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Index Insurance for Agricultural Transformation in Africa

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ABSTRACT

Over the past two decades, researchers, practitioners, and policy-makers have shown great interest in using index insurance to manage agricultural production risk in order to promote technical transformation of agriculture in the developing world. Unlike conventional agricultural insurance, which indemnifies policyholders for verifiable production losses arising from multiple perils, index insurance pays policyholders based on the observed value of a specified "index" variable, such as rainfall, that is highly correlated with losses. Index insurance is less susceptible to the structural problems that have rendered conventional agricultural insurance too expensive and financially un-sustainable for the developing world. Index insurance, however, offers less efective individual risk protection than conventional insurance and faces non-trivial challenges for sustainable implementation. This article summarizes lessons learned from index insurance projects undertaken in sub-Saharan Africa since 2000 and points the way forward for the use of index insurance to support African agricultural development in the 21st century.

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Introduction

The overarching objective of this report is to provide a review and critical evaluation of research and development activities in agricultural index insurance in sub-Saharan Africa since 2000. The report is designed to inform African farmer-based organizations, agricultural lenders, processors, policy-makers, and international donors about the benefits and costs of index insurance and its prospects for promoting technical transformation of African agriculture in the 21st century.

Over the past twenty years, substantial experience has been gained with the implementation of index insurance in developing countries, including a wide array of feasibility studies, applied research, and pilot projects, many of which have been conducted in African countries, including Burkina Faso, Cote d'Ivore, Ethiopia, Ghana, Kenya, Malawi, Mali, Senegal, Tanzania, Uganda, and Zimbabwe. Much of this work has been undertaken or financially supported by international organizations as diverse as the African Union (AU), Japan International Cooperation Agency (JICA), Centre International de Recherche sur lEnvironnement et le D´eveloppement, Deutsche Gesellschaft f¨ur Technische Zusammenarbeit (GTZ), International Food Pol-icy Research Institute (IFPRI), International Livestock Research Institute (ILRI), International Research Institute for Climate and Society (IRI), Organization for Economic Cooperation and Development (OECD), Syngenta Foundation for Sustainable Agriculture (Syngenta), United Kingdom Department for International Development (DfiD), United Nations World Food Program (UNWFP), United States Agency for International Development (USAID), and the World Bank. Virtually all of the work has been conducted in close collaboration with national agricultural development banks, large private banks, microfinance institutions, savings and credit cooperatives, major private and state insurance companies, farmer-based organizations, national agricultural ministries, and non-governmental organizations.

Through these index insurance projects, many valuable lessons have been learned. And although the results of many of the initial projects have been disappointing, they have pointed the way to innovative uses of index insurance that offer great promise. The development community continues to be optimistic about the use of index insurance in the developing world and re-mains committed to its development, particularly as a means of supporting the expansion of credit to historically marginalized smallholders and small and medium size agricultural enterprises. In the following sections, we pro-vide an overview of index insurance, addressing its design, its strengths, and its weaknesses. In the subsequent sections, we review selected index insurance projects that have been conducted in sub-Saharan Africa since 2000 and summarize the lessons learned from these projects. In the final sections, we review the current thinking about the best ways to use index insurance, particularly in support of expansion of credit and adoption of advanced agricultural production practices.

Agricultural Risk in Developing Countries

Weather-related perils such as droughts, floods, hail, cyclone, and hurricanes present pervasive risks for agriculture throughout the developing world, with adverse consequences not only for farmers but for other stakeholders in the agricultural marketing chain, including lenders, processors, exporters, and consumers.

Weather risk can be especially problematic for poor farmers who live at subsistence or near subsistence levels, most of whom do not possess an ad-equate asset base or ready access to financial services (e.g., credit, deposit facilities, and insurance). In the absence of well-developed financial services, poor farmers in developing countries employ a variety of methods to cope with risk, including informal communal income risk sharing, enterprise diversification, storing, investing in livestock as a store of wealth, mitigation, and avoidance. These risk-coping practices, however, can be costly and inefficient, thereby limiting farm profitability and impeding efforts to adopt improved production technologies that will promote emergence from poverty. More-over, these practices typically offer very poor protection against widespread catastrophic weather events. For example, communal risk-sharing arrangements can work during "normal times", but can easily fail after a widespread weather catastrophe that adversely affects the incomes of all members of the community simultaneously. Diversification across crops also offers very limited protection against catastrophic weather events, since such events typically adversely affect the production of all crops simultaneously. And investing in livestock offers a poor hedge against the loss of income from widespread catastrophic weather events since, during such times, many farmers simultaneously attempt to liquidate their stocks to sustain their income, profoundly depressing sales prices.

Although the effects of catastrophic weather events are felt most immediately and most profoundly at the farm level, the effects are propagated through the agricultural marketing chain via the contractual relationships that exists among its members (Miranda and Gonzalez-Vega 2011). In particular, agricultural banks, input suppliers, cooperatives, and processors who provide loans to farmers can experience dramatic increases in loan delinquency and default after a catastrophic weather event that simultaneously affects a large number of its farmer-borrowers. Agricultural loans, when avail-able, typically carry higher interest rates than nonagricultural business loans, as lenders attempt to pass the costs of systemic, weather-related default risk to borrowers. High interest rates paid by farmers reduce the demand for agricultural production loans, impeding investment in productive farm activities and stifling the evolution of efficient financial markets for the rural sector.

Problems of Conventional Crop Insurance

Much agricultural insurance available in developed countries is based on "conventional" forms of insurance that cover verifiable farm level crop or livestock production losses from one or more named perils. The actuarial experience with conventional crop insurance dating back to the beginning of the twentieth century, however, has been universally disappointing. Privately operated crop insurance programs have typically failed when attempted, and have enjoyed success only in very narrow applications, such as hail insurance. Virtually all currently operating crop insurance programs in developed countries consistently pay indemnities far in excess of the premiums collected from agricultural producers, and subsist only by virtue of substantial government subsidies in the form of government reimbursement of administrative costs borne by private insurers and marketers, government payment of the greater part of premiums ostensibly charged to farmers, and government-run reinsurance agreements that are actuarially favorable to insurers.

