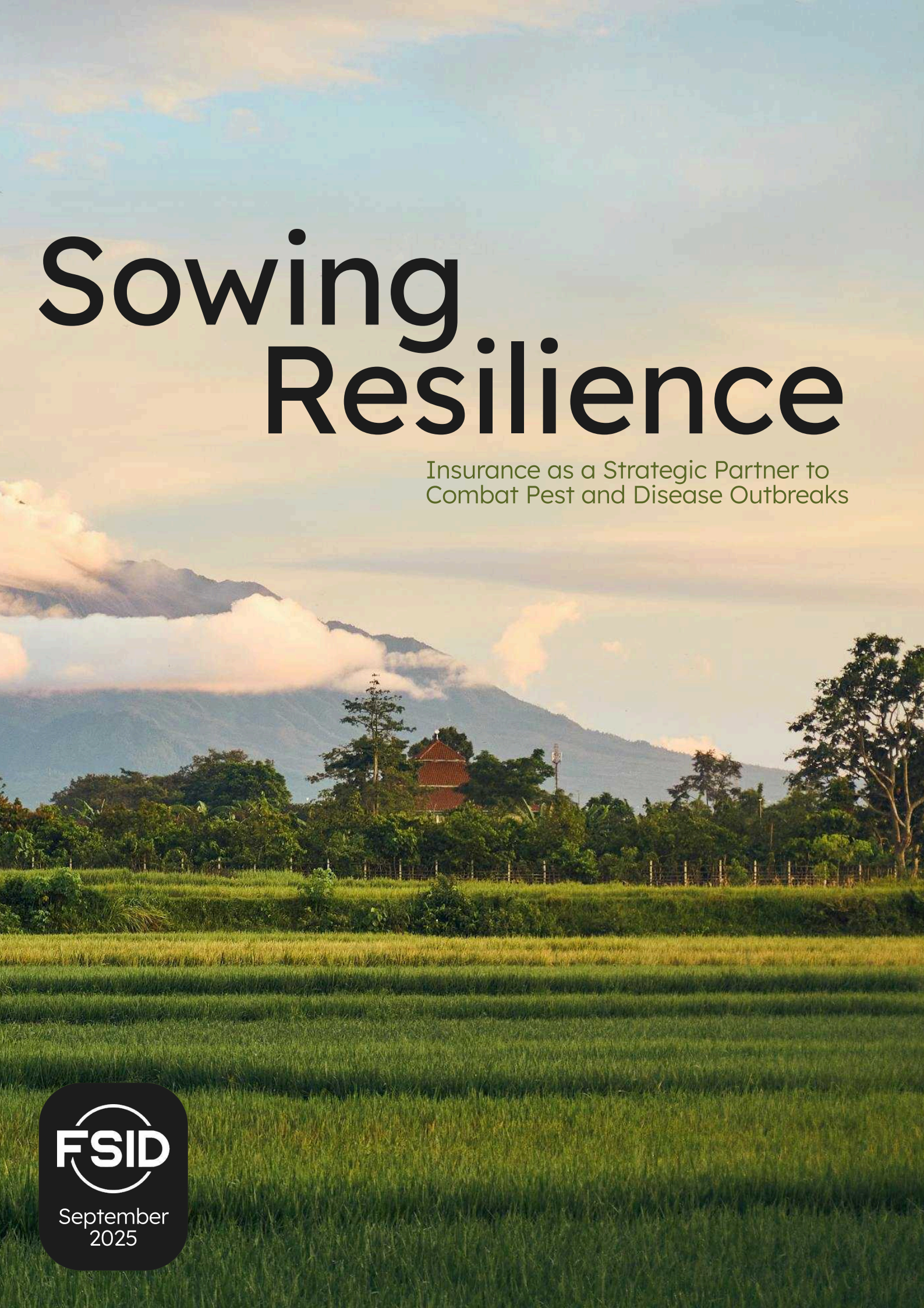
Sowing Resilience

Insurance as a Strategic Partner to Combat Pest and Disease Outbreaks



FSID

September 2025

Contents

Executive Summary

Globally, up to 40% of agricultural crops are lost to pests and diseases annually, yet insurance products covering these perils are under-represented and underutilised. Despite the significance of crops in global food systems and their vulnerability to a wide range of risks, over 60% of insurable crop production remains uninsured. While weather-related perils like drought dominate insurance payouts and innovation, pests and diseases remain largely uncovered, even in many high-income countries.

Emerging technologies now offer insurers viable solutions to long-standing challenges of covering pests and disease, such as basis risk, moral hazard, and lack of claims data. Remote sensing for early warning systems and for the measurement of disease severity can enhance existing products by reducing basis risk and improving claims attribution, while on-ground sensors and AI/ML smartphone diagnostics can extend insurance coverage into new geographies where data was previously scarce. Scenario modelling can provide underwriters and reinsurers tools to manage portfolio risk and anticipate shocks. Together, these enable the development and expansion of traditional crop insurance products into new perils.

