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**Review of Evidence on the Design and Impact of Agricultural Insurance
for Smallholder Farmers in Low- and Middle-Income Countries**

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ABSTRACT

Agricultural insurance has long been promoted as a tool to help smallholder farmers manage production and market risks, yet affordable, well-functioning coverage has proven difficult to deliver at scale. This paper reviews peer-reviewed evidence on the design, implementation, and impacts of agricultural insurance in low- and middle-income countries, with a focus on innovations that have emerged since early indemnity-based multi-peril crop insurance programs gave way to index-based and hybrid approaches. It synthesizes findings on ex ante and ex post impacts, on design features that shape cost, basis risk, and payment timing, and on distribution channels and inclusion of women and low-income households. The review finds that insurance can meaningfully protect household consumption and assets after shocks and encourage productive investment beforehand, but that these benefits depend heavily on accurate loss assessment, adequate coverage size, and trust built through distribution partners. The paper concludes with operational recommendations for policymakers and practitioners on product design, subsidies, and distribution, and identifies priority evidence gaps, including the optimal design of subsidies and insurance's potential to address non-weather-related risks.

Keywords: agricultural insurance, index insurance, smallholder farmers, risk management, climate risk, low- and middle-income countries

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ACRONYMS

ACRE – ACRE Africa (agricultural microinsurance provider)

IBI – Index-based insurance

IBLI – Index-based livestock insurance

IFPRI – International Food Policy Research Institute

ISF – ISF Advisors

MPCI – Multi-peril crop insurance

PBI – Picture-based insurance

PMFBY – Pradhan Mantri Fasal Bima Yojana (India's national crop insurance scheme)

ROI – Return on investment

1. INTRODUCTION

Agricultural workers and households face numerous production and market risks that can disrupt livelihoods, threaten food security, lead to the loss of productive assets, and potentially trap them in poverty (Constantinescu et al. 2025; Carter and Barrett 2006; Dercon and Hoddinott 2004). Many farmers, especially smallholders, struggle to manage these risks, which can create additional barriers to productivity growth, the adoption of sustainable technologies and practices, and other opportunities to improve livelihoods. New technologies and farming practices often carry greater uncertainty than established methods, making farmers hesitant to adopt them even when they could increase productivity or improve livelihoods over the long term. Even for more conventional or proven investments, farmers may be unable or unwilling to take on additional financial risk. These challenges are intensifying as climate change drives more frequent extreme weather events and shifting growing conditions.

Insurance can be a valuable tool for farmers, input suppliers, and other actors along food value chains to manage risk. However, providing affordable insurance through market mechanisms is often challenging. The detailed data needed to price insurance, such as plot-level yield data, weather patterns, and other production indicators, are frequently unavailable, particularly in developing settings (ISF 2022). At the same time, climate change is increasing variability in growing conditions, making production outcomes harder to predict. Moreover, extreme weather events, pests, diseases, market fluctuations and other agricultural shocks tend to affect large numbers of farmers in the same area at the same time, limiting the ability of insurers to pool risk effectively. Political and economic risks to agricultural production are also difficult, if not impossible, to anticipate in advance. These uncertainties make it difficult for private companies to develop insurance products that are both viable for insurers and affordable for farmers.

Even if all risks can be accounted for, it is often costly to assess agricultural damage and the value of payouts, especially for small farmers in remote areas. Such processes can also take time, which delays urgently needed payments. Similarly, insurers have limited ability to monitor farmer management practices and limit moral hazard concerns. When it is difficult to assess a farmer's level of risk and price their contracts accordingly, farmers with less risk exposure are more likely to opt out of insurance while those with greater risk tend to opt in, gradually increasing the level of risk shouldered by the insurer and leading to higher premiums (the "adverse selection" problem).

These issues have limited the scope and reach of private agricultural insurance. As a result, comprehensive agricultural insurance coverage has largely been limited to niche markets for high value agricultural products (Hazell and Timu 2024) or to highly subsidized government-led schemes.

Brief History of Agricultural Insurance

Early examples of agricultural insurance were typically public multi-peril crop insurance programs (MPCIs) to protect farmers against a wide array of risks on an indemnity basis. Programs often paired these insurance arrangements with agricultural credit provided by state-owned agricultural development banks. The programs were often expensive, and premiums needed to be heavily subsidized to make them affordable for farmers. By the late 1970s, billions of dollars were being spent annually on public subsidies for MPCI programs. However, studies of several programs found they were prone to corruption, encouraged farmers to take excessive risks, discouraged risk mitigation action, crowded out financially sustainable insurance practices and promoted poor lending practices (Hazell, Pomareda, and Valdés 1986; Hazell and Valdés 1984).

Eventually, funders began looking for more effective and financially sustainable strategies for providing insurance. Researchers began to examine index-based insurance arrangements (IBI), which use an objective index of weather measurements, satellite images, or average yields for a geographic area to determine payouts. An early example of IBI was established in India (Dandekar 1976) and many others

were launched in the 1990s as researchers and funders saw potential to address the high costs and moral hazard issues that plagued the earlier indemnity insurance programs.

Since then, various innovations have been built on the IBI framework, incorporating new types of indices, technologies, and layered designs (ISF 2022; Constantinescu et al. 2025). Other arrangements and bundling approaches seek to mitigate the persistent challenges to insuring farmers and increase demand for insurance products. A large body of research has been produced that identifies the strengths, limitations, and impacts of different insurance schemes.

Report Scope and Outline

This report reviews existing research on agricultural insurance with a focus on recent innovations. It synthesizes lessons on the impacts, design, and implementation of successful schemes, drawing on well-published peer-reviewed findings. The following section outlines major categories of insurance innovations assessed in this review, which have been developed over time to address central insurance needs and challenges. The next section reviews existing evidence on both the *ex ante* and *ex post* impacts of these different insurance arrangements. This is followed by an examination of key design features and how they influence costs, basis risk, and timing of payments, among others. Later sections review distribution channels and evidence on inclusion with a focus on women and low-income farming households. The final section provides operational guidance on the design and implementation of agricultural insurance and climate risk management at the country level.

2. MAIN AGRICULTURAL INSURANCE APPROACHES

A range of insurance tools have been developed in response to specific challenges and to enhance the benefits of insurance for agricultural actors and insurance providers. These can be grouped into several broad categories based on their key features and advantages. Increasingly, implementers are recognizing the benefits of bundling multiple insurance arrangements with other agricultural services and resources such as credit or the provision of inputs.

Indemnity based: The large majority of non-agricultural insurance products are of an indemnity-based nature, and this was the approach followed by the initial MPCPI programs established during the 1970s. Indemnity insurance arrangements in agriculture base payouts on the direct measurement of the losses experienced by the policyholder, typically by an adjuster visiting the field in person. Insurance coverage generally includes losses from a wide range of extreme weather, pests, diseases or other disasters outside the grower's control, a clear advantage compared to other arrangements that may only cover losses linked to specific events like low rainfall or high temperatures. The advantages of this approach are its accuracy, transparency, and comprehensiveness, though this comes at the expense of a lengthier and costlier process (which can become particularly salient after large covariate shocks, when a large number of farms must be evaluated over a short period of time).