The problems underlying the actuarial failure of conventional crop insurance programs are well understood by economists and insurers. The most pervasive causes of actuarial failure of such programs are asymmetric information problems in the form of moral hazard and adverse selection (Shavell 1979; Akerlof 1970; Quiggin, Karagiannis, and Stanton 1993). Moral hazard, also known as the "hidden action" problem, arises when the purchase of insurance changes the incentives of the insured, prompting them to en gage in riskier practices after purchasing the insurance and thus causing the indemnities paid by the insurer to rise. Adverse selection, also known as the "hidden information" problem, arises because the insured is better in-formed of his risk than the insurer. As a result, high-risk individuals tend to purchase more insurance than low-risk individuals, further causing the indemnities paid by the insurer to rise beyond expectations.

Although asymmetric information problems are endemic to all forms of conventional insurance, special problems arise when applied to agricultural production. An ideal condition for the efficient functioning of insurance markets is that individual risks be independent or nearly so, so that the aggregate payouts made by insurers is predictable. Agricultural production, however, is exposed to droughts, freezes, floods, windstorms, pestilence, and disease, which affect many farmers simultaneously, causing losses across individual agricultural producers to be significantly correlated. Due to the lack of stochastic independence of losses, an agricultural insurer is exposed to the vagaries of weather and other catastrophic events that could lead to bankruptcy. International reinsurance is generally available to insurers for addressing these systemic risks. Reinsurance, however is expensive and difficult to obtain due to the thinness of markets and variations in commercial laws, business customs, and government regulatory environments across developing countries. The high costs of reinsurance must be passed on to the insured, thus increasing premium rates and reducing the demand for insurance.

Yet other problems arise with the provision of conventional insurance for agricultural production in developing countries, particularly to small producers. Conventional insurance requires that contract terms and premiums be tailored to the risk profiles of the individual policyholder. However, the historical farm-level production loss data needed to design farm-specific con-tracts and compute fair premium rates is often unavailable or highly suspect. Moreover, conventional insurance requires verification of individual loss claims submitted by producers. The costs of properly designing insurance and verifying losses introduces costs that must be borne by the

insurer and which must be added to the premiums charged. These costs, as a percent of the coverage offered by insurance contract, can be especially high for small producers, causing premium rates to rise well beyond what the smallholder would be willing to pay for the insurance.

Although some forms of conventional insurance are available in some developing countries, careful inspection reveals that they are available on a very limited scale, only to the largest and most sophisticated producers, and only for the protection of large farm assets (e.g., machinery and infrastructure) from common perils such as fire and theft. Conventional insurance for protection of crop and livestock production losses due to weather is extremely rare, and generally unavailable only to large, export-oriented producers. Due to the endemic asymmetric information, systemic risk, and high transactions costs, conventional agricultural insurance is not a viable solution to the agricultural risk problems of the developing world (Mahul and Stutley 2010)

The Promise of Index Insurance

To overcome the limitations of the conventional crop insurance an alternative form of insurance, "index insurance", has received increasing attention from researchers, practitioners, and policymakers since the early 1990s. Unlike conventional crop insurance, which indemnifies farmers based on verifiable farm level production loses, index insurance pays the insured based on the observed value of a specified "index" or other closely related variable (Miranda and Vedenov 2001; Bryla and Syroka 2007).

Ideally, an index is a random variable that is objectively observable, reliably measurable, and highly correlated with the losses of the insured, and which, importantly, cannot be influenced by the actions of the insured. The most widely used index in agricultural insurance is rainfall. However, other weather or weather-related indices have been used or otherwise considered in index insurance design, including temperature, satellite-measured vegetation indices, and El Ni˜no-Southern Oscillation indices. Indices that are not strictly speaking weather variables, but which nonetheless serve as proxies for the impact of widespread weather events on production agriculture, include area-yields, river flood levels, and regional livestock mortality rates (Miranda 1991; Khalil, Kwon, Lall, Miranda, and Skees 2007).

Index insurance avoids many of the problems that plague conventional crop insurance. Because the insured cannot influence the value of the index, and thus the contract payout, index insurance is essentially free of moral hazard. Because an index insurance contract's premium rate is typically based on publicly available information, not privately held information, index insurance is largely free of adverse selection problems. Because index insurance does not require individually-tailored payout terms or separate verification of individual loss claims, index insurance is less expensive to administer. And because index insurance has simpler information requirements and exhibits greater uniformity and transparency of contract, index insurance is easier to reinsure. These features of index insurance can substantially reduce its cost relative to conventional crop insurance, making it more affordable, particularly to poor agricultural producers in the developing world.

To concretely illustrate how an index insurance contract works, consider the following hypothetical example of a simple rainfall insurance contract designed to protect farmers against droughts: A farmer, prior to a specified closing date preceding planting, elects a liability (maximum payout) of $50 and pays the insurer a $5 premium, computed from the published premium rate of 10%. In return, the insurer promises to pay the insured at harvest an amount that depends on the total rainfall measured at the specified nearby weather station during the three most critical months of the growing season. For example, the contract might pay no indemnity if total rain-fall exceeds 550mm, but would pay $10 if total rainfall is between 500 and 550mm, $25 if total rainfall were between 450 and 500mm, and the maximum amount of $50 if total rainfall were less than 450mm.

The preceding example is simple and belies the fact that most index insurance products that have been developed in the developing world are more complicated. For example, index insurance products may possess more refined terms that allow payments to be made at multiple times during the growing season, with payout schedules designed to reflect that the impact of rainfall on production differs across the various agronomic phases of plant development. Also, indices used to design index insurance contracts are not limited to rainfall measured at established meteorological stations, and may involve remotely sensed vegetation indices that are functions of data acquired

from orbiting satellites. However, the basic idea remains the same: the index is chosen so that it can accurately reflect general growing conditions encountered by farmers in a defined area and the insurance payouts are not based on the individual losses of the insured.

Index insurance products may be designed and marketed with different points of impact. Index insurance may be classified according to who receives and controls the uses of the payouts. "Micro" index insurance contracts are designed to provide payouts to farmers or small groups of farmers to assist them in managing farm-level production risk. "Meso" index insurance contracts are designed to provide payouts to businesses or other formal entities that provide financial intermediation and other services to large groups of farmers, such as banks, input suppliers, processors, and cooperatives, who wish to protect the integrity of the loans or other financial and marketing arrangements that exist between them and their farmer clients. We refer to such institutions as "risk aggregators" because they systematically suffer from the impact of adverse weather on its many farmer clients simultaneously. In a meso index insurance contract, the aggregator receives the payouts, and is responsible for setting rules for using them.

