DISASTER RISK FINANCING & INSURANCE TECHNICAL NOTE

Agricultural Data and Insurance

Innovations in agricultural data development for insurance

Highlights

- Robust agricultural data is critical for sustainable agricultural insurance programs.
- For agriculture insurance in low or middle income countries coordinated investments in agriculture data with access rights may be the best solution.
- Combining yield, weather, and satellite data in sensible ways can lead to higher quality, more cost-effective products than just using one type of data.
- Data sources are continually improving with technology advancements and the addressing of operational challenges. Agriculture insurance programs need to be responsive to these innovations.

Background

Insurance requires high quality data. From an insurance perspective data is high quality if it is timely (so that claims can be paid quickly), relevant (so the product offers reliable protection), audited to international reinsurance standards, and cost-effective. High quality data forms the basis for high quality insurance solutions for vulnerable people, firms, and governments. Without such data, insurance markets are unlikely to develop in a sustainable manner.

Insurance products for low-income farmers or herders are usually built on indices that use agricultural or climatic data. Farm-level multiple peril crop insurance (MPCI) is generally not feasible for small farmers and herders, as the low sums insured and high cost of auditing data make the schemes uneconomic. By contrast, while index insurance is typically cheaper to deliver, the quality of the protection that index insurance offers depends significantly on the quality of the index, which in turn depends on the quality of the underlying data. Only if the index reflects agriculture conditions experienced by the farmer is it likely to provide cost-effective, reliable protection with low basis risk[1].

Insurance can be one component of a comprehensive risk management strategy. Farming and herding is very risky, particularly in developing countries, and a comprehensive risk management strategy can help protect livelihoods and support productivity. Beyond insurance, insurable data can be used to put a cost on risk which can inform agricultural policy decisions and guide investments in risk mitigation.

The Challenge

Governments have important roles to play in establishing a framework for data collection, auditing, financing and management. Given that data for agriculture insurance is expensive and non-rivalrous[2], it is likely to be natural monopoly in most low or middle income countries. It does not make economic sense for every insurance company to set up their own weather stations in the same area to capture the same data. Instead, coordinated investments in weather stations, where the data is available on standard, reasonable terms to all insurance providers ensures that the monopoly in insurable data is neither market-distorting nor exploitative. In return for gathering the data, for example, the provider could charge a fee for products which use their data. This is how the Motor Third Party Liability database operates in Turkey. The data is collected and stored in TRAMER, a centralized data system, which is managed by an executive committee consisting of both public and private sector institutions. The data is used by multiple public and private sector organizations and is funded through fees paid by the users of the data.

[1] Basis risk is the risk that an indexed claim payment does not fully reflect the loss incurred by the farmer or herder. For example a weather index insurance policy might not pay if the weather at the contractual weather station is good, even if an insured farmers has suffered a catastrophic loss due to pestilence, disease, localized weather, etc. If basis risk is low then the product will offer reliable protection. If it is high protection will be unreliable.

[2] Non-rivalrous goods may be consumed by many at the same time at no additional cost (e.g., national defense or a piece of scientific knowledge).

A strong audit function for the collected agricultural data is necessary to access international reinsurance markets. Agricultural shocks are covariate in nature and access to international reinsurance markets is important to off-load some of this risk outside the country. However, reinsurance companies have high standards for the data they are willing to use to develop and price insurance products, and will charge significantly higher premiums if they have concerns about how the data is audited. Therefore, it is important that agriculture data is audited through a transparent process (Box 1).

Box 1. Improving the quality of yield data in India

For the past eight years, the World Bank has been providing technical assistance to improve the National Agriculture Insurance Scheme in India (NAIS), which provides agriculture insurance coverage for nearly 30 million farming households. A key challenge was a lack of standardization, trained personnel, and monitoring for crop cutting experiments (CCEs)[3] which exposed the NAIS to significant delays, basis risk, and the risk of manipulation.

To address these challenges, a pilot was undertaken where CCEs were video recorded with GPS-tagged footage using mobile phones. The data was then provided to insurance companies by SMS at the time of the CCE to allow real-time monitoring. This innovative use of technology greatly improves the quality of data collected, and thus the trust of (re)insurers.

It is also an example of how the speed of data collection can be significantly improved through using developments in technology. Whereas before insurance companies could experience three-month delays in receiving the data under the paper based CCE reporting system, under the new model the data could be made available to insurance companies far quicker (potentially on the day the CCE is conducted through SMS), which would enable them to disburse claim payments sooner, ultimately benefiting effected farmers.