A more modern approach that resembles traditional indemnity products is Picture-Based Insurance (PBI), where policy holders or local agents use a smartphone app to take pictures of their fields and share them with the insurance providers not only when damage arises, but also on a regular basis (for instance once per growth stage) over the growing season.¹ The app provides guidance to farmers to ensure the quality of the pictures, in addition to geotags and visual aids to minimize misreporting and fraud. These pictures are then used to assess losses based on expert review and automated algorithms. This approach allows producers to accurately document losses while providing evidence that the affected crop was managed appropriately, keeping plot-level assessment costs low while reducing the incidence of moral hazard. PBI has been found to accurately identify severe damage and outperform index-based products in Haryana, India (Ceballos et al. 2019) and is currently being brought to scale by private sector insurers in Odisha, India, Kenya, and Uganda (UNEP 2024).

Index-Based Insurance: Since gaining prominence in the 1990s and early 2000s, index-based insurance (IBI) has become a cornerstone of many modern agricultural insurance programs. At its core, IBI relies on objective indices such as weather data, satellite imagery, or average yields within a defined geographic area to approximate losses and determine payouts. Typically, contracts compensate farmers when the index crosses a predefined threshold within a specified time period. Recently, advances in data availability and index design have improved the accuracy of loss assessments while reducing operational costs. However, a persistent gap in high quality, granular ground level data covering yields, weather, soil conditions, and pest or disease outbreaks continues to constrain index performance and contributes to ongoing basis risk (ISF 2022).

¹ See digital impacts exchange playbook on PBI for more details: <https://exchange.dial.global/playbooks/picturebased-insurance-pbi>

Table 1. Different examples of weather index-based insurance arrangements and their key features

Index Insurance Type	Description
Total seasonal rainfall index	This arrangement bases potential payments on total rainfall in a given season, with payments increasing according to a step function. For such products, total rainfall is often expressed as a fraction of normal rainfall, calculated to be the historical average rainfall. They fail to account for long dry spells, phenological stages of crop growth, and soil capacity to retain water, making them unreliable at approximating actual losses.
Multiple phase weather index	In this arrangement, the growing season is divided into sequential phases of varying duration, typically chosen to correspond to the crop-growth stages as defined by crop calendars. Payments are based on actual rainfall compared to the water requirements of the crop in each phase, only triggering if rainfall is sufficiently low or high. Multiple phase approaches are more intuitive to farmers by associating rainfall insurance with critical crop-growth phases. They also provide interim payouts that can be used to address potential losses. Some variations also account for long dry spells or compounding effect of rainfall over different phases.
Consecutive Dry Days Index	In this arrangement, the index is simply equal to the maximum consecutive number of dry days within a specified period and pays out if a certain number of days is reached. Dry day indices fail to account for volume or rain on their own, can be paired with rainfall volume indices.
Excess/Untimely Rainfall Index	Indices have been designed to capture excessive rain in similar arrangements to those already described for rainfall deficits. They can account for consecutive rainy days, aggregate rainfall over a short period of time (often a few days), or rely on a piecewise linear function of rainfall in each crop growth phase.
Soil moisture index	These arrangements use satellite or in-field sensors to monitor soil moisture levels and provide payouts if levels reach below or above a threshold that would indicate potential crop stress. These models can provide a more direct measure of the relationship between crop growth and rainfall by accounting for soil water retention.
Normalized Difference Vegetation Index	Another satellite-based index measures vegetation levels in predefined zones and provides payouts when these fall below a certain level. They have been used effectively for livestock insurance, but it can be challenging to delineate insurance zones over large areas of pasture or rangeland.
Low temperature or frost indices	This index is designed to protect against adversely low temperatures, by basing payouts on a function of the minimum temperature in the covered period. This type of product accounts for a very narrowly defined type of risk but can be combined with other indices to account for other threats to yields.
High temperature indices	These can be a type of multiple phase arrangement, where payments are a function of the mean temperature for a given crop growth phase or frequency of excess daily temperatures.
Weather indices for pest and disease	The risk of infestation from some pests and diseases, like aphids or potato blight, are partially determined by relative humidity, temperature, and rainfall. These indices try to measure such risk, but they are complex and relatively little research is available on their ability to ultimately account for effects on yields.

The underlying index can be based on a variety of different measurements related to crop growth. Table 1 provides an outline of more common weather IBI arrangements from Clarke et al. (2012), which illustrates their versatility and relative ability to approximate yield losses. These can include total rainfall, average temperature, or number of dry days, among others. Area-yield indices attempt to estimate the average yield in a given insurance zone, based on a representative sample of farms in it. This can be more accurate at estimating losses than weather IBIs and can provide coverage for a broad set of perils affecting yields, but requires historical disaggregated yield data to define thresholds and a careful

definition of insurance, together with an effective sampling strategy (Clement et al. 2018). In addition, area-yield indices typically rely on crop-cutting experiments, which can be logistically cumbersome and expensive to conduct at large scale. Key examples include the national (mostly area-yield-based) PMBFY program in India and the public area-yield insurance scheme in China. In both these cases, public support and infrastructure (e.g. extension services, personnel that conduct the crop-cuts, offices to store and weigh samples) are key for at-scale implementation.

IBI products can be adapted to different contexts and farmer needs. For example, one experimental arrangement offered producers a range of narrowly defined index products paying out above specific rainfall thresholds over specific timeframes. Heterogeneous producers could then choose a combination of these “micro” insurance products and bundle them into a personalized insurance product that covered their specific risk profile (Ceballos and Robles 2020). The study found farmers’ portfolios indeed reflected their crop mix, planting dates, soil type, and other factors. When compared to simulations of more traditional products, this flexible arrangement increased farmer welfare.

Early trigger insurance: Some programs have developed early payout or even anticipatory action mechanisms to ensure payments reach farmers when they are most needed, by relying on leading indicators of losses. For example, some multiple-phase weather IBI products and early consecutive dry day products are designed to provide payouts well before harvest so growers can take mitigative action. One program in Bangladesh, for instance, paired a yield-based index program with conditional early payouts if farmers experienced 12 sequential days without rain during the growing season, with a higher payout if the dry spell reached 14 days (Hill et al. 2019). Since dry spells are correlated with increased irrigation costs or lower yields, the mechanism was able to effectively anticipate payouts and provide growers with knowledge that they would receive payouts early enough in the season for them to increase costly irrigation to minimize the losses.

Bundled approaches: Insurance products are increasingly offered alongside complementary services such as credit, seeds, and fertilizer. This integrated approach enhances the appeal of insurance for producers, encourages the adoption of improved inputs, and helps reduce risk for both farmers and insurers. In particular, bundling insurance with credit has gained traction, with well-known examples including insured loans in India’s PMFBY and Pula, ACRE Africa, and risk contingent credit programs in Africa (Pula 2025; ACRE Africa n.d.; Ndegwa et al 2020). A key advantage of this model is that it improves access to finance for farmers by reducing lenders’ risk exposure. Credit may also be more familiar to farmers with more tangible and immediate benefits relative compared to insurance, so bundling may make insurance more appealing for farmers and overcome initial skepticism about insurance arrangements. Another advantage of insuring loans is that it makes insurance more targeted—there tends to be an investment or asset that farmers and financial institutions would want to see insured. Digital platforms such as DigiFarm can further support bundling by providing producers with access to these services, along with agricultural inputs, soil testing, and other offerings (Benni 2023). While these bundled models are valuable and have become a key vehicle for agricultural insurance distribution, they tend to cover only a very limited portion of farmers’ overall risk exposure, creating the danger that policymakers may underestimate or overlook the substantial residual risks that farmers still face.