The Problems with Index Insurance

Although index insurance enjoys certain advantages over conventional agricultural insurance, it also suffers from several drawbacks, the most severe of which is known as "basis risk" (Miranda 1991). Basis risk refers to the failure of index insurance to cover all losses that may be experienced by the insured. In particular, since the index insurance payout is based on an index, rather than verifiable losses, it is possible for the insured to suffer a significant loss without receiving a payout; conversely, it is possible for the insured to receive a payout without suffering a significant loss. Basis risk can be especially acute were there is significant variation across farmers in production practices, growing conditions, and proximity to the weather stations on which the contracts are written.

Basis risk is endemic to index insurance contract design and arises regardless of the index used, the policyholder for which such contracts are intended, and the venue for which the contract is developed. Basis risk at any level, whether micro or meso, can be partially addressed in one of two ways. First, the basis risk associated with index insurance products can be reduced through greater insurance product diversity. This is achieved by offering a wider array of index insurance products, tailored to different production practices and risk exposures, and by offering contracts written on a geographically dense network of weather stations or more geographically refined satellite observation grids. Virtually all pilot project studies have concluded that investment in additional automated weather stations, rain-fall gauges, or river level gauges is needed to ensure the effectiveness of index insurance contracts based on meteorological indices. However, the costs of developing a multiplicity of tailored weather insurance products and constructing, maintaining, and securing a broad network of weather observation stations can be substantial, creating an impediment to the expansion of index insurance programs, particularly micro insurance programs. Moreover, the building of new weather stations on which to write index insurance con-tracts introduces the additional problem that historical weather index data for those stations do not exist, creating ambiguities for the actuarial rating of the index insurance contracts written on these stations, likely resulting in higher reinsurance premiums. Using satellite based observations has the advantage that satellites can make observations at very high levels of spatial resolution. However, satellite observations are by their very nature remote, and thus provide less precise information of actual conditions on the ground.

Second, the basis risk associated with index insurance products can be reduced by designing contract indemnity schedules so that indemnities correlate maximally with policyholder losses. However, such efforts are frustrated by limited understanding of the relationship between weather and production and by the paucity of farm-level yield and loss data needed to optimize product design. Many institutions have experimented with ways to over-come these limitations. For example, research has demonstrated that models based on water requirement satisfaction have a remarkable ability to predict aggregate yields and to capture the complex relationships that exist among aggregate yields and rainfall. However, the data needed to parameterize models that can address variation in local soil, moisture, and production practices are generally unavailable in developing countries. Moreover, the design of index insurance products is constrained by the lack of sophistication of their intended users. Due to farmer lack of experience with active farm-level risk management using financial products, micro index insurance products must possess a simple and transparent design. This requirement limits the development of sophisticated insurance contracts whose payout schedules precisely capture the complex relationships between weather

and farm level production, including products based on compound indices using multiple weather variables and contracts with highly nonlinear indemnity schedules.

However, even if the resolution of weather measurements is refined and better agronomic models can be developed, natural limits exist to the degree to which basis risk can be reduced. Losses at any level, but particularly at the farm level, can be caused by many factors that simply are unrelated to the index used in contract design. Such factors might include, for example, wind damage, hail, fire, pestilence, disease, and accidents besetting farm workers. It is entirely possible, therefore, for a farmer to live adjacent to a rainfall gauge for which a contract has been optimally designed to reflect local production practices and growing conditions, yet the contract could still embody substantial basis risk if rainfall can explain only a portion of the variability of the farmers losses.

Index Insurance Pilot Programs in Africa

Researchers and international agencies have undertaken extensive index insurance research and market development activities in sub-Saharan Africa over the past twenty years. These activities have included: designing and actuarially rating of index insurance contracts; educating and fostering cooperation among farmers, lenders, insurers, government officials, and regulators about the potential benefits of index insurance; acquisition, validation, and statistical analysis of weather and agricultural production data; assessment of adequacy of weather station network density, security, and real-time re-porting capabilities; exploring the feasibility of alternative insurance indices; identifying and testing alternative ways to incorporate index insurance into farm, firm, and governmental risk management strategies; and improving insurance marketing and delivery mechanisms.

The many pilot programs and studies undertaken in sub-Saharan Africa have provided many valuable lessons. However, their number is too great to permit detailed summaries of all of them within the confines of this re-port. We have, however, selected four countries in which index insurance projects have been undertaken for more detailed discussion. The countries and projects were selected based on several criteria. First, all projects re-viewed evolved past the stage of conceptualization, implying that a contract was designed and rated, a marketing framework was developed, and the insurance product was "marketed", leading to some uptake of the product, however modest. Second, the projects reviewed provided important general lessons learned, whether positive or negative, regarding proper index insurance contract design, marketing, financing, regulation, and education. Third, the projects reviewed exhibit geographical and structural diversity.

Ethiopia

The World Bank initiated an index insurance program for farmers in Ethiopia in March of 2006 in collaboration with the state-owned Ethiopian Insurance Corporation (EIC). Because of their strong outreach to the rural sector and the greatest business incentive in becoming involved in the pilot, cooperatives were chosen to act as intermediaries and deliver the index insurance product to prospective farmer clients.

EIC selected two potential pilot areas where they had clients who had ex-pressed interest in index insurance and where there were National Meteorological Agency weather stations with adequate historical weather data. Based on preliminary assessments, EIC elected to work with the Alaba woreda of the Southern Nations, Nationalities and Peoples Region for the pilot program. The objective of the pilot was to develop a deficit rainfall index insurance contract aimed at maize production. EIC worked with local cooperatives to market the product since cooperatives were engaged in service provision to farmers, including input supply, and credit and saving facilities.

The pilot program encountered a number of difficulties. While suitable data was found for a number of stations in Ethiopia, there was a lack of sufficient data for the development of weather insurance contracts on a large scale. In addition, the reporting capabilities for many existing stations were found to be weak, indicating that long-term investment in new technology, cleaning of data, and upgrading of infrastructure would be necessary for expansion of the pilot project. The

cooperatives also were found to be poor partners and ultimately became an obstacle to marketing. Banks were considered as possible alternatives, but at the time, the government provided standing guarantees to cover bank losses from providing credit to farmers to purchase fertilizer, undermining bank incentives to pursue active risk management strategies that would use weather risk management products. In the end, fewer than 50 farmers purchased the insurance contract, and it was concluded that index insurance programs run through banks was infeasible. It was further concluded that if government loan guarantees were removed, additional capacity would have to be built within banks to carry out weather risk assessments, given that their current risk assessment practices do not consider the quantitative impact of weather risk on lending.

