Module 11: ICT APPLICATIONS FOR AGRICULTURAL RISK MANAGEMENT

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IN THIS MODULE

Overview. Risk and uncertainty are ubiquitous and varied in agriculture. They stem from uncertain weather, pests and diseases, volatile market conditions and commodity prices. Managing agricultural risk is particularly important for smallholders because they lack resources to mitigate, transfer, and cope with risk. Risk also inhibits external parties from investing in agriculture. Timely information is essential to managing risk. Information communication technologies (ICTs) have proven highly cost effective instruments for collecting, storing, processing, and disseminating information about risk.

Topic Note 11.1: ICT Applications for Mitigating Agricultural Risk. ICTs have reduced the costs of gathering, processing, and disseminating information that helps farmers mitigate risk. Information services using mobile phones and radios can direct early warnings of inclement weather, market movements, and pest and disease outbreaks to farmers. With an early warning, steps can be taken to limit potential losses. Farmers can also access advisory services remotely to support their decisions related to risk-mitigating activities or to choose the most appropriate action in response to an early warning. These decision support systems are critical for transforming information into risk-mitigating action.

• Through mKRISHI, Farmers Translate Information into Action to Mitigate Risk

Topic Note 11.2: ICT Applications to Transfer Agricultural Risk. Applications of ICTs to transfer agricultural risk through instruments such as insurance and futures contracts are still quite limited. The widespread use of these instruments seems to be hampered by low levels of institutional development, high costs, inability to customize products to meet smallholders’ requirements, and poor financial literacy rather than by the information constraints that ICTs can address. In a few instances, ICT applications are facilitating the design and delivery of index insurance. Although ICTs have made it easier for smallholders to access and participate in spot commodity exchanges, their use of ICT to participate in futures contracts to hedge price risks remains a distant dream.

• ICTs Enable Innovative Index-based Livestock Insurance in Kenya
• Kilimo Salama Delivers Index-based Input Insurance in Kenya through ICTs

Topic Note 11.3: ICT Applications for Coping with Agricultural Risk. While there have been few applications of ICTs to cope with agricultural shocks, those that exist are proving important and potentially transformative. Mobile phones enable ground personnel or affected persons to report more easily to whoever is coordinating a response to the shock. This communication leads to better-targeted relief efforts. In the event of a shock, ICTs facilitate transfers and remittances to farmers from state and relief agencies as well as from farmers’ extended social networks. Finally, disaster management is using more sophisticated applications to collect and synthesize information from the field. In the future, these disaster management applications might be applied to respond to agricultural shocks.

• Electronic Vouchers Are a Targeted, Traceable Lifeline for Zambian Farmers
• Community Knowledge Workers in Uganda Link Farmers and Experts to Cope with Risk
The module begins by distinguishing among the kinds of risks that affect agriculture and then describes three major strategies for managing risk: risk mitigation, transfer, and coping. The crucial role played by information and ICTs in each major risk management strategy is described, along with lessons from the experience to date. Topic notes and innovative practice summaries detail specific applications, their lessons, and principles for success.

Defining and Describing Risk

The terms “risk” and “uncertainty” indicate exposure to events that can result in losses. Although the terms are often used interchangeably, they have slightly different meanings. Risk can be defined as imperfect knowledge where the probabilities are known; uncertainty exists when these probabilities are not known. Many of the losses expected from the risks inherent in modern agrifood systems are in fact related to uncertain events for which there are no known probabilities, although subjective probabilities can be conjured by expert opinion (Jaffee, Siegel, and Andrews 2010).

Risk in agriculture can be further classified according to whether it predominantly affects the immediate production environment, markets, or the broad institutional context in which commodities are produced and supplied:

- **Production risks** include bad weather, pests and diseases, fire, soil erosion, other kinds of environmental degradation, illness and loss of labor in the farm family, and other events that negatively affect the production of agricultural products.
ECONOMIC AND SECTOR WORK

commodities. These risks have a direct, immediate impact on local agricultural production, but it is essential to understand that their effects are transmitted from the farm all along the supply chain.

- **Market risks** can include volatile prices of agricultural commodities, inputs (fertilizer, pesticide, seed, and so on), and exchange rates, as well as counterparty risks, theft, risk of failure to comply with quality or sanitary standards, or risks imposed by logistics. These risks usually emanate from market actors (such as traders and exporters), and their effects are transmitted back to the farm.

- **Enabling environment risks** can include political risks, the risk that regulations will suddenly be applied, risks of armed conflict, institutional collapse, and other major risks that lead to financial losses for stakeholders all along agricultural supply chains.

Risks can be idiosyncratic—affecting only individual farms or firms (for example, illness of the owner or laborers, acidic soil, particular plant and animal pests and diseases) or covariate—affecting many farms and firms simultaneously (major droughts or floods, fluctuating market prices). The high propensity for covariate risk in rural areas is a major reason that informal risk management arrangements breakdown and that formal financial institutions hesitate to provide commercial loans for agriculture (Jaffee, Siegel, and Andrews 2010).

**Risk Management Strategies**

Agrarian communities have traditionally employed various formal and informal strategies to manage agricultural risk, either before or after the effects of risk are felt. Ex ante strategies (adopted before a risky event occurs) can reduce risk (by eradicating pests, for example) or limit exposure to risk (a farmer can grow pest-resistant varieties or diversify into crops unaffected by those pests). Risk can also be mitigated ex ante by buying insurance or through other responses to expected losses such as self-insurance (precautionary savings) or reliance on social networks (for access to community savings, for example).

Ex post strategies (adopted to cope with losses from risks that have already occurred) include selling assets, seeking temporary employment, and migrating. Governments sometime forgive debts or provide formal safety nets such as subsidies, rural public works programs, and food aid to help farms and firms (and their laborers) cope with negative impacts of risky events.

Although ex ante measures allow farms and firms to eliminate or reduce risks, reduce their exposure to risk, and/or mitigate losses associated with risky events, they present real and/or opportunity costs before a risky event actually occurs. In contrast, ex post risk management measures respond only to losses that actually occur, but they can have very high real and opportunity costs when that happens. Farmers make decisions based on their evaluation of risks and the resources at their disposal.

Each strategy for managing risk can be carried out through a variety of instruments, each with different private and public costs and benefits, which might either increase or decrease the vulnerability of individual participants and the supply chain. When selecting a mix of risk responses, it is essential to consider the many links between risk management strategies and instruments (Jaffee, Siegel, and Andrews 2010).

To sum up, agricultural risk management strategies can be classified into three broad categories:

- **Risk mitigation.** These actions prevent events from occurring, limit their occurrence, or reduce the severity of the resulting losses. Examples include pest and disease management strategies, crop diversification, and extension advice.

- **Risk transfer.** These actions transfer risk to a willing third party, at a cost. Financial transfer mechanisms trigger compensation or reduce losses generated by a given risk, and they can include insurance, reinsurance, and financial hedging tools.

- **Risk coping.** These actions help the victims of a risky event (a shock such as a drought, flood, or pest epidemic) cope with the losses it causes, and they can include government assistance to farmers, debt restructuring, and remittances. Government and other public institutions, through their social safety net programs, play a big role in helping farmers cope with risk.

There is a distinct role for both public and private institutions in helping smallholders to manage agricultural risk. Private interventions include individual actions and private arrangements among individuals (either informal arrangements or formal, contractual arrangements). Governments have a supporting role to play here, which may include providing infrastructure, information, and a suitable framework for private institutions. As noted, governments and civil society also have a role as providers of safety nets.
Central Role of Information and ICTs in Risk Management

All of the above-mentioned strategies—risk mitigation, transfer, and coping—have limitations, and farmers often deploy a combination of strategies to manage their risks. The mix of strategies often depends on factors like the availability and understanding of different risk management instruments, institutional and physical infrastructure, a farmer’s capabilities and resource endowment, and a farmer’s social network. Information about what needs to be done, when, how, and why is fundamental for smallholders and other stakeholders in the agricultural sector to implement actions to mitigate risk, transfer risk before it occurs, and determine how to cope once those events have occurred.

Farmers’ information needs and sources are varied and change throughout the agricultural production cycle (table 11.1), but all farmers require a comprehensive package of information to make decisions related to risk.