3. IMPACTS OF AGRICULTURAL INSURANCE

There is robust evidence showing that insurance programs, when they function as intended, offer significant *ex post* protection against production shocks to households. Bertram-Huemmer and Kraehnert (2018) found households who received payouts from an index-based livestock insurance (IBLI) policy after an adverse winter weather event had recovered faster and held larger herds, with effects enduring for three years after the initial shock. They also note 73 percent of households used these payments to buy food and other necessities, providing a lifeline under challenging circumstances and enabling them to maintain productive assets (Bertram-Huemmer and Kraehnert 2018). Similarly, analyses of insurance in Mozambique, Tanzania, Bangladesh, and Mexico, found that farmers who received insurance payouts after a drought were able to spend more on crop production or cultivate on a larger scale in the following seasons (Boucher et al. 2024; Hill et al. 2019; de Janvry et al. 2016). Two of these studies also found this led to higher yields and income (Hill et al., 2019; de Janvry et al., 2016).

In addition to benefiting insured households, agricultural insurance can also serve as an effective disaster response tool for governments. By providing or subsidizing coverage for a large share of the population, governments can establish a pre-arranged compensation mechanism that can be activated quickly following a natural disaster. Compared with ad hoc disaster assistance, insurance programs may be easier to budget for and plan, helping to improve the predictability and timeliness of support (Hill et al. 2021). However, other forms of assistance, such as emergency cash transfers, may be more appropriate for certain groups such as extremely poor households that may not be well served by insurance-based approaches.

Even when payouts do not occur, farmers can still benefit substantially *ex ante* when covered against production risks. Evidence across a range of products and contexts shows that farmers who trust their insurance coverage are more likely to make investments that increase productivity and income. These findings are documented in studies including Bulte et al. (2020) on multiperil crop insurance in Kenya; Stoeffler et al. (2022) on area yield insurance in Burkina Faso; Hill et al. (2019) on rainfall and area yield insurance in Bangladesh; Jensen et al. (2017) on livestock insurance in Kenya; Cai (2016) on area yield insurance in China; Fuchs and Wolff (2016) on rainfall index insurance in Mexico; Cai et al. (2015) on swine insurance in China; Mobarak and Rosenzweig (2013) on rainfall index insurance in India; Elabed and Carter (2015) on area yield insurance in Mali; and Karlan et al. (2014) on rainfall index insurance in Ghana. One study estimates that these effects translate into an approximately 15–30 percent increase in farm investment (Carter and Chiu, 2020). While insurance can have welfare benefits even if not increasing investments, for instance by creating peace of mind and improving mental health, these welfare benefits are more difficult to measure, and studies therefore tend to use investments as an indicator for *ex ante* impacts.

These studies also demonstrate a strong return on investment (ROI). For example, Cai (2016) finds that having area-yield coverage in China is associated with a 16 percent increase in crop production. Similarly, Jensen et al. (2017) show that insurance-induced increases in spending on livestock health care, along with related behavioral changes, reduced livestock losses and increased milk production by \$5.95 per Tropical Livestock Unit per month. The authors estimate that each dollar spent on insurance generated an estimated return of \$1.58 in increased income (Jensen et al. 2017), through a combination of reduced precautionary savings, improved investment in livestock health, increased herd size, and the adoption of improved pastoral strategies.

While the benefits of insurance are clear, they are highly dependent on the design of insurance programs. As noted in the previous section, government indemnity insurance programs that were popular in the 1970s were found to be costly and ineffective, with low or often negative ROI. In comparison, the evidence around the impact of index insurance is mixed. Impacts tend to be heterogeneous across different farmer groups. For instance, two studies of IBLI in Kenya show the programs prevented a fall in

consumption and an increase in emergency asset sales after a drought, but consumption effects were larger for poorer households, while asset effects were larger for richer households (Janzen and Carter, 2019; Jensen et al., 2017). In addition, the size of payouts or the extent of insurance coverage matters. The positive effects of IBLI in Bertram-Huemmer and Kraehnert (2018) were driven by households that purchased a higher value of insurance and received a significantly higher payment, while those who received lower payments (under ~USD 136) did not recover significantly faster than those without insurance. These findings have implications for insurance design, where insurance coverage must be sufficiently large in relation to policy holders' overall risk to experience its benefits.

4. DESIGN AND IMPLEMENTATION

Cost

Insurance costs or premiums can be broken down into two main components. First, premiums include actuarial (pure) risk costs, which represent the expected value of insurance payouts. These are estimated based on the insured value and the historical frequency and severity of losses. Second, premiums include administrative and operating costs, which include expenses related to program operation, such as marketing, enrollment, distribution, data collection, contract management, damage assessment, and payout processing expenses. In addition to these two categories, premiums incorporate profit margins as well as risk or safety loadings that factor in various elements such as data quality uncertainty, climate trend uncertainty, or re-insurance premiums.

Providing insurance is costly. This is particularly true in the early stages of an insurance product, when design, rollout, and evaluation expenses are high relative to premiums. Even after an insurance product is established, premiums and actuarially fair prices vary widely across products and contexts. For indemnity livestock insurance, Bertram-Huemmer and Kraehnert (2018) report premiums of 1.4-1.7 percent, while Cai et al. (2015) estimate premiums at 6 percent of the insured value for sows in China. For weather index-based insurance bundled with improved seeds, premiums are around 6 percent of insured value (seeds in this case) in Kenya (Bulte et al. 2020) and between 6 and 10 percent in Malawi (Giné and Yang 2009). Rainfall index insurance based on satellite data carries premiums ranging from 7.75 to 11.5 percent of insured value in Burkina Faso (Kazianga and Wahhaj 2020). In India, Clarke et al. (2016) report premiums between 1.5 and 8 percent for a public weather index insurance program, depending on the crop and Cole et al. (2013) report premiums between 2.6 and 4 percent for a program in Andhra Pradesh and Gujarat. Cai, de Janvry, and Sadoulet (2020) find a 3 percent actuarially fair price for area-yield index insurance for rice in China, while Hill et al. (2019) estimate an actuarially fair price of about 18 percent for area-yield index insurance that paid out with a high frequency and with an early trigger component for rice in Bangladesh. Administrative loadings for agricultural insurance fall in the 20–40 percent range above the actuarially fair price, although they can exceed this range. Factors like small portfolio size, high distribution and verification costs, or the expense of data and modeling required for index-based designs increased administrative loading costs.

Despite evidence that insurance can generate positive impacts, high costs and low demand continue to constrain program scale. Farmers' willingness to pay is often found to be well below market prices. For example, in a study of bundled index insurance and improved seeds, no more than 33 percent of farmers were willing to pay the full market price, and average willingness to pay was 11 percentage points lower (Bulte et al. 2020). Similarly, Hill et al. (2019) find that insurers would need to offer a 15 percent discount on the actuarially fair price to sell even a single unit of area-yield index insurance with an early warning trigger to rice farmers in Bangladesh. This usually results in farmers preferring partial coverage: livestock insurance programs in Mongolia and Kenya find producers typically insuring only about 30 percent of their herd value (Bertram-Huemmer and Kraehnert 2018; Jensen, Barrett, and Mude 2017).

