IV General insurance

11 Designed for development impact: Next-generation index insurance for smallholder farmers

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Risk is economically costly in low-income agricultural economies, prompting protective self-insurance strategies that keep small farmers poor as they eschew remunerative, but risky, opportunities. To make matters worse, self-insurance only partially protects small farm households against drops in consumption that can irreversibly damage the long-term physical and cognitive development of young children. These problems are further compounded because risk stunts the development of rural financial markets, making it harder for small farmers to capitalize on and move forward with new technologies and market opportunities.

Recent technological advances in remote sensing and automated weather measurement open the door to innovative index insurance contracts that can transfer the correlated or covariant risk out of small farm economic systems. However, realizing the risk transfer potential of these advances and that of older ideas like area yield insurance[1] is subject to both demand- and supply-side constraints. A number of recent projects have shown that the supply-side challenges can be overcome. Index contracts based on area yields, weather and remotely sensed vegetative growth data have all been designed and approved by regulatory bodies, offered for sale by commercial providers and reinsured by international reinsurance companies.

Despite this supply-side progress, contract demand and take-up have been tepid, and there is little evidence to date that index contracts have helped small farmers better manage risk, achieving higher incomes for themselves and securing better human development for their children. In a review of experience with weather index insurance, Hazell et al. (2010) observe that in order to be sustainable, insurance contracts must resolve these demand-side constraints. This chapter fleshes out this observation and proposes that the next generation of index insurance contracts be designed for demand and development impact through:

[1] Area yield insurance measures average yields in a defined geographic area (e.g. a valley or administrative district) and makes payments when these average yields fall below a specified “strikepoint” level.

1. **Intelligent design of contracts to reduce basis risk:** Success in this area will require moving beyond weather-based contracts and using either area yield indices, vegetation indices based on satellite images or combinations of these information sources. Choosing between these information sources and designing optimum contracts that reduce basis risk will also require a demand-based approach, rooted in data on actual farmer outcomes and livelihood strategies.
2. **Systematic interlinking of insurance with credit:** Risk is a development problem precisely because it forces small-scale farmers into self-insurance strategies that leave remunerative but risky economic opportunities unexploited. By explicitly linking index insurance with the finance needed to take up these new opportunities, index contracts can overcome the constraints to insurance take-up created by basis risk and contract loadings that make insurance expensive. Exactly how this interlinking can be achieved depends on the nature of the existing property rights regime and financial market environment.

Section 11.1 introduces basic concepts of agricultural risk and of index insurance, illustrating both the strengths and the weaknesses of index insurance from the perspective of the small farm household. Section 11.2 shows how micro household data can be used to intelligently design contracts through choice of signal and statistically optimal loss and indemnity functions. Section 11.3 then shows how interlinking credit and insurance can be used to overcome problems of uninsured basis risk and contract loadings in order to create a demand-worthy index insurance contract designed for development impact. Section 11.4 concludes the chapter.

11.1 Agricultural index insurance basics

This section introduces the index insurance problem from the perspective of the small farm household, considering the potential effectiveness and costs of index insurance relative to traditional mechanisms of self-insurance. These observations open the door to consideration of the options for improving the relative desirability of index insurance and its development impacts.

11.1.1 Index insurance and the risks faced by agricultural households

The challenges of index insurance design are best understood by rooting the discussion in the outcomes at household level. Random or uncontrollable forces that cause real, consumable household income to dip below its typical or average value are of particular concern to households. The goal of insurance is to protect households against such deviations.

For reasons that are well described in the literature, agricultural index insurance works not by insuring the household directly against shortfalls in its own income or yields,[2] but instead by insuring a direct or predicted measure of the average or typical yield losses experienced by neighbouring households in a region. An index insurance contract can be represented as an indemnity schedule that links payments to an index that predicts typical losses in the zone covered by the index. To avoid problems of moral hazard and adverse selection, it should not be possible for the index to be influenced by the insured, nor should benefits depend on which particular individuals choose to purchase the insurance.

Figure 11.1 illustrates the indemnity schedule that might accompany a zone-level yield loss predictor function built around a rainfall signal. The horizontal axis shows a rainfall index (perhaps cumulative rainfall measured in millimetres) and the vertical axis shows indemnity payments. The contract is defined by a lower and an upper strike level. When the rainfall index dips below (signalling drought), indemnity payouts begin as shown by the dashed line in the figure. Similarly, when rainfall exceeds the upper strike point (signalling flood conditions), payouts to the insured farmers are triggered again.

A key question faced in index insurance is the extent to which household yield shortfalls track the index of predicted shortfalls. If the index signalled exactly a 100-kilo loss every time the yields were 100 kilos below the household's long-term average, then index insurance would perfectly cover all risks faced by the household. The problem of course is that no index will perfectly correlate with any individual's losses in this way.

The index that predicts average losses will not perfectly track individual households' yield shortfalls for three reasons:

1. **Pure idiosyncratic risk:** A single farm's crop may suffer damage from an idiosyncratic factor such as animal or bird damage, or highly localized weather events. Different levels of pure idiosyncratic risk characterize different agro-ecological zones. In the Sahel, for example, rainfall is highly localized, creating significant variation in yield losses between neighbouring villages, or even between households in the same village.
2. **Noise created by the geographic scale of the index:** As the geographic zone covered by a single index increases in size, household losses will correlate less well with the insurance index. For example, a weather-based index that only has to cover households within 1 kilometre of the weather station will track household outcomes better than an index that has to cover all households within 30 kilometres of the weather station.

[2] A myriad of experience has shown that trying to insure all sources of variation in agricultural outcomes for small farmers is beset by a host of problems rooted in the costs of obtaining information on small farm outcomes that render such insurance infeasible (see Hazell, 1992).

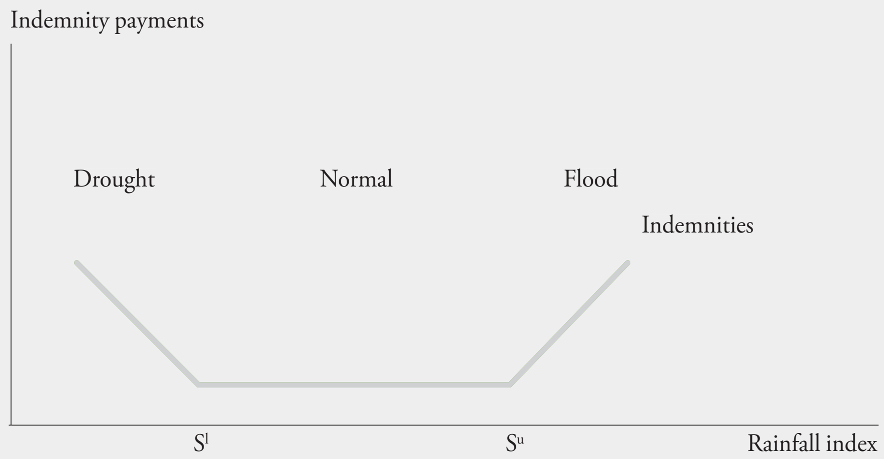
3. **Noise created by index prediction errors:** The average loss within a defined geographic zone can be measured directly with high precision (as with area yield contracts in the United States where yields are measured to a tolerance of +/– 2 per cent), or it can be predicted using weather or satellite information that is likely to be cheaper to implement, but also likely to have a larger margin of error when used to predict even the average loss.

Together, these three elements create what is called basis risk, yield losses experienced by the household that are not correlated with the insurance index and are therefore uninsured by the index insurance contract. As the second two sources of basis risk are influenced by the design of the contract (geographic scope and exact index used), we refer to them as "design effects" on basis risk.

The linear contract structure in Figure 11.1 is simple, and close variations of it have been used in several index insurance pilots, including ones in Ethiopia, India, Kenya and Malawi. However, implicit in this structure is the assumption that losses are linear in the rainfall index. Empirical analysis of the sensitivity of yields to rainfall like Carter's (1997) West Africa work suggests that yield losses respond in a non-linear way to rainfall shortages or excesses. If this is correct, then these common linear loss contracts will have large design effects that unnecessarily increase basis risk.

Section 11.2 discusses ways to estimate statistically optimal predictor functions that can be used to design more effective indices and contracts. The stylized linear indemnity schedule represented in Figure 11.1 is highly unlikely to be the contract structure that minimizes design effects.

Figure 11.1 **A stylized rainfall index insurance contract**



Once an indemnity schedule is designed, historical information on the index, such as rainfall data, can be used to calculate the probability distribution of the index and the actuarially fair premium, which is simply the expected or long-term average payment under the indemnity schedule. The market premium is then defined as the actuarially fair premium plus mark-ups or loadings associated with the costs of providing the contract (for example sales costs, capital costs and reinsurance costs). Loading premia can vary based on the quality and quantity of the data used to construct the probability distribution of the signal. For agricultural index insurance contracts offered by the US Department of Agriculture, the typical loading level is 20 per cent (Smith and Watts, 2009).