Farmers typically have been poorly informed. As the founder of a market information service noted:

Most [farmers] have long relied on a patchy network of local middlemen, a handful of progressive farmers, and local shop owners to receive decision-critical information, whose reliability, accuracy, and timeliness can have a critical impact on their decision making and therefore livelihood. These are fundamental decisions, such as what price to sell the crop, where to sell (given the numerous fragmented markets), when to harvest, and when to spray pesticides to save the crop.

Mehra 2010

Research in Sri Lanka found that the cost of information, from the time the farmer decides what to plant until produce is sold at the wholesale market, can be up to 11 percent of production costs. The study also found that information asymmetry is an important contributor to overall transaction costs (De Silva 2008). ICTs such as the Internet, networked computers, mobile phones, and smart phones are the latest in a long line of technologies (the newspaper, telegraph, telephone, radio, and television) that support risk management practices by collecting, processing, distributing, and exchanging information (World Bank 2007).

A survey of current applications of ICTs to manage agricultural risk suggests that they are valuable for two primary reasons. First, ICTs channel information, advice, and finance to farmers who are difficult to reach using conventional channels. Second, ICTs reduce the costs for organizations to provide risk management services, because they can greatly reduce the costs of collecting, storing, processing, and disseminating information.

These cost reductions have produced two effects that encourage private investment in ICTs to manage agricultural risk. First, previously unprofitable activities have become profitable. Second, reductions in operating costs can reduce prices for the end user. Products and services that were once too expensive for the poor have come within reach, opening a new market segment for risk management products.

The use of ICTs to manage agricultural risk is at such an early stage that it is difficult to discern trends, but interesting developments are underway. Increasingly, the private and public sectors are collaborating to invest in ICTs that can deliver timely information to farmers. With continuing improvements in technology, software, and infrastructure, the quality and richness of that information are improving over time to address specific needs for individual farmers.

Information services will allow farmers ever more interactive, two-way communication with agricultural experts and others in the agricultural innovation system (see Module 6). With the incorporation of ICTs, supply chains are becoming far more transparent and capable of including smallholders (see Module 10). The technology seems to help farmers avoid default risks and produce to consistent quality specifications, which is an important step towards participating in more lucrative commodity markets.

As observed earlier, the encouraging trend in risk transfer products is the use of ICTs to design insurance contracts.

| TABLE 11.1: Farmers’ Information Needs in Relation to the Crop Cycle and Market |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| **BEFORE PLANTING**         | **BEFORE HARVEST**          | **AFTER HARVEST**           | **MARKET INFORMATION**      |
| • Information on agricultural inputs such as seed, fertilizer, pesticide | • Good agricultural practices | • Postharvest management | • Alternative market channels |
| • Credit                    | • Pest management           | • Storage                   | • Commodity prices          |
| • Weather                   | • Harvesting time and techniques | • Grading and standardization | • Wholesale market price information |
| • Soil testing              | • Packaging                | • Logistics                 | • Consumer behavior         |

Source: Adapted from Narula and Sharma 2008.
deliver insurance policies, assess crop damage, and deliver indemnity payments. Although the agricultural insurance markets in developing countries are very small, ICTs clearly have features that should help broaden those markets.

With regard to risk coping, technologies that allow real-time visualization and assessment of damage are beginning to be applied to agricultural shocks such as floods. Two other technologies—mobile money and electronic voucher systems—are expected to be more regularly incorporated into the operations of multilaterals and governments that must transfer funds to beneficiaries without access to financial institutions (see Module 7).

**KEY CHALLENGES AND ENABLERS**

If it is difficult to ascertain trends from nascent activities such as those described in the topic notes, it is even more challenging to assess outcomes and draw lessons. Many of these activities should be evaluated rigorously to determine their impacts and critique their approaches to using ICT in managing agricultural risk. Despite these caveats, several preliminary insights, cross-cutting challenges, and key enablers for risk mitigation, risk transfer, and risk coping should be noted.

First, in some instances, farmers will pay for risk management services, particularly information services, customized to their needs. However, before adequate customization occurs, most risk management services need public or private funding to support farmers’ initial access. Thus partnerships are central to assembling the combination of knowledge, skills, and resources required to manage risk through the use of ICTs.

Successful efforts display cooperation between software developers, hardware manufacturers, agricultural experts, financial intermediaries, state governments and institutions, donors, nongovernmental organizations (NGOs), mobile operators, and others in the private sector. These partners might have different incentives for participation that may not always be compatible, and different stakeholders may have different time horizons. To hold such partnerships together, an appropriate balance must be struck between stakeholders’ competing interests and short- and long-term gains.

Because partnerships, particularly with the participation of the private sector, are so vital in risk management, an enabling policy environment and institutional framework supporting business and entrepreneurship is also critical to incentivizing private investment to cope with or transfer risk. Additional fundamental elements are adequate physical and telecommunications infrastructure for the cost-effective deployment of ICTs. Where costs are sufficiently low because mobile infrastructure is already available, more profitable opportunities may exist. Successful ventures will offer insight into ways of ensuring sustainability and use on a wide scale.

Farmer capacity is also challenging. Rural areas, where risk management services are so desperately needed, also lack education services, financial services, and even agricultural services. Many aspects of human capacity—such as financial literacy, knowledge of best agricultural practices, and familiarity with technology—are prerequisites for using risk management tools successfully.

Highly developed software programming skills and technical expertise are also critical for deploying ICTs. Many risk management services were able to leverage the significant human resources of larger organizations such as Reuters and Tata Consulting Services to develop their software (see Topic Note 11.1). This capacity is not universally available. In addition, providers must be able to assess and thoroughly understand the needs of their clients; experience shows that most technology-driven projects that do not connect with and address users’ needs have higher rates of failure.

Women and other vulnerable groups do not have equal access to risk management tools. Traditional cultural norms in many societies restrict women’s mobility, education, assertiveness, and awareness, all of which affect their ability to acquire information or advisory services to help manage agricultural risks. The underlying structural gender constraints make them passive recipients rather than active seekers of information. Even when women proactively seek information, their access to information and ability to use it are hampered by gender norms and stereotypes (ILO 2001:6).

Theoretically, the impersonal nature of ICTs overcomes some of the traditional barriers and gender asymmetries that women face in accessing information. A mobile phone, for example, does not differentiate between a female farmer and a male farmer, but a male extension worker might. It is often difficult for women farmers to travel long distances to ascertain market prices, but a short messaging service (SMS) might deliver that information without breaking any traditional stereotypes and gender norms. Very little data, disaggregated by the gender of beneficiaries, is available on the impact of ICT applications in agricultural risk management. Increasing gender-disaggregated data and analyzing the effects of risk management instruments on
women’s agricultural experience over the long term could provide useful guidance for improving women’s access to such instruments.

Trust in information and trust in transfer products are also critical issues in risk management. The information delivery mechanism seems to influence farmers’ confidence and trust in the information as well as how they use it. Farmers are more likely to act upon information received directly from an expert than on information provided by an automated database. Farmers are also more likely to trust and act on information they receive from a person standing in front of them than from somebody on the phone or an automated phone message.

Because most initiatives discussed in this module have yet to be studied rigorously, it is difficult to draw quantitatively sound causal relationships between ICT for risk management interventions and gains in risk reduction. Support is needed for research to establish the impact of ICT in risk mitigation, transfer, and coping systems. Such evidence would not only improve the interventions but garner support to scale up effective innovations.

In nearly every instance in which investments in ICT have helped agricultural stakeholders to manage risk, external support has been critical for providing complementary public goods, including:

- **Infrastructure**, especially electricity delivery and mobile network coverage.
- **Institutional and regulatory reform**, especially with regard to commodity markets that raise barriers to the adoption of ICTs for risk management.
- **Business climate reforms** to encourage continued participation and innovation from the private sector. Donors can also encourage and foster cooperation among public and private sector actors.
- **Technological, agricultural, and financial literacy among smallholder farmers.** Low literacy represents a significant barrier to smallholders’ effective use of ICTs to manage risk.

Donors such as the World Bank can also monitor innovative applications in risk management, evaluate their impact on small-scale farmers and the agricultural sector, and provide research and technical support where necessary.