Insurance can also play a transformative role as a strategic enabler, not just by providing compensation for losses but by empowering farmers to take preventive actions when threats emerge. Insurance can enhance coordination, incentivise anticipatory actions, and provide financial resilience against cascading impacts of outbreaks. Evidence from countries like China shows that insurance adoption can improve farmer incomes and spur investment in better farming practices.

This white paper provides a more detailed exploration of the role of insurance covering perils of pest and diseases in crops, including challenges facing the deployment and uptake of such products, and how new technologies provide opportunities for innovation.

Up to 40%
of global crops lost to pests/disease

60%
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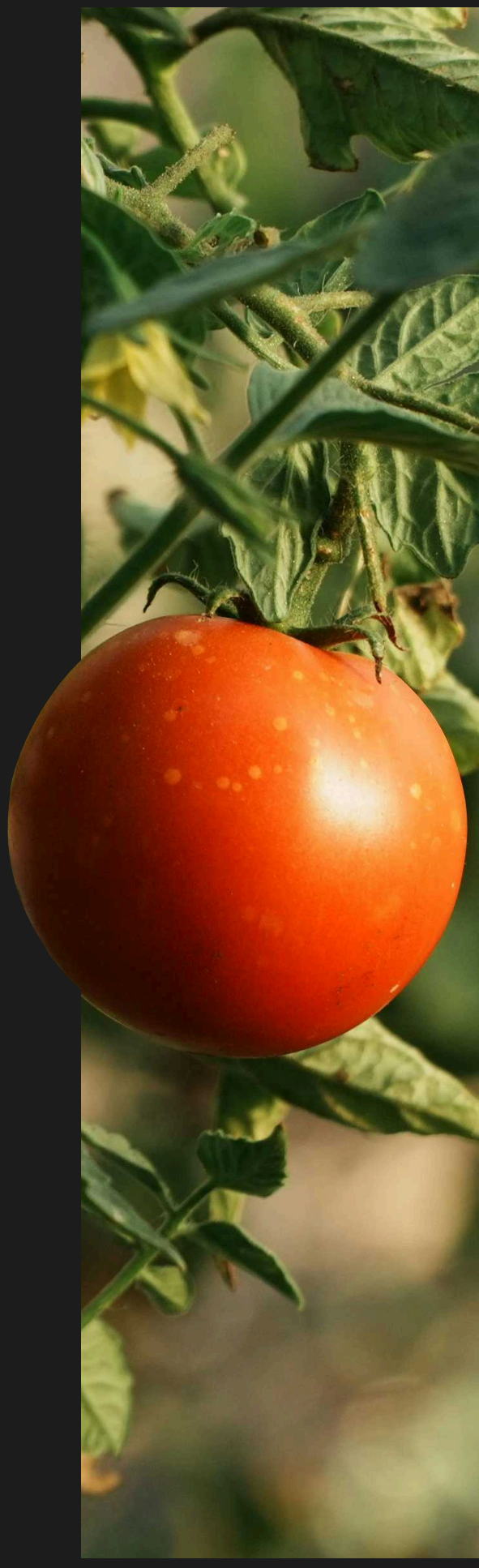
billions
in annual losses



Gaps and opportunities

The case for crop insurance of pests and disease

1. Large losses, little coverage

Agriculture supports livelihoods and economies. Its contribution to national GDP varies dramatically from nearly 20% in sub-Saharan Africa to under 1% in North America[1]. In absolute terms, gross agricultural production is concentrated in a few countries with 60% of food production being from China, US, India, Brazil, and Argentina[2] combined. Crops contribute a sizable portion of these production statistics - approximately one third of global agricultural land area (1.6B ha), or one tenth of global total land area[3] in 2022 - and half of this cropland is dedicated to just four crops (wheat, maize, rice, soybeans).

Despite the scale and importance of agriculture, insurance penetration is low with about 60% of insurable crop production being unprotected in 2022[4]. Crop insurance varies dramatically across countries with large agricultural production volumes - from over 80% of the area of crops insured in China[5] and the USA[6], to 20% in Brazil[7] or 40% in India[8].

Current insurance products predominantly focus on weather-related perils such as drought and extreme temperatures. These perils dominate losses and indemnity payouts[6], as well as significant innovation in indemnity, index-based, and hybrid products[9]. In contrast, pests and diseases of crops - responsible for up to 40% of global crop losses annually - are rarely covered.