A number of pilot projects have shown that index insurance contracts in this form can be defined and supplied by the commercial market (see Hazell, 2010). In addition, recently introduced products that have also satisfied national and international insurance supply standards include a satellite-based livestock insurance contract in Kenya *(see Chapter 12),* and area yield contracts in Mali and Peru.[3] While these supply-side achievements are absolutely critical, index insurance will only have its desired development impact if the insured understand how it works and choose to modify their behaviour, thus generating informed demand and take-up.

11.1.2 Self-insurance compared to index insurance contracts without interlinking

As a prelude to thinking about how to create index contracts that are demand-worthy, this section examines the demand for index insurance from the perspective of a typical small farm family that has a diversified livelihood strategy and has options for self-insuring against agricultural risk. In contrast to the analysis in section 11.3 below, this section assumes that insurance is not interlinked with credit or other opportunities to improve average family income. Specifically, it assumes that the household grows the same crops, with the same technology, with or without index insurance. Section 11.2 argues that unless index insurance is in fact interlinked with expanded economic opportunities, demand for the insurance is likely to be low. Correspondingly, demand or take-up of credit and new agricultural technologies is also likely to be low for small farm sectors unless it is interlinked with low-cost risk management tools, such as index insurance.

As detailed in the appendix to this chapter, we analyse demand for index insurance from the perspective of a small farm household that obtains 50 per cent of its income from non-agricultural sources, and 50 per cent of its income on average from farm production using a risky, but relatively safe, low input technology. For this analysis, we assume stylized levels of overall risk and a reasonable

[3] Details on these and other projects are available at http://i4.ucdavis.edu.

division of this risk between correlated risks (such as weather and insect invasions) and idiosyncratic risks.

Under our assumptions, for half of the time this family would have lower-than-average agricultural income and therefore lower-than-average household consumption. For the other half of the time, the family would have higher-than-average consumption. Despite its self-insurance strategy, 10 per cent of the time the family would face significantly reduced consumption (less than 75 per cent of its average consumption level) due to a poor agricultural crop *(see appendix Figure 11.4).* In other words, the family faces "basis" risk that is not insured under its self-insurance strategy. In addition, if the family eschews more productive strategies (such as greater levels of fertilization of its crop) in order to reduce risk, then it is also paying an implicit loading, meaning that self-insurance reduces its average income. The challenge is whether index insurance – with its level of basis risk and loading – can do better than the family's stylized self-insurance strategy.

Index insurance gives the family the option of adding a new risk management tool to its traditional risk management strategies. The analysis detailed in the appendix assumes that half of all agricultural risk faced by the household is a correlated risk that can be covered by the index insurance contract. The other half is basis risk, resulting from either true idiosyncratic risk or from design effects, that is not insured by the index insurance contract. The simulation analysis assumes that the family faces loading costs of 20 per cent, meaning that after insurance is purchased, average family consumption will fall slightly below its pre-index-insurance average.

As shown in the appendix, under these somewhat conservative assumptions, index insurance lowers the probability of extremely low consumption from about 10 per cent to 3 per cent. While lower, this probability is not zero, reflecting the reality of basis risk and the possibility that the family could have a low outcome and still not receive any compensating insurance payment under the index contract. In addition, because of loading costs, the contract presents the household with a zero-sum game: the (imperfect) reduction in the probability of low consumption is purchased at the cost of reduced average income. As analysed in greater detail by Carter et al. (2010), only the most risk-averse fraction of the population (those who are most deeply worried about low consumption outcomes) would find this kind of index insurance attractive. When combined with the other factors that might inhibit the adoption of a new, relatively complex contract (such as inability to understand it or lack of confidence that the insurance will really pay out as advertised), this trade-off may explain the sometimes weak demand for index insurance when it is not combined with measures to simultaneously improve access to credit, improved technologies and new markets.

11.1.3 Options for improving the demand-worthiness of index insurance

As summarized by Hazell et al. (2010), many pilot projects have met with weak demand. While there are a plethora of reasons that might explain the sluggish take-up of novel index contracts (including inability to understand and lack of confidence in the contract), the fact that self-insurance, basis risk and loadings compromise the desirability of the contract is surely also part of the explanation, as evidenced by the discussion above. Recognizing this problem, Hazell et al. (2010) suggest two things. First, it advocates better-designed contracts that have lower basis risk. Second, it advocates combining index insurance with other agricultural services, creating what it calls a value-added proposition. The remaining two sections of this chapter build on these suggestions, expanding and combining them into a next-generation approach to index insurance for small-scale farmers.

11.2 Designing contracts to minimize basis risk

Figure 11.1 uses a standard rainfall contract to illustrate the more general functioning of index insurance. While index insurance is sometimes generically called weather or rainfall insurance, the importance of the basis risk problem demands that well-designed contracts consider options beyond weather-based indexes and choose an optimum contract design that minimizes basis risk.

While rainfall contracts are typically based on expert advice on rainfall levels at which crop damage occurs, the ad hoc linear loss and indemnity functions used in some contracts are unlikely to be statistically optimal and minimize prediction error – that is, the design effects on basis risk are likely to be large. Fortunately, widely available micro data on farm households allows estimation of a statistically optimal loss function for rainfall or any other candidate signal. The resulting contracts, or hybrid combinations of them, can then be compared to see which one offers the best value to the beneficiary population, taking into account the predictive power of the signal[4] as well as the cost of obtaining it.

To illustrate these ideas and their implementation, this section summarizes an analysis of West African grain crops that used micro data to compare the desirability of rainfall, area yield and satellite-based index insurance contracts.

11.2.1 Minimizing design-induced basis risk for West African grain farmers

This section considers grain yields in six villages in Burkina Faso where the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT)

[4] The remote sensing literature has already made substantial progress in identifying transformations of satellite signals of vegetative cover that best predict farmer yield outcomes on the ground. The same methodology can also be applied to other potential insurance indices.

intensively interviewed farm households over the 1980 to 1985 period. Detailed production data were obtained from 25 households in each village for the three crop years 1980/81 to 1982/83 (see Carter (1997) for details on the data). For the analysis here, each household's production is aggregated across all of its sorghum and millet fields to create an annual grain yield figure for each household. The goal of a contract minimizing basis risk is thus to create an index that can statistically explain as much of the yield fluctuation faced by households as possible.

One possible index would be simply average village yields. A contract based on this village yield index would provide a payout to farmers based on the degree to which village yields deviate from the long-term average. Using the ICRISAT data, we can replicate an area yield index simply by taking the average yield across all households in each village for each crop year. Within a village, all farmers' fields are at most a few kilometres apart. While the Sahelian region from which these data come is famous for large idiosyncratic risk generated by highly variable local weather patterns, we would still anticipate that each household's yields would closely follow its village average yields. In this case, a contract based on village average yields would be relatively effective, as insurance indemnity payments would tend to correctly compensate households for losses experienced.

The analysis detailed in Laajaj and Carter (2009) shows that about half of the yield fluctuations experienced by households can be explained by average village grain yields. The other half represents the basis risk that would be uninsured even under a village-level area yield contract. While it is surprising that as little as half of the risk may be common across villagers, note that it is precisely this correlated risk that households would have trouble managing through traditional mechanisms of social sharing and reciprocity.

While this village-level area yield index represents the basis-risk-minimizing index insurance contract for this semi-arid environment of West Africa, it would in all likelihood be impractically expensive to implement as it would require an annual yield survey in each village where households were covered.[5] We therefore need to consider whether there are alternative, cheaper mechanisms that can achieve similar predictive power to the area yield index.

The ICRISAT data includes rainfall information collected in each village. Note that this rainfall information is extremely high-density as it is the equivalent of having a weather station every few kilometres. In practice, such a high density of weather stations is not economically feasible. Nonetheless, it provides another useful benchmark against which to compare the performance of a third

[5] It might also raise problems of moral hazard, as villagers might be able to collectively agree to underproduce so that village yields would drop and everyone would receive an insurance payout.

possible index, one based on satellite data on vegetative cover (NDVI). Because this latter kind of data is less familiar, we present a brief overview of it before comparing the performance of NDVI-based contracts with that of alternative contracts based on more familiar measures.