In response to the 2011 East Africa drought, the Japan International Co-operation Agency (JICA) and the Ethiopian Ministry of Agriculture launched the Rural Resilience Enhancement Project (RREP) in 2012 to enhance the resilience of Ethiopian rural communities to climate change and drought. One of the project components was the introduction of weather index insur-nce for farmers in low rainfall areas of Oromia Region. The insurance pays insured famers when rainfall amounts fall below a certain level and to insulate themselves from the effects of drought. The introduction of insurance was complemented by capacity-building training on basic principles of insurance, agriculture risk management and the concept weather index insurance directed at unions, cooperatives and development assistants, as these will be the first level contact for farmers. Weather index insurance was introduced in 8 districts in Oromia region in collaboration with partners such as the Oromia Insurance Company and various farmer cooperatives and unions. By the end of the second year of the project, some 5,600 teff, sorghum, wheat, maize and haricot beans farmers registered for weather index insurance with a total liability of more than 572,000 Ethiopian Birr ($28,199).

Readers interested in index insurance activities in Ethiopia may wish to consult: McIntosh, Sarris, and Papadopoulos 2013; Norton, Osgood, Mada-jewicz, Holthaus, Peterson, Gebremichael, Mullally, and The 2014; Vargas Hill and Viceisza 2012; Dercon and Christiaensen 2011; Dercon, Vargas Hill, Clarke, Outes-Leon, and Taffesse 2014; International Research Institute for Climate and Society 2009; Leblois and Quirion 2010; Bryla 2009; Norton, Holthaus, Madajewicz, Osgood, Peterson, Gebremichael, Mullally, and The 2011; Vargas Hill, Hoddinott, and Kumar 2011; Vargas Hill and Robles 2011; Ahmed, Gommes, McIntosh, and Sarris 2011.

Kenya

In 2010, the International Livestock Research Institute, supported by Finan-ial Sector Deepening Kenya (FSD), UK Department for International Development, the US Agency for International Development, and the World Bank, initiated an index-based livestock insurance (IBLI) pilot in the Marsabit district in northern Kenya (Mude, Barrett, Carter, Chantarat, Ikegami, and McPeak 2009a). In this region, the prospect of major livestock losses during severe droughts reduces incentives to build herds. The insurance was expected to increase investment in livestock, as well as access to credit. Index insurance products are appealing due to high transaction costs of monitoring animal deaths, especially as most herders in the region move to adapt to spatiotemporal variability in forage and water.

The index selected for the pilot was the Normalized Difference Vegetation, which is computed from remotely-sensed satellite measurements. The NDVI is used to measure the vegetation available for livestock to consume. Household-level livestock mortality data collected on a monthly basis from 2000 to 2008 were used to estimate the relationship between the index and actual losses using a regime-switching regression model. Fortunately for project designers, the ground mortality data for herders in the region, which are necessary to tie the NDVI observations to quantifiable livestock deaths, were available from the World Bank-funded Arid Lands Research Management Project and the Pastoralist Risk Management Project (Chantarat, Mude, Barrett, and Carter 2013).

After creating an optimal index insurance con-tract, in-depth surveys were conducted randomly in five villages, with the goal of assessing demand, risk attitudes and willingness to pay for an in-dex insurance product. Results indicated that almost 70% of herders would pay premiums 20% over actuarially fair prices to purchase a contract that paid if livestock deaths exceeded 30% strike of the insured population. The studies further revealed that farmers perceived the greatest benefit of index insurance to be increased access to farm input loans. However, farmers also expressed a series of concerns with index insurance, including: high cost of the product, failure of the product cover other weather risks such as excess rainfall, delays in receiving indemnity payments, failure of the product to address price risk, and lack of confidence.

The Equity Insurance Agency, a private insurers, was chosen as the mar-keting agent for the policies, with UAP Insurance acting as the local under-writer of contracts. Premiums for the NDVI insurance product, which are either 5.5% or 3.25% of the value insured, depending on where the client resides, were subsidized by the international donors. However, the premiums paid by clients for the insurance remained 30% to 40% higher than expected indemnities. In February 2013, the prohibitions against other commercial insurers from marketing the product expired. Given the interest in under-writing expressed by other insurers, increased competition was expected to reduce market premium rates. While the introductory contract was targeted to individual farmers, a second phase of the pilot was instituted to focus on meso-level clients, such as cooperatives, NGOs and donor agencies.

After the completion of three sales periods, the demand for index insurance began to tapering off. According to Andrew Mude, economist and project leader at ILRI, during the first season of contract sales, in January and February 2010, 1979 policies were sold; in the following season, in January and February 2011, the number of policies fell to 599; finally, in the third sales period, in August and September 2011, only 500 policies were sold. Groundwork suggests that pastoralists

in Kenya want to be reassured that the index insurance product works; in the most recent sales period, the index trigger was met, and all policyholders received indemnities. While, prior to the opening of the sales period for the January/February 2012 season, it was hypothesized that sales would increase due to the payouts received in the previous season, no contracts were sold due to undisclosed complications among partners in the program.

Overall, the livestock pilot program in Kenya highlights the nuances in index insurance contract design and sales. In this case, state-of-the art satellite imaging reduces basis risk and the burden of on-the-ground data collection, while a lack of competition among insurers drives up premium rates for herders whose interest in the product already seems to be waning. Finally, panel data analysis will offer impact evaluation studies that are critical to the further development of index insurance pilots, especially where welfare effects on the poorest groups are considered.

Non-livestock agricultural index insurance has also been introduced in Kenya. Preliminary work in Kenya in 2005-6 supported the development of a micro deficit rainfall insurance product to partially insure loans for maize farmers in Eldoret, Kitale and Nakuru. In 2008, The World Bank joined forces with the Financial Sector Deepening Trust of Kenya (FSD), and the International Livestock Research Institute (ILRI) to develop a weather risk management strategy for Kenya. The primary objective of the work was to determine whether reducing weather risk helps banks and agribusinesses provide better services to farmers, given that lack of traditional forms of collateral have curtailed the ability to expand their business.