[1] Food and Agriculture Organization Corporate Statistical Database, 'FAOSTAT', 2023, http://www.fao.org/faostat/en/#data/QC.
[2] McKinsey & Company, McKinsey on Climate Change (2020).
[3] FAO, Land Statistics 2001–2022: Global, Regional and Country Trends, FAOSTAT Analytical Briefs no. 88 (2024)
[4] Swiss Re Institute, Economic Insights. Crop Insurance: Offering a Way to Support Food Security, Issue 23/2023 (2023)
[5] Wang et al., 'Agricultural Insurance, Climate Change, and Food Security: Evidence from Chinese Farmers', Sustainability 14, no. 15 (2022)
[6] USDA, 'Risk Management - Crop Insurance at a Glance'.
[7] Souza et al., 'Risk Management in Brazilian Agriculture: Instruments, Public Policy, and Perspectives' Climate Policy Initiative (2020)
[8] Swiss Re, Crop Insurance – Pricing Aspects & Pool as a Risk Sharing Mechanism, n.d., (accessed 25 June 2025)
[9] Nguyen et al., 'Satellite-based data for agricultural index insurance: a systematic quantitative literature review', Nat. Hazards Earth Syst. Sci., 25, 913–927 (2025)

Despite their magnitude, pests and diseases present challenges for crop insurers:

- basis risk[10] (when a payout does not match actual losses),
- moral hazard[11] (when insured farmers take fewer preventive measures),
- lack of historical claims data (insufficient data to support reliable pricing)
- standardised recording of data (inconsistent or fragmented outbreak data)
- unpredictability and volatility (outbreaks are often sudden and widespread)
- attribution difficulties (costly verification of losses)
- perceived lack of demand/need (some pests and diseases are localized, low severity, or managed through other means)

These obstacles have impeded product development, leaving most losses from pests and diseases absorbed by farmers and governments, with significant consequences for economic stability and food security.

However, emerging technologies are shifting this landscape. Satellite-based Earth Observation, AI/ML smartphone diagnostics, ground sensors for fungal pathogens, and outbreak modelling platforms now make it possible to monitor pest and disease dynamics in real time, reconstruct historical patterns, and attribute losses to these perils more accurately. These tools directly address the long-standing hurdles mentioned above.

For the insurance sector, this opens three major avenues:

- Expand existing products by adding coverage of pests and disease,
- Enter new markets where lack of data has previously prevented product development, such as high-growth agricultural regions of the Global South.
- Offer value-added services such as early warning systems, and outbreak coordination platforms that improve risk management and customer retention.

Ultimately, covering pests and diseases is an insurance growth opportunity. By leveraging these new technologies and risk management tools, insurers and reinsurers can access underserved premium pools, extend their geographical reach, and strengthen their role as enablers of global food security.

[10] Carter et al., 'Where and How Index Insurance Can Boost the Adoption of Improved Agricultural Technologies', Journal of Development Economics, 118, 59–71 (2016)
[11] Carter et al., 'Index-Based Weather Insurance for Developing Countries: A Review of Evidence and a Set of Propositions for up-Scaling', Revue d'Economie Du Developpement 23, 5–57 (2015)

2. Technological solutions to close critical gaps

Covering pests and diseases with crop insurance has long posed technical and operational challenges. Five key issues have made insurers hesitant to include biotic perils in their products and prevented more widespread adoption of crop insurance for pests and disease:

- basis risk[12,13], (when a payout does not match actual losses)
- adverse selection[14] (when only high-risk farmers opt in)
- moral hazard[15] (when insured farmers take fewer preventive measures),
- lack of historical claims data and
- standardised recording of data

Emerging technologies now offer pathways to tackle these issues by reducing uncertainty, improving risk quantification, automation of claim validation, and providing mechanisms for data collection, enabling more accurate and responsive insurance models across these under-represented perils.

For index-based products, the use of remote sensing - including data from multi-spectral satellites and drone - can detect indicators of plant stress that often correspond with early-stage disease outbreaks[16]. These have been deployed as weather-related indices but could also be deployed as indices for pests and diseases. Beyond fully remote approaches, just as weather stations provide triggers for drought or rainfall insurance, plant health sensors or aerial imaging can serve as proxies for disease presence, particularly when changes in vegetative indices, such as the Normalised Difference Vegetation Index (NDVI), are observed over time[17]. In some cases, environmental sensors that detect airborne fungal spores offer additional data layers for monitoring the conditions that precede biological outbreaks, improving the correlation of indices with disease-related losses.

[12] Carter et al., 'Where and How Index Insurance Can Boost the Adoption of Improved Agricultural Technologies', Journal of Development Economics, 118, 59–71 (2016)
[13] Carter et al., 'Index-Based Weather Insurance for Developing Countries: A Review of Evidence and a Set of Propositions for up-Scaling', Revue d'Economie Du Developpement 23, 5–57 (2015)
[14] Mario et al., 'Index Insurance for Developing Countries', Applied Economic Perspectives and Policy 34 (3) 391–427 (2012)
[15] World Bank, 'Weather Index Insurance for Agriculture: Guidance for Development Practitioners'. Agriculture and Rural Development Discussion Paper 50 (2011)
[16] Terentev et al., 'Current State of Hyperspectral Remote Sensing for Early Plant Disease Detection: A Review', Sensors 22 (3) (2022)
[17] Cheng et al., 'Change Detection Methods for Remote Sensing in the Last Decade: A Comprehensive Review', Remote Sensing 16 (13) (2024)

For indemnity products, AI/ML and mobile technologies are opening doors for on-the-ground diagnostics. AI-driven smartphone apps using computer vision can now identify plant diseases with growing accuracy[18], giving farmers tools to verify disease presence. These are supported by traditional diagnostic methods, including field sampling and lab testing, which remain crucial for confirming outbreaks of specific pests or pathogens. When combined with high-resolution geotagging, these tools allow insurers to implement targeted, evidence-based payouts while minimising misreporting and reducing the cost of in-person assessments.