11.2.2 The Normalized Difference Vegetation Index

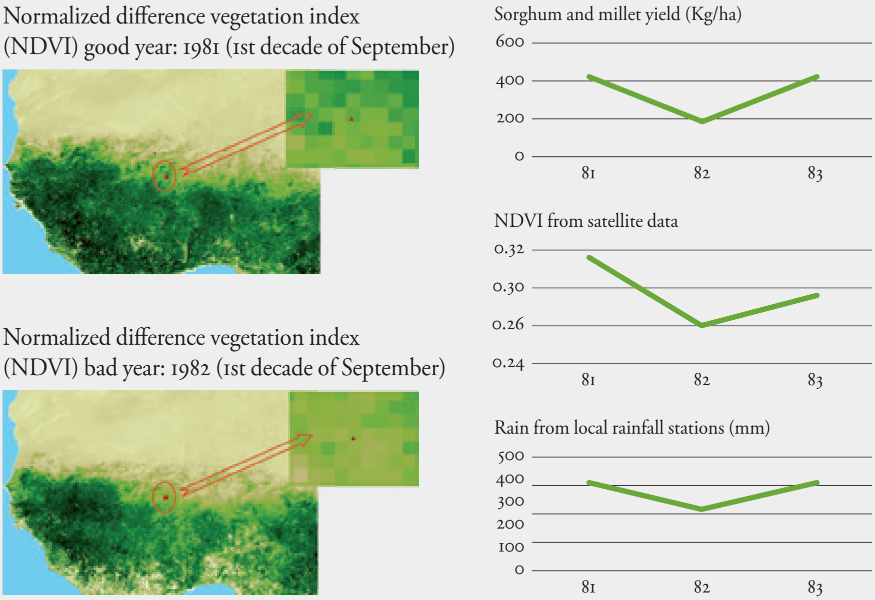
The Normalized Difference Vegetation Index (NDVI) is a satellite-based measure of vegetation density. NDVI is scaled to lie between zero and one, with low values indicating very little vegetative growth and high values indicating dense vegetation. Every 10 days NDVI is measured at a resolution of eight kilometres by eight kilometres (that is, a unique NDVI measure is provided for each eight kilometres by eight kilometres pixel). NDVI measures at this resolution are freely available on the FEWS NET (Famine Early Warning System Network) website.[6] The availability of NDVI at this resolution is equivalent to having a separate weather station (or an area yield survey) for each eight kilometres square. If NDVI can be shown to have similar capacity to predict individual farmer yields as meteorological or area yield data, then clearly it would emerge as the preferred basis for an insurance index on simple cost and simplicity grounds. In addition, NDVI is available going back to 1981, meaning that the long-term data needed to accurately price an insurance index are available.

Figure 11.2 illustrates how NDVI works. The diagrams on the left side of the figure display actual NDVI data for West Africa. A brown to green colour spectrum has been used to graphically display the zero-to-one NDVI scale, with browner colours signalling low NDVI values and greener colours high NDVI values. The insert in each diagram shows the individual eight kilometres square pixels for the region surrounding the village of Silgey, one of the six villages included in the ICRISAT study in Burkina Faso. The dot on the insert is the pixel where the village centre is located.

The first of the three charts on the right side of Figure 11.2 show 1981–1983 grain yields from Silgey as measured by the ICRISAT Village Level Studies discussed further below. The middle chart displays average NDVI for that time period, while the bottom chart shows rainfall as measured by a village rainfall gauge maintained by the ICRISAT study. Impressionistically, these figures show that NDVI tracks village level yields. While this is encouraging, we need to evaluate more carefully the precision with which NDVI can predict village yields and form the basis for a valuable insurance index contract.

[6] Higher-resolution data that measure NDVI for each square of 30 by 30 metres can be purchased.

Figure 11.2 **Yield prediction using satellite data**



11.2.3 Area yield, weather and NDVI contracts compared

While the raw NDVI signal could be used as the basis for an index insurance contract, there is a well-developed literature on remote sensing that has explored the transformations of NDVI that best predict crop yields. For the analysis here, we employ the transformation of NDVI information called the vegetation condition index (VCI). VCI is defined as:

$$VCI = 100 * (NDVI - NDVI_{min})/(NDVI_{max} - NDVI_{min})$$

For a given village, the VCI uses long term series of NDVI to relate present NDVI to the extreme values observed since 1982 at this same time of the year.

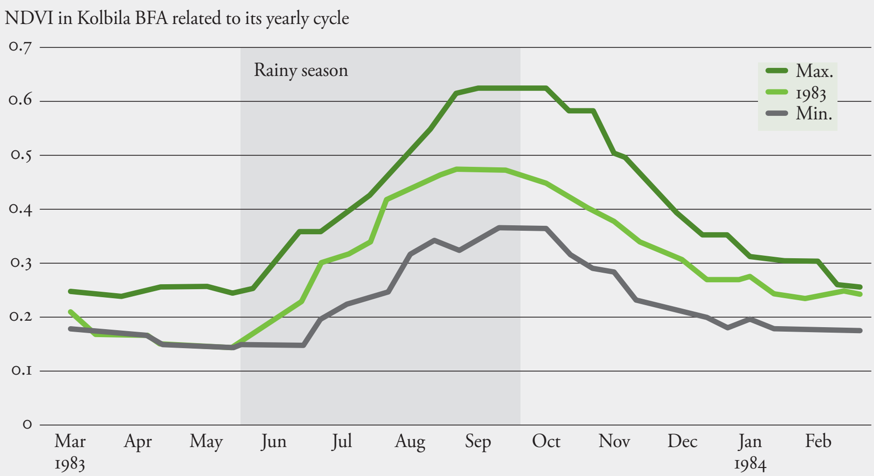
Figure 11.3 plots the VCI measure for the year 1983 for the village of Kolbila, another of the ICRISAT study sites. Also shown on the graph are the historical minimum and maximum values of NDVI for Kolbila. As can be seen in Figure 11.3, the VCI for Kolibila was close to zero in April 1983, but around a half in September 1983. An advantage of the VCI transformation is that it relates absolute NDVI values to a local context and therefore facilitates the use of NDVI data coming from heterogeneous places.

So how much basis risk would exist under an index insurance contract written on the village-specific VCI? Laajaj and Carter (2009) estimate the statistically optimal (basis-risk-minimizing) predictor function that can be obtained for the VCI.

Conducting a similar exercise using rainfall data at village level, they find that the VCI index achieves 89 per cent of the variance reduction of the village yield index. The rainfall measure achieves 75 per cent of the risk reduction of the village-level area yield contract. Interestingly, when the VCI and rainfall measures are combined into a hybrid index, no additional variance reduction is achieved beyond that obtainable with the VCI-based index alone.

While it may be possible to improve the predictive power of rainfall data through further analysis, it is important to note that an insurance scheme is unlikely to be able to afford to have the village-level weather measurements that are available in the ICRISAT data. Even the most ambitious proposals for weather station construction suggest that each station would have to cover a circle with a radius of 25 kilometres. By way of comparison, some 30 separate NDVI measurements would be available within a circle of that radius, meaning that a high-density NDVI-based contract should have a further design advantage over weather-based contracts.

Figure 11.3 **Calculation of VCI using maximum and minimum NDVI**



While analysis of the ICRISAT data for West Africa suggests that NDVI can not only offer lower basis risk, at lower cost than rainfall-based indices, this finding should not be generalized for other agro-ecological environments. In some situations remote sensing may provide a cost-effective index, as is the case with livestock mortality predictions in Kenya *(see Chapter 12)*, while in other situations it may prove to be an unreliable predictor of agricultural yields (as was discovered when satellite information was found to be a poor predictor of cotton yields in Mali). These findings show that designing a cost-effective index insurance contract that minimizes basis risk should consider a variety of index options by using micro data to ground truth and select the optimal index. At the same time, the analysis also shows that there are limits to the elimination of basis risk, even through optimal contract design. In the extreme case of the Sahel, it would appear to be difficult to use index insurance to eliminate more than half of the agricultural risk faced by farmers. Given these technical limits to the quality of index insurance, the next section explores the possibilities for further improving the development impact value and sustainability of insurance by interlinking it with credit.

11.3 Interlinking insurance and credit

The analysis in section 11.1 assumed that the small-scale farm household had access to only one traditional agricultural activity. While the risks associated with such activities are important, development economics has long been preoccupied with the notion that one of the biggest costs of risk is that it induces farm households to shy away from riskier, new technologies and economic opportunities that offer improved average incomes over a period. In addition, risk stunts the development of rural financial markets, compounding the adoption problems for liquidity-constrained farm households. This section argues that explicitly connecting index insurance with these kinds of activity will not only solve the development problem that makes risk so costly, but will also resolve the problem of tepid insurance demand.

11.3.1 High-return economic activities and small-scale farm households

High-return economic activities typically require significant up-front investment in purchased inputs of improved seeds and fertilizers. This factor alone increases the risk exposure of the family as a drought year means negative, not just zero, net income. In addition, the yield variance of high-return activities also tends to be higher, in part because these activities are less well-adapted to climatic stress than are traditional activities that have evolved in the farm's specific agro-ecological system. Finally, the increased cash costs of production may simply exceed the liquidity available to the household, making access to capital through financial intermediaries or value-chain operators indispensable.

To explore the performance of index insurance in combination with new, higher-return technologies, we return to the stylized household model detailed in the appendix. We now assume that with significant investment in seeds and fertilizer equal to the household's non-farming earnings, the household can use an improved technology that increases average net agricultural income by 25 per cent over the traditional crop activity.

This high-return technology offers the household the prospect of having higher income and therefore higher consumption. However, given the input costs and the riskiness of the new technology, this higher average consumption comes at the cost of increased risk.

Under these additional assumptions, our simulation analysis shows that the probability of household consumption falling below 75 per cent of its long-term, traditional-technology average rises from 10 per cent to nearly 20 per cent if the new technology is adopted without insurance *(see Figure 11.5 in the appendix).* In addition, it raises a non-trivial probability that consumption could fall to as little as 50 per cent of its old long-term average. Even assuming that the household had the savings to finance the high-return activity, this stark trade-off between risk and return would discourage many farmers from adopting the new technology,[7] keeping them safe, but also perpetuating a low standard of living.