Insurable agricultural data can be useful for other purposes, and any such investments should be designed to maximize potential spillovers. High quality agricultural data can serve numerous functions for the government as well as the private sector. It can help target subsidies such as water, fertilizer or seeds to areas that will benefit most. It can be used in developing cropping patterns for farmers to increase yields. It can also be used to select areas to focus expansion (or implementation) of irrigation programs. Moreover, sound agricultural data has been seen to crowd in good mitigation techniques by putting a price on risk, encouraging farmers to switch to lower risk crops that are cheaper to insure. This was observed through the World Bank project with the Government of India (GoI). Initially under the National Agriculture Insurance Scheme in India (NAIS), a cap of 3% was applied to premiums charged regardless of the risk. High subsidies leading to under-priced insurance may have contributed to the production of crops (for example groundnut in the state of Gujarat) in areas where crop yield risk was historically very high. Through an enhanced new scheme which offers premiums that are much closer to risk-based premiums, farmers are incentivized to grow other, more economically viable crops.

The reliability with which an index captures major agricultural shocks is most important for poorer, more vulnerable farmers. As they are the least equipped to cope with basis risk they have the most to gain from more reliable protection. Coordinated investments in the right type of data is a necessary precondition of agricultural insurance that serves vulnerable farmers.

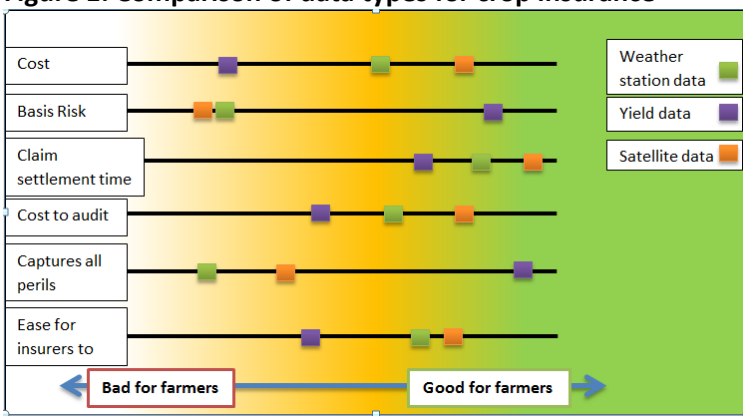
Options for insurable agricultural data

For example, there are three key types of data typically used for crop insurance: weather station, yield and satellite data. These data types can be compared against several key metrics (Figure 1)[4].

[3] A crop cutting experiment involves a trained individual visiting a designated farm, harvesting an area (for example, a 5x5 meter square) for a designated crop, waiting for the produce to dry, and then weighing it. Sample-based area yield indices are typically calculated as the average yield from a series of CCEs of randomly selected (using statistical methods) plots of land in the area the index is designed to cover.

[4] Note these are indicative representations developed using expert opinion meant for illustrative purposes.

Figure 1. Comparison of data types for crop insurance



Source: World Bank (2013)

While the most expensive to collect and audit, yield data typically offers the lowest basis risk among the three types of agricultural data considered. Indices based on yield data (see box) typically provide the most comprehensive cover to farmers, capturing perils which other data sources cannot (for example pests and disease). However, yield data can be much more expensive to collect and audit due to the farm visits required, and as traditionally implemented has often led to long claim settlement time.

Insurance products based solely on weather or remote sensing indices can be less costly than products which require yield data. In recent years there has been a lot of interest in pure weather index-based insurance (WII) or pure remote sensing index insurance (RSII) products to provide low cost insurance coverage for rural farmers and herders.

However, there is a growing body of statistical evidence that suggests that basis risk for WII and RSII can be too high for the product to reliably protect farmers and herders. Basis risk means that an insured farmer could experience an event that destroys their crop yet the insurance does not pay. This may not be a big concern if the probability of this happening is very low but it can be a real concern, significantly reducing the client value of the product, if the probability is too high. Whilst there is still a need for further research the current evidence suggests that basis risk can be high for pure WII or pure RSII. For example, recent joint research by the World Bank and the Agricultural Insurance Company of India found that across one Indian state the correlation between weather indexed claim payments and farmer yield losses was only 14%. In addition, that there was a 1-in-3 chance that a farmer would receive no insurance payout in a very bad year (Clarke et al. 2012).[5]

Moreover, the data-scarce environments in which pure WII and RSII are most attractive are precisely the environments in which there is little yield data to fit and validate such products. This makes consumer protection challenging for the regulator. Moreover, many examples of indexed products designed based on agronomic theory rather than statistical optimization and validation that have subsequently been validated with yield data have been found to perform poorly.