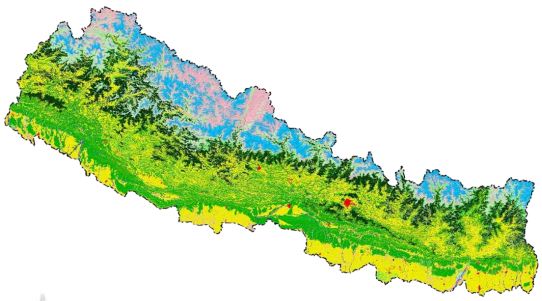
Hybrid products, which combine both index-based and traditional indemnity-based approaches, offer perhaps the most promising way forward. These systems can use satellite or drone-based data and AI/ML-powered change detection algorithms to flag potential outbreak zones, which then trigger deployment of diagnostic teams to confirm the presence of pests or disease. This is particularly promising for pests and diseases that have a strong phenotypic signature and that can be measured using either UAV, light or SAR - such as black Sigatoka[19] or banana bunchy top virus[20] in bananas and plantain. This tiered verification model balances the scalability of index-based systems with the precision of indemnity assessments. It also allows insurers to streamline their operations by focusing diagnostic resources only where anomalies have been detected - reducing cost, increasing trust, and improving overall product viability. While these products require higher assessment costs these typically have a lower loss ratio and result in higher satisfaction of policyholders.

Without standardised recording of losses and accurate elucidation of the cause of pest and disease outbreaks, including the apportioning of impacts from pests/disease and those of other perils, it is difficult for insurers to price premiums fairly and transparently or forecast payouts - actuarial pricing is often based upon historical claims data. Standardisation of data is essential for any coordinated response, especially where such coordination is needed across administrative boundaries. Beyond being a diagnostic tool, these AI/ML technologies can be viewed as filling these data gaps, aid in reporting standardisation, and providing an opportunity to validate risk models of perils of pests and disease.

[18] Jafar et al., 'Revolutionizing Agriculture with Artificial Intelligence: Plant Disease Detection Methods, Applications, and Their Limitations', Frontiers in Plant Science, 15-2024 (2024)
[19] Fajardo et al., 'Early Detection of Black Sigatoka in Banana Leaves Using Hyperspectral Images', Applications in Plant Sciences, 8 (8) e11383 (2020)
[20] Alabi et al., 'Banana Mapping in Heterogenous Smallholder Farming Systems Using High-Resolution Remote Sensing Imagery and Machine Learning Models with Implications for Banana Bunchy Top Disease Surveillance', Remote Sensing, 14 (20) (2022); Selvaraj et al., 'Detection of Banana Plants and Their Major Diseases through Aerial Images and Machine Learning Methods: A Case Study in DR Congo and Republic of Benin', ISPRS Journal of Photogrammetry and Remote Sensing, 169 110–24 (2020)

Data from multi-spectral satellites can detect signals of plant stress that often correspond with early-stage disease outbreaks.

Much of the generated data needed for deployment of index-based or hybrid insurance products, such as weather-based or soil-based landcover maps, could be a value-add for policyholders if provided in a platform for policyholders. For instance, Swiss Re has offered Opti-Crop[21] as a weather monitoring platform for customers. In many countries, even those with a high reliance on agriculture, the penetration of insurance is low - in Nepal, for instance, where agriculture contributes over 20% to national GDP, agricultural insurance covers only about 1%[22] of smallholder farmers. Providing data back to customers offers an approach to improving insurance penetration and customer retention.



Land cover map of Nepal

[21] Swiss Re, 'Opti-Crop', 2025, https://swissre-a1b1zg0.opti-crop.com/map/precipitation.
[22] Devkota et al., 'Determinants of Livestock Insurance Adoption in Nepal', Cogent Food & Agriculture, 7 (1) (2021)
Image: Nepal land cover map of 2010, by Uddinkabir, July 23, 2015, Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Land_cover_map_of_Nepal_using_Landsat_30_m_(2010)_data.jpg, CC BY-SA 4.0.

3. Insurance as a strategic partner

Effective management of crop pests and diseases not only requires technical but also financial solutions. Farmers often face the barrier of lacking the funds needed to act early when a threat emerges - whether that means purchasing fungicides, roguing infected plants, or implementing biosecurity measures. Without the financial means to take these prudent actions, even the most knowledgeable and well-trained farmers may be forced into inaction (or suboptimal action), allowing small problems to become widespread outbreaks. Insurance, when designed to cover pests and diseases, can provide the necessary liquidity at the right time to enable these crucial interventions.