The decision to utilize the traditional technology when the high-return activity is available and financially feasible can be examined as an insurance-like decision. From this perspective, practising self-insurance by continuing to utilize the traditional technology carries a very high loading as it reduces expected household income from agriculture by 25 per cent, while reducing overall average household consumption. As discussed above, this self-insurance strategy also carries uninsured or basis risk, as the self-insured household still faces positive probabilities of low consumption outcomes. When seen from a development perspective, to improve household economic well-being, the challenge of index insurance is not to eliminate all basis risk and loadings, but simply to do better than the costly self-insurance that is available by relying on traditional technologies. As the next sections describe, the mechanisms for doing this depend critically on the nature of the financial market.

11.3.2 Index insurance and adoption of the high-return activity when loans are fully secured

The discussion here and in the following section assumes that small farm households lack the savings to purchase the new technology even if they wanted to. To explore how insurance and credit might interact in this environment, we assume that agricultural loans are offered by a competitive lending sector on terms that yield lenders expected profits exactly equal to the economy-wide opportunity cost of capital. We also assume that borrowers repay loans to the extent possible using all realized agricultural income and any security required for the loan. When loans are fully secured – meaning that the security is sufficient to repay the loan in full even if there is a crop failure – the lender bears no risk. Under these terms, a loan functions much like self-finance, as the farm household is fully

[7] When analysed from the conventional economic perspective of expected utility theory, only households with very low degrees of risk-aversion or higher-than-average stores of wealth would adopt the technology (see Carter et al., 2010).

liable and bears the full risk associated with adopting the high-return activity. It may be possible for loans to be fully secured in economies where there are individual titles to land.

As fully secured loans function like self-finance, only the least risk-averse households would be willing to accept the probability of very low outcomes in return for the prospect of higher incomes. This case, in which small-scale farm households have access to a loan to finance a high-return activity, but turn it down and decline to adopt the activity, corresponds to what Boucher et al. (2008) describe as risk-rationing. These authors show theoretically that risk-rationing is most likely to affect lower wealth households and, empirically, may constrain the choices and income of up to 20 per cent of small-scale farmers in Central and South America.

With a fully secured loan, the benefits of index insurance will accrue directly to the household, which carries all of the risk. The simulation results shown in the appendix indicate that when combined with a loan and an index insurance contract, the new technology can be undertaken with almost no risk of consumption falling below 50 per cent of its long-term average. However, even with interlinked credit and insurance, the household would still face some increase in the risk of consumption falling to less than 75 per cent of its long-term average relative to the self-insurance strategy. Beyond that level, the interlinked contract strongly dominates the self-insurance strategy as for most of the time it offers higher household consumption than would the self-insurance strategy. While this interlinked contract still presents the household with a trade-off (higher returns at some increased risk of low outcomes), the trade-off is much less severe than that offered by the high technology without insurance. Analysis by Carter et al. (2010) shows that while this interlinked contract is still characterized by a trade-off, all but the most risk-averse agents would prefer the interlinked contract to the low-technology, self-insurance strategy.

The trade-off that remains even with the interlinked contract can be reduced or even eliminated completely if basis risk can be reduced under the index insurance contract. The discussion so far has assumed that index insurance can cover half the risk faced by the farm household and that the other half remains as basis risk. This is roughly the quality of the insurance that can be obtained using satellite signals for Sahel grain producers or other contracts that have minimized design effects. However, in environments where more of the risk is insurable (say two-thirds rather than a half), or where intelligent contract design can further reduce design effects on basis risk, it is possible for interlinked contracts to completely dominate self-insurance strategies *(see Figure 11.5 in the appendix)*. That is, compared to the self-insurance strategy, when adopted with an interlinked credit and insurance contract the high-yielding technology offers less risk of low consumption outcomes and a much greater chance of high consumption outcome. Even the most risk-averse agent would be expected to prefer the interlinked arrangement to the self-insurance of low technology (conditional on understanding and having confidence in the contract).

It is important to note that there are still basis risk and loadings under this interlinked contract. While it is thus inferior to a perfect insurance contract offering full cover, such an infeasible option is not an especially interesting point of comparison. The more interesting comparison is with the extant self-insurance strategy with its degree of basis risk and high loadings. Interlinking credit and insurance is important precisely because it opens the door to dominating self-insurance and crowding-in technological change.

11.3.3 Index insurance and credit supply in environments where high levels of security are available ("high-collateral environments")

The discussion so far on interlinking has assumed that loans are fully secured, so that the household bears all the direct risk of a production shortfall that leads to default. While lenders do not directly bear any immediate risk if their lending is fully secured, they do potentially face what might be termed political economy risk. In the event of a major covariant shock that leads to crop failure and results in the security provided by small farm households being realized, lenders might well anticipate political pressure and forgive outstanding debt rather than cause farmland to be reposed. As described by Tarazona and Trivelli (2005), this scenario took place following the 1998 El Niño event in Peru. Note that this political economy risk is directly tied to covariant shocks, as the political possibility for this kind of debt forgiveness exists where large numbers of farmers can point to an easily observable event.

The magnitude of this political economy risk depends on the lender's loan portfolio. As modelled by Carter et al. (2010), lenders will react at the market level by increasing the rate of return required on uninsured agricultural loans as the proportion of the loan portfolio in agriculture increases. An increase in the number of small farms taking up loans (induced by the availability of index insurance contracts) would thus be expected to provoke an increase in the cost of capital to the agricultural sector, a force that would tend to choke off the increased take-up.

Explicitly interlinking loans and index insurance contracts would be expected to resolve this problem. While index insurance contracts do not cover all risks, they do cover the covariant risks that power the political economy problem faced by lenders. The next section discusses interlinking more thoroughly in environments in which little security is available, where it is potentially of even greater importance.

11.3.4 Index insurance and adoption of the high-return activity in environments where little security is available ("low-collateral environments")

It is unlikely that loans will be fully secured, especially in many smallholder areas in sub-Saharan Africa. If a loan is not fully secured, the lender carries some of the risk of low yield. Even if lenders are willing to grant loans with a low level of security, they will need to charge higher interest rates in order to achieve a given expected rate of return. In addition, because defaults on agricultural loans are likely to be correlated, lenders are likely either to severely limit the amount of agricultural loans in their portfolio (Tarazano and Trivelli, 2005) or, if they increase them, to require an ever higher rate of return to compensate for the additional risk on their balance sheets (Carter et al. 2010).

In this context, supply of credit to finance new technologies is likely to be restricted and expensive. Moreover, simply offering index insurance to farmers is unlikely to have much impact, as the benefit of the insurance will accrue primarily to the lender, who bears a substantial portion of the risk where little security is available. Neither credit nor insurance markets are likely to emerge independently in low-collateral environments, and agricultural technologies and income are likely to stagnate.

Interlinked insurance-credit contracts are one possible way out of this conundrum. An index insurance contract that covers the covariant risk faced by lenders should be sufficient to relax the constraints that restrict the supply of credit to the small farm sector. At the same time, if lenders face competitive pressure, the loan rates will drop and reduce the cost of credit to the small farm household, creating yet more demand for capital and increased take-up of the high technology.

While these mechanisms are somewhat different from those considered above where a high level of security is available, according to the analysis of Carter et al. (2010), the net result is almost identical in terms of the overall impact on farm incomes and levels of well-being. Index insurance contracts interlinked with credit and take-up of improved technology can dominate the high basis risk and implicit loadings that small farm households pay when they self-insure by adopting traditional technologies.

11.3.5 Marketing interlinked index insurance

While compelling on its own terms, the interlinking of intelligently designed index insurance contracts and credit also potentially offers important marketing advantages. In low-collateral environments, in which most of the direct benefits of index insurance will accrue to lenders, it may make sense to market it directly to lenders as portfolio or meso-level insurance *(see Chapter 4).* While in a perfectly competitive loan market the benefits of this portfolio insurance would trickle down to borrowers, in the real world in which rural loan markets are far from competitive, an approach to insurance oriented towards development impact will need to consider a contractual mechanism that ensures that the benefits of the insurance are indeed passed on to borrowers. In high-collateral environments, interlinking may still offer marketing advantages, as a single contract can offer both credit and insurance.

11.4 Conclusion: Designed for development impact

Small farm agricultural insurance is not an end in itself. Its importance comes from its ability to relieve a fundamental problem of economic development, namely the economically costly self-insurance and coping strategies that can make and keep smallholders poor. Approaching the insurance problem from this development impact perspective suggests a demand-centric approach to contract design, rooted in data on small farm households and their production technologies and constraints.

As explored in this chapter, this approach allows evaluation of alternative insurance indices – area yield, satellite-based, weather-based and hybrid combinations – and selection of a statistically optimal contract design that reduces uninsured basis risk in a cost-effective fashion. In addition, this approach opens the door to context-sensitive interlinked credit-insurance contracts designed to simultaneously deepen financial markets and facilitate small farm technology take-up by operating on both the demand and supply sides of the agricultural credit market. As argued here, it is the combination of intelligently designed contracts and interlinking that will allow index insurance to dominate small farm self-insurance strategies, sustain demand and, ultimately, achieve the desired development impact, both on small farm incomes and on human development outcomes.