Readers interested in index insurance activities in Kenya may wish to consult: Chantarat, Mude, Barrett, and Carter 2013; Lybbert and McPeak 2012; Financial Sector Deepening Trust Kenya 2013; Syngenta Foundation 2014; Osgood, McLaurin, Carriquiry, Mishra, Fiondella, Hansen, Peterson, and Ward 2007; Carter and Janzen 2012; Jensen, Barrett, and Mude 2014.

Burkina Faso

During 2008-2009, The World Bank undertook a study to help the Government of Burkina Faso map and quantify drought risk throughout the country and to evaluate the feasibility of using weather insurance products to strengthen agricultural credit for cotton producers. The study was undertaken in partnership with the Africa Poverty Reduction and Economic Management Department (AFTP4) and the Africa Financial Sector Unit (AFTFS), and was co-funded by the Global Facility for Disaster Reduction and Recovery (GFDRR).

Cotton in Burkina Faso is grown under rain-fed conditions, and is vulnerable to production loss from variable seasonal rainfall deficits, as well as from excess rainfall and associated flooding. Weather risk is often cited as a significant impediment to the provision of credit by lenders to cotton producers. The feasibility study focused on the credit problems facing cotton farmer groups (GPCs), which typically consist of about 30 farmers and which historically have not had access to crop insurance.

The study thoroughly evaluated available cotton production data, avail-able meteorological data, and the current state of Burkina Faso network of meteorological stations, and assessed their adequacy for the implementation of an index insurance program. Given this information, the study initially considered a range of index insurance contract design options, including micro, meso, and macro rainfall index insurance contracts, contracts based on flood indices, and contracts based on area yields. In addition to addressing technical issues pertaining to contract design, the study also examined issues pertaining to the delivery and uses of index insurance, with special focus on how the insurance could be structured to strengthen access to credit to by cotton farmer groups.

Data available for Burkina Faso current network of meteorological stations and unmanned rainfall gauges was found to be inadequate for capturing localized rainfall events for all cotton producers, as a major proportion of the target market lived more 20 km from the nearest weather station. Expansion of the network of existing weather stations and rain gauges would be needed to ensure that a micro farm-level insurance program would be fully scalable throughout the country. The real-time data reporting capability of the majority of stations and the security at unmanned rainfall stations were also found to be inadequate for risk transfer.

Market-based index insurance appears likely to be feasible in Burkina Faso only for products that cover deficit and/or excess rainfall. The likelihood of success for index insurance market development efforts would be maximized if focused on producer groups that market their product though central organizations with strong linkages with other actors in the marketing chain, including input suppliers, marketers, and lenders. For example, micro products could be marketed to farmers or formal farmer groups (GPCs) and distributed through a market intermediary such as a cotton gin company, a bank, or an apex body of farmers such as the cotton producers union, UN-PCB. However, a meso level approach in which such intermediaries are the policyholders, with onward benefits to farmers in times of a payout, could be a more appropriate and simple interim solution to address the marketing and educational challenges in early stages of market development. Such a program is currently being run in Malawi, where a bank and three trading companies hold index insurance policies, but associate payouts from particular stations to nearby farmer groups.

Ghana

The Ohio State University and the African Center for Economic Transformation, in collaboration with the University of Ghana, is currently under-taking a three-year program of research, outreach, and education designed to promote the adoption of improved production practices among Ghanaian smallholders through the use of index insurance. OSU/ACET is testing through randomized control trails the hypotheses that coupling index insurance with production loans that require any indemnity payment to be first applied to outstanding loans will reduce the impact of widespread agricultural loan defaults on lenders during adverse systemic natural events, thereby allowing lenders to expand access to credit among smallholders and reduce the interest rates they charge on agricultural production loans.

OSU/ACET is building on the current and continuing activities of the Ghana Agricultural Insurance Programme (GAIP), a programmatic initiative that originated from the GIZ-facilitated Innovative Insurance Products for the Adaptation to Climate Change (IPACC) and enjoys continuing sup-port from the US Agency for International Development Financing Ghanaian Agriculture Project. Under the GAIP project, which is being implemented in collaboration with the Ghana National Insurance Commission, a detailed agricultural insurance feasibility study was conducted in the first half of 2010 (Stutley 2010). The study found "a major need in Ghana to improve farmers access to rural finance if they are to invest in improved seed and fertilizer technology and to thereby increase their production and yields and farm in-comes". The study further proposed introducing "crop insurance as part of a coupled program with production credit, seeds and fertilizers and preferably with output marketing assistance". The coupling of agricultural insurance with credit through rural banks, micro-finance institutions, input suppliers, exporters, processors, and cooperatives has thus become the focus of current and planned GAIP activities in Ghana.

GAIP was formed in May 2010 with 19 Ghanaian insurance companies providing their capacity under a pool coinsurance agreement and with a Technical Management Unit (TMU) responsible for creating, designing, rating and selling crop insurance products in Ghana. GAIP launched its first crop insurance product in Ghana in 2011, a rainfall deficit (drought) index insurance product marketed to commercial rural banks and non-governmental organizations (NGOs) lending to maize farmers. In the first year, over 3,600 farmers purchased drought insurance through five lenders, including three banks and two NGOs. More recently, GAIP has been developing area-yield index insurance for major food cereals, oil seeds, and root crops, with plans to start a pilot program for maize in the Upper West Region, Wa, Jirapa and Sissala West in 2013.
OSU/ACET, working directly with GAIP, is carrying out a three-year program of impact assessment and experimentation of GAIP index insurance initiatives. OSU/ACET's primary objective will be to investigate the impacts of crop insurance-continent agricultural loans on the agricultural credit system and on the technological transformation of Ghanaian smallholders.

Specifically, OSU/ACET will evaluate the impact of index-insurance-contingent loans on a) the incidence of loan defaults and of losses from default during droughts and other systemic events that reduce yields in the aggregate; b) the adoption of higher yielding agricultural technologies among smallholders, c) loan provision terms (interest rates and loan amount) offered by lenders to smallholders, and d) an expansion of rural lender portfolios, including provision of loans to customers who historically did not qualify for loans.

The GAIP project, which is on the verge of expansion, provides an exceptional opportunity for an evaluation of index insurance. The opportunity arises because product design and distribution have largely been settled, but the proper use of these instruments in holistic risk management remains an unsettled question. Outcomes and impacts of the coupling of credit and index insurance will depend on changes in lender and smallholder behavior. Index insurance will change the lenders terms of access to credit, but it is still the case that how the smallholder responds to index insurance will drive the level of effect. Consequently, outcome indicators at the level of the smallholder will serve as proxies for behavioral responses at the level of the lender.

