developed and tested many climate-smart agricultural technologies and practices, including stress-adapted germplasm from advances in breeding (for instance drought-tolerant maize and flood-tolerant rice), diversified farming systems including agroforestry, and conservation agriculture, which is a system of practices that reduces soil disturbance from tillage, maintains soil cover with organic material, and diversifies crops through intercropping or rotations. These technologies and practices have been developed to stabilize production and reduce exposure to weather risk (Hansen *et al.*, 2019). These risk-reducing technologies could lend themselves well to being bundled with index insurance.

Risk-reducing technologies and index insurance have the potential to complement each other and solve the problems they face when offered in isolation. Risk-reducing technologies may protect the farmer against moderate periods of drought, thus already providing a form of insurance. However, such varieties do not protect the farmer from extreme weather events. In fact, investments in risk-reducing technologies such as drought-tolerant seeds could expose farmers even more to extreme weather, because these seeds are typically more expensive than the local varieties that farmers grow. Vice versa, index insurance covers the farmer against extreme events, but paying out during moderate drought years would make the insurance policy more expensive. Proper bundling of the two and structuring insurance to trigger payouts only for extreme weather events may help resolve these issues by leveraging complementarities between the two types of innovations (Lybbert and Carter, 2013). Bundling with drought tolerant varieties would also add an implicit subsidy to the cost of insurance by reducing the cost of reinsurance due to the reduced value-at-risk that the insurer faces.

Ward *et al.* (2019) tested this by eliciting the valuation for drought-tolerant rice and weather index insurance as complementary risk management tools among smallholder farmers in Bangladesh. Farmers generally did not value the drought-tolerant variety enough to purchase it if offered independent of insurance, but when bundled with insurance, their valuation of the variety increased. Farmers also valued insurance on its own, but even more so when bundled with the drought-tolerant variety, suggesting strong complementarities between the two different risk management instruments. In a study in Odisha, India, Ward and Makhija (2018) find that smallholder farmers' valuation for such a complementary risk management product is highly sensitive to the basis risk implied by the insurance product, with farmers less enthusiastic about risk management products that leave significant risks uninsured.[3] This is also consistent with the theoretical predictions in Kramer and Ceballos (2018) that in the presence of basis risk, calibrating weather index insurance bundled with stress-tolerant varieties to trigger insurance payouts only in case of extreme weather events can worsen demand.

Another way of bundling CSA and insurance is through climate-smart insurance subsidies. India has a large national insurance scheme, in which premiums are highly subsidized; farmers only pay around 2-5% of the sum insured, and a small fraction of the insurance premiums (Fisher et al 2019). These premium subsidies could be used to promote more sustainable farming systems by conditioning premium subsidies on the adoption of climate-smart technologies and practices. This approach was piloted in the states of Punjab and Haryana, India, which face an environmental hazard from large-scale crop residue burning. While testing a picture-based insurance approach,

3 Ward *et al.* (2019) and Ward and Makhija (2018) use discrete choice experiments to elicit willingness to pay for the drought-tolerant seeds, insurance and the bundled product. Although these hypothetical measures of willingness to pay may not reflect actual willingness to pay for insurance versus seeds, the main purpose of the studies was to elicit the value of the bundled product relative to the value of the stand-alone products.

researchers varied experimentally whether farmers received insurance coverage unconditional on management practices versus conditional on not burning residues. The no-burning condition significantly reduced the proportion of farmers burning their residues, suggesting that premium subsidies can be used to promote desirable behaviours that have positive externalities for the surrounding communities (Kramer and Ceballos, 2018).

AR4D has also tested the potential for bundling insurance with other formal or informal financial services. Although weather index insurance can cover covariate risks such as droughts, basis risk in the insurance product design and idiosyncratic risks such as pests or disease could still lead to losses not covered by the insurance product. Bundling insurance products with other financial risk management instruments, either formal or informal, could help farmers cope with the financial losses from these uninsured risks, thereby potentially increasing take-up. In Ethiopia, researchers for instance tested the provision of insurance through informal funeral societies (*iddirs*) that traditionally share risk. Insurance take-up was considerably higher in groups where insurance trainings had emphasized risk sharing (Dercon *et al.*, 2014), suggesting important complementarities between on the one hand informal risk sharing for idiosyncratic shocks and basis risk and on the other hand formal index insurance to cope with covariate shocks.

Participatory approaches to index design and implementation

Another component of AR4D utilizes participatory approaches in the design and implementation of index insurance. Participatory approaches hold two key functions: collecting data to explore and validate data sources and parameters of a product through crowdsourcing with farmers and local experts, and developing awareness, capacity and ownership of farmers and insurance stakeholders by engaging them throughout the design and validation process.

The Social Network for Index Insurance Design (SNIID) process developed by the International Research Institute for Climate and Society (IRI), one of the partners in the CGIAR, is a farmer-centred index design process using participatory processes and crowdsourcing to collect information on cropping calendars, crop vulnerability, historical risk profiles and season monitoring to co-produce and validate index products. It is coupled with insurance games simulating farmers' seasonal decision-making processes in the face of risk, to explore preferred risk coping strategies and unpack complex concepts such as insurance, basis risk, frequency of payout, satellite data and comprehensive risk management strategies. Additional experimental research games can be played to explore specific questions such as farmers' preferences regarding payout frequency, or group and individual insurance compared to other risk management options (Greatrex *et al.*, 2015).