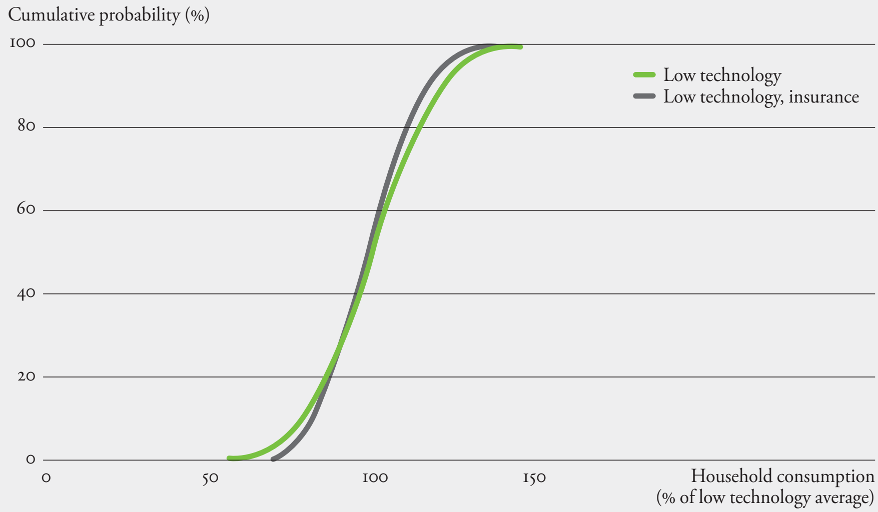
Appendix – Simulation analysis index insurance versus self-insurance

This appendix provides additional detail on the simulations discussed in sections 11.1 and 11.3. A complete discussion of these simulations, as well as further analysis of the degree to which there would be a demand for index contracts is given in Carter et al. (2010).

Index insurance with traditional technology only

Figure 11.4 illustrates the risk faced by a stylized farming household both with and without index insurance, assuming the opportunity set is unchanged. The horizontal axis shows the income available for family consumption as a percentage of the family's average consumption without insurance (100 per cent would thus be the family's average consumption level). The vertical axis shows the cumulative probability of different consumption outcomes for the family. The green line shows these probabilities when the family does not have an index insurance contract. For 50 per cent of the time the family will have consumption levels at or below its average, and under the assumptions made for the simulation, for 10 per cent of the time the family will need to make do with consumption at or below 75 per cent of its normal level.

Figure 11.4 **Insuring the traditional technology**



The grey line shows the consumption probabilities if the family's agricultural production is insured by an index contract. For illustration purposes, we have assumed that half of the yield variation faced by the family is covered by the index contract and that the other half is uncovered basis risk. We also assume that the premium charged for the contract has a loading of 20 per cent, meaning that the household pays 20 per cent more in premiums than it expects to recover from indemnity payments. Finally, we assume that the strike points are set in such a way that pay-offs are triggered whenever measured or predicted zone yields fall below their average level.

Careful examination of Figure 11.4 shows both the strengths and weaknesses of index insurance. First, the probabilities of extremely low outcomes drops substantially. With insurance, there is only a 2 per cent chance of household consumption falling below 75 per cent of its normal level, down from a 10 per cent chance without insurance. While lower, this probability is not zero, reflecting the fact that the contract does not cover all risks. Complete insurance cover without basis risk would stabilize household consumption at its mean level (less mark-up or loading costs). As can be seen from Figure 11.4, substantial basis risk remains relative to this idealized (but infeasible) complete insurance.

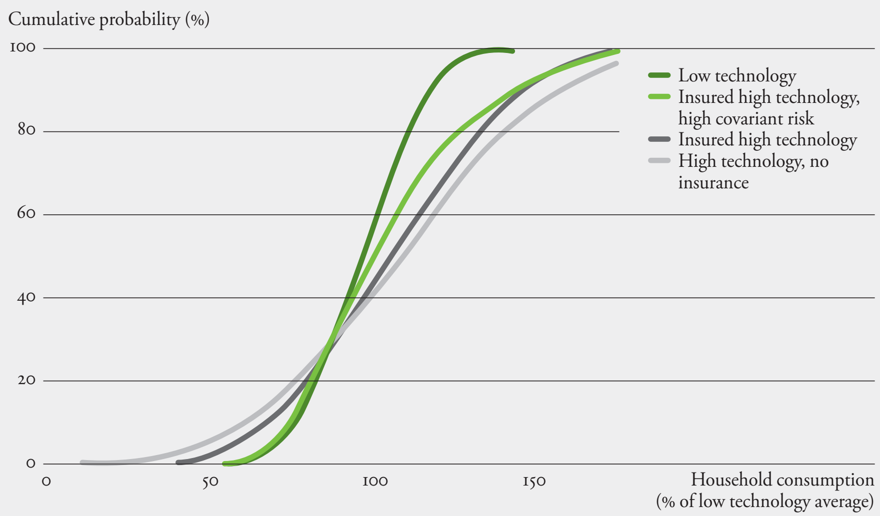
This factor, along with the fact that premiums are marked up by 20 per cent means that even with insurance, the family's consumption can still fall below its pre-insurance average of 100 per cent. Household average income is also reduced by 1 or 2 per cent because of the loadings charged to the insurance. The partial reduction in the probability of low outcomes is purchased at the cost of reduced average income.

Index insurance and high-return economic activities

Figure 11.5 illustrates the cumulative distribution function for the stylized high-return activity described in section 11.3 above. Compared to the traditional activity (shown here as the dark green line), the high-return activity has mean returns that are 25 per cent higher than the traditional agricultural activity and requires the purchase of significant cash inputs. The light grey line in Figure 11.5 shows the probability of different household consumption outcomes under the high-return activity when the cash costs are either completely self-financed by the household, or, equivalently, financed by a fully secured loan.

As can be seen, under the high technology the household faces almost a 10 per cent chance that its total consumption will be less than 50 per cent of the average income it can obtain under the low technology. However, some 40 per cent of the time household consumption will be at least 25 per cent higher than average income under the low technology.

Figure 11.5 **Interlinking insurance and credit for technology take-up**



The dark grey line in Figure 11.5 shows the impact of index insurance when interlinked with credit and technology take-up in a relatively unfavourable agro-ecological environment in which only 50 per cent of the risk faced by households can be covered by a well-designed index insurance contract. Despite this disadvantage, this interlinked insurance arrangement pushes the risk of low consumption outcomes back towards the levels under the traditional, low-returning technology. At the same time, the interlinked adoption of the new technology outperforms self-insurance strategy 70 per cent of the time. While this interlinked contract still presents the household with a trade-off (higher returns at some increased risk of low outcomes), the trade-off is less severe than that offered by the high technology without insurance.

Finally, as shown by the light green line in Figure 11.5, interlinked adoption of the new technology can completely dominate self-insurance if more (two-thirds) of the overall risk faced by households is insurable, covariant risk.

12 Livestock insurance: Helping vulnerable livestock keepers manage their risk

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Livestock accounts for 40 per cent of global agricultural output and supports the livelihood and food security of over one billion people (FAO, 2009). A livestock-related livelihood represents a way out of poverty for a significant number of the world's poor. However, the poor still face a number of risks when they strive to access the benefits of the growing and vibrant livestock sector.

Reducing the inherent vulnerability of people dependent on livestock in smallholder production systems has been the central motivation of livestock insurance targeting poor or vulnerable populations. While some countries, such as India, have significant experience with livestock insurance for the poor, improvements in the provision of insurance products, as well as innovations in their design, are fuelling interest in the potential of insurance to reduce the vulnerability of the poor to the risks associated with a livestock livelihood. A growing recognition of the importance of risk management as a key pillar of any poverty-reducing strategy (Pica et al., 2008), coupled with a complex, evolving livestock economy that offers opportunities for the poor, provides a foundation upon which livestock insurance may flourish.

This chapter highlights experiences that have offered valuable lessons on the potential benefits of livestock insurance, analyses the reasons for the failure of some insurance products and examines the conditions required for the successful implementation of a livestock insurance product. Section 12.1 illustrates the significance of the livestock economy globally and discusses the importance of managing the livestock risks to improve well-being in rural environments. Section 12.2 draws attention to a sample of livestock insurance experiments across the globe and summarizes the experience gained with them. Section 12.3 underlines the common challenges that many livestock insurance pilots face. By highlighting new innovations in insurance design and provision, section 12.4 discusses various opportunities that can help counter the obstacles to livestock insurance.

12.1 Why livestock insurance?

Livestock plays an important role in the livelihood of the poor. It serves as both a source of income and a source of productive wealth that the poor can expect to rely on for future income flows. It is also one of the few assets readily available to the poor, and especially to women, who have greater difficulty accessing other productive livelihood opportunities (FAO, 2009). It is estimated that close to one billion people, or about 70 per cent of the world's 1.4 billion people living in extreme poverty, depend on livestock for their livelihoods (Delgado et al., 1999).