The Solution

With technological innovations and increasing understanding of farming practices, there are continual improvements in data quality and reductions in cost. These improvements can involve: (i) getting better data series such as more frequent, higher resolution satellite data (e.g., infrared technology to see through clouds); (ii) using different data sources in interesting ways (Box 2); (iii) innovations in satellite technology that drive down the cost of using maps and models to identify houses and roads and separate different types of crops in intercropped land; and (iv) using state of the art mobile phone technology in conducting CCEs, which can improve the accuracy and speed in which the data is collected for yield indices (see Box 1 for more details).

Box 2. Combining data sources to improve quality

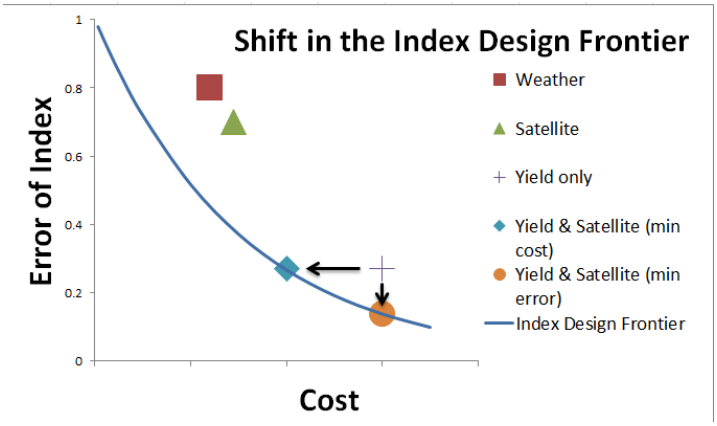
The World Bank team working on the NAIS project in India investigated the benefits of combining data sources to improve the timeliness and accuracy of data. The total claim payment of the proposed product would be the maximum of the two indices, one based in yield data and the other based on weather station data. Given weather station data is quicker to obtain, under scenarios where a claim is payable, the claim payment due from the weather index would be paid at, or even before, harvest. Once the yield data becomes available, and if the area yield indexed claim payment exceeding the weather indexed claim payment, a "top-up" payment would be paid at the end of the season.

Other combinations of data are possible such as WII interpolation. Here remote sensing data is used to interpolate between the gaps in the ground station network of weather data, thus improving the accuracy and reducing basis risk of indices developed.

5

The Index Design Frontier captures two key aspects of indices[6]: the basis risk and the cost of creating indices representing agriculture risk (Figure 2). The basis risk is captured by the y-axis, "Error of the Index", with high values associated with high basis risk as measured by the root mean squared error. The cost of the index is shown on the x-axis with high values representing higher costs. The frontier represents the most cost effective solutions available.

Figure 2. Illustrative Shift in the Index Design Frontier



Source: World Bank (2013)

It is often possible to reduce basis risk or reduce costs by designing index insurance products that use more than one type of data (see Box 3). Practitioners can either have same quality data at a lower cost or same cost for data at a higher quality, by moving onto the frontier from behind it. This can be seen in Figure 2. Using yield data on its own would place one at the purple cross. Combining yield data with satellite data one can (i) achieve the same accuracy for a lower cost – move to the blue diamond, or; (ii) improve the accuracy for the same cost – move to the orange circle; thus shifting the Index Design Frontier.

Box 3. Shift in index design frontier: case study India

A recent analysis conducted under the World Bank project with NAIS in India was a study to investigate the potential benefits of combining data sources. In the study, satellite data was used to target the CCEs for generating a yield index. In areas where satellite data indicated crop yields may be unusually low, additional CCEs were carried out; in areas where satellite data indicated crop yields may be normal or good , fewer CCEs were carried out.

The results of the study were surprisingly strong: In areas where there is a high correlation between satellite data and crop yields (approximately 70%), using satellite data to target CCEs can either reduce the cost of conducting the CCEs by a factor of four, or improve the accuracy by a factor of two. It is also worth noting that under this scenario using satellite data alone, despite a fairly high correlation, would reduce the accuracy by at least a half when compared to using both satellite and yield data.