Acting early is not just good practice - it is essential for reducing the large scale spread and severity of pest and disease outbreaks. Proactive measures can dramatically reduce the eventual scale of losses. These actions, however, often require upfront investment or carry risk themselves. Insurance coverage tied to biological risks can help farmers afford and justify these pre-emptive actions, thereby serving as a built-in incentive for more resilient and responsible farming practices. In the case of novel pathogens, strategically placed surveillance across a region can form an effective early warning system and lead to a speedy response.

Beyond just short-term emergency response, insurance also plays a longer-term role in building farmers' financial resilience. A reliable safety net allows them to absorb shocks, diversify income, and invest in more sustainable practices. In the context of pests and diseases, this financial buffer is a missing piece of effective management. Without it, even farmers who take preventive action remain exposed to financial ruin if an outbreak strikes. This resilience will be increasingly important as climate-induced volatility tests farmers.

Insurance works. Evidence from global experience supports the potential of insurance to improve farmer outcomes. For instance, studies from China show that farmers who adopted agricultural insurance not only saw improved income stability, but were also more likely to invest in higher-quality inputs and adopt risk-reducing technologies[23]. This underscores the role of insurance not simply as a payout mechanism after losses, but as an essential partner in driving smarter, more sustainable decisions before those losses occur.

Smallholders are a large portion of global agricultural production. Globally, smallholders generate 40% of total calorie production and over 50% of the calories humans consume[24]. Within Africa, this is much higher at approximately 70-90%. Without instruments for risk mitigation, smallholders are highly susceptible to pest and disease outbreaks in crops. Smallholders represent another front where insurance products can contribute to stability in production via rapid access to credit, reduction in food security, or as an avenue for education of best practice in agriculture.

Many smallholders cannot afford insurance premiums, particularly for multi-peril crop insurance which may have higher premiums, without assistance from government subsidies - a persistent barrier to market expansion. Recent initiatives, led by charities such as Humanity Insured, have been tackling this obstacle by sourcing funding to subsidise premiums.

In smallholder contexts there is evidence that farmers are unaware of agricultural insurance. For instance, in a survey of smallholder farmers in Ghana, where 14% had ever used an agricultural insurance product, 65% of respondents were unaware of the insurance products[25]. Similarly, low awareness in smallholders in Nepal impacted livestock insurance uptake[26].

50%

of the food humans consume comes from smallholder farms

70-90%

of Africa's calories come from smallholder production

65%

of smallholder farmers in Ghana are unaware of crop insurance

[23] Li et al., 'Does Crop Insurance Increase Farmers' Income? Evidence from the Pilot Program of Agricultural Catastrophe Insurance in China', Economic Analysis and Policy, 86 1002–19 (2025)
[24] Ren et al., 'Trade-Offs in Agricultural Outcomes across Farm Sizes', Earth Critical Zone, 1 (1) 100007 (2024)
[25] Ankrah et al., 'Agricultural Insurance Access and Acceptability: Examining the Case of Smallholder Farmers in Ghana', Agriculture & Food Security 10, (1) (2021)
[26] Devkota et al., 'Determinants of Livestock Insurance Adoption in Nepal', Cogent Food & Agriculture, 7 (1) (2021)

Effective and sustained responses to pests and diseases in crops rely heavily on coordination and cooperation - across actions, surveillance systems, and data sharing mechanisms. Outbreaks do not respect farm boundaries or administrative lines, and without synchronized interventions, surveillance, and communication, efforts in one area can be quickly undone by inaction in another. Insurance can serve as a powerful enabler of this coordination. Well-designed insurance mechanisms, particularly those addressing catastrophic biological events, can include stipulations that incentivise or require risk-reducing measures - such as participation in monitoring networks, data sharing agreements, or adherence to containment protocols. Tying coverage or payouts to coordinated action and shared data, insurance provides a structured, scalable incentive for governments and farmers to act collectively and the financial resources to do so. Without this alignment, the unpredictability of outbreak re-emergence remains high. Insurance thus can be more than a financial safety net - an organising force that helps ensure consistent, cooperative responses across fragmented agricultural landscapes. Furthermore, recognition of insurance as a force for coordinated action against pest and disease outbreaks can increase customer demand.

4. Future trends

Global food demand is projected to increase by approximately 35-56% by 2050, driven in large part by increasing population and diet trends in the developing world. A range of broad trends are expected in the coming decades that are relevant to crop production and agricultural risk management that will impact frequency and severity of pest and disease outbreaks.

Climate change

Climate change is expected to have a range of varied impacts on crop production. Most importantly, an expected increase in the frequency of extreme weather events[27] is likely to increase volatility of yields. Higher volatility of yields may lead to higher volatility in prices to growers and consumers[28], making planning more difficult for supply chains and placing further strain on the ability to prevent and manage outbreaks of pests and disease.

The impacts of climate change on pests and disease are complex and dependent on the ecology of the pathogen and their host[29,30].

Interactions between pests and diseases and weather-related events are summarised in table 4. Some of the strongest evidence for climate change impacting invasive species is that of range expansion of terrestrial arthropods[31] - such as aphids, beetles, and caterpillars - many of which are amongst the most damaging pests to crops worldwide and feed on multiple crops. These threats may necessitate more involved biosecurity measures and biological pest control methods. Environmental suitability modelling can help inform where pest ranges may adapt, guiding new directions for insurance products.