Although the livestock revolution represents a powerful vehicle for channelling pro-poor growth (IFAD, 2004; Thornton et al., 2008; FAO, 2009) a major hindrance to the poor's engagement in livestock production is their high degree of vulnerability to the many sources of mortality, morbidity and other risks that pervade the livestock production and marketing chain. Any disease, accident or theft of livestock leads to a substantial loss for the household. In addition, huge production risks associated with dairy activities render animal husbandry a risky proposition for low-income households. The production risks can relate to a scarcity of input such as fodder or water for the animals, the high morbidity of individual animals or an epidemic *(see Table 12.1)*. The tropical climate and poor hygienic conditions pertaining in many developing countries are some of the factors that trigger or aggravate diseases such as mastitis, foot and mouth disease (FMD) and haemorrhagic septicaemia.

Table 12.1 **Types of risk in livestock livelihoods**

Production risk	*Price risk*
Death, accidental and natural	Weak rural infrastructure, e.g. roads, temperature-controlled supply chain
Disease: – High morbidity due to epidemics and variable risks – Stoppage of milk production due to diseases such as mastitis and FMD	Fluctuations in cost of livestock and products
Problems in input supply: – Lack of dry and green fodder for animals – Lack of water during droughts causing stress	

Animal death is the biggest risk for poor cattle owners. Since animals often represent a major asset for a low-income household, perhaps even its most valuable asset, their death can cause a significant decline in the household's net worth, not to mention a fall in income and productive output. If the animal has been purchased through a loan, the household may have a debt on an asset it no longer owns.

Depending on the context, other risks are also important. Heffernan et al. (2003) conducted a survey of 3 000 households across Bolivia, India and Kenya and found that livestock diseases are the most significant problem for approximately 20 per cent of all producers. Others (Perry et al., 2003; Pica-Ciamarra, 2005) have argued that in low-income countries across Africa, Asia and Latin America animal diseases are a major factor in limiting meat and milk production and depressing livestock incomes. Moreover, for a majority of livestock livelihoods, especially in semi-arid areas, climate-related shocks that result in water and fodder scarcity constitute the most significant risk. Most of the production systems the poor engage in – agro-pastoral, pastoral and smallholder crop-livestock systems – are rain-fed, with severe shortfalls often resulting in productivity-reducing morbidity and, in many cases, widespread mortality.

The initial consequence of the growing water and fodder scarcity is a reduction in lactation rates, which lowers daily income. The calving frequency of weakened animals is also likely to be adversely affected, with consequences for the expected income stream from a future herd. In addition, emaciated livestock have impaired immune systems and are more likely to succumb to diseases, further perpetuating the cycle of morbidity. In extreme cases, severe shortages of water and forage lead to mortality.

Uninsured risks, particularly for valued productive assets, leave poor households exposed to serious losses from negative shocks. The welfare costs due to forgone investment opportunities and ineffective coping methods are considerable (Dercon, 2005; Dercon et al., 2005; Barrett et al., 2006; Carter and Barrett, 2006).

Mortality due to the key sources of vulnerability – starvation and disease – has generally been the most amenable to insurance, and comprises the set of risks that a majority of livestock insurance programmes cover. However, not all risks are insurable, and therefore it is important to build an overall risk management strategy that also includes reducing risk through preventive measures such as better feeding, vaccination, breeding and de-worming.

12.2 Livestock insurance provision to the poor

In the few examples of livestock insurance schemes in developing countries, governments and the public sector have often been the pioneers. As an extension of the agricultural support that governments may provide, including the guarantee of minimum prices for agricultural commodities, re-financing, extension services and subsidies for inputs, insurance covering the inherent risks of agricultural production is a complementary method to boost agricultural production and the economic welfare of rural households.

India, which holds the largest stock of livestock in the world and boasts one of the largest government-supported insurance programmes for agriculture in the developing world, has offered various livestock insurance schemes since 1971, when nationalized banks, through the Small Farmer's Development Agency, began to finance the purchase of cattle and offered mandatory insurance to protect their loans (Sharma, 2010). Table 12.2 describes the various programmes started by the Government of India since then.

Table 12.2 **Chronological events in the insurance history of India**

Year	*Implementing agency/programme*	*Note*
1971	"Cattle Insurance Scheme" by Small Farmer's Development Agency	Nationalized banks began to finance the purchase of cattle and agreed to collect premiums from beneficiaries. Cover was for one year and the premium was collected annually.
1983	"Cattle Insurance Policy" under Integrated Rural Development Program (IRDP)	Livestock and asset insurance was extended to the poor along with the IRDP subsidized loans (50 per cent subsidy). Compulsory product with loan. The premium amount was 2.25 per cent (death) + 0.85 per cent for permanent total disability and the product had no age limit for the cattle.
1983	Livestock insurance under market agreements	Voluntary product and no subsidy. For animals not covered under IRDP. Premium: 2.85 to 4.00 per cent. Age specified: two to eight years for milk cow, three to eight years for buffalo.
2006	"Livestock Insurance Scheme" implemented by State Livestock Development Boards and State Animal Husbandry Departments	The insurance premium is subsidized 50 per cent. Competition increased between public and private players; premium not to exceed 4.5 per cent for annual policies and 12 per cent for three-year policies.

One salient similarity between these programmes is that even where private players have underwritten the risk and provided the agency and distribution services, the Government of India has subsidized these efforts, mostly by paying 50 per cent or more of the market premium. Despite this, product take-up has been relatively low, with less than 8 per cent of total insurable cattle covered (indiastat.com, 2010). Among the reasons cited for such a performance are poor implementation and limited distribution, inability or unwillingness to pay, and limited awareness of the product.

This pattern of government support is mirrored in other developing countries with livestock insurance programmes. In Eritrea, the National Insurance Corporation of Eritrea (NICE), established in 1993, offered a range of subsidized insurance products ranging from medical and asset accident insurance to various agricultural policies, including livestock losses (Mohammed and Ortmann, 2005). NICE's livestock insurance policy, limited to dairy cattle, indemnifies the insured for death due to accidents, illness, diseases and epidemics. With a subsidized premium of 4 per cent of a cow's value, indemnification is limited to 75 per cent of the sum insured.

Despite the high asset value of cattle in Eritrea and the considerable mortality risks faced, almost 10 years after the product was offered only 4.4 per cent of dairy farmers have used its services (Mobae, 2002). Studies indicate that such a low demand is due to poor NICE cover, lack of farmer understanding of the product, and an ineffectively tailored product (Mohammed and Ortmann, 2005).

In the Islamic Republic of Iran, where agriculture accounts for a quarter of the nation's GNP and 85 per cent of the agricultural workforce is employed in livestock production (Naeemi Nezam Abadi, 1999), livestock insurance is offered through the state-owned Agriculture Bank. While the product is subsidized and target clients claim strong demand for livestock insurance, take-up has been quite weak (Chizari et al., 2003). The cost and unfavourable terms of the policy, as well as slow and uncertain claims payments, have been highlighted as the cause of the poor acceptance level (Chizari et al., 2003).

Viet Nam has had a more varied and comprehensive experience with livestock insurance than Eritrea and Iran because the role of the state has been more pronounced and livestock insurance has been offered as a stand-alone product. In Viet Nam, much like in India, the logic behind livestock insurance is driven by the demand for credit for livestock purchases. Sixty per cent of households currently take out loans for livestock production and 54 per cent of all formal loans in the rural areas of northern, central and southern Viet Nam are for livestock (Dufhues et al., 2004; Duong and Izumida, 2002). As such, there is a demonstrated need for livestock insurance to protect lenders from default risk.

Dufhues et al. (2004) investigated the constraints and potential of livestock insurance schemes in Viet Nam by looking at four different types of insurance providers: a credit-linked insurance product within a state-owned company; a credit-linked insurance product offered through a development project; a pure livestock insurance contract offered by a state company; and finally, a private insurance company. These efforts faced several challenges, including the collapse of the state-owned company offering pure livestock mortality contracts, and large losses met by the state-owned company and the development project offering credit-linked products. Dufhues et al. (2004) conclude that the lack of mortality data available to determine premiums accurately, as well as political pressure to set low-level premiums, have been the biggest problems facing the development of a sustainable livestock insurance market for smallholders in Viet Nam.

The progress made in Viet Nam, however, is promising. The private, strictly commercial initiative was driven by Groupama, one of Europe's leading multiline insurance companies with a strong emphasis on agricultural insurance across the world. In September 2002, Groupama began to offer livestock insurance in Viet Nam. After the first several years in which Groupama made losses on this product, the company has expanded its extension infrastructure, opened complementary veterinary shops to assist with monitoring and verification, carried out data collection exercises to improve its understanding of the risks, and revised its product terms.

Similar experiments have been conducted by BASIX and IFFCO-Tokio in India. BASIX's successful implementation of the product has constantly led to lower mortality and morbidity in the area and more widespread livestock insurance *(Box 12.1)*. Preliminary results from the Indian insurer IFFCO-Tokio's technology-driven product give hope that livestock insurance can be commercially viable *(see Box 12.2)*.

Box 12.1

Livestock risk management strategy by BASIX, India

BASIX, a livelihood promotion institution, offers a full range of financial and non-financial services to assist poor households. Bundled with preventive veterinary care, its livestock insurance product underwritten by Royal Sundaram covered 26 129 cattle as at 31 March 2008. One of the main process innovations was that the certification of animal value and health was delegated to BASIX field staff. It reduced transaction costs as no veterinarians were involved, so the product could be offered at a lower price. The lack of technical knowledge was overcome by staff training. It was also assumed that even if the BASIX staff made some errors, the benefits of this solution would outweigh costs, which were previously generated by low-quality and fraud-prone veterinary services.