**Topic Note 11.1: ICT APPLICATIONS FOR MITIGATING AGRICULTURAL RISK**

**TRENDS AND ISSUES**

While agriculture will continue to be risky, many risks can be mitigated by timely action and through the application of best practices. Typical risk mitigation actions might be spraying crops with the appropriate pesticides in response to an early warning of a nearby pest outbreak or optimally altering cropping patterns in response to news from commodity futures markets.

Information is the most critical requirement for effective risk mitigation, and farmers need a variety of information to make choices to manage risk. Two types of information are most important for risk mitigation:

- **Early warnings** about the likely occurrence of inclement weather, pest and disease outbreaks, and market price volatility.
- **Advisory information** to help farmers decide upon a course of action to manage production risks optimally or to respond to early warnings.

The connection between agricultural advisory services and risk mitigation is an important one, because information alone is often not sufficient to manage risk. In Uganda, for example, the Grameen Foundation found that even if a farmer knew that a banana disease was spreading nearby, he or she required help in choosing the right action to prevent infection of the plants they owned (Grameen Foundation 2010a).

In many cases, the early warning or decision support information already exists. State meteorological services generally collect weather information and create forecasts. Similarly, agricultural institutes, research universities, or extension services are typically well aware of best practices in crop selection, production techniques, input use, pest management, global commodity trends, and other topics critical to smallholder farmers. International organizations also generate early warning and decision support information. USAID’s Famine Early Warning System (http://www.fews.net) provides information for governments to manage food security risk, for example. A similar system at FAO helps to manage food security risk—the Global Information and Early Warning System (http://www.fao.org/gIEWS/english/index.htm).
One difficulty has been to collect and process this information so that it is relevant to individual farmers. Another has been to transmit the information to rural populations in poorly connected areas in cost-effective ways. ICT applications have made it easier and cheaper to achieve these objectives.

There is some doubt about whether an early warning alone can help farmers mitigate risk. Many of these causal links have not been tested empirically. Latent demand for advice in addition to warnings appears to exist, but it is not clear whether farmers are willing to pay for such advice delivered using ICTs or whether the private sector can deliver such information sustainably. Public-sector and development institutions should remain active in this space and keep a close eye on pilots in countries such as India, Uganda, and Kenya.

**RECENT ICT APPLICATIONS FOR RISK MITIGATION**

Farmers in many countries receive news of impending bad weather and catastrophic events, pest and disease outbreaks, and price volatility in commodity markets. The use of ICTs has reduced the cost and increased the profitability of providing this information, which has attracted private-sector participation in a space traditionally dominated by state extension services or agricultural institutes. The private sector originally developed services to provide market price information, but most of these services have evolved to deliver news about impending catastrophic and inclement weather.

**Risk-Mitigating Information**

The quintessential example of applying ICTs to agriculture is the Indian agribusiness giant ITC and its e-Choupal service (http://www.itcportal.com/rural-development/echoupal.htm), detailed in Module 9. This extensive network provides approximately 4 million farmers with information on market prices, the weather, pest and disease outbreaks, and expert advice. The service is free; ITC profits by using its information service kiosks to procure commodities and market agricultural inputs to farmers (ITC 2010).

Reuters Market Light (http://www.marketlight.org/) detailed in Module 3, modifies the information delivery model of e-Choupal by eliminating the kiosks and reaching out directly to farmers (box 11.1). Developed by the Thompson Reuters information company, the service provides highly personalized, professional information to India’s farming community. It covers over 250 crops, 1,000 markets, and 3,000 weather locations across 13 Indian states in 8 local languages (Mehra 2010). The information is delivered directly to farmers’ mobile phones through SMS. RML subscription cards can be purchased from local shops, input suppliers, banks, and post offices.

Rigorous, empirical evaluations have yet to be carried out to determine the quantitative relationship between information availability and the implications for risk mitigation. A preliminary study in Sri Lanka concluded that 40 percent of post-production losses could be mitigated with timely information (Mittal, Gandhi, and Tripathi 2010). From an internal study, Thompson Reuters claims that through information sharing, an estimated 1 million farmers in over 15,000 villages have used the service and received high returns on their investment, amounting to over US$ 4,000 from additional profits and US$ 8,000 on saved costs, far exceeding the service fee (International Chamber of Commerce 2010).

Through the ESOKO platform (http://www.esoko.com/) described in Module 3, West African farmers and traders
receive targeted, scheduled text messages on commodity prices or offers from buyers. The focus is on creating a transparent, stable market and reducing transaction costs. Similarly, the Kenya Agricultural Commodity Exchange (http://www.kacekenya.co.ke/) makes prices on the exchange available by text message (KACE 2010). These services improve farmers’ ability to negotiate prices and serve to partially mitigate price risk. Even so, they cannot mitigate the more significant price volatility that originates in global markets.

Research institutes are also innovating in the delivery of information services. MTT Agrifood Research Finland is piloting the EVISENSE project (https://portal.mtt.fi/portal/page/portal/mtt_en/ruralenterprise/tomorrowsfarm/envisense/forecast) to provide 24-hour disease forecasts to Finnish farmers using a combination of technologies such as weather sensors, databases, mobile phone SMS, GPS, and online management systems. Sensor networks across the country feed weather data to a centralized server. This centralized database contains farmer-specific cropping information provided by the farmer. Computer models use the site-specific data along with the weather data to predict pest outbreaks. If an outbreak is predicted, farmers receive messages on their mobile phones and can then log onto the Internet to download additional information from a farm management information system. The online system recommends which spray agents to use and when to combat the impending attack.

Through EVISENSE, farmers can mitigate the risk of disease by spraying their crops with the appropriate pesticide ahead of an outbreak. The spraying plan can be sent to the computer on the tractor’s sprayer to carry out the spraying. Once it is entered into the tractor’s system, the plan can be fine-tuned using GPS systems on the tractor and location-specific data on moisture, wind, and predicted rainfall from MTT’s SoilWeather system. For example, if rain is predicted within three hours of spraying, the spraying will be discontinued. This information prevents expensive inputs from being wasted away and damaging the environment (MTT 2009).

Mobile phones are not the only way to deliver early warning information. Radio remains very important: More farmers are likely to receive information from the radio than from any other source. Recent data show that in sub-Saharan Africa, even among more developed nations, the penetration of radio still exceeds that of the mobile phone (figure 11.1).

**FIGURE 11.1:** Ownership of Radios and Mobile Phones in Ghana, Kenya, and Zambia, 2010

![Graph showing ownership of radios and mobile phones in Ghana, Kenya, and Zambia.](https://example.com/graph.png)

Source: InterMedia AudienceScapes Surveys 2010.

best course of action to manage risks in production or respond appropriately to early warnings. For instance, weather information and advisory services are in place in many countries to help stakeholders make optimal decisions from crop planning to crop sale to manage risks. Again it is important to emphasize that such advisory services are important for risk mitigation because they help farmers translate good information into practical actions that reduce their exposure to risk.

Such services enable farmers to interact in various ways (such as voice interaction or SMS queries using mobile phones) with an automated database containing best practices and recommendations to handle most routine queries. Common queries might include ideal planting times, optimal input applications, or suggestions on which crops to plant based on market trends. In unique cases, queries are referred to agricultural experts. In other cases, the farmer is able to speak directly with extension personnel.

The mKRISHI service recently piloted by Tata Consulting Services in India is a prototypical example of remote extension services that allow two-way interactions. (“Krishi” is “farming” in Hindi.) A farmer uses the platform to access best practices and query agricultural experts through low-cost mobile phones, mostly using SMS (Banerjee 2010).

MKRISHI is not the only program of its kind to offer remote extension services heavily reliant on ICTs. Other countries have experimented with slightly different ways of linking the farmer to extension information. The Kenya Farmers Helpline (“Huduma Kwa Wakulima”) (http://www.kencall.com/index.php/site/kenya_farmers_helpline/) was launched in 2009 by KenCall, a Kenyan business process outsourcing company, with support from the Rockefeller Foundation. Instead of using SMS, farmers call the Helpline and speak to an agricultural expert in English or Swahili (Lukorito 2010). Kisan Call Centre (India) and Jigyasha 7676 (Bangladesh) are similar operations that provide customized expert advice to farmers.