To address affordability constraints, program implementers frequently subsidize premiums. Many of the studies reviewed involve substantial support from governments or donors. For instance, Jensen et al. (2017) report a 40 percent subsidy for livestock index-based insurance in Kenya, while Cai (2016) finds a 67 percent subsidy for weather-based indemnity crop insurance in China. In Bulte et al. (2020), insurance bundled with improved seeds is provided free of charge, implying a 100 percent subsidy. In India's PMFBY, premiums are capped at 2 percent for staple crops and subsidies were provided for commercial crops ranging from 25 to 50 percent of the actuarially fair premium depending on the crop (Clarke et al. 2012). These subsidies often appear crucial to generate take-up despite the persistent gap between farmers' willingness to pay and commercially viable pricing.

However, even when insurance is subsidized or offered at reduced rates, demand remains relatively low and only modestly responsive to price changes. Several studies estimate price elasticities of demand, consistently finding limited sensitivity. Hill et al. (2019) estimate an elasticity of -0.65 for area-yield index insurance with an early trigger among rice farmers in Bangladesh. Cai et al (2020) estimate an elasticity of -0.44 for similar products in China, while Casaburi and Willis (2018) find an elasticity of -0.39 for area-yield index insurance in Kenya, noting that this may be an underestimate due to the binary nature of the purchase decision. Cole et al. (2013) find an elasticity of 1.04 - 1.16 for rainfall insurance in India, but note other factors such as low financial literacy, lack of trust, and liquidity constraints that keep demand low. Together, these findings suggest that lowering prices alone is unlikely to generate large increases in uptake.

One of the main advantages of IBI is its lower cost of loss assessment compared to traditional indemnity insurance. Because payouts are triggered by an objective index, insurers do not need to conduct costly and time-consuming field assessments, which are especially challenging in remote rural areas. However, the overall cost of providing IBI and its financial viability vary significantly depending on the index design and the availability of infrastructure and reliable historical data. For example, the unavailability of a weather station network may pose a binding constraint to the supply of weather-station based IBI, or weak road infrastructure may impede the timely implementation of crop-cutting experiments for area-yield IBI. If historical data is incomplete or unreliable, insurers will raise premiums to account for the added uncertainty in pricing.

Jensen et al. (2017) provide a detailed analysis of the costs of a livestock IBI program in Kenya and compare them to those of a cash transfer program in the same region. They estimate an average cost of USD 177.5 per Tropical Livestock Unit, or about USD 805.75 per client, between 2009 and 2013. By comparison, the cash transfer program cost USD 640 per client. However, the authors emphasize that these higher insurance costs are largely driven by fixed expenses associated with product development and study implementation. Once the program is established, marginal costs decline substantially, with the cost of enrolling an additional client only about 6 percent of that for the cash transfer program, indicating significant potential for cost reductions at scale.

Recent innovations have further expanded options for reducing costs in both delivery and claims assessment. For instance, picture based insurance allows farmers to submit smartphone images of their fields, enabling insurers to assess damage remotely and at lower cost while maintaining field level accuracy. Marketing and scaling strategies can also be optimized to reduce expenses. In Burkina Faso, a program offering rainfall insurance to urban migrants intended to protect family members in rural areas found that marketing and enrollment costs ranged from USD 17.24 to USD 43.10 per subscription, compared to USD 34.48 to USD 69.00 for rural clients (Kazianga and Wahhaj 2020).

To stimulate demand, some programs have experimented with discount vouchers and rebates at the point of purchase (for example, Hill et al. 2019; Hill et al. 2016; Karlan et al. 2014; Cole et al. 2013; McIntosh et al. 2013; Cai et al. 2020). Evidence suggests that the structure of these incentives matters. In a randomized trial in Bangladesh, Hill et al. (2019) find that farmers offered rebates purchased 57 percent fewer insurance units than those offered equivalent discounts. They also estimate that farmers would require at least a 15 percent discount or a 33 percent rebate relative to the actuarially-fair price to induce the purchase of at least one unit. These findings are consistent with liquidity constraints, as farmers tend to value immediate price reductions more than delayed reimbursements. At the same time, some farmers—particularly those who are highly risk averse—prefer rebates, viewing them as a form of savings that protects their cash in case the insurance does not pay out.

Basis Risk

Basis risk is a central challenge in agricultural insurance, one that can reduce both the effectiveness of programs and demand from producers. In its most pernicious version, it refers to the risk that a policyholder experiences a loss that the insurance is intended to cover but does not receive a payout because the index or assessment mechanism does not accurately capture the loss. Basis risk therefore limits the ability of insurance to improve farmer welfare and can undermine trust in insurance products. On the other hand, upside basis risk occurs when the index or assessment mechanism generates a payout despite the absence of actual losses. Such payments do not carry the same cost as missing a payment when needed, but they do result in a farmer receiving a payout when it is not needed, and given this is ultimately paid for in the price of the insurance, it reduces the value proposition of an insurance contract. By experimentally varying this risk, for example by altering a farmer's distance from the nearest weather station, several studies show that perceived basis risk reduces overall demand for insurance (Hill et al. 2016; Jensen et al. 2018; Mobarak and Rosenzweig 2013).

Basis risk is most relevant for index-based insurance because payouts rely on an indirect measure of losses. Mismatches can occur when, for example, a farmer insured under a weather-index policy experiences crop damage from adverse weather, but the index does not register the event and no payout is triggered. Because growing conditions vary over time and space due to both weather and non-weather factors, basis risk can be substantial, particularly for narrowly defined weather indexes. In Kenya, Jensen et al (2016) finds that a weather index-based livestock insurance product only protected farmers from about 31 percent of risk from high loss events on average. Similarly, for a public weather-based index insurance program in India, Clarke et al. (2012) estimate a 33 percent probability of no payout even after complete crop failure (downside basis risk) and a 45 percent probability of a payout in seasons with very good harvests (upside basis risk).

More comprehensive index designs generally face lower basis risk because payouts are more closely tied to realized outcomes. For instance, large public crop insurance programs in India and China rely on area yield indexes, which can achieve relatively low basis risk when agricultural zones are well defined and sufficient yield data are available (Clarke et al. 2016; Cai, de Janvry, and Sadoulet 2020). However, this reduction in basis risk comes at a cost, since conducting crop cutting experiments to measure yields at scale can be very expensive, creating a clear design tradeoff between accuracy and cost.

Recent innovations have sought to reduce basis risk without substantially increasing costs. High resolution satellite data, for example, can improve measurement of growing conditions and has been used to enhance both weather index design and payout accuracy in East Africa (Enenkel et al. 2018; Black et al. 2016). In livestock insurance, remote sensing has been used to develop index-based products based on vegetation indices. However, even these approaches remain subject to basis risk (Chantararat et al. 2013; Jensen et al. 2024; Jensen et al. 2016).