Readers interested in index insurance activities in Ghana may wish to con-sult: Akotey, Osei, and Gemegah 2011; Sarris 2002; Stutley 2010; Muamba and Ulimwengu 2010; Meissner 2012.

Lessons Learned

Micro Insurance

Micro index insurance products intuitively appear to have the greatest potential to help farmers, since such products provide payouts directly to farmers and in principle can be tailored specifically to their immediate risk management needs. As such, most early efforts to develop index insurance involved micro contracts designed to protect individual farmers.

The results of most index insurance pilot programs, however, have been disappointing, with significant uptake of index insurance among smallholders occurring only if it is heavily subsidized or coupled with other benefits, such as low-interest loans, and with the demand disappearing as soon as the subsidy is eliminated (Miranda and Farrin 2012). Although high basis risk is generally recognized as the primary cause of low or non-existence demand for micro insurance products, other problems have undermined the development of markets for micro index insurance.

The development of micro index insurance products has also been found to require substantial investment in training and education of farmers. In order to create demand for micro products at the farm level, farmers need to be educated about the relative costs and benefits of such products and need to be properly trained to use them effectively to manage their risks, especially given that index insurance do not cover production losses from perils unrelated to the index, including losses from pestilence and disease. Micro index insurance products, moreover, if they are to be offered on a wide scale, require investment in efficient delivery mechanisms, including the training of a sales force and the development and maintenance of physical points of purchase and indemnity collection.

Considerable skepticism has been growing regarding the benefits of index insurance offered directly to farmers (Binswanger-Mkhize 2012). Micro insurance products have not been proven to provide direct substantive risk reduction benefits to farmers in excess of costs. In most pilot projects, demand for micro products has for the most part been artificially generated by making their purchase compulsory as a condition of obtaining credit or participating in marketing contracts that provide value to farmers. It is entirely likely that, due to high basis risk, farmers would not be willing to pay market rates for micro index insurance. This would impose severe constraints on efforts to expand the market for index insurance by offering stand-alone micro products to poorer farmers without strong formal marketing relationships.

Meso Insurance

Strengthening the credit relationship between farmers and lenders has been the articulated objective of most index insurance pilot projects. Two inter-related factors that have been identified in the development economics literature as critical impediments to wider adoption of improved technologies in developing countries: lack of access to credit, particularly to overcome any lumpiness of investment, and the riskiness of agricultural returns, primarily due to significant rainfall variation. Subsistence farmers in developing countries, on the one hand, are either unable to obtain credit because they lack collateral or are reluctant to risk losing their assets pledged as collateral in case of an adverse shock, while their access to informal credit is not sufficient for the

adoption of improved technologies (Mude, Chantarat, Barrett, Carter, Ikegami, and McPeak 2009b). Lenders in developing countries, on the other hand, are reluctant to supply loans to subsistence farmers because droughts and floods can cause many borrowers to default simultaneously, thereby exposing the lender to substantial undiversifiable systemic risk.

However, many recent field experiments involving coupling credit and index insurance contracts have failed to produce significant sustainable positive effects. For example, Malawian farmers' demand for credit is found to de-crease when loans are coupled with a rainfall insurance contract, even though there is considerable risk of income loss due to drought (Gine and Yang 2009). A randomized experiment offering insured loans to farmers in Ghana finds no significant difference in loan uptake among treatment and control groups (Karlan, Kutsoati, McMillan, and Udry 2011), although farmers in the treatment group are found to shift production to more perishable, and therefore riskier, crops. These results suggest that by indemnifying the farmer after a drought or other indexed event, index insurance could increase default rates on loans by implicitly reducing the severity of punishment associated with default.

In the failed field experiments, index insurance contracts were bundled with loan packages offered to farmers, with farmers receiving the payouts. However, simply bundling an index insurance contract with a loan, and entitling the farmer to receive the payouts, effectively converts the contract into a micro product, bringing with it all the problems and limitations associated with micro products, most notably higher basis risk and higher development costs. Bundling index insurance contracts with loans will be ineffective at reducing loan defaults if the lender-borrower relationship is beset by moral hazard problems due to high costs of monitoring, liberal or ineffective loan recovery policies, government interventions that force lenders to forgive loan defaults, government loan repayment guarantees, or more generally lack of effective mechanisms for penalizing delinquent borrowers.

However, important alternative uses of index insurance to support agricultural credit remain largely unexplored. Recent contributions suggest that the benefits of index insurance on loan provision, and thereby on improved technology adoption, may be dramatically increased if the indemnity goes to the lender rather than to the farmer (Miranda and Gonzalez-Vega 2011; Farrin and Miranda 2015). When a lender requires all of its smallholder borrowers to purchase index insurance to obtain a loan, with the additional condition that any indemnity must first be awarded to the lender for repayment of an outstanding loan, with the residual passed to the smallholder, then the incentives for strategic default are curtailed, substantially reducing the negative impacts on lenders of widespread loan defaults in the event of an adverse systemic weather event. The immediate benefits of index insurance contracts employed in this fashion are expected to be greater to an agricultural lender (or any other value chain participant that agglomerates risk) than to individual agricultural producers because a lender effectively diversifies much of the idiosyncratic risks borne by its borrowers and thus can be expected to face lower basis risk than its borrowers individually.

Index insurance products used in this manner avoid some of the problems associated with micro products. The basis risk problems that undermine micro index insurance contracts can be expected to be less pronounced for meso products offered to agricultural lenders and other actors in the marketing chain that that provide financial services to farmers. Lenders and other "risk aggregators" possess loan portfolios that include loans to many farmers who are dispersed

geographically and may further vary in production practices. These loan portfolios, if reasonably large, effectively diversify the idiosyncratic production risks borne these clients, while retaining the systemic risks due to widespread adverse weather effects. As such, index insurance designed to cover systemic adverse agricultural production shocks in the lenders geographical scope of business should track lender cash flow shortfalls more closely than those of any one individual farmer client.