**Decision Support Systems**

Besides fostering the delivery of timely and accurate information to mitigate risk, ICT applications also act as decision support systems. These systems help stakeholders choose the
Radio (a traditional source of extension advice) is becoming a more interactive source of advice with the advent of mobile phones and call-in (or text-in) programs. The African Farm Radio Research Initiative (http://www.farmradio.org/english/partners/afrri) of Farm Radio International (http://www.farmradio.org/) creates content that can be broadly described as agricultural extension information, including weather forecasts, price news, and early warnings about pests and diseases. (For details, see Topic Note 6.2.)

**Supply Chain Integration and Traceability**

ICT applications are also helping supply chains become more vertically integrated. Better cooperation between farmers and buyers along the supply chain mitigates default risk. Amul in India has installed Automatic Milk Collection Unit Systems in village dairy cooperatives. These systems enhance the transparency of transactions between the farmer and the cooperative and have lowered processing times and costs. The application uses computers connected to the Internet at the milk collection centers to document supply chain data such as fat content, milk volumes procured, and amount payable to the member (Bowonder, Raghu Prasad, and Kotla 2005) (for considerably more detail, see IPS “IT Tools for India’s Dairy Industry” in Module 8).

Dairy Information Services Kiosks at collection centers describe best practices in animal care to enhance milk yield and quality and assists dairy cooperatives to effectively schedule and organize veterinary, artificial insemination, cattle feed, and related services (Rama Rao 2001). Delivery of such comprehensive information helps to improve integration of the supply chain, thus reducing default risk. The early detection of production volatility makes it possible to take preemptive measures to address the underlying risk.

ICT applications, particularly GIS and RFID technologies, have had an impact in mitigating two additional forms of risk in the supply chain: sanitary and phytosanitary (SPS) risk and default risk. Larger aggregators and traders use software systems to collect and track information about who is growing what and whether farmers are adhering to the food safety and quality standards imposed in Europe and North America, especially for perishable foods. Traceability technologies and software to increase integration in supply chains, such as Muddy Boots (http://en.muddyboots.com/) (see Module 10), help to mitigate default risk when suppliers rely on large numbers of small-scale farmers. Fruilema (http://www.fruilema.com/), an association of fruit and vegetable producers and exporters in Mali, launched a web platform for potential buyers to track the entire mango production chain and enables Fruilema to comply with Global G.A.P. standards (see IPS “Mango Traceability System Links Malian Smallholders and Exporters to Global Consumers” in Module 12).

**LESSONS LEARNED**

A number of insights emerge from recent experiences in using ICTs to mitigate agricultural risk. One important insight is that the missing link in providing risk-mitigating information to farmers was not the information itself but the challenge of aggregating, personalizing, and disseminating it in a timely and cost-effective way. The content that farmers need is already produced by universities and government institutes.

Any use of ICT applications to mitigate agricultural risk must ensure that the fundamental requirements described above are present or can be developed easily. For example, farmers’ familiarity with ICTs should be assessed before initiating an intervention. Similarly, there should be a baseline understanding of whether farmers have the capacity to make good use of the information. Do farmers have access to rural finance, markets, transport, technology, inputs, and so on? If not, consider awareness and education programs regarding risk-mitigating strategies or appropriate responses to early warnings.

One difficulty in providing early warning or advisory services to farmers was not that the information was lacking, but that it could not be delivered effectively. ICTs make it easier to collect information from the universities and institutes that produce it and then to personalize it and provide it directly to farmers. The medium matters, however. A radio announcement is different from a phone call, which is again different from a text message.

Collaboration between the private and public sector is increasing. The public sector generates early warnings and provides expert advice, while the private sector has found that it can leverage ICTs (particularly mobile phones and back-end data collection and processing systems) to deliver this content to farmers quickly. Profitability remains a challenge. In many instances, the upfront investment and capital costs (such as the cost of investing in weather and ICT infrastructure) as well as the operational costs are high. A longer-term horizon and significant economies of scales are required to break even.

The ability to deliver highly personalized information is another key to earning revenue. Farmers naturally want information relevant to themselves—their crops, their plant and livestock disease, their markets—in the language they speak. It is difficult to elicit direct payment for services from farmers, but if farmers see a value proposition, they are often willing to pay for a service.

As a result, private participation in delivering information should be encouraged where possible, but the commercial sustainability of such initiatives should be analyzed rigorously. Information service providers should be encouraged to partner with the public sector to source content. It is difficult
to imagine that the private sector would find it profitable to invest in generating content as well as delivering it (unless delivering it to farmers they contract). State-funded institutions have been critical partners in sharing their knowledge and resources without cost. Cooperation and connectivity are critical between information distributors (mobile application developers) and information creators (universities, news organizations, meteorological services, government data services).

Technology considerations are also critical. Even though farmers can get weather information from the radio, those reports come only at a certain time and are easily missed, because farmers are often in transit or working in the field away from the radio. Text messages, which can be stored and accessed at any time, are preferred because they ensure that farmers receive the critical early warning. Mobile infrastructure is vital for most services that transmit risk-mitigating information to farmers (except for services relying on radio).

New capacities in technology may lead to even better risk mitigation strategies. The growing sophistication of mobile phones and falling costs of weather sensors make it likely that farmers will soon have access to a richer variety of information that is even more tailored to their location, crop choice, and general information needs. Java-enabled phones, for instance, are cheaper and allow farmers to access information using menus instead of simply sending SMS queries back and forth. Two-way interaction between farmers and advisors, in which farmers can ask and receive answers to specific questions, are likely to increase but also to command a premium. A direct connection overcomes literacy and language barriers, though these barriers should also ease as voice recognition technology improves.

Through the advisory service, farmers might inquire how much fertilizer or pesticide to use, so they can optimize their use of these costly inputs. Similarly, farmers might inquire about when to harvest to avoid inclement weather. Farmers with cameras in their phones can submit photographs to supplement their messages. While responding to farmers’ queries, experts are able to incorporate soil information by accessing the soil sensor nearest to the caller’s location (Pande et al. 2009). Farmers can also request a voice- or SMS-based expert response.

**Growth and Development**

MKRISHI was conceived and developed at the innovation lab of Tata Consulting Services (TCS). The first pilot was deployed in 2010 to an estimated 500 farmers in Uttar Pradesh and Punjab, who pay US$ 1–2 per month to use the service. The service is being provided at a subsidized cost, as farmers were unwilling to pay the unspecified higher cost at which the service was initially offered (Pande 2010). However, mKRISHI has found that farmers may be more willing to pay if information on market linkages and the facilitation of credit is offered along with the advisory services.

Like RML, mKRISHI disseminates a wide range of personalized information; the critical difference is that experts can respond to farmers’ queries. To provide the early warning and news information, the system relies on a web-based mobile platform that ties into many information sources. Data are gathered from commodity exchanges, agricultural research institutions (often state supported, such as Punjab Agricultural University), banks, weather servers, local markets, and solar-powered weather and soil sensors distributed throughout the areas where the service is offered (figure 11.2) (Pande et al. 2009).

To respond to farmers’ queries, mKRISHI relies on an automated database of frequently asked questions. The database

**INNOVATIVE PRACTICE SUMMARY**

**Through mKRISHI, Farmers Translate Information into Action to Mitigate Risk**

MKRISHI is innovative because it enables farmers to transform information into risk-mitigating actions ("TCS’ mKRISHI on Pilot Run in Maharashtra," *The Financial Express*, 2009). The mKRISHI platform, developed by Tata Consultancy Services in 2007, enables farmers to access best-practice information and agricultural experts through low-cost mobile phones using SMS (Banerjee 2010) (image 11.2). The connection between agricultural advisory services and risk mitigation is an important one, because information alone is often not sufficient to manage risk.
ECONOMIC AND SECTOR WORK

FIGURE 11.2: The mKRISHI Infrastructure

| Source: TATA Consulting Services. |
| Note: CDMA = Code Division Multiple Access, a standard used by mobile phone companies. |

can handle most questions, which are usually generic, but more specific or sophisticated questions are forwarded to 10 experts with Internet access. These experts interact with a system that resembles email; they are able to see attached photos and soil sensor information with each message and their response is sent back to the farmer by SMS.

Impact, Scale, and Sustainability

Farmers reportedly use mKRISHI to choose planting strategies, optimize fertilizer use, and time the harvest to avoid bad weather. Such choices surely contribute to risk mitigation, and some early data from the pilot studies and interactions with farmers show promise in this regard.