Picture based insurance (PBI) offers another approach to reducing basis risk at relatively low cost. By using geotagged images of farmers' fields to assess damage, PBI can capture a broader range of shocks than many index based approaches. Evidence comparing PBI with weather index and simulated area yield insurance for wheat in northern India finds that PBI correctly identifies severe crop losses in 71.4 percent of affected sites, compared to at most 34.4 percent for the other methods (Ceballos et al. 2019). It also performs better at avoiding false payouts, with payouts in only 7.1 percent of normal yield cases, compared to 24.2 percent for weather index insurance and 5.5 percent for simulated area yield insurance. However, the same study found PBI to be less accurate for detecting moderate losses, suggesting potential complementarities with other approaches, and a need for hybrid solutions. The approach appears to be particularly effective at building trust and stimulating demand. Multiple studies in India, Kenya, and Ethiopia show that PBI increases insurance uptake (Kramer et al. 2024a; Kramer et al. 2024b; Kramer, Porter and Bizuayehu, 2023). This may reflect greater farmer involvement in the assessment process and the transparency of visual evidence, which together enhance confidence in how payouts are determined.

Hybrid insurance models attempt to combine the strengths of different approaches while reducing basis risk. Some products combine weather index coverage for risks such as rainfall deficits and floods with indemnity components that cover hazards such as hail, frost, pests, and disease (Bulte et al. 2020). Another innovation is gap insurance, or conditional audits, which combine weather index insurance with area yield verification. In these systems, the weather index determines most payouts, but area yield assessments are triggered when the index does not indicate a loss despite reported damage. This reduces the need for costly yield assessments for all insured farmers while improving accuracy. Such products have been piloted in Ethiopia and Bangladesh, with relatively high uptake, although demand may have been influenced by contextual factors (Berhane et al. 2015; Flatnes, Carter, and Mercovich 2018; Hill et al. 2019). With the rise of remote sensing, smartphone penetration and other digital technologies, such area yield assessments could also be replaced by other fail-safe triggers, including options that could compensate farmers for plot-level damage not captured through an area yield approach.

Trust in insurance is closely linked to basis risk but is also shaped by farmers' financial literacy, prior experience, perceived transparency, availability of accountability mechanisms, and the broader institutional context. In many cases, insurance is less familiar to farmers than agricultural credit or inputs, and the potential benefits can be less clear (Hazell and Timu 2024). Farmers do not purchase insurance because they do not trust that it will pay out when needed, or because they did not understand that the product only makes payouts when shocks occur, and under specific conditions. Various studies have found that trust plays a central role in insurance uptake, with endorsements from trusted local actors, prior relationships with insurers, and credible information sources (such as government agents) substantially increasing demand (Cole et al. 2013; Giné et al. 2008; Akter et al. 2016). Complexity in product design can limit uptake, as it increases the extent to which farmers struggle to understand contract terms and potential benefits (Clarke et al. 2016). For this reason, clear and simple communication is essential, and insurers can support informed decision making by sharing historical index performance and implied payout rates under different scenarios (Clarke et al. 2016). Ultimately, many farmers may still rely heavily on the opinions of trusted individuals or institutions to inform their decisions, making local partnerships important for expanding insurance.

Experiential learning can also increase trust and demand. Bulte et al. (2020) find that farmers who receive free insurance for one season are willing to pay 7 to 8 percent more in subsequent periods. Cai et al. (2015) show that villages experiencing higher livestock losses during a winter storm subsequently exhibit higher insurance uptake, suggesting that observed payouts increase perceived value. Similarly, Cai et al. (2020) find that receiving a payout under area yield insurance in China increases second year take up by 36.8 percent, with effects persisting for several years when combined with financial training. Other studies analyzing repeat-purchase behavior find that experiencing or observing insurance payouts substantially increases subsequent uptake by roughly 9 to 50 percentage points (Cole et al. 2014; Hill et al. 2016; Stein 2018).

Timing

Insurance programs must be responsive to shocks, meaning they should assess damages and deliver payouts quickly so that farmers receive support when it is most needed. Evidence shows that even when assessments and payments are accurate, slow insurance programs are less effective at protecting farmer welfare (Stoeffler et al. 2022), and delays in payment can also reduce demand for insurance (Hazell 1992; Mahul et al. 2011; Ghosh et al. 2021). Weather index based insurance (IBI) programs are generally better positioned to provide rapid payouts because they rely on predefined indices that are remotely monitored. In contrast, indemnity insurance often requires site visits and detailed damage verification, and area yield index insurance requires time-consuming area yield measurements, which can slow down payment delivery. Delayed payments can also reduce the value of disaster insurance, since it may fail to meet short-term needs (Hill et al. 2021). However, as noted above, faster payment systems in IBI can come at the cost of higher basis risk, creating an important tradeoff between speed and accuracy. Additionally,

very little evidence is available on how quickly farmers actually receive payments from index contracts. This should be reported more often.

Early trigger insurance mechanisms are designed specifically to ensure payment (or knowledge of a future payment) is received at the right time. By ensuring that funding is anticipated or available at critical periods in the agricultural process, early triggers in an insurance policy can enhance farmer resilience. For example, some area yield-based insurance products include an early warning feature that triggers payouts and is activated when local weather stations record conditions such as a high number of consecutive dry days. Evidence from such designs shows strong demand for early triggers, as well as improvements in the welfare benefits of insurance when payments arrive sooner (Hill et al. 2019). Hill et al. (2019) found that an early announcement of the index triggering a payment—as a result of prolonged dry spells during the rainy season—allowed farmers to mitigate subsequent losses in that season by spending more on irrigation.

The timing of premium payments is another key determinant of insurance uptake. In many programs, farmers are required to pay premiums upfront at the beginning of the growing season. This structure can discourage participation, particularly among liquidity constrained farmers (Casaburi and Willis 2018; Liu et al. 2020, Cole et al. 2013). This constraint is important because agricultural production itself requires substantial upfront expenditures for land preparation and planting, while income is only realized after harvest. As a result, even when insurance is affordable in expected value terms, farmers may struggle to make payments at the required time.

Relaxing liquidity constraints by allowing farmers to defer premium payments can significantly increase demand. Casaburi and Willis (2018) study a contract farming arrangement in sugarcane where insurance is bundled with the crop contract and premiums are deducted at harvest. In this setting, 72 percent of farmers offered the delayed payment option purchased insurance, compared to only 5 percent under a standard upfront payment contract. This increase in demand far exceeds the effect of a 30 percent price reduction, which had no impact on uptake. Even when farmers were given a cash gift slightly larger than the premium, uptake reached only 33 percent, still less than half of the rate under delayed payment. In other contexts where insurance is purchased annually, similar effects can be achieved by allowing premiums to be paid at the start of the following growing season (Liu, Chen, and Hill 2020).

Distributional channels and bundling

Insurance can be delivered through a variety of channels, with important implications for demand, affordability, and financial sustainability. In many low- and middle-income countries, the combination of affordability constraints and weak demand has limited the expansion of private sector insurance markets. As a result, most large-scale insurance programs have been initiated by the public sector, which is able to use public resources to offer heavily subsidized premiums and extend coverage through private insurance providers at scale. At the same time, many smaller scale innovative pilots have been developed by researchers, insurtech firms, and international nongovernmental organizations, often in partnership with governments and local insurers (ISF 2022; Hazell and Timu 2024).