Compared to micro index insurance products, meso index insurance products are targeted to a more sophisticated audience with greater financial analytical capacity. Meso index insurance products offered to aggregators can be more sophisticated in structure than micro products, allowing the coverage to be more precisely tailored to the losses of the insured. Index insurance contracts based on compound indices and highly nonlinear payout schedules that would be inappropriate less sophisticated farmers thus become possible. Furthermore, obtaining regulatory and legal authority to market meso insurance products is likely to face fewer logistical obstacles, given that lenders have a history of working with regulators. In addition, meso index insurance products require less extensive delivery mechanisms, since in many cases they can be sold through over-the-counter transactions. And finally, since the number of decision makers that need to be properly educated is much less with meso products, educational costs can be substantially reduced.

Meso index insurance products, however, present very different technical and contract enforcement issues related to their use. International donors, multilateral organizations, and other sponsors of index insurance develop-mental programs are typically motivated by the desire to directly and demonstrably improve the welfare of poor farmers. Thus, the most pressing questions surrounding the design of meso index insurance pertain to how such contracts can best be used so as to provide benefits to the farmer.

Weather Data

Accurate rating and efficient design of index insurance products requires long, clean, internally consistent historical data records. Because less data leads to higher premium rates charged by insurers for index insurance products, index insurance offered in areas where little data are available are less likely to succeed. As learned in Ethiopia, areas covered by weather stations with 20% or more missing data from the last 30 years would not be viable candidates for insurance pilots (Bryla 2009).

Unfortunately, most index insurance research and pilot program findings have cited insufficient or low quality weather data as a major obstacle to the expansion of index insurance programs beyond the pilot phase. The availability of reliable weather data at needed temporal resolutions varies across developing countries and in some countries the scarcity of data can be especially severe. It is not uncommon, for example, for available rainfall data series to span fewer than twenty years or to exhibit major gaps of missing observations, even at World Meteorological Organization-registered weather stations. Moreover, it is not uncommon to find evidence of ad hoc attempts to fill in missing data. For example, in some rainfall data series, it has been noted that the exact same nonzero level of rainfall is recorded for a sequence of consecutive days, a highly improbable occurrence. One example of where a scarcity of data severely affects contract design is that of area-yield index insurance. Because the basis risk associated with area-yield index insurance is, in theory, lower than that of contracts based on weather or irrigation water supply indices, farmers' willingness to pay for area-yield insurance has been estimated to be twice as high as that for rainfall insurance (Carter, Boucher, and Trivelli 2007). However, although area-yield insurance may be more desirable, rainfall data are more likely to be avail-able in developing countries, whereas reliable and sufficiently detailed yield records may be nonexistent. Rainfall collection systems are also less costly than developing a reliable yield estimation procedure for small geographical regions.

Numerous pilot programs have has invested in technical meteorological and statistical studies aimed at creating synthetic rainfall data by correlating satellite data and ground station rainfall measurements. These methods can provide reasonable estimates of conditional expectations of rainfall on highly-refined spatial grids. However, synthetic rainfall index data constructed in this fashion have also been found to underestimate the variability of rainfall at any location and to under-predict the duration of dry spells. The use of synthetic data could therefore substantially bias estimates of expected index insurance indemnities, thus undermining the actuarial performance of the index insurance product and leading to sub-optimal index insurance contract designs, as well as higher reinsurance rates.

Product Development and Capacity Building

By capacity building, we refer generally to efforts to create the conditions wherein the market for index insurance can, in the future, be independently sustained and developed to the maximum beneficial extent by local stake-holders, without continued direct financial support from governments or international agencies. Local capacity is built primarily through education, outreach, technical assistance, and other forms of knowledge transfer, but also involves the forging of sustainable cooperative working relationships among stakeholders. More specifically, effective capacity building requires: establishment of an institutional framework that allows stakeholders to cooperate in finding new and appropriate ways to use index insurance to enhance the performance of the agricultural value chain and to improve the welfare of the rural sector; transferring essential technical skills to insurers, reinsurers, and government agencies that would permit new index insurance products to be designed and old ones to be refined to meet the varied and changing risk management needs of farmers, lenders, agribusinesses, and government authorities; transferring essential risk management skills that would permit for the proper use and optimal integration of index insurance with the operational practices of farmers, lenders, agribusinesses, and government agencies; and development of a legal and regulatory framework that will foster the evolution of markets for index insurance through entrepreneurial initiative.

Experiences in sub-Saharan Africa have repeatedly demonstrated that strong institutional working partnerships among stakeholders are essential for the establishment of an efficient self-sustaining index insurance program with the potential for independent growth. Building institutional networks and working partnerships has been a high priority in virtually all index insurance programs, and has been most successful when it has involved multiple stakeholders, without focusing on only one. Just the same, building institutional networks has been found to be most successful if a leader can be identified among stakeholders, either in the form of a powerful farmer group, processor, or lender. Strong leadership serves as an effective catalyst to the creation of strong institutional partnerships, as the leader can serve as an example for other stakeholders and can facilitate the creation of a network by drawing on its extensive political and business contacts.

Transfer of technical knowledge pertaining to the design of index insurance products is also essential if the marketing of such products is to pass to local insurers. Virtually all insurers employ resident actuaries with sound analytical skills. However, the design and rating of index insurance products present unique problems and require skills that are not part of traditional actuarial training. To properly design index insurance contracts, it is important to understand the basic agronomic relationships that exist between weather indices and agricultural production. The design of such contracts, moreover, must rely on basic weather and production data, rather than the experiential loss data most commonly the object of analysis in conventional actuarial analysis. Furthermore, correlated risk and basis risk, which are relatively minor concerns with conventional forms of insurance, become major issues in designing index insurance contracts.

Outreach to smallholders can be especially expensive and challenging, given that most farmers lack experience using market insurance and, in most cases, a lack formal education. Substantial effort has been invested in the education of stakeholders what will directly use index insurance products, most notably farmers, farmer groups, lenders, and processors. From the outset, index insurance projects have demonstrated that index insurance, because it is a relatively new financial product without an established record of success, is often received with considerable skepticism by such

stakeholders. Educating stakeholders can be achieved only if educational programs are targeted to the unique concerns of each stakeholder and are attentive to the differences in educational level and technical training across stakeholders.

Outreach to lenders also presents challenges, given that most lenders do not have a history of active risk management using financial instruments such as insurance. Most pilot program educational efforts have largely been limited to situations in which lenders and farmers have well-established marketing relationships. The successes of these efforts owe a great deal to the fact that farmers and lenders clearly have a joint stake in using index insurance to support and sustain their credit relationship. Little is known, however, as to whether the same educational methods will be transferable to the education of farmer without such relationships.