If productivity increases can be partially attributed to superior risk mitigation, then indirect quantitative research suggests that an agricultural advisory service such as mKRISHI improves risk mitigation. Much evidence supports the idea that effective delivery of traditional extension services to farmers improves productivity. Returns to extension services vary by crop and by geography, but studies show them to be quite high: “75–90 percent in Paraguay, 13–500+ percent in Brazil, and 34–80+ percent in a group of countries in Asia, Africa, and Latin America” (Birkhaeuser, Evenson, and Feder 1991:643). Again, however, the implication of delivering such services remotely is still to be tested.

As noted, mKRISHI was made available to 500 farmers in two Indian states as of 2010, and there are plans to offer the service across India. There are also discussions about launching similar services in the Philippines and Ghana (Banerjee 2010).

The sustainability of the mKRISHI platform is still questionable. The complexity of the platform and the numerous pieces that are tied together, from people to technologies to automatic sensors, imply a difficult and expensive challenge to sustainability. Another challenge is posed by the inability to collect the full marginal cost of the service from farmers (Pande 2010).

The independent development and implementation of the project by a large private company suggests, however, that the program might be able to sustain itself until it can resolve operational challenges to profitability which seems to be occurring. Much of the basic information comes from public sources, and mKRISHI has been able to organize and personalize it through a large consortium of partners. The ready availability of the basic information (a public good) thus becomes one of the prerequisites for building and sustaining such operations.
Farmers face many important risks that they can do little to mitigate through better agronomic practices or the use of early warning information, as described in Topic Note 11.1. Among these risks, price volatility and bad weather risk can be particularly devastating. Low prices at harvest can significantly reduce a farmer’s income, while weather risk in the form of floods or droughts can reduce yields or destroy crops.

Farmers (or farmer groups) in developed nations can use specific instruments to transfer their risk to a third party in exchange for a fee. The third party can be a public or private insurance company in the case of weather risk or a commodity futures exchange in the case of price risk. In developing countries, the availability of such instruments is limited, although pilot projects are starting to introduce them.

ICTs are playing a critical role in these pilot studies on risk transfer. Advances in mobile phone applications for money transfers, improvements in the resolution and cost of satellite imagery, and the pyramiding of multiple ICTs (mobile phone, GIS, remote sensing data) to create newer applications are all promising trends that could be leveraged to transfer agricultural risks.

The heightened volatility of international commodity prices and the threat of climate change have increased developing-country stakeholders’ interest in risk transfer instruments. Now the bigger challenge is to make risk transfer instruments such as insurance and price hedging more relevant and affordable for smallholders. The ability of ICTs to reduce transaction costs, deliver information and financial transactions, provide real-time data about hazards, and perform remote damage assessment can also help in piloting and scaling up risk transfer instruments.

Instruments to Transfer Risk
Transferring risk through insurance has several important benefits. Insurance stabilizes asset accumulation by reducing the negative impact of weather shocks. Insurance also fosters investment, because it reduces the uncertainty of returns (Mude et al. 2009) (box 11.2).

Insurance contracts are complex, however, and profitable insurance operations face numerous challenges. These challenges include the difficulty of designing contracts to avoid problems of moral hazard and adverse selection; insufficient data; high administrative costs in delivering the product, assessing damages, collecting premiums, and making payments; and weak institutional and policy environments (Wenner and Arias 2003). Low trust and financial literacy have also limited the effective demand for insurance and limited the willingness to pay for policies (Gine, Townsend, and Vickery 2008). In recent years, a modified form of insurance, weather-based index insurance, has been piloted in several parts of the world to address the moral hazard and adverse selection challenges and to lower the costs of damage assessments (box 11.3).

Farmers can use other means of transferring risk to avoid the problems caused by large fluctuations in the prices of the commodities they produce. By transferring risk through futures contracts traded on commodity futures exchanges, farmers gain a means of managing the price volatility of agriculture commodities, which lends greater certainty to their production planning and farm investment decisions (UNCTAD 2009:17–18) (box 11.4).
Like insurance, commodity futures exchanges have significant requirements, particularly with regard to policies, regulation, and financial literacy. Exchanges must be governed by clear rules, operated transparently, and regulated properly to ensure the level of confidence that traders demand. Such institutional capacity is often limited in developing nations. The trading of futures contracts also requires specialized knowledge that most farmers or farmer cooperatives do not have. Even in the United States, less than 10 percent of farmers interact directly with commodity futures exchanges. They do make use of futures prices to make planting and production decisions, however (Cole et al. 2008). Efforts are underway in China (UNCTAD 2009:13) and India to teach farmers how to make use of futures markets, but ICTs do not play a central role (Cole et al. 2008).

**ICTs and Risk Transfer Instruments**

Although ICT applications have made it easier for farmers to access information from commodity futures markets, such applications have not served to facilitate greater interaction with the futures markets to transfer price risk.

With respect to insurance, however, ICTs seem to be easing constraints arising from the lack of data and high administrative costs. Data requirements can be intensive; for example, weather insurance contracts require time-series data on weather and associated losses for farmers. High-resolution satellite imagery has made data available to design insurance contracts that once would have been impossible to develop given the lack of data in many countries. Advances in ICT can help overcome gaps in weather data by creating synthetic data based on satellite information. Together, new data and lower costs have facilitated the development of innovative index insurance products that are currently in various stages of testing.

For example, AGROASEMEX (http://www.agroasemex.gob.mx), a Mexican national insurance institution focused on the rural sector, was a pioneer of indexed weather insurance (and now offers catastrophic risk insurance). In 2007, the institution began to offer an insurance product for pasture land based on an analysis of vegetation detected by satellite (called Normalized Difference Vegetation Index or NDVI) (IFAD and WFP 2010:65–73). Satellite data also allowed the International Livestock Research Institute (ILRI) and its partners to overcome data limitations and create an index-based livestock insurance program in which damage is assessed through remote sensing (see IPS “ICTs Enable Innovative Index-based Livestock Insurance in Kenya,” later in this note).

In Nicaragua and Honduras, synthetic data were created through a public-private partnership in collaboration with the local meteorological agency. Three insurance companies (Equidad in Honduras and LAFISE and INISER in Nicaragua) currently use these data to design index insurance contracts for farmers.

Another novel insurance scheme, Kenya’s Kilimo Salama (http://kilimosalama.wordpress.com/), is described in the
innovative practice summary at the end of this note. It uses weather indicators as a proxy for input losses.

**LESSONS LEARNED**

Compared to the range of applications for risk mitigation, ICT applications to transfer weather and price risk to third parties are limited. Risk transfer instruments such as insurance and futures contracts have fared poorly in developing countries in general. Such instruments often require well-developed institutions and high levels of financial literacy, which are often lacking in rural areas of developing countries.

The critical message here is that ICT applications reduce the cost of delivering insurance and improve the dissemination of prices from international futures markets, but by themselves they are unlikely to foster widespread use of risk transfer instruments. Before ICTs can be used to transfer risk, the environment must be conducive. Appropriate infrastructure, institutional structures, and policies for developing and delivering such instruments must be in place. Farmers must exhibit sufficient demand for the instruments. High levels of financial literacy and technical skills are also required. Technical expertise is absolutely vital for accessing and interpreting satellite data and designing actuarially sound policies.

Unique partnerships are essential to incorporate ICTs into risk transfer products such as index insurance. The array of partners must have the vital technical skills just described and must be able to access distribution channels, provide financial support, and assist with implementation. There is a role for the public sector to develop and disseminate basic information about risk, because such information in the public domain facilitates the creation of risk markets. Governments can also have a role in planning emergency response to infrequent but catastrophic risks, while allowing private markets to handle insurance. Partners must also be willing to collect data and make it available for insurance companies to price policies correctly or, in the case of index insurance, to create the index that links weather events to specific losses.

An enabling regulatory and policy environment is fundamental for risk transfer tools to work and is characterized by such traits as the rule of law, contract enforcement, and private property rights. For commodity markets, a rules- or principles-based approach to regulation and governance, instead of a discretionary approach, is essential for success (UNCTAD 2009). In the case of insurance, the insurance providers need to be regulated to ensure that they can deliver on payouts.