Weather-related peril	Example interaction with plant pests/ disease
Drought	- Impact depends on how the pest affects/ feeds on the plant[32] - Drought generally increases damage from fungi and insects[33]
Excessive rainfall	- High humidity can increase the virulence of fungal diseases[34] - Impacts are varied depending on how pest damages the plant[35]

Table 4: Impacts of pest and disease from extreme weather events.

[27] IPCC, 'Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems' (2019)
[28] McKinsey & Company, McKinsey on Climate Change (2020).
[29] FAO on behalf of IPPC Secretariat, 'Scientific Review of the Impact of Climate Change on Plant Pests – A Global Challenge to Prevent and Mitigate Plant Pest Risks in Agriculture, Forestry and Ecosystems' (2021)
[30] Skendžić et al., 'The Impact of Climate Change on Agricultural Insect Pests', Insects, 12, (5) (2021)
[31] Hulme, 'Climate Change and Biological Invasions: Evidence, Expectations, and Response Options', Biological Reviews, 92 (3) 1297–313 (2017)
[32] Schneider et al., 'The effect of climate change on invasive crop pests across biomes', Current Opinion in Insect Science, 50, 100895 (2022)
[33] Gely et al., 'How Do Herbivorous Insects Respond to Drought Stress in Trees?', Biological Reviews, 95 (2) 434–48 (2020)
[34] Velásquez et al., 'Plant–Pathogen Warfare under Changing Climate Conditions', Current Biology, 28 (10) R619–34 (2018)
[35] Kim et al., 'Mechanisms and Modelling Approaches for Excessive Rainfall Stress on Cereals: Waterlogging, Submergence, Lodging, Pests and Diseases', Agricultural and Forest Meteorology, 344, 109819 (2024)

Introductions via trade

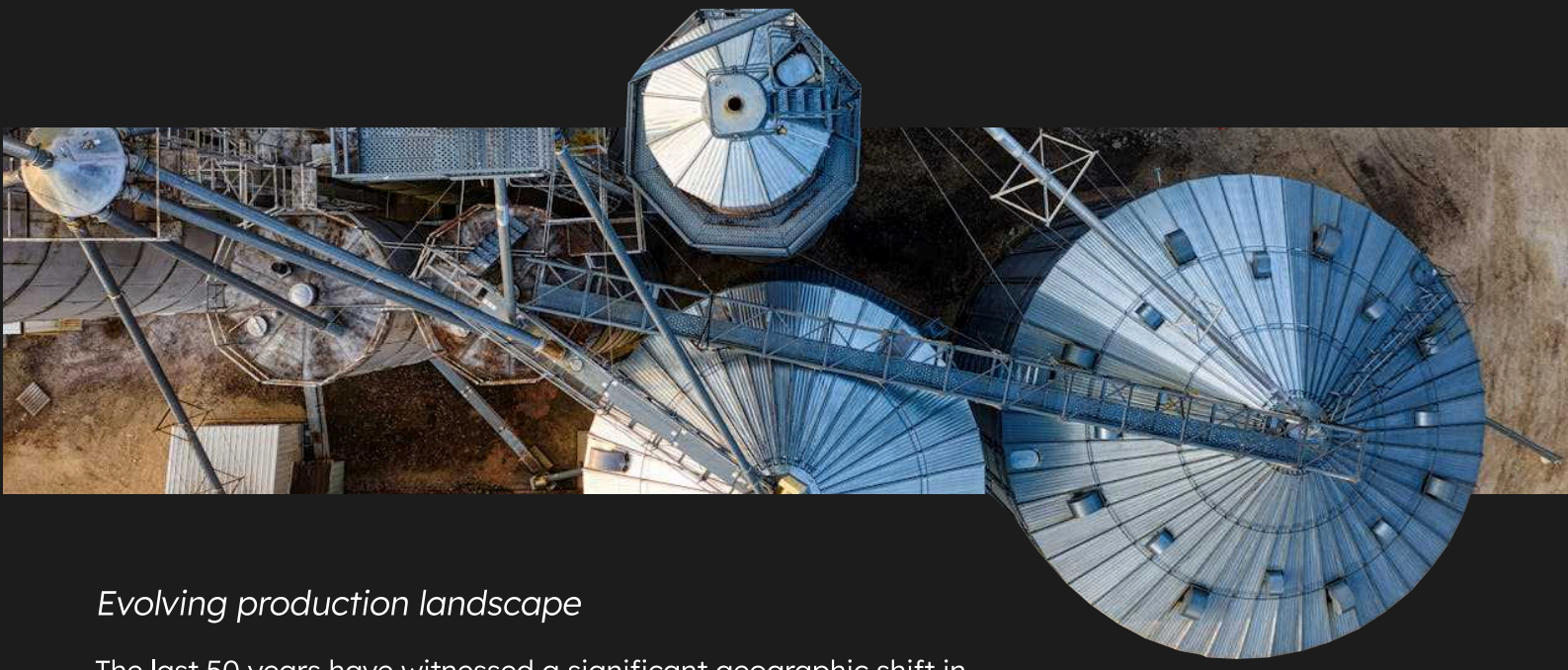
The risk of introduction of a new invasive alien species by humans, including insects, is expected to have an increasing trend on every continent except North America and shows no signs of saturation[36]. These increases have continued despite stronger and more frequent policy responses to limit the spread[37].