To reduce mortality risk, field staff provide preventive veterinary services to policyholders. Other product features included a 10-day waiting period from the date of tagging, 100 per cent sum insured, underwriting by the insurance company based on submission of electronic data by BASIX, and a discount on premiums for multiple animals (5 per cent for two animals, 10 per cent for three or more). These features have enhanced the value proposition to farmers, and reduced fraud and moral hazard.

Source: Adapted from BASIX, 2011.

Before introducing some of the innovations in processes and policies that can unleash the promise of livestock insurance, the next section describes in greater detail some of the difficulties that must be overcome.

12.3 Difficulties in providing livestock insurance

Livestock insurance is a relatively small segment of the market, accounting for 4 per cent of the total agricultural insurance premiums written worldwide (Iturrioz, 2009). Observations indicate the huge potential but very low penetration of this market, which implies that livestock insurance is either too costly or is not designed to meet the specific needs of the target clientele. These problems – high cost of premiums or poorly designed products – are the result of a series of hindrances across the supply chain.

Like many other insurance products, livestock insurance is plagued by the twin problems of moral hazard and adverse selection, which are based on asymmetric information between the insurer and the insured. Ineffective identification techniques, costly claims verification methods, and a lack of standard valuation considerably facilitate the rampant fraud in the industry. In parts of India, insurers fear that a substantial portion of livestock insurance claims are fraudulent, as indicated by the high mortality rate in insured areas (Sharma, 2010). To curb losses due to moral hazard and adverse selection, insurers resort to tighter controls which not only increase the costs of premiums but also make it difficult to comply, thereby discouraging take-up. There is a serious need to improve verification and monitoring processes to break the perpetuating cycle of fraud and low take-up.

Livestock insurance, particularly those products targeted at smallholder populations in rural areas, is considered a transaction-heavy product for the following reasons:

– **Monitoring and verification:** To combat fraudulent claims, insurers must appoint their own veterinarian, or other relevant agent, for tagging, valuation and risk calculation. Verification of a loss in remote rural areas for one to two insured animals is a considerable transaction cost relative to the revenue stream drawn from the particular client.
– **Valuation of animals:** The value of livestock is closely correlated with their age, health and production capacity. Due to the range of breeds in different geographical areas with different feeding patterns, insurers find it difficult to assess the correct value and are therefore hesitant to enter this market.
– **Identification of animals:** Insurers obviously need to know which animals they are insuring; however, poor identification techniques substantially increase the moral hazard problem and consequently affect product pricing.
– **High operational cost:** Operational processes associated with issuing policies and settling claims can be labour-intensive, and hence expensive.
– **High incidence of fraudulent claims:** Fraudulent practices are rampant in livestock insurance due to fragile identification methods.

– **Absence of actuarial pricing:** It is difficult to produce an effective design in an environment lacking in data to make credible probability assumptions and to price insurance products appropriately. Consequently, underwriting becomes difficult when the policyholder is unable to or does not disclose the correct health status and history of animals.
– **Complementary systems for risk reduction:** Most livestock support services such as artificial insemination or natural service, vaccination and de-worming are time-sensitive. Government institutions are not always able to deliver on time due to both financial and bureaucratic constraints. Though the government understands that there is a compelling need to improve the dairy and animal husbandry sectors, efforts can be so thinly spread that the desired positive effects are not achieved. Therefore, many obstacles remain unchallenged, probably due to the public nature of animal health interventions.

While supply-side obstacles present the biggest hindrances to a sustainable livestock insurance market, demand considerations must also be taken into account. Demand-side challenges for livestock insurance are not much different from those for other insurance products. Inability or unwillingness to pay, coupled with a limited knowledge of the product, hinder the growth of livestock insurance.

12.4 Catalysing the market: Innovations to make livestock insurance viable

Despite these significant challenges to achieving viability and scale, some innovations are emerging that enable the obstacles identified to be circumvented. As explained below, some recent developments in product design, identification methods, operational processes, institutional models, technology and subsidies may pave the way for the expansion of viable livestock insurance.

Expansion of product risk cover

There is a need for more comprehensive cattle-care covers. Most livestock products cover mortality and its various causes, but insurance may be more attractive if it addresses more than death risk and tries to graduate towards "productivity cover". Productivity (e.g. lactation rates or calving frequency) can be affected by disease, climactic extremes and other factors that lead to considerable income shocks for the poor. While greater risk cover means higher premiums and thus lower demand from households with limited liquidity, premiums for such products could be made more attractive by bundling them with risk-reduction strategies to contain overall risk and help households benefit from the arrangement.

Improved identification methods

Various identification methods have been tested in the market with interesting trade-offs between costs and effectiveness *(see Table 12.3)*. As shown by the IFFCO-Tokio example *(see Box 12.2)*, the rapid improvement in technology for the identification and tracking of livestock may help overcome one of the biggest difficulties for livestock insurance. Radio frequency identification (RFID) not only facilitates identification, but also has other important applications, such as the ability to gather and store appropriate data easily. Once RFID technology has enabled sufficient data to be generated and recorded it will become easier to implement risk-reduction measures and to track diseases than it has been in the past. Technologies that can help identify and track the physiological characteristics of animals need to be further analysed so that their costs and benefits can be assessed. In time, cost reduction, greater efficiency and the information-provision capacity of technology-based livestock identification and tracking systems will reduce the expense of monitoring and bring down the incidence of fraud. This should permit a considerable reduction in premiums.

Table 12.3

Comparison of different techniques for identification of livestock

Issue/strategy	*Read distance*	*Ease of reading*	*Retention*	*Ease of application*	*Cost*
Metal tag	Inches	Varies	Low	Easy	< US$0.01
Branding	Feet	Good (while still visible)	Fades over time	Difficult	Cheap
Tattoo	Few metres	Low	Fades over time	Difficult	Cheap
Ear notch	Feet	Difficult	Long	Difficult	Cheap
Colour pattern	Metres	Difficult	Long	n.a.	Cheap
Bar-code	Inches	Varies	Good to moderate	Easy	Cheap
RFID (implant)	Inches to feet	Easy	Good to moderate	Slightly difficult	US$1 to US$4 (depends on volume)
RFID (external)	Inches to feet	Easy	Good to moderate	Easy	US$1 to US$4 (depends upon volume)
DNA testing	n.a.	Lab testing	Lifetime	Test takes time	Very expensive
Retinal imaging	Inches to feet	Easy	Lifetime	Equipment set-up	Not used extensively
Muzzle identification	Inches	Requires expertise	Good	Precautions to take muzzle imprint	Still in experimental stage

Source: Adapted from Comparison of animal identification devices and numbering systems, 2010.

Improved processes

Both the BASIX and IFFCO-Tokio examples described in this chapter emphasize the importance of redefining the involvement of veterinarians in the livestock insurance processes. There is a high risk of collusion between veterinarians and farmers and even other intermediaries involved in the value chain, such as lenders. Therefore, both schemes employ their own veterinarians and use their front-line staff to take over some of the veterinary tasks.

Box 12.2

Improving the viability of livestock insurance at IFFCO-Tokio

IFFCO-Tokio is testing a livestock insurance model to reduce fraud by using an identification device based on RFID technology. In the period from August 2008 to March 2010, almost 15 000 cattle were insured. While the project is still in its pilot stage, the lower claims ratio (42 per cent), which is less than a fifth of the claims ratio with traditional ear tags, suggests that the new technology is working.

Perhaps even more important than the technology is the change in process that IFFCO-Tokio initiated because of the technology. IFFCO-Tokio now oversees the tagging of each new animal, reducing the possibility of claims being filed for uninsured animals. There is still visible resistance to the new technology from bank staff and veterinarians as it is no longer possible for them to make fraudulent claims. Contrary to previous concerns, the RFID-driven cattle product is well accepted by clients. By and large, the cattle owners accept the new technology as the enrolment and claims processes are clear, and the technology does not increase stress for cattle. Some have even indicated that they prefer RFID to the external tag because it protects their privacy, as neighbours do not know that they received a loan to purchase the animal.

Source: Adapted from the ILO's Microinsurance Innovation Facility, 2011a.

Index-based insurance

Index-based insurance is a promising innovation that has gained attention over the past decade and given rise to many pilot products across the world *(see Chapter 11).* Index-based insurance products might be particularly relevant given low-income households' growing exposure to climate-related risks *(see Chapter 4).* The creation of insurance markets for events that can be precisely calculated and linked to a well-defined index is increasingly being championed as a way to make the benefits of insurance available to the poor (World Bank, 2005; Skees, 2008; Hazell et al., 2010).

Although typically associated with crop insurance, index-based insurance can also be relevant for livestock cover *(see Table 12.4).* This technology sharply reduces transaction costs and hence may help to make a product profitable. Index-based insurance also helps to reduce the moral hazard and adverse selection problem. However, all this comes at the cost of basis risk, whereby there may be a discrepancy between the insurance payout and the farmer's actual losses.