The application of ICTs to risk transfer products has yet to mature, and interventions should be undertaken with extreme caution. This topic note describes promising examples, but any attempt to replicate them should take the local context into account. Furthermore, the current pilot programs should be subject to impact analysis to quantify their value. In the meantime, efforts can focus on improving the coverage and quality of ICT infrastructure, improving the institutional framework required to support risk transfer products, and improving the awareness of transfer products and their proper use among farmers and cooperatives.

**INNOVATIVE PRACTICE SUMMARY**

**ICTs Enable Innovative Index-based Livestock Insurance in Kenya**

ICTs have enabled International Livestock Research Institute (ILRI) and its partners to overcome data limitations and prohibitive administrative costs to create an index-based livestock insurance product. Damage is assessed by remote sensing, and the insurance is distributed through wirelessly connected point of sale systems deployed across the country.

ILRI, part of the Consultative Group on International Agricultural Research (CGIAR) (www.cgiar.org), developed its Index-based Livestock Insurance product (http://www.ilri.org/ibli/) in 2009 in collaboration with a wide array of partners, including private and government players (ILRI 2009). Initiated in 2010, the pilot program provides farmers with livestock insurance for 6–8 animals per year for a premium of US$ 50–100 (Waruru 2009).

Index-based livestock insurance seeks to interrupt the downward spiral of vulnerability, drought, and poverty in northern Kenya—a process that is exacerbated by climate change. Northern Kenya is home to 3 million pastoralist households and is prone to severe drought (Mude et al. 2009). Pastoralists earn a livelihood by grazing cattle (also sheep, pigs, and poultry) on semiarid to arid land and by selling meat, milk, and eggs (image 11.3). Livestock account for 95 percent of family income in an area where the incidence of poverty is 65 percent, the highest in the country (FAO–AGAL 2005:3). If drought occurs, the vegetation that the cattle graze upon is lost. Cattle starve, depriving vulnerable pastoral families of their sole source of income.
Livestock insurance allows farmers to pay a premium to transfer the risk of livestock dying in a drought to an insurance company. If a drought occurs, the policy indemnifies the pastoralists' loss. Previous insurance programs were not sustainable. The administrative costs of assessing the losses of remote pastoral communities, collecting premiums, and paying out indemnities were prohibitive.

It is unclear whether the advent of ICTs will make such programs more sustainable, because other factors affect sustainability, such as creating effective demand or minimizing basis risk. Programs such as index-based livestock insurance are being attempted, however, because ICTs greatly reduce the administrative costs that crippled previous programs. As noted, ILRI’s index-based program was designed using satellite data; damages are assessed by satellite; and delivery, premium collection, and indemnity payments are all done through wireless point of sale systems.

**Growth and Development**

Much of the technical work on the insurance product was done by Cornell University and the University of Wisconsin BASIS program in collaboration with Syracuse University and the Index Insurance and Innovation Initiative. As with the design of any index insurance, the challenge was to find sufficient data on both the peril as well as the indicator. Both kinds of data are necessary; data on the indicator are used to statistically predict the peril and price the insurance correctly.

The innovation in this case was to use vegetation as the indicator, because vegetation can be measured objectively by satellite to indicate the level of drought. Fortunately, the United States’ National Oceanic and Atmospheric Administration has collected the high-quality imagery necessary to construct a Normalized Difference Vegetation Index since 1981, and the imagery is available free of charge.

Statisticians used data on livestock losses for Marsabit District, the pilot region, to create an index to predict livestock mortality based on the remotely collected vegetation data (image 11.4). This procedure allowed for actuarially fair pricing of the index insurance (Mude et al. 2009).


Two significant operational challenges arose: creating effective demand and delivering the insurance cost-effectively. Education by way of experimental games proved critical to generate effective demand. Before a farmer would pay for an insurance program, he or she would need to understand what value the product added and how it would work. The challenge was exacerbated by low literacy (Mude et al. 2009).

In a vast region with so few market channels, cost-effective delivery of the insurance product was also a significant challenge. Policies were sold through Equity Bank’s point of sale system based on handheld mobile devices, which have been rolled out to 150 areas across northern Kenya. This channel was primarily developed for another program (DFID’s Hunger Safety Net Program).
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Impact, Scalability, and Sustainability

It is too early in the pilot stage to assess the program’s actual effectiveness in managing risk and ultimately reducing poverty. An evaluation is to be conducted by the University of Wisconsin at the end of the pilot. The results will help design any modifications in the insurance program and influence decisions on scaling up the pilot to other areas. The plan is to expand the program throughout the country if it proves successful in Marasabit District (Mude et al. 2009). Meanwhile, an ex ante assessment of the insurance found that:

“... household initial herd size—i.e., ex ante wealth—is the key determinant of IBLI [index-based livestock insurance] performance, more so than household risk preferences or basis risk exposure. IBLI works least well for the poorest, whose meager endowments effectively condemn them to herd collapse given prevailing herd dynamics. By contrast, IBLI is most valuable for the vulnerable nonpoor, for whom insurance can stem collapses onto a trajectory of herd decumulation following predictable shocks.

“District-level aggregate demand appears highly price elastic with potentially limited demand for contracts with commercially viable premium loadings. Because willingness to pay is especially price sensitive among the most vulnerable pastoralists (i.e., those not currently caught in a poverty trap, but on the verge of falling into one) for whom the product is potentially most beneficial, subsidization of asset insurance as a safety net intervention may prove worthwhile. Simple simulations find that relatively inexpensive, partial subsidization targeted to households with herd sizes in specific ranges can significantly increase average wealth and decrease poverty, at a rate of just $20 per capita per one percent reduction in the poverty headcount rate.”

Chantarat et al. 2009

This last point has implications for sustainability, which faces substantial financial hurdles if the product cannot be commercially viable. The development and pilot of the program were funded by Financial Sector Deepening Trust in Kenya, the UK Department for International Development (DFID), and USAID (Waruru 2009), but plans to expand nationally would require substantial private investment.

There are also questions of dependency on other programs. The satellite data, for example, are critical. If they are lost, there would be sustainability concerns. Similarly, the point of sale system used to deliver the insurance is funded by a separate program; any changes to that program might threaten the insurance program.

INNOVATIVE PRACTICE SUMMARY

Kilimo Salama Delivers Index-based Input Insurance in Kenya through ICTs

The Kenyan insurance scheme Kilimo Salama (http://kilimosalama.wordpress.com/) (its name means “safe farming” in Swahili) innovates by using mobile phones to collect premiums and distribute payouts, thereby reducing assessment and administrative costs. Weather indicators are used as a proxy for the loss of inputs. Under Kilimo Salama’s “pay-as-you-plant” model, agrodealers sell insurance policies according to the quantity of inputs purchased.

Kilimo Salama was developed by the Syngenta Foundation for Sustainable Agriculture in partnership with Safaricom, UAP Insurance, MEA Fertilizers, and Syngenta East Africa Limited. The program specifically insures the cost of inputs in case of poor weather over the planting season. Plans are in place to offer a crop loss product in addition to the input loss insurance.

The premium amount is 10 percent of the input cost, which is shared equally by farmers and the input companies.
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(50 percent each). The farmer thus pays a premium of 11 cents on a bag of higher-yielding maize seed that costs US$ 2.20 or 31 cents on a 10-kilogram bag of fertilizer that sells for US$ 6.20 (Kilimo Salama n.d.)

When the products are sold, the seller activates the insurance policy using the Kilimo Salama application on the seller’s handset by (1) scanning a product-specific bar code with the camera phone, (2) entering the farmer’s mobile number, and (3) linking the farmer to the local weather station (image 11.5). The buyer receives an SMS confirming the insurance policy (“First Micro-Insurance Plan Uses Mobile Phones and Weather Stations to Shield Kenya’s Farmers,” Science Daily, 2010).

ICTs are used in every part of the operation. Thirty solar-powered weather stations automatically monitor the weather; paperless channels are used to sell product; the Safaricom 3G network is used to cheaply and quickly transmit monitoring, sales, and payout data; and M-PESA (owned by Safaricom) is the platform used to make indemnity payments electronically. The Kenya Meteorological Department provided the supporting weather data to create the index and correlate it to crop losses and therefore to input-investment losses (Ogodo 2010).

Each insurance policy sold requires the farmer to be registered to the nearest weather station (Ogodo 2010). If there is excess rain or insufficient rain, as measured by the weather reporting stations, the index correlating rainfall and crop growth defines the payout due. Then the payment is made straight to the farmer’s handset using M-PESA (see IPS “M-PESA’s Pioneering Money Transfer Service,” in Module 2).