Invasive alien species have previously capitalised upon dispersal via human-mediated trade routes and can cause sudden and severe damage to crops. Traditional crop insurance models may be inadequate in this evolving landscape and multi-peril crop insurance - covering a wider range of threats including pests, diseases, and other biological shocks - may become more sought after.

Shifting demographics of farms

The agricultural workforce is undergoing a demographic shift, with aging farmers becoming a global concern[38]. In many countries, especially in the Global North, the average age of farmers continues to rise. These changes will likely push innovation in automation and remote sensing to maintain production levels amid shrinking labor pools

Trends indicate a consolidation of holdings, with the number of farms declining and the average farm size increasing[39]. These are reflected in country-level statistics, such as Argentina[40]. This shift is largely driven by economic pressures as larger farms often benefit from efficiencies in input use, access to capital, and technology adoption.



Evolving production landscape

The last 50 years have witnessed a significant geographic shift in agricultural production, with more land under harvested in the Global South than in the Global North[41]. This shift indicates an evolving global production system where the share of production responsibility from Global North is with countries in Latin America, sub-Saharan Africa, and Southeast Asia. This trend is expected to continue, amplifying the importance of risk mitigation strategies and instruments for production stability in the Global South.

[36] Li et al., 'Managing the Risk of Biological Invasions', iScience, 26 (11) 108221 (2023); Seebens et al., 'No Saturation in the Accumulation of Alien Species Worldwide', Nature Communications, 8 (1) 14435 (2017)
[37] McGeoch et al., 'Global Indicators of Biological Invasion: Species Numbers, Biodiversity Impact and Policy Responses, Diversity and Distributions', 16 (1) 95–108 (2010)
[38] Liu et al., 'The Aging of Farmers and Its Challenges for Labor-Intensive Agriculture in China: A Perspective on Farmland Transfer Plans for Farmers' Retirement', Journal of Rural Studies, 100, 103013 (2023)
[39] Erenstein et al., 'Farms Worldwide: 2020 and 2030 Outlook', Outlook on Agriculture, 50 (3) 221–29 (2021)
[40] World Bank, Argentina Agricultural Sector Review. Working paper on 'The performance of Argentina's agri-food sector', Washington, D.C. (2023)
[41] Economic Research Service, USDA, 'Global Changes in Agricultural Production, Productivity, and Resource Use Over Six Decades', (2024)

Potential products

This section bridges theory and practice, offering concrete illustrations of how the topics discussed in this paper could play out in the real-world.

Potential products

1. Cover of pathogens with index-based products

Index-based insurance products represent a promising avenue for managing the risks associated with plant pests and diseases, particularly in agricultural systems where traditional indemnity-based insurance is difficult to implement. Unlike conventional insurance, which relies on in-field loss assessments, index products (sometimes called parametric products) pay out based on the occurrence of predefined triggers - such as specific weather thresholds - making them faster, more scalable, and potentially less expensive to administer. This makes them well-suited for addressing crop losses from plant pathogens, whose occurrence and severity are often tightly linked to environmental factors.

These products are especially valuable in smallholder farming contexts, where large numbers of dispersed policyholders make on-the-ground loss verification logistically and economically challenging. By using objective, remotely sensed, or meteorological data, index products can offer a practical alternative that ensures rapid payouts and reduced administrative burdens. In areas with limited insurance penetration and high vulnerability to crop disease outbreaks, such mechanisms can enhance resilience and reduce economic shocks at scale.

A logical entry point for developing these products is in diseases whose epidemiology is closely tied to weather. Many plant pathogens - particularly fungal diseases - have well-established links to factors like humidity, leaf wetness, and extreme rainfall. For example, Late Blight in potatoes, a disease driven by weather conditions, has already been covered using a weather-index insurance product in India[42]. This provides a strong precedent for the development of similar products for other fungal pathogens. Sensor stations that detect fungal spores in the air offer further data avenues for constructing index-products, analogous to how weather stations are used in weather-based index products.

Other candidate pathogens for index-based insurance models include Fusarium Wilt in bananas and Coffee Leaf Rust, both of which are influenced by environmental conditions. By aligning index triggers with known disease risk factors - such as rainfall intensity, relative humidity, or soil moisture- it is possible to design tailored insurance products that offer meaningful protection to farmers. Continued improvements in Earth Observation data and disease modelling make it increasingly feasible to detect diseases using satellite data, which has significant potential to enable the design of accurate, transparent, and effective index-based insurance tools to mitigate pest and disease risks in agriculture.