Over the past decade, bundling has emerged as a key distributional innovation in agricultural insurance. Index insurance has increasingly been bundled with agricultural inputs such as seeds and fertilizer (e.g. Kilimo Salama/ACRE Africa and One Acre Fund) or with agricultural credit, including large-scale public schemes such as India's PMFBY. These approaches have allowed insurance to piggyback on established agricultural value chains, facilitating rapid scale-up (Hazell et al. 2021; Kramer et al. 2022). For such bundling to work, the insurance component is typically made to be compulsory (or requires explicit opt-out from the farmer), invisibly raising the costs of these inputs for the farmer by embedding the premium in the price of the input package. Another key limitation, underlined above, is that bundled insurance coverage often applies only to the value of the bundled input or loan, leaving farmers exposed to

substantial residual income losses even when an insured shock occurs. In competitive input markets, farmers may also seek out alternative suppliers to avoid paying the cost of insurance reflected in higher prices for bundled products when the benefits are not clear. We discuss the role of regulations in addressing this and facilitating bundling in the subsection on “The role of subsidies and regulation”.

Bundling insurance schemes with agricultural credit overcomes liquidity constraints to insurance access and reduces the cost of insurance provision. Insurance providers can work with local financial institutions to offer both these services to farmers, which can provide them with the cash to pay premiums, sometimes incorporated as a markup on interest rates. Lenders can also benefit from these arrangements, since the insurance reduces the risk of lending and makes their loan portfolio more resilient to shocks. Evidence suggests this approach can increase demand for insurance, in addition to potentially enhancing insurance’s impacts on investment and productivity. A study from Kenya compared the uptake of regular loans to loans with an included insurance arrangement, where insurance payments would offset loan repayment obligations of the borrower in the case of poor growing conditions (Shee et al. 2019). The researchers found 40 percent of farmers adopted the insured loan compared to 30 percent for the standard loan, many of whom had not accessed credit before.

Some programs also pair insurance with seeds (Bulte et al 2020). For example, ACRE Africa offers replanting guarantees in which seeds bought from participating retailers are insured against early-season weather shocks. If adverse weather occurs, farmers receive timely payouts that allow them to purchase new seeds and replant within the same season. Kramer et al (2023) found that bundling insurance with seeds increases willingness to pay compared to what farmers would be willing to pay for seeds or insurance alone. The bundling effect was largest for seeds of non-drought-tolerant varieties, even though bundling with the provision of seeds of drought-tolerant crop varieties has been found to have large impacts of insurance (Boucher et al. 2024). Adding insurance when providing seed of drought-tolerant varieties led to an overall increase in agricultural investment when farmers experienced the benefits of these risk reduction strategies after a shock. Similar interventions could bundle insurance with extension services or other technologies.

Distribution channels also play a critical role in building trust, which is a key determinant of insurance demand. Evidence shows that farmers are more likely to purchase insurance when they have prior experience with the insurer (Giné, Townsend, and Vickery 2008) or when the product is endorsed by trusted local actors or government agents (Cole et al. 2013; Akter et al. 2016). Providing insurance through local groups, especially those that already have some experience with insurance provision to members such as funeral insurance groups has been shown to increase demand (Dercon et al 2014). This could in part be because these groups have the ability to cover aspects of basis risk. Some successful models have provided insurance through farmers organizations, which may have capacity to reach more farmers, better knowledge about the farmers, and greater administrative capacity at the local level (Hazell and Timu 2024). These findings highlight the importance of working through local partners and engaging community leaders to strengthen credibility and improve uptake. Others have indicated the potential for providing insurance through crop aggregators such as traders and processors, but it is not always clear how this would work in practice as in competitive markets, there would need to be a way to minimize side-selling for a combined financial and physical transaction to work.

Several studies have examined how local social networks can be leveraged to support insurance provision (de Janvry et al 2014; Dercon et al. 2014; Kazianga and Wahhaj 2020). In many settings, informal risk sharing arrangements already exist, where community members provide mutual support during periods of financial stress. These networks can complement formal insurance by covering smaller, idiosyncratic shocks at low cost, while formal insurance can address larger covariate shocks that affect entire communities. This combined approach can increase appeal by lowering costs and enhancing perceived security through trusted social structures.

Evidence from Ethiopia illustrates this mechanism. In a study of farmer risk sharing groups, leaders received training on risk management and insurance, with some sessions specifically emphasizing the role of informal risk sharing for idiosyncratic shocks. Groups led by individuals who received this targeted training showed higher demand for formal insurance (Dercon et al. 2014). Similarly, in Burkina Faso, a rainfall index insurance product was offered to urban migrants on behalf of their rural relatives, effectively leveraging social ties across locations (Kazianga and Wahhaj 2020). This approach achieved strong uptake over a short enrollment period with minimal marketing and revealed willingness to pay levels comparable to rural clients. By reducing marketing costs and tapping into existing social relationships, targeting urban migrants may represent a cost-effective strategy for expanding coverage.

The main limitation of these approaches is that they rely on the existence of strong pre-existing risk sharing networks, which may not be present in all contexts. Nonetheless, there is substantial scope for future research and program design to adapt and extend these models to settings with weaker or differently structured social ties.

Inclusion

Insurance can be a useful tool for most farmers, in addition to other actors in agricultural value chains. Nevertheless, many insurance programs tend to be available or meet the needs of only a fraction of these. One estimate suggests only 20 percent of smallholder farmers globally have access to insurance and less than 3 percent in sub-Saharan Africa (ISF Advisors 2018). In a review of gender and agricultural insurance, Timu and Kramer (2023) summarize evidence indicating that women farmers tend to face a greater burden from agricultural risk compared to men, and may benefit more from effective insurance as a result (Dercon and Krishnan 2000; Hoddinott and Kinsey 2001; Quisumbing, Kumar, and Behrman 2018). Despite this finding, women in some contexts are less likely to buy insurance (Akter et al. 2016; Clarke and Kumar 2016; Delavallade et al. 2015). In a case study from Bangladesh, Akter et al. (2016) found evidence that this is largely attributed to lower trust in insurance institutions and lower financial literacy among women. This may reflect underlying inequities in decision-making power, education, and other areas of empowerment. There may also be underlying biases toward men in the design, marketing, and recruitment for insurance programs.

Several studies also suggest women's risk is systematically different from men's in some contexts requiring different product designs. For example, Delavallade et al. (2015) find that insuring health shocks is more important to women than it is to men given they carry a large share of the burden of managing ill health within the household. These results indicate a need to better understand women's insurance needs and design insurance programs to address these needs (Timu and Kramer, 2023). Some programs have successfully reformulated insurance products to better address risks faced specifically by women, which was shown to increase demand (Arteaga, Carter, and Hobbs 2023).

Moreover, insurance remains largely inaccessible to poor households who may be most in need of risk management solutions. This problem is even more severe for landless farmers, who tend to be on the lower end of the income distribution and high end of the vulnerability spectrum. Several studies have verified demand for insurance is lower for poorer farmers (Jensen et al., 2018; Takahashi et al., 2016; Cole et al., 2013; Giné, Townsend and Vickery, 2008). These families often have limited savings or other assets to help them cope with major shocks and, as such, face greater risk of negative impacts to their food security or long-term well-being.