The insurance program was piloted to 200 farmers linked to two weather stations in 2009 in Laikipia District. There was a drought in both areas, and 80 percent of the input investment was returned to farmers linked to one weather station, whereas the other station reported a less severe drought and the payout was 30 percent of the investment (“First

**Topic Note 11.3:** ICT APPLICATIONS FOR COPING WITH AGRICULTURAL RISK

**TRENDS AND ISSUES**

Regardless of the best efforts to mitigate or transfer risk, agricultural production is inevitably susceptible to risks of floods, drought, and disease, among others. Such risks, when they materialize, can force farmers to deviate from their agricultural activities, disrupt them, or in the worst case, shut them down (Jaffee, Siegel, and Andrews 2010:21). Coping involves responding to a shock in ways that immediately curtail further losses in the short term, protect remaining life and assets in the medium term, and enable recovery in the long term.
Left to their own devices to cope with unmitigated risks, farmers typically employ strategies that are expensive in the long run. They may quickly sell productive land and other assets at below-market prices to generate cash; deplete personal savings, if they have any; pull children out of school; or borrow at high interest rates (Cole et al. 2008). Farmers also turn to their social networks for support, but this strategy does not work when entire villages are affected. When a farmer loses crops to floods, he or she may not be able to rely on family members in the same village who have suffered the same fate.

To prevent people from resorting to expensive coping strategies, governments and relief organizations attempt to quickly identify and assist those affected by shocks. Timely assistance can stem further losses and begin the recovery process. Assistance might be provided in the form of food vouchers, low-interest loans, technical assistance to resume productive activity, subsidized fertilizers, or loan cancellations.

**RECENT APPLICATIONS**

A few ICT applications are used to cope with agricultural shocks such as droughts, floods, and disease outbreaks, but they are proving important and potentially transformative. First, ICTs such as mobile phones (particularly those equipped with GIS and cameras) can be used to collect information after a shock about the extent of the damage, numbers of individuals affected, and who needs relief. These field data have proven vital to relief efforts, especially for better targeting and coordinating an effective response. Second, ICTs (particularly mobile phones) have been used to address the problem of disbursing remittances or aid vouchers to individuals affected by agricultural shocks. Farmers are difficult to reach and lack access to financial institutions, but increasingly they have mobile phones.

The use of ICT applications to assess the nature and extent of risks and improve the coordination and targeting of coping strategies has been particularly noteworthy for disease outbreaks. Rapid assessment and response are critical to controlling disease outbreaks. Only after a farmer has recognized the symptoms and identified the disease can he or she adopt the appropriate control methods.

Mobile technologies are being used to collect information from the field to assess damage or monitor outbreaks. For example, to monitor the threat of bird flu, the Animal Husbandry and Veterinary Services of the Government of India created an SMS-based reporting service to track animal health. Fieldworkers collected information about the health of animals and reported it to the directorate for analysis via text message (E-Agriculture 2008). MKRISHI helps farmers cope with similar shocks. If an outbreak occurs, farmers can submit photos or describe the outbreak through SMS to receive assistance in identifying the disease or pest and recommendations for managing the outbreak.

The Community-level Crop Disease Surveillance Project (CLCDS), discussed in an innovative practice summary following this note, takes this activity a step further. Piloted in Uganda by the Grameen Foundation, the project employs community knowledge workers to help identify diseases and advise on control methods.

Another significant challenge in coping with shocks is the need to disburse transfers and remittances rapidly to affected farmers, many of whom have limited access to formal financial services. The advent of mobile money has dramatically eased this constraint, making it faster for farmers to receive remittances from their social networks or receive transfers from governments and relief agencies.

The leader in this space is Safaricom’s M-PESA (http://www.safaricom.co.ke/index.php?id=745) a money transfer system that allows individuals to deposit, send, and withdraw funds using SMS. M-PESA has grown rapidly, currently reaching approximately 38 percent of Kenya’s adult population. The M-PESA model has been copied with little modification worldwide (Jack and Suri 2009:6), but it has yet to be applied specifically to agricultural risk. (See IPS "M-PESA’s Pioneering Money Transfer Service,” in Module 2, for an overview.)

A Zambian company, Mobile Transactions (http://www.mtzl.net/), delivers electronic payments, vouchers, and loan disbursements using mobile phones, scratch cards, and a countrywide agent network (see the innovative practice summary following this topic note). The voucher system primarily targets organizations that regularly make transfers to a large number of beneficiaries, such as the World Food Programme.

Another promising approach is the combined application of remote sensing, GIS applications, and crowdsourcing technologies to allow real-time damage assessment. Aside from improving the identification of affected areas, real-time assessments reduce the time lag between the shock and the delivery of assistance. These tools have not yet been used in response to agricultural shocks, but their use in response
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The combination of trained personnel and information services delivered through various ICT channels might be the most effective way to help farmers cope with disease outbreaks that require a rapid response. The ICTs serve to reduce the training required, which in turn reduces the administrative costs of such programs. Reducing the required qualifications also expands the supply of people eligible for the job.

Public institutions, governments, and NGOs often play a big role in helping farmers cope with risks. ICT applications can equip these institutions with better tools to manage their social safety net programs. Mobile money and electronic vouchers seem to have matured sufficiently to be replicated in other contexts and incorporated into plans to transfer funds to farmers affected by drought or flooding. Similarly, information services that empower people without formal education in agriculture to serve as agricultural extension workers might also be a replicable approach, provided that the infrastructure and human capacity are present. Their effectiveness, however, should be determined first. Finally, because ICT applications for risk coping are still maturing, their incorporation into a risk coping strategy should ensure that alternative coping mechanisms can be used in the event that the technology fails.

INNOVATIVE PRACTICE SUMMARY

Electronic Vouchers Are a Targeted, Traceable Lifeline for Zambian Farmers

Mobile Transactions (http://www.mtzl.net/) is a private Zambian company that began operating in January of 2010. Through mobile phones (image 11.7), scratch cards, and a national network of agents, the company provides access to banking services for rural Zambians. It has also designed a voucher system for organizations that regularly make transfers to a large number of beneficiaries, such as food vouchers that help rural people cope with shocks such as droughts and floods.

The vouchers are quickly delivered through the Mobile Transactions system in a targeted, transparent, and traceable
way. Between January and August of 2006, the World Food Programme used the system to deliver food subsidies worth US$ 500,000 to 32,000 Zambian recipients. FAO used Mobile Transactions to subsidize the purchase of agricultural implements worth US$ 600,000 for 6,000 recipients (Hesse 2010).

**How the Voucher System Works**

Operationally, there are two key aspects to the mobile voucher system: (1) setup and voucher distribution and (2) voucher redemption. Farmers themselves do not need phones, nor is continuous mobile coverage necessary (McGrath 2010).

Mobile Transactions clients sign a contract and an account is set up for them to deposit the funds they wish to disburse. They are also given access to an Internet-based system that indicates the level of funds disbursed, when, and to whom (WFP 2010).

Vouchers can be redeemed only for subsidized items (food, farm implements, and so forth) at previously authorized retail locations. The participating retailers are given a phone and a Mobile Transactions account and are trained to use the system. Retailers are also familiarized with the paper vouchers. Once the client and retailers are set up, the client deposits funds into the Mobile Transactions account at a regular bank. This money is credited to the client’s account within the Mobile Transactions system.

The remaining step is to register beneficiaries, who are identified by their national identification cards and assigned a unique number. The unique reference number on each voucher card can be linked to any registered beneficiary number. This linkage is made using a mobile phone when the beneficiary collects the voucher by presenting his or her national identification card.

Redemption of the voucher requires the following steps: (1) the farmer takes the scratch card to an authorized retail agent; (2) the Mobile Transactions system validates the card against the farmer’s beneficiary pin number on the voucher, which is revealed by scratching; and (3) if the system responds with a national identification number that matches the identification card the farmer presents, the retailer provides the subsidized product. The retailer, in turn, (4) receives an electronic payment into his or her account in the Mobile Transactions system. Finally (5), this transaction becomes visible to the client immediately through the Internet-based system.