[42] Clarke et al., Weather-based crop insurance in India. WPS 5985, Policy Research Working Paper (World Bank, 2012)
Image: Coffee leaf rust (Hemileia vastatrix), photograph by Smartse, July 15, 2011, Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Hemileia_vastatrix_-_coffee_leaf_rust.jpg, CC BY-SA 3.0.

2. Claims assessments of outbreaks using remote sensing

Claims assessment in indemnity-based agricultural insurance products is often one of the most costly and time-consuming stages of the insurance process. In cases involving widespread outbreaks or remote farming regions, deploying field teams for verification can be logistically challenging and economically inefficient. As a result, the sector has increasingly explored the use of remote sensing for automated claims assessment across a range of perils - including drought, flood, and now, pests and diseases.

Recent advances in AI and machine learning have made it possible to classify disease-related stress in crops using Earth observation (EO) data. These tools can detect phenotypic signatures associated with specific pathogens, enabling insurers to automate or assist in claims validation. This approach is particularly promising for diseases that manifest with clear and distinguishable signals in spectral, thermal, or radar data. Examples include the detection of Xylella fastidiosa in olive trees in Italy[43], Yellow Rust in wheat in China[44], and bacterial leaf blight in rice in Indonesia[45] - many achieved using freely available satellite imagery.

These developments mark another major innovation in the application of Earth observation to plant health monitoring, particularly for the peril of pest and disease outbreaks. By reducing the cost and complexity of claims assessment, such technologies have the potential to make insurance products more accessible and scalable - especially in regions with large numbers of smallholders. As EO capabilities continue to expand and algorithms become more precise, remote claims verification for biotic threats is set to become an increasingly powerful tool in the insurance industry's arsenal.

[43] Zarco-Tejada et al., 'Previsual Symptoms of Xylella Fastidiosa Infection Revealed in Spectral Plant-Trait Alterations', Nature Plants 4, no. 7 (2018): 432–39
[44] Zheng et al., 'New Spectral Index for Detecting Wheat Yellow Rust Using Sentinel-2 Multispectral Imagery', Sensors 18, no. 3 (2018)
[45] Caasi, OC et al., 'The Potential of Using Sentinel-2 Satellite Imagery in Assessing Bacterial Blight on Rice in West Java, Indonesia', Journal of ISSAAS, 26 (1) (2020): 1–16

3. Coupling early warning systems and financial assistance to mitigate outbreak risks of pests or pathogens

With recent advances in Earth observation, artificial intelligence, machine learning, and geospatial modelling, it is possible to detect anomalies in vegetation and attribute those anomalies to likely causes, such as abiotic stress like weather extremes, or biotic threats like pests and pathogens. These approaches have huge potential to address the critical challenge of early detection of outbreaks, which is key to enabling early intervention and preventing the situation from getting out of hand.

In cases where the origin of an anomaly is unclear, these tools can guide strategic deployment of surveillance resources. By highlighting specific locations where unusual patterns occur, they help target field teams to investigate more efficiently and cost-effectively. Ground truth data collected from these inspections can then be used to improve and refine the classification accuracy of future EO-based anomalies, strengthening the system's reliability over time. This iterative feedback loop enhances the ability to distinguish between different stressors at landscape scale, improving both early detection and response.

When combined with scenario modelling tools that simulate pest or pathogen spread under varying environmental conditions and intervention strategies, such systems can form the basis for anticipatory action frameworks. For example, in the case of novel outbreaks like Banana Bunchy Top Disease (BBTD) in a country with large banana exports, such as Ecuador, these technologies can enable rapid response and containment before the disease reaches epidemic scale. For insurers, integrating these capabilities into risk monitoring platforms not only improves their, and their policyholder's, understanding of emerging threats and proactive responsiveness but also opens the door for innovative insurance products that can provide rapid financing of surveillance and anticipatory action before pathogen expansion.

Image: Orbiting Carbon Observatory-2 artist rendering, NASA/JPL-Caltech, 2014, NASA Jet Propulsion Laboratory, http://www.jpl.nasa.gov/spaceimages/details.php?id=PIA18374, Public Domain.

Sowing Resilience Together

Pest and disease outbreaks pose persistent risks to agriculture and food security. Insurance has the potential to act not only as a financial safety net but as a strategic partner in prevention, preparedness, and response. By aligning financial instruments with scientific innovation, stakeholders can reduce losses, enable anticipatory action, and strengthen resilience across agricultural and environmental systems.

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FSID's mission is to prevent losses caused by pests and disease by harnessing next-generation tools that empower people to make smarter, faster decisions. We create AI/ML-powered tools that forecast, monitor, and mitigate the impacts of pests and diseases on crops, forests, and ecosystems. Our solutions are not only scientifically robust but practical and impactful, providing end-to-end solutions for early detection, risk assessment, and data-driven strategies to predict and manage outbreaks.

Suggested citation: FSID (2025) *Sowing Resilience: Insurance as a Strategic Partner to Combat Pest and Disease Outbreaks.* London, UK.