Role of Government

Governments can be both impediments and catalysts to the development index insurance markets. Government programs such as loan guarantees and buffer stocks can severely undermine development of a market for index insurance. Moratoriums on loan repayments during catastrophes, a common dictate of central governments to publicly owned or supported agricultural banks, can also undermine the benefits of index insurance to credit relation-ships. Educational efforts aimed at government officials must make clear how government policies undermine development of index insurance contracts and must explain how index insurance can be used as a cost-effective substitute for existing government programs and established credit-easing practices.

Government can be a catalyst by ensuring that insurers target small-holders, particularly if a publicly owned insurer involved in index insurance contracts. Governments and their regulatory agencies also play a central role in properly positioning index insurance programs within the existing insurance and financial regulatory framework. Index insurance is difficult to classify, as it possesses qualities of a derivative financial product and qualities of a conventional insurance product, without strictly satisfying all the conditions that ideally define either type of product. In many countries there is no clear precedent for classifying index insurance contracts within existing laws or regulatory framework. Multiple regulatory agencies therefore often need to cooperate to design appropriate oversight provisions for index insurance products, and this is possible only with a strong commitment from the regulators and the central government.

Role of Donors

Donors can offer to provide short-term subsidies to address some of the operational costs (e.g. marketing costs associated developing tailored marketing tools for the different value chain players) of insurance companies. Very often index insurance companies are set up by NGOs with social protection objectives and limited profit maximizing objectives. It is later that the need to become commercially viable arises and doing so usually requires further investment by the insurance company in marketing which, if done alone, can increase their operation costs and further raise the already high premium rates. Donors' support in subsidizing marketing costs to increase awareness among risks aggregators such as rural banks and microfinance institutions,

nucleus farmers, processors who use out-growers should be given priority.

It is further important for donors to help build the capacity of risks aggregators to use index insurance and appreciate its value as a tool for managing portfolio risks. Donors can sponsor the development of business process models that outline in detail how index insurance can be operationalized in various agricultural businesses. The insurance companies should also be capacitated to develop, rate and underwrite new products tailored to clients' line of business without having to depend on the services of an external consultant.

Lastly, governments can also be capacitated by donors to develop a habit of regularly and objectively collecting data that are often used as index by index insurance companies. These data include rainfall, area yield data for all crops, soil moisture content level. These data can be sold to insurance companies at cost recovery basis who in turn will use them to rate their insurance policies.

The Way Forward

Most early index insurance products were micro products designed for farmers, who would receive the payouts provided by the contract. However, given uniformly disappointing results with micro insurance products, researchers are now paying increased attention to offering index insurance to lenders, input suppliers, processors, and exporters strengthen the agricultural value chain in general, with farmers benefiting indirectly.

It is becoming apparent that the best way forward with index insurance is to use it to strategically manage the portfolio risks borne by lenders, processors, and exporters. Only then can the basis-risk reduction benefits promised by meso index insurance products be fully realized. Index insurance has the potential to reduce loan defaults (or losses from such defaults) across many farmers simultaneously in the event of a widespread drought, flood, or other natural disaster. Thus, if properly integrated into a lenders portfolio risk management and loan policies, index insurance could dramatically reduce the lenders exposure to catastrophic risk and promote the expansion of credit supply to subsistence farmers at lower interest rates, which in turn should spur increased adoption of higher-yielding agricultural technologies.

However, proper uses of index insurance by lenders in holistic portfolio risk management requires a deeper understanding of the cash-flow risks faced by lenders and the debt restructuring policies they employ to manage such risks. Although lenders arguably are more sophisticated than farmers and thus better able to implement complex risk management practices, it is also true that many rural lenders in developing countries lack a culture of active risk management practices that employ insurance, reinsurance, and derivative products. Operational cash-flow models and risk management practices can be intricate and opaque and can vary from one lender to the next. Efforts to develop lender portfolio risk management strategies that incorporate index insurance can encounter difficulties if lenders are reluctant to openly discuss their trade and internal cash-flow management practices with index insurance specialists. For meso index insurance products to gain wide acceptance from donors and international agencies, there is a very practical need to demonstrate that they can generate tangible benefits to poor farmers, either through lower interest rates on loans or through significant expansion of services offered to such farmers.

Moreover, index insurance is not a substitute for strong loan recovery practices, and cannot compensate for weak ones. Weather index insurance can strengthen credit relationships only through improved monitoring and enforcement of contract performance, which could be addressed, say, by establishing functional national identification and credit information systems or employment of collateral substitutes such as joint liability groups or buyer agreements. Without such measures, bundling strategies may fail when at-tempts are made to scale up the index insurance market to reach farmers without strong formal marketing relationships.

Most pilot projects have been developed around a specific crop or farmer group and typically with the involvement of one or a very small number of lenders or processors. Although many lessons have been learned from these efforts, questions remain as to whether index insurance can take root in Africa and support its agricultural transformation. These questions, how-ever, can only be answered by attempting expansion of the most promising pilot programs so as to 1) include larger number of poor farmers on the fringes of the agricultural marketing chain; 2) span a greater variety of crops and production practices over a wider geographical scope; 3) develop alternative institutional frameworks that includes wider stakeholder representation, including a combination of banks, input suppliers, processors, and exporters; and 4) promote chances in lender, processor, and exporter risk management strategies.

Research on index insurance has answered some questions about the cost-effectiveness of index insurance, but has also raised new ones. From these efforts, new ideas regarding the use of index insurance and new challenges to the development of index insurance markets have emerged. As such, there is still a need for additional work before we can establish whether index insurance can help address the catastrophic risk management problems faced by the poor living in the developing world. Formal follow-up impact assessment studies based on benefit-cost principles, conducted using appropriately de-signed survey instruments or controlled randomized field experiments could provide answers to a myriad of pressing questions pertaining to the large-scale viability and the value of index insurance, including: Can lenders, processors, and exporters become more resilient to systemic shocks as a result of incorporating index insurance in their practices? Do contingent credit con-tracts reduce aggregate loan defaults in times of widespread adverse weather events? Can index insurance lower interest rates charged to farmers or alter loan recovery and principal repayment scheduling practices so as to benefit farmers? Has index insurance encouraged lenders, input suppliers, and processors to expand their businesses? Have farmers production practices been improved by index insurance?

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