Through statistical analysis of the implied basis risk of different data sources, and analyzing the costs of investing in different data sources, practitioners can decide where they wish to lie on the Index Design Frontier. Statistical analysis can be conducted on the benefit of combining data sources to determine the basis risk of a combined index (see Box 3 for more details). Combining this information with the associated cost of the index, practitioners can investigate different index designs and decide where on the Index Design Frontier they wish to lie. Investments can then be made to develop the desired data market infrastructure based on this analysis. Investments could involve developing data warehouses whilst enhancing the weather station network by buying additional weather stations, developing yield data through crop cutting processes or investing in enhanced satellite data.

Using agricultural insurance to support enhanced data

Development of agricultural insurance can complement investments in the data market infrastructure. Agriculture insurance programs shouldn't necessarily use only the existing agriculture data available. If current data quality is low, patchy or non-existent, investments in new data may be necessary. Under such scenarios, it is important that the other sections of the program are designed to use and support the new data that is being invested in. An example of this is developing a risk financing layer with the government acting as a reinsurer.

For example, in data sparse environments the government could support risk financing for agriculture insurance programs in the short-medium term while high quality data series are being invested in. This can increase demand for insurance by reducing the costs for farmers, as it avoids the high additional premiums charges from reinsurance companies due to the uncertainty of the data.

[6] Another key issue is timeliness of collection and claim payment. It has been set aside for this analysis as timeliness is becoming less of an issue with technology. With new innovations data can be collected before harvest for certain technologies, and even audited CCE data can now be made available within a week of harvest.

Data uncertainty is a key concern for private (re)insurance companies. It can lead to large increases in premiums charged to farmers through "data uncertainty" loadings or, in extreme cases where data is very poor, the absence of insurance cover. This means that high layers of risk (covering low probability events) and elements of coverage based on new datasets (designed to reduce basis risk) are typically expensive to reinsure. In such scenarios, the government can establish a risk financing fund which provides risk financing on best estimate actuarially fair cost basis to programs investing in improved data sources.

The Government of Mongolia (GoM) implemented such an approach during the initial years of the Index Based Livestock Insurance project by financing providing a "social" layer of risk through a World Bank line of credit, to complement investments in the data market infrastructure. Over time the reinsurance markets became more comfortable with the new data collection and audit processes and now the GoM is able to access cost effective reinsurance even for high layers of risk.

Lessons Learnt

Insurance for low-income farmers is usually built on indices, which need to be of high quality to provide meaningful protection. This is especially true for poorer, more vulnerable farmers who are poorly equipped to manage agriculture risk.

As large agriculture shocks can affect an entire country, reinsurance is typically critical, and therefore demonstrably robust audit mechanisms need to be in place, due to the high standards reinsurance companies have for data.

Governments have a key role in developing the data market infrastructure due to the fact that the collection of data can be a natural monopoly.

Indices can be based on a combination of yield, satellite and weather station data. The data types have each have advantages and disadvantages, and combining different types of data can lead to products that offer both speed and reliability.

Practitioners should ensure that they have the highest quality data possible for a given level of investment. Data is continually improving due to technological and operational advancements, so in order to obtain the highest quality data practitioners must ensure they remain up to date.

Through providing a layer of reinsurance, governments can support a*griculture insurance programs in initial years, while investments are being made in the data market infrastructure.*** The government can then offload the risk to reinsurance markets over time as data quality improves.

Further Information

World Bank (2012). *Improving Farmers' Access to Agriculture Insurance in India*. World Bank Policy Research Working Paper 5987. The World Bank. Washington, DC.

World Bank (2012). *Weather Based Crop Insurance in India*. World Bank Policy Research Working Paper 5985. The World Bank. Washington, DC.

Mahul, O. and Stutley (2010). *Government Support to Agricultural Insurance: Challenges and Options for Developing Countries.* The World Bank. Washington, DC.

DRFI Program website: *worldbank.org/fpd/drfi*

Contact

Olivier Mahul, Program Manager, Disaster Risk Financing & Insurance Program, FCMNB and GFDRR, The World Bank, omahul@worldbank.org

Daniel Clarke, Senior Disaster Risk Financing & Insurance Specialist, Disaster Risk Financing & Insurance Program, FCMNB and GFDRR, The World Bank, dclarke2@worldbank.org

Barry Maher, Disaster Risk Financing & Insurance Specialist, Disaster Risk Financing & Insurance Program, FCMNB and GFDRR, The World Bank, bmaher@worldbank.org