Trust is an important component when delivering insurance. Co-producing the index product by engaging with farmers along every step of the way, from index design to implementation and payouts, will increase the understanding and attractiveness of insurance products. These participatory approaches are now being increasingly combined with mobile technologies to reach more farmers and help address the need to go to scale while keeping farmers at the centre of the process.

Impact evaluation

As argued earlier, take-up and renewal alone are insufficient indicators of impact. In general, high take-up and especially high renewal rates can offer a signal that an insurance scheme provides a first indication that insured clients perceive the insurance product to offer value for money, but the conclusion that the insurance program is welfare-enhancing, and does so in a cost-effective way, cannot be drawn at face value. Instead, AR4D can work with insurance initiatives to ascertain that insurance products are indeed welfare-enhancing for targeted farmers through an ex-ante cost-benefit analysis, prior to rolling out a program. In addition, by building long-term monitoring and evaluation (M&E) components into insurance programs, economists and other social scientists within the AR4D community can help insurance initiatives conduct ex-post impact assessments and identify the main channels through which these impacts occur.

In designing impact evaluations, it is important to consider when impacts occur, when they are being observed, and how they can be measured. In this regard, it is important to distinguish between impacts *ex ante*, which would be unconditional on experiencing extreme weather events and receiving insurance payouts, and impacts *ex post*, which are experienced by beneficiaries who are affected by extreme weather events, and for whom the insurance product should make payouts. Moreover, data collection and analyses need to be centred around the core hypothesis that one of the main impacts of insurance is a smoothening of consumption, meaning that well-designed impact evaluations measure consumption repeatedly over time, in order to assess whether insurance prevents food rationing and spending cuts among households facing weather shocks. The degree to which consumption smoothing generates welfare benefits also depends on beneficiaries' preference for consumption smoothing, or risk aversion, meaning that it is important for impact evaluations to elicit such preference parameters. Prior to the roll-out of a scheme, AR4D, donors or governments and insurance industry can work together to design strategies to measure impacts on household welfare and conducting cost-benefit analyses.

AR4D offers a toolbox of evaluation approaches that can help in this regard. These evaluation approaches are designed to address attribution problems in the sense that they help assessing whether differences between an intervention group and a counterfactual can be plausibly attributed to the insurance program. Simply evaluating outcomes by comparing insured and uninsured individuals or households often leads to selection bias, where those who choose to participate in the treatment (insurance) are systematically different than those who do not. Higher take-up is for instance observed among wealthier, more educated and more progressive farmers, who could have increased agricultural investments also in the absence of the insurance program, meaning that differences between the insured and the uninsured (even if measured over time) could be due to systematic differences in unobserved characteristics rather than the insurance program itself.

Methods that help overcome this evaluation challenge include natural experiments, quasi-experimental approaches that rely on econometric techniques such as propensity score matching or regression discontinuity designs, and randomized control trials (RCTs). Researchers can use variation in whether individuals were offered insurance coverage, but often, in situations where such variation cannot be introduced, alternative strategies are often feasible in which smallholder farmers or other value chain actors are randomly assigned into an encouragement arm, which receives a promotion (for instance awareness raising or premium subsidies) to enrol, versus a control arm, where no additional encouragements are offered to sign up for the schemes. Different types of programs and implementation plans call for different evaluation strategies. Involving impact evaluation specialists from the AR4D community early in the program design can facilitate the integration of a long-term independent evaluation strategy into the roll-out plans of an insurance initiative.

Conclusion/recommendations

Insurance is an important tool that can enable farmers to manage better climate-related risks and to invest in more profitable production systems and practices. Index insurance payouts improve coping with extreme weather events, and indeed help smallholder farmers increase their agricultural investments even during years without insurance payouts. However, there is only sparse evidence of how these benefits translate to transformative impacts on the livelihoods of smallholder farmers, and the evidence often focuses on microinsurance programs implemented at a small scale. And while it is important that policymakers are calling for an increase in the number of insured smallholder farmers, the risk is that this focus on scaling is shifting insurers' priorities from providing high-quality products, offering real value for their clients, to flooding the market with low-quality products that have not been adapted adequately to farmers' local context, and with poor awareness of insurance benefits.

In this light, it is imperative to look beyond take-up or renewal, and to document the welfare costs and benefits of different types of insurance programs as they are going to scale. This includes addressing the questions whether and how index insurance has transformed farmers' livelihood strategies and incomes; and how it contributes to adaptation, without focusing only on how it improves responding to shocks. AR4D can help define and measure indicators of success needed at scale. In addition, AR4D can help identify opportunities to strengthen product quality and value propositions, for instance by helping programs overcome challenges in data availability, targeting and distribution of insurance, bundling with complementary risk management strategies, and embedding insurance into the agricultural value chain.

AR4D produces evidence, methodologies and research products that are available to the insurance industry as public goods. Use of these public goods will however lead to impacts only if programs are developed, implemented and evaluated through strong partnerships. Agricultural insurance could be viewed as an extension of both financial services and agricultural development. It therefore falls within the domain of a broad spectrum of private- and public-sector actors, including the insurance sector (insurers, re-insurers), and stakeholders primarily interested in agricultural development (input providers, non-governmental organizations (NGOs), farmer groups, policymakers and the AR4D community). Initiatives driven by one of these two sectors are likely to lack vital expertise and overlook viable solutions to the challenges. Partnerships between these various stakeholders, including AR4D, will be critical in order to build insurance programs that truly have the capacity to improve adaptation and resilience at scale among the rural poor.

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