Table 12.4

Index-based insurance experiments for livestock insurance

Country	*Scheme or type of insurance*	*Salient features*	*Service provider*
Mongolia	Death cover	Index-based product for migrating population during harsh winters based on historical mortality rates	Risk-layering by cattle rearers, insurers and government
Kenya	Cover for catastrophic events like drought, which impacts fodder	Index-based product against drought and other weather phenomenon using NDVI	Pilot by private insurers with the support of the International Livestock Research Institute

Mongolia was the first to pilot an index-based insurance product for livestock that covered substantial losses due to extreme winters *(see Box 12.3).* In January 2010, the second index-based livestock insurance product was launched in the Marsabit district of northern Kenya and was aimed at providing insurance cover for livestock mortality due to a prolonged lack of forage (Mude et al., 2010). The Marsabit index is derived from a satellite-based normalized differenced vegetation index (NDVI) series that summarizes the state of rangeland forage availability. More than 1 000 livestock were insured during the period to May 2011.

Both of the projects are still in their experimental phase and need datasets to substantiate the success stories. Moreover, index-based livestock insurance might be effective in semi-arid zones but its application to areas with more complex, multi-activity agricultural production might not be possible. The jury is still out on the effectiveness of this solution if no subsidies are received from the Government.

Community-based model

While there are few experiments around the globe to test and verify community-based models for livestock, their potential benefits cannot be neglected. The Livestock Protection Scheme (LPS) running in Andhra Pradesh, India is one example. The programme was successful in reducing fraud through community supervision and vigilance (Sharma and Shukla, 2010). The programme managed to keep the total delivery costs down and achieved significant outreach *(see Table 12.5).* Close monitoring with strong community ownership resulted in reduced fraud, helped to build trust among community members and was instrumental in increasing enrolment. However, the scheme is self-insured, which might become a problem if mortality increases and, as with many community-based schemes, it might run into governance problems when a larger scale is achieved.

Box 12.3

Index-based livestock cover in Mongolia

In 2005, the World Bank was invited to assist the Government of Mongolia with a livestock insurance programme. Since it was clear that it would be impossible to implement a traditional scheme that performed a loss assessment on animals in the vast space of Mongolia in harsh winter conditions, alternative methods for measuring livestock losses were sought. Mongolia had been conducting a census of animals every December since the early 1920s, which provided estimates of mortality rates of animals by species and by *soum* (rural districts). It was proposed that these data be used as the basis of premiums for a new insurance programme. Policymakers and others understood that premiums based on *soum*-level mortality rates would retain the incentives for herders to work hard to save their animals in severe winter conditions.

The goal of index-based livestock insurance (IBLI) is to provide cover for catastrophic livestock mortality events within a region, recognizing that smaller, individual livestock mortality risks are better addressed through appropriate household-level risk management strategies. The IBLI pilot involves a public–private partnership with a commercial insurance product, the Base Insurance Product (BIP), and a Disaster Response Product (DRP) to compensate herders when major livestock losses occur. The BIP pays when *soum* livestock mortality rates exceed 6 per cent. Losses beyond 30 per cent are managed by the DRP and currently paid with a contingent loan from the World Bank, with the intention that they will be financed by the Government of Mongolia after the pilot ends. Thus, the commercial exposure (BIP) is for the layer between 6 and 30 per cent mortality and the social component (DRP) is for losses exceeding 30 per cent mortality. Herders can select their sum insured based on an aggregate value of all their animals for the specific species. Typically, herders have been insuring about 30 per cent of the estimated value of their animals.

In general, IBLI has exceeded the performance goals that were developed when the project started. Four insurance companies are currently participating. In 2006, 2400 policies were sold; over 3700 policies were sold in 2007; and 4100 policies were sold in 2008, representing 14 per cent of herders in the pilot provinces. In 2008, following high livestock losses, US$340000 was paid out to 1783 herders. All financing systems worked as planned; a small amount was drawn from the contingent debt facility. Lenders have offered lower interest rates and better terms for loans to insured herders, and the National Statistics Office has successfully implemented a mid-year census to facilitate timely payments as most losses occur in the first five months of the year.

Source: Adapted from GlobalAgRisk, 2009.

Table 12.5

Parameters of performance for LPS, Andhra Pradesh, India

	2006 to 2007	*2007 to 2008*	*2008 to 2009*	*2009 to 2010*
Enrolment	3 519	4 756	48 675	90 035
Claims received	96	120	327	–
Percentage of claims	2.73	2.52	0.67	–

Source: LPS, DRDA, State Government of Andhra Pradesh, India, 2011.

Smart subsidies

As transaction costs are high and capacity to pay is low, governments may need to intervene to catalyse livestock insurance. This has often been accomplished with the provision of blanket subsidies to state-owned insurance companies or even as discounted premiums paid to private insurers. While a strong case can be made for the need for subsidies to support nascent ideas that may result in social welfare gains, their application has often been ad hoc, dampening incentives for innovation, and has been blamed for many failed attempts to provide livestock insurance. In addition, as mentioned above, various government programmes have shown that direct subsidies have not helped to increase coverage, instead leading to stagnation in product development.

There is a strong case for well-targeted "smart" subsidies that could help to accelerate the development of livestock insurance based on the principles of a competitive market:

- **At producer/farmer level:** Subsidies can be used as premium discounts for livestock keepers who practise risk-reducing husbandry. It will help to achieve the objectives of inculcating good risk-reducing practices by rewarding those who engage in them with discounts, and reducing overall premiums by minimizing the actual exposure to risk.
- **At intermediary level:** Where aggregators help to pool risks and reduce transaction costs, subsidies could be in the form of the fixed costs to set up the necessary business processes. Intermediaries can also be encouraged to provide data or other services that can help insurers operate more efficiently at lower cost.
- **At insurers' level:** Premium subsidies could be given to insurance companies, but they should regularly bid for these subsidies in an open and transparent system that allows new competitors to enter. The provision of premium subsidies could also come with conditions that insurance companies must adhere to, such as performance contracts, to retain the business.

The provision of subsidies can reduce premiums, stimulate demand and improve innovation in contract design by increasing information, reducing the leakage due to fraud and allowing the provision of premium discounts to clients who take other risk-reduction measures. However, as the PICC case study shows *(Box 12.4)*, even if subsidies can make the product more affordable, it might not be enough to stimulate demand for it.

Box 12.4

Paying the premium after the term?

PICC, a state insurer in China, in collaboration with the Government's agriculture extension services, has been piloting a voluntary swine insurance product since 2005 in Sichuan province. The local government pays a 40 per cent subsidy for the premium, which is set at an affordable rate of RMB 10 (US$1.50) per animal. Demand for insurance remains low even when premiums are heavily subsidized. Sales stagnated at the level of 200 000 pigs covered annually, or 20 to 25 per cent of the total market.

Liquidity constraints and a lack of trust in insurers play important roles in the low take-up of microinsurance. To overcome these problems, researchers from the Beijing-based International Centre for Agricultural and Rural Development (ICARD) and the US-based International Food Policy Research Institute are testing an alternative premium collection arrangement in which farmers will be allowed to defer paying until the end of their insured period. Farmers who enrolled in the pilot programme in 2011 were provided with an insurance voucher that identified them as having the swine insurance cover. This arrangement enables farmers to benefit from insurance despite the trust issue and liquidity constraints they face. Default on premium payment is expected to be limited by eligibility to access insurance in the next period, as well as by the involvement of government extension services in the scheme.

Source: Adapted from the ILO's Microinsurance Innovation Facility, 2011c.

12.5 Conclusion

Livestock production offers a credible way out of poverty for many smallholder livestock keepers. However, for them to effectively participate in the livestock revolution and share in its expected benefits, they must have access to methods of managing the various risks involved in livestock rearing and marketing.

Livestock insurance has the potential to help many livestock keepers manage the production risks they face. Despite its promise, however, the implementation of livestock insurance poses many challenges. The supply of livestock insurance is hampered by difficulties in identifying and tracking insured livestock and the substantial cost of making sales to smallholders in remote areas. This naturally creates disincentives for the design of intelligent policies. Catalysing supply would require tapping into innovations in new information technologies that reduce fraud and the costs of delivery. It is important to point out that in the current distorted market, demand also remains a big problem due to lack of awareness and unwillingness to pay the premium.

Solutions can be developed to improve the livestock insurance markets throughout the world. The application of index-based and community-based models to livestock insurance is definitely worth further exploration. Better marketing strategies and motivating insurance sales agents to sell livestock insurance products will certainly help to boost demand. New technologies such as RFID and NDVI are being tested. Finally, the livestock insurance sector can aim to build strong livestock management systems. Risk reduction and risk transfer systems should be integrated so that the overall performance of the livestock sector can be improved.

Despite early failures in livestock insurance provision, a more favourable institutional and infrastructural environment, technological improvements in design and delivery, and growing demand, not to mention insights gained from previous experiments, offer hope for commercially viable and welfare enhancing livestock insurance. Even where subsidies may be necessary, the case for subsidized livestock insurance as a productive safety net to facilitate the entry of the poor into livestock production and marketing could be compelling.