The electronic money service is simpler than paper vouchers. Agents throughout the country who have gone through the setup process are able to accept money from individual payers and transmit the payment to the recipient using the mobile phone and a unique code. The recipient can use that unique code to redeem his payment from a nearby agent for cash.

**Impact, Scalability, and Sustainability**

The World Food Programme has not yet used the Mobile Transactions system to help people cope after a shock. The infrastructure is there, however, in the event that food rations need to be increased to allow farmers to cope with threats to food security. Most such threats in Zambia are agricultural: flood, drought, and cattle disease (WFP 2010).

No rigorous impact evaluation of this electronic voucher system has been conducted. Though quite different in some regards, the impact of mobile money might be used to approximate the impact of the Mobile Transactions system. Studies of Kenya’s M-PESA indicate there are
significant impacts. Those relevant to risk are: (1) more efficient risk sharing through the expanded geographic reach of social networks and the (2) facilitation of timely transfers of small amounts of money, which enable support networks to keep shocks manageable (Jack and Suri 2009:11).

Mobile Transactions has grown rapidly over its brief existence, from 2,500 voucher transactions worth US$ 60,000 in January 2010 to about 23,000 transactions worth US$ 700,000 in August 2010 (figure 11.3). The company is working to replicate the model internationally through partners in Zimbabwe.

Mobile Transactions earns revenue from fees charged, which are approximately 5,000 kwacha (ZMK) or about US$ 1.08 per transaction. The company is searching for additional capital to supplement the financing they have already received from venture capital firms and grants. It also hopes to begin transferring payments on behalf of the Government of Zambia.

**INNOVATIVE PRACTICE SUMMARY**

**Community Knowledge Workers in Uganda Link Farmers and Experts to Cope with Risk**

Community knowledge workers are also discussed in detail in Module 4, which discusses gender implications; as well as in Module 2, which focuses on regulatory issues. This summary is concerned largely with their role in helping communities cope with risk.

The Community-level Crop Disease Surveillance Project (CLCDS) provides Ugandan farmers with real-time advice for coping with pest and disease outbreaks. CLCDS was piloted in Bushenyi and Mbale Districts between December 2008 and August 2009 as part of the Grameen Foundation’s larger Community Knowledge Workers project (http://www.grameenfoundation.applab.org/section/communityknowledge-worker-project).

Primary funding for the pilot came from the Bill and Melinda Gates Foundation. Community knowledge workers in the pilot districts used mobile phones equipped with extension information to identify diseases and offer advice about control methods (image 11.8). The workers were also trained to collect disease outbreak data and transmit it to experts. With the data, experts can recommend appropriate responses. If this can be done quickly, individual outbreaks can be contained before they become epidemics (Grameen Foundation 2010a:66).

**Development and Growth**

CLCDS responds to the gap between scientific recommendations and on-farm practices in controlling crop diseases. The difficulty of collecting timely data on spreading diseases and the limited effectiveness of on-farm control methods aggravate disease epidemics, which reduce crop yields, quality, and income at the household, community, and national level (Grameen Foundation 2010a:58). In Uganda, three diseases threaten banana production. Of these, banana bacterial wilt alone is responsible for losses of US$ 70–200 million in Uganda (Grameen Foundation 2010a:59).

For CLCDS, Grameen Foundation partnered with the International Institute of Tropical Agriculture (IITA), the National Agricultural Research Organisation (NARO), and MTN-Uganda (a mobile network operator) to develop and test a disease surveillance system. They used several ICTs to bridge the gap between agricultural experts and farmers: mobile phone applications, a centralized database of disease information, and GIS. The community knowledge workers tie all of these people and pieces together.

To respond comprehensively to farmers’ queries, knowledge workers had access to seven information services...
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(Gantt and Cantor 2010), several of which offer the kinds of information needed to mitigate or cope with risk. See box 11.5 for details.

Impact, Scalability, and Sustainability

The CLCDS team recruited and trained 38 community knowledge workers, who completed over 6,000 surveys (2,991 related to banana disease) and had more than 14,000 interactions with smallholder farmers (Gantt and Cantor 2010). The initial group of 38 CKWs has now grown to 98 operating in eastern Uganda (Grameen Foundation 2010b).

By the end of the pilot, knowledge workers had trained over 3,000 farmers in the appropriate methods for banana disease identification, preventive measures, and control procedures. The CKWs were estimated to have reached 500–1,000 farm

BOX 11.5: Information Services Used by Community Knowledge Workers in Uganda

- **Google SMS Farmer’s Friend**. A database of locally relevant, organic tips and advice, plus a three-day and seasonal weather forecast. The knowledge worker searches the database through codes sent via SMS. (See IPS “Farmer’s Friend Offers Information on Demand, One Query at a Time,” in Module 2.)

- **Google SMS Trader**. A user-generated trading bulletin that provides farmers with the contact details of traders and vice versa through SMS posting and notifications. Developed in partnership with MTN-Uganda and Google.

- **AppLab Question Box**. Community knowledge workers phone this service to speak to an operator with access to an Internet database and expert agricultural advice from NARO. This tool was developed in partnership with the NGO Open Mind and NARO.

- **CKW Search**. A series of forms, presented in Java, guides community knowledge workers through a menu to search for agronomic techniques for banana and coffee production. Content was provided by NARO, the Uganda Coffee Development Authority, and IITA.

(continued)
households in their communities (Grameen Foundation 2010b). Farmers reported increased revenue and decreased losses upon using the helpline information to treat livestock and plant diseases (Gantt and Cantor 2010).

CLCDS also showed how a mobile survey system could enhance scientists’ ability to monitor disease outbreaks in real time and deliver information to farmers in remote areas through the knowledge workers, particularly to areas where extension officers and agricultural researchers do not regularly visit (Grameen Foundation 2010a:66). Once CKWs submitted their survey results, scientists could access and view the data directly from the web and download the results for analysis. The surveys provided data showing the spatial distribution of banana disease in the communities. The team of scientists viewed thousands of digital photos of disease symptoms, which knowledge workers submitted with their surveys (Gantt and Cantor 2010).

With this information, scientists could map disease incidence. Over time, they began to better understand the spread of diseases, the adoption of control techniques in different areas, and how these and many other factors intersect to impact farmers’ livelihoods. This information is used to prioritize actions and communicate recommendations to farmers via the knowledge workers (Grameen Foundation 2010a:67).

Having up-to-date information that included details of the exact locations of a disease, agricultural experts could develop a plan of preventive measures and allow the rapid dispersal of information that would decrease the spread of the disease. The GIS data could then help scientists to pinpoint sites to collect plant samples of new or suspicious disease reports for subsequent diagnosis in the laboratory (Gantt and Cantor 2010).

Given the pilot’s success, CLCDS will be scaled up with additional support from the Bill and Melinda Gates Foundation over four years to provide the service to 200,000 farmers across Uganda (Grameen Foundation 2010a). The bottleneck is the limited number of knowledge workers. Grameen Foundation is training new ones and attempting to partner with existing extension services (Grameen Foundation 2010b). Farmers are not currently charged for the service (they are compensated for participating in surveys, however), and it is not yet clear how the program will continue when external funding ends.

The operational success of the CLCDS to date has depended on the ability to: (1) recruit excellent knowledge workers; (2) make information accessible to them through mobile phone applications; (3) train them in disease identification and control; (4) train them in the use of ICT tools for data collection and effective dissemination of information; and (5) maintain partnerships with experts to verify and analyze information to provide actionable advice to support the knowledge workers.

**BOX 11.5: continued**

- **Input Supplier Directory.** An SMS-based keyword search service gives the location and contact details of shops offering specific agricultural inputs such as seed, pesticide, and fertilizer. Content was provided by the Uganda National Input Dealer Association.

- **Banana Disease Control Tips.** Pre-loaded HTML pages show control measures for specific banana diseases. Content was provided by IITA.

- **Market Prices.** An SMS-based keyword search service gives retail and wholesale prices for 46 commodities in 20 markets. Information provided by FIT Uganda, a local market price provider.

The AppLap Question Box and CKW Search draw from a database that the project team has built and continues to expand and refine. This database of actionable agricultural information is populated by agricultural research organizations and other experts and reviewed by an Expert Review Board for further dissemination to farmers through knowledge workers.

*Source:* Author and Grameen Foundation 2010b.
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REFERENCES AND FURTHER READING