To better meet farmers' diverse needs, programs can also be designed to offer a more flexible range of insurance options and allow agricultural actors to choose the options that work best for them. Often insurance indices are designed to meet the needs of a hypothetical farmer. While such tools are aligned with farmer experiences in the insured area on average, they do not effectively capture the heterogeneity in risks faced by real farmers and may inadvertently provide better service to those who fit closer with

typical farmer preferences. One strategy introduced to better account for this heterogeneity is to offer farmers a variety of “insurance coupons” optimized to cover a narrow category of risk, such as a specific level of rain fall over a given month. Farmers can then decide how best to bundle coupons to suit their needs. Farmers responded positively to these options during pilots in Ethiopia and Uruguay, though there was no change in demand overall (Ceballos and Robles 2020; Hill and Robles 2011).

Research has identified several other factors limiting insurance access for poor households including a lack of information on insurance alternatives, limited financial literacy, and higher levels of basis risk. In particular, households may not be aware of innovative insurance products designed to be affordable and reduce liquidity constraints. Similarly, future risks may not represent an immediate priority for many households if they are currently facing more immediate needs or financial constraints. In both these cases, stronger marketing and financial counseling may make insurance more accessible to these households and help them make informed decisions about purchasing insurance (Vasilaky et al., 2020; Cai and Song, 2017; Cai et al., 2015). Poor households also tend to live in more remote areas, typically farther away from weather stations where index insurance data is collected, thus facing higher basis risk. This can be addressed through programs that use high-resolution satellite data that can provide more localized measurements, or gap insurance arrangements that provide contingencies in cases where the index did not trigger but the farmers still experiences losses.

Financial literacy can play an important role in improving smallholders’ access to insurance and their ability to make informed financial decisions. Many smallholder farmers are less familiar with insurance than with other financial services, and index insurance products can be particularly difficult to understand. As a result, limited financial literacy is frequently cited as a barrier to the adoption of insurance and other financial services.

Evidence on the impact of financial education on insurance is mixed. Several studies find that financial education programs can increase insurance uptake (Liu et al. 2023; Cai et al. 2020; Hazell and Timu 2024). For example, Giné et al. (2020) found that financial literacy materials increased demand for insurance, but only when a large share of farmers’ neighbors received the same information, suggesting that social networks can influence the effectiveness of financial education. Cole et al. (2013) found only a small effect of financial education on insurance uptake in India, while endorsements from trusted sources had a much stronger influence on purchasing decisions. They note improving financial literacy alone may not increase the perceived value of insurance for farmers. Existing evidence indicates that financial education is most effective when delivered over multiple days and through interactive approaches, such as games (Gaurav et al. 2011) or hypothetical scenarios that help farmers understand potential losses and insurance payouts (Clarke et al. 2016).

The role of subsidies and regulation

Subsidies have been central to agricultural insurance from its earliest iterations, and the evidence consistently shows they are necessary to bridge the gap between commercially viable pricing and what farmers are willing or able to pay. In many of the programs reviewed in this report, premium subsidies are substantial: Jensen et al. (2017) report a 40 percent subsidy for livestock index-based insurance in Kenya, Cai (2016) finds a 67 percent subsidy for indemnity crop insurance in China, and in India’s PMFBY program, premiums for staple crops are capped at 2 percent of the insured value with subsidies of 25–50 percent for commercial crops (Clarke et al. 2012). These subsidies appear essential to achieving meaningful take-up given that farmers’ willingness to pay is typically well below market prices.

There are a number of reasons why subsidizing insurance is attractive for a government. Citizens often expect governments to provide support in the case of climatic shocks that severely affect their livelihoods and income. Insurance premium subsidies can be a way to bring this contingent liability that governments face onto their budget books through a regular annual expenditure rather than making ad hoc disaster

relief. When done well it can be done in a way that complements social protection targeting and coverage (Jensen et al 2017). Secondly, it can be a way to encourage investment in agricultural production, that could be more cost-effective way than direct input subsidies. A direct comparison between the two types of support has not been made, but this would provide the needed advice on which is the best approach in a given context. Third, farmers are often a significant voting bloc, and insurance premium subsidies can be politically popular.

The way subsidies are done can help support the development of domestic insurance markets or hold them back. A critical concern running throughout the evidence is how subsidies can be designed without crowding out private sector provision or undermining farmers' incentives to reduce risk. Historical experience with early public multi-peril crop insurance programs in the 1970s provides a cautionary example: heavy government subsidization was found to encourage farmers to take excessive risks, discourage risk mitigation action, crowd out financially sustainable private insurance, and promote poor lending practices (Hazell, Pomareda, and Valdés 1986; Hazell and Valdés 1984). More recently, Hazell and Timu (2024) find that governments have sometimes inadvertently crowded out successful private models when attempting to scale them up. The risk of moral hazard — where insured farmers reduce their own efforts to prevent or mitigate losses — is particularly acute in indemnity-based schemes where payouts are directly tied to observed damage. Index-based insurance largely avoids this problem because payouts are determined by an objective index rather than by the farmer's own actions, preserving incentives for risk reduction (ISF 2022).

Hazell and Varangis (2020) set out best practices for subsidizing agricultural insurance that support private market development: they recommend channeling subsidies through private insurers rather than competing with them directly, setting subsidies at levels that support market entry without creating dependency, and phasing subsidies toward product development and distribution costs rather than ongoing premium support. Public financing towards product development and towards establishing the information systems needed to price and deliver insurance also has the benefit of not reducing incentives to reduce risk.

Beyond subsidies, regulation and quality standards could also play an important role in supporting insurance market development. Insurance is fundamentally a credence good as its value cannot be observed at time of purchase (a promise to pay in the future when certain conditions are met). As with other credence goods, standards and regulation can help build market trust by protecting both policyholders and providers from fraud, low quality insurance products and payout timeliness (Abate et al. 2021). There are few standards on insurance products, despite calls for more. There is currently too little evidence on whether and how regulation and standards improves quality and builds trust. Requiring insurance providers to publish standardized data on claim acceptance rates, processing times, and payout outcomes would be an important first step toward building the accountability mechanisms that could potentially improve trust and inform farmer decision-making. There is thus a clear role for governments not only as subsidizers of insurance but as regulators and standard-setters that create the conditions under which private markets can operate credibly and at scale.

Beyond regulations for insurance, it could also be the case that assessing regulations in the financial industry more broadly could unwittingly hold back the development of insurance markets. Regulations around the types of transactions that can be conducted over mobile money platforms can, even if not intended to, prevent insurance from being distributed through a low-cost platform. Regulations around how interest rates are set can prevent reducing interest rates for farmers that take an insured loan. Conversely, regulations that mandate that interest rates are lowered if a loan is insured or that require insurance to be taken with a loan can have a strong positive impact on the scale of the insurance market.

5. EVIDENCE GAPS

Research has identified many important lessons about agricultural insurance and innovations to improve insurance program implementation. However, as these innovations have been developed and tested, new questions and knowledge gaps have arisen.

More replication studies are needed to better understand the impacts of insurance programs across different contexts and with different shocks. The benefits of insurance need to be better estimated and compared to the full set of costs for developing and scaling insurance programs (Osgood and Shirley, 2012). More research is also needed on the role, targeting, and optimal design of insurance subsidies, particularly around their cost-effectiveness, distributional impacts, long-run sustainability, or whether—and under what conditions—they can be phased out relative to alternative uses of public funds (Kramer et al 2022, Hazell and Varangis 2020).

