Science-based insurance

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Crops are at risk in a changing climate. Farmers in the developing world will be able to insure against harvest failure if robust insurance packages, based on a geophysical index rather than individual loss, become widely available.

Climate change with its potential to alter seasons, rainfall variability and temperature regimes[1] poses a growing threat to the development agenda. Small-scale farmers in developing countries, who have few modern technologies or improved crop varieties at their disposal, are among those most vulnerable to changing patterns of rainfall and temperature.

In developed countries, crop insurance is a commonly employed mechanism by which farmers and ranchers can guard against the reduction or destruction of yields by extreme weather events. However, traditional crop insurance is largely absent in less-developed countries, because costs of implementation are high and there are not enough effective financial institutions to broker insurances. Furthermore, insurance policies perversely provide an incentive for farmers to neglect their fields, a problem that is usually countered with expensive site visits by insurance claim adjusters[2], which would not be financially feasible in the developing world.

So-called index insurances, where an insurance indemnity payout depends on the exceedance of a threshold variable such as water level (for floods) or consecutive days without rain (for droughts), could fill that gap. Many insurance companies and non-profit development organizations are working to develop index insurance for small farmers. In principle, index insurance can serve several purposes. Apart from reducing the risk for small farmers, it can facilitate the availability of credit: banks are more likely to lend to a farmer who is insured against loss of harvest.

However, designing and pricing effective index insurance programs has proved to be extremely difficult, even in places where adequate crop and weather data are available. In the developing world, weather stations are few, records are discontinuous and historical weather data difficult to access[3]. To make the concept viable in these more challenging circumstances, a high degree of participation and engagement from the geoscience community is key, in particular to provide access to satellite remote sensing and high-resolution climate simulations.

No easy solution

Success in providing appropriate insurance products for small farmers could have dramatic effects on poverty in the developing world. By reducing defaults in bad years, insurance could allow farmers to take out loans to make critical investments in fertilizer, high-yielding seeds and other technologies that enable substantially higher productivity. Thus suitable insurance products may place these farmers on a more consistent path of income growth, and allow them to break free from the perpetuation of poverty[4]. As the global demand for food doubles in the coming decades, small and medium-sized farms in the developing world could then make a substantial contribution to the necessary increases in global crop production.

Index insurance does, however, also bring disadvantages. Because payouts are based on an index rather than yield reduction at the level of the farm, farmers are not guaranteed reimbursement if harvests fail. Therefore, the biophysical index — which is usually based on rainfall or vegetation health — must be chosen with utmost care, based on scientifically sound relationships between the index and the insured crop. Variations in planting date, fertilizer use and choice of seeds, as well as gradients in microclimate and a warming climate can all diminish the validity of these relationships. The implementation of index insurance products is therefore not straightforward: they must be robustly validated, and communicated very carefully if they are to be successful.

Supply and demand

Marketing index insurance products will not be straightforward either. Constraints on both supply and demand must be overcome to bring the concept to a large scale. Demand for index insurance products may initially be low because very poor farmers in developing countries tend to have a low base of assets and because cash flow is tight at the beginning of the season when insurance must be bought. A pervasive and long-standing mistrust in financial institutions will exacerbate the problem. However, it should be possible to overcome these obstacles if insurance companies work to build trust with their clients and provide their products as part of a package that combines insurance cover with loans for

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Manual rain gauge in Adi Ha, Ethiopia in 2009. This gauge is used as part of the validation for an index insurance project that also incorporates remote sensing data of rainfall at a location where there are very few ground-based rainfall measurements.

investment in higher productivity[5,6]. As a prerequisite, farmers must understand the benefits and limitations of the products.

Supply, on the other hand, is constrained mainly by difficulties in distribution, in the absence of a network of brokers, and in the lack of sufficient data to develop robust insurance products. The former can be overcome with some investment. This leaves a lack of suitable weather and climate monitoring data as a key remaining constraint[3]. Availability of ground-based observations is very limited, but satellite remote sensing data are being increasingly explored for this purpose. They are reliable, prompt and inexpensive. And most importantly, they are independent from both the insured and the insurer. Nevertheless, results in developing countries have been mixed[5]: reliably relating biophysical metrics to crop production will require a substantial amount of research.

Joint solutions

Comprehensive remote sensing datasets and Earth science models should, in principle, be able to solve the problem that ground data are insufficiently resolved to act as a trigger for index insurance payments. However, off-the-shelf technologies such as the observations of the vegetation index[7] must typically be adapted before they can be reliably used as an index, which requires research.

If observations from remote sensing or modelling are applied naively[5], this may lead to inappropriate solutions that may damage the acceptability and reputation of a very promising tool. Many of the potential problems could be easily solved with direct interaction between remote sensing scientists, economists and insurance implementers.

If done well, index-based insurance products could transform the prospects of farmers in the developing world. To help get this transformation off the ground, Earth scientists are needed to ensure that any products designed are robustly rooted in research. Otherwise, development organizations and insurance companies will move ahead without a solid geoscientific basis. If so, their efforts to reduce the vulnerability of the world's poorest farmers may not succeed. ❐

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References

1. US Climate Change Science Program and the Subcommittee on Global Change Research *The Effects of Climate Change on Agriculture, Land Resources, Water Resources and Biodiversity in the United States* (US Climate Change Science Program, 2008).
2. Skees, J. R. *Agr. Resource Econ. Rev.* **37,** 1–15 (2008).
3. Hellmuth, M., Osgood, D., Hess, U., Moorhead, A. & Bhojwani, H. *Index Insurance and Climate Risk: Prospects for Development and Disaster Management* Vol. 115 (International Research Institute for Climate and Society, 2009).
4. Schwank, O. *et al. Insurance as an Adaptation Option Under UNFCCC.* Background paper (Swiss Federal Office for the Environment, 2010).
5. Balzer, N. & Rispoli, F. *The Potential for Scale and Sustainability in Weather Index Insurance for Agriculture and Rural Livelihoods* (United Nation's World Food Program, 2010).
6. Gine, X. & Yang, D. *J. Dev. Econ.* **89,** 1–11 (2009).
7. Tucker, C. J. *Remote Sens. Environ.* **8,** 127–150 (1979).