The direct and indirect impacts of insurance on different social groups (such as landless farmers, Mobarak and Rosenzweig, 2013, or migrants, Kazianga and Wahhaj, 2020) also remain relatively understudied.

Although product quality has improved over time, researchers should continue examining the best combinations of innovations to offer high value products to farmers, which will likely also contribute to increasing insurance demand across contexts. For instance, little is known about the potential benefits of bundling together insurance coverage for multiple risks, with the aim of providing farmers more holistic risk management instruments.

As more products are available there is a need for systematically collecting and monitoring data on product quality. In this regard, requiring insurance providers to publish details on the number and location of claims, whether they were accepted or rejected, and on the length of the loss assessment and payout processes, would be an important first step.

Cost remains a core challenge. There is a need for more data on insurance products' cost structures, including administrative costs, reinsurance costs, and uncertainty loadings. Such understanding could help devise strategies to reduce costly components of premiums and make insurance both more financially viable for insurers and more affordable for farmers.

Better understanding how to improve the reach and inclusivity of agricultural insurance is also a key evidence gap. Many vulnerable populations remain underinsured. Moreover, most insurance products are typically limited to specific client profiles, yet they could benefit excluded groups such as landless farmers or upstream actors in the value chain. Gender differences in risk preferences, uptake, and access to insurance are also promising avenues for future research. Improving the accessibility and effectiveness of insurance products for underserved groups remains an important goal.

Existing insurance programs typically focus on a limited set of weather- and yield-related shocks that are relatively easy to predict and assess. Providing protection against conflict, political disruptions, or other social risks would be far more difficult, but could yield substantial benefits. Future research could explore ways to expand insurance coverage to address these types of risks.

While studies have noted that households covered by agricultural insurance increase investment, few provide evidence of how this investment, in turn, impacts productivity and income, as noted by Rosenzweig and Udry (2020). Other outcomes, such as impacts of insurance on other risk mitigating behavior or investment are also unclear, though the little existing evidence suggests it may be small (Fuchs and Wolff, 2011). While insurance is designed to protect households from shocks, there is little evidence on the value of negative impacts averted from these shocks and how they compare to the cost of insurance. This type of analysis should also be expanded beyond farming households to understand the value of insurance for other private sector actors along food value chains. When harvests are bad, the

costs of procuring inputs increases for agro-processors and traders in a way that they cannot always offset through higher sales prices and further work on insurance for agri-MSMEs is also important. Similarly, research should seek to identify factors that influence the magnitude of these impacts and how these can be leveraged in insurance design. Finally, literature has primarily focused on ex post impacts on coping strategies, and the impacts both ex post and ex ante on investments, with little research available to point at impacts of insurance on mental health and subjective wellbeing—the primary mechanism through which insurance could improve people’s lives.

Finally, climate change is increasing the risks associated with extreme weather across food systems. While insurance can play an important role in managing climate-related risks, researchers need to assess how long-term climate trends may reshape the overall risk landscape. In some areas, climate-driven extreme weather and disasters could raise insurance costs to unsustainable levels. Foresight analysis can help assess this possibility by identifying where and to what extent risks may exceed insurable thresholds, and by informing the development of alternative risk management arrangements and targeted investments.

6. RECOMMENDATIONS

This review has focused on lessons that can be taken from the peer-reviewed evidence base on insurance in low and middle income countries that has emerged over the last ten to twenty years. On the basis of this we make a series of recommendations.

First on product design and distribution:

1. The accuracy of loss assessment is a first-order design concern, not a secondary tradeoff to be managed around cost and speed. Weather index products have been found to miss payouts on roughly a third of complete crop failures while triggering payouts in a similar share of good-harvest seasons. Farmers weigh this inaccuracy heavily in their purchase decisions, and mismatched payouts undermine the welfare protection insurance is meant to provide. As such, narrowly defined weather indices should only be used where more accurate alternatives are feasible. Area-yield indices perform much better but require expensive crop-cutting infrastructure that can be unavailable at scale. Picture-based insurance is a feasible low-cost indemnity product that can be prioritized over narrow weather indices, since the evidence shows it identifies severe losses far more reliably and produces far fewer false payouts, while still avoiding the costly in-person adjuster visits that made traditional indemnity insurance difficult to scale.
2. Where index products remain the only feasible option, given data, infrastructure, or cost constraints, they should be paired with safeguards such as conditional audits or gap-filling assessments that catch losses the index misses, and their accuracy limitations should be communicated transparently to farmers rather than treated as an acceptable cost of scale.
3. Early trigger features that pay out or signal a payout before harvest, rather than only after, add further value by allowing farmers to take mitigating action during the season rather than simply coping after the fact. Across contexts, the size of the payout matters as much as its accuracy; coverage that is too thin relative to a household's overall risk exposure appears to generate little measurable benefit.
4. Distribution strategy and inclusion should be treated as core design questions rather than afterthoughts. Bundling insurance with credit, seeds, or other inputs has proven to be one of the most effective ways to reach farmers at scale by piggybacking on existing value chains and by making the product's benefits more tangible, but bundled coverage typically protects only the value of the underlying loan or input, leaving substantial residual risk unaddressed.
5. Trust, built through local partners, farmer organizations, informal risk-sharing groups, and firsthand experience with payouts, is consistently a stronger driver of uptake than financial literacy training or price incentives alone.
6. Reaching underserved groups, including women, poorer households, and landless farmers, will likely require products and marketing deliberately designed around their specific risk profiles and constraints rather than a one-size-fits-all offering built around an average farmer.

Second, on cost and subsidies:

1. Scaling insurance sustainably requires addressing cost and affordability together. Farmers' willingness to pay is consistently well below actuarially fair prices, and price reductions alone do little to shift demand, which means subsidies will likely remain a necessary feature of these markets for the foreseeable future.

2. The evidence favors channeling subsidies through private insurers rather than displacing them, directing public funds toward product development, data infrastructure, and distribution rather than open-ended premium support. However, in general more evidence on how to supply subsidies to support market development is needed.
3. Any public subsidies should also be paired with progress on regulatory standards that build market credibility, such as published claims and payout data.
4. Attention to the timing of premium payments is equally important: allowing farmers to pay at or after harvest, rather than requiring cash upfront during the planting season, has repeatedly produced larger increases in uptake than price discounts of similar value, reflecting the binding liquidity constraints many smallholders face.

We highlight several evidence gaps that merit priority attention going forward. First and as mentioned, the role and optimal design of subsidies is underexplored: little is known about their long-run cost-effectiveness, distributional consequences, or the conditions under which they can eventually be reduced or phased out. As support to insurance increasingly moves from piloting products to scaling cases of success, more focus on this is needed.

Second, evidence on inclusion remains thin for specific groups such as landless farmers and migrants, and on whether newer innovations such as flexible or bundled multi-risk products meaningfully improve welfare rather than simply increasing uptake. Finally, most research to date focuses on weather- and yield-related shocks and on investment as an outcome; far less is known about its potential to cover harder-to-predict risks such as conflict or price shocks, or its value for agri-MSMEs and other actors along food value chains beyond the farm household.

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