

# Kenya

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## Toward a National Crop and Livestock Insurance Program

### BACKGROUND REPORT



WORLD BANK GROUP



GFDRR



Ministry of Foreign Affairs



USAID  
FROM THE AMERICAN PEOPLE



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# Acronyms and Abbreviations

<b>AIDP</b>	Agriculture Insurance Development Program
<b>AIM</b>	Agricultural Insurance Manager
<b>ALRMP</b>	Arid Lands Resources Management Project
<b>ARC</b>	Africa Risk Capacity
<b>ASAL</b>	arid and semi-arid land
<b>AYII</b>	area yield index insurance
<b>CCE</b>	crop-cutting experiment
<b>eMODIS</b>	enhanced Moderate Resolution Imaging Spectroradiometer
<b>FSD</b>	Financial Sector Deepening
<b>GFDRR</b>	Global Facility for Disaster Risk Reduction and Recovery
<b>GIS</b>	geographic information system
<b>GoK</b>	Government of Kenya
<b>GPS</b>	Global Positioning System
<b>HSNP</b>	Hunger Safety Net Program
<b>IBLI</b>	Index Based Livestock Insurance
<b>ILRI</b>	International Livestock Research Institute
<b>IRA</b>	Insurance Regulatory Authority
<b>MALF</b>	Ministry of Agriculture, Livestock and Fisheries
<b>MPCI</b>	multi-peril crop insurance
<b>NAIP</b>	National Agricultural Insurance Policy
<b>NDV</b>	Normalized Difference Vegetation Index
<b>NPCI</b>	named peril crop insurance
<b>PPP</b>	public-private partnership
<b>SACCO</b>	savings and credit cooperative
<b>SDA</b>	State Department of Agriculture
<b>SDL</b>	State Department of Livestock
<b>TLU</b>	Tropical Livestock Unit
<b>TSU</b>	technical support unit
<b>USAID</b>	U.S. Agency for International Development
<b>WII</b>	weather index insurance
<b>Currency:</b>	Kenyan shilling (K Sh)

## SECTION

## A

# Introduction

**This Agriculture Insurance Solutions Appraisal proposes the technical concept of a potential public-private partnership (PPP) in agricultural insurance in Kenya, covering both crop and livestock.** It lays out the rationale for the proposal, offers an insurance PPP solution for the identified challenges, and makes a suggestion for the required underlying institutional framework. This technical report is meant to guide further policy making and technical development processes and to form the basis for further discussion among all involved stakeholders.

**In Kenya agriculture is risky, and that risk has large human and economic costs.**

Agriculture is key to the Kenyan economy, generating approximately 30 percent of annual gross domestic product and approximately 50 percent of revenue from exports. It is also an important source of employment: over 61 percent of the population has jobs in agriculture.<sup>1</sup> But agriculture in Kenya is a risky activity, often unirrigated and highly vulnerable to the impacts of climate change.

**Despite the recognized need for a commercially oriented, internationally competitive, and modern agricultural sector, rural lending in Kenya is low.** Agricultural lending accounted for only 4.3 percent of total lending in Kenya in 2012 (Central Bank of Kenya 2012). A large-scale agricultural insurance program would support resilient, viable expansion of agriculture credit to farmers by removing agriculture risk from the balance sheet of rural banks and cooperatives, thereby making them more robust to agricultural shocks. Without adequate coverage of agricultural

insurance, agriculture credit will remain insufficient to fully meet the needs of farmers and herders.

**Moreover, international experience suggests that agricultural insurance programs will not scale up unless based on a balanced partnership between the public and private sectors.** In recent years, numerous private sector agricultural insurance pilots have been implemented in Kenya with support from donor partners for index-based crop insurance. However, to date most of these programs have failed to reach significant scale. Overall, experience from other countries suggests that both the government and the private sector must play a role in developing the agriculture insurance market.<sup>2</sup>

**Recognizing the importance of its involvement, the government of Kenya (GoK) is collaborating with the World Bank to investigate how agriculture insurance can help transform the agriculture sector and promote food security, economic growth, and shared prosperity in the medium to long term.** The collaboration, which is undertaken with the Agriculture Insurance Development Program (part of the World Bank Group's Disaster Risk Financing and Insurance Program), aims to understand how insurance could form part of a strategy to derisk agriculture value chains and more generally function within a broader risk management framework. The GoK has identified the agriculture sector as a key area of focus under the Kenya Vision 2030 plan to promote Kenya's transition to a middle-income country; and agricultural insurance is a stated priority of government, as

### Box 1– Key International Lessons for the Design and Implementation of Agricultural Insurance

- Agricultural insurance programs are challenging to develop and successfully sustain.
- Carefully designed and well-implemented agricultural insurance programs can support a range of government policy objectives, such as increased access to credit, improved agricultural productivity, reduced vulnerability, and social protection.
- Agricultural insurance should be considered by government alongside other potential agricultural risk management and social protection interventions, since other interventions may offer higher benefit-cost ratios or be a precondition for successful agricultural insurance.
- Agricultural insurance programs are more effective and efficient when underwritten by the private insurance sector and actively supported by government under carefully designed PPPs.
- Financial support to agricultural insurance programs can provide a faster, more cost-effective way of supporting agricultural producers' recovery from shocks than ad hoc post-disaster relief.
- Cost sharing between government, donors, and farmers may differ for different segments of the population depending on policy priorities.

Sources: Mahul and Stutley 2010; World Bank–GFDRR Disaster Risk Financing and Insurance Program 2014.

reflected in the Second Medium Term Plan (MDP 2013). The government is exploring initiatives to further derisk the agriculture sector value chain in order to facilitate better access to markets and unlock access to credit, which would in turn allow farmers to purchase higher-yielding technology (seeds, fertilizers, plant protection chemicals, etc.) and increase their incomes. These initiatives aim simultaneously to ensure food security in Kenya and transform the agriculture sector.

**This technical report investigates the institutional policy and design issues associated with agriculture insurance PPP structures, as well as their fiscal cost and welfare benefit.** Taking into account Kenya's current agriculture insurance policy and government institutions, our analysis sought to identify sound policies and institutional structures that would unlock the innovative potential of the private sector in agriculture insurance. For both crop and livestock, we analyzed the current market to understand what high-quality products could be developed in the short, medium, and long term to meet Kenya's needs.

# Institutional Frameworks

## Rationale for Public-Private Partnerships in Agricultural Insurance

The agricultural insurance market in Kenya has failed to reach scale. With the exception of some small-scale pilots and niche retail activity, the private sector is currently not providing agricultural crop and livestock insurance (GoK 2014a). This chapter considers possible causes for the agricultural insurance market's failure in Kenya, the rationale for and benefits of a public-private partnership (PPP) for developing agricultural insurance, and the appropriate functions of the public and private sectors within a PPP. The final section suggests a vision for a PPP and makes recommendations for next steps.

Weather index insurance (WII) has been considered a potential solution for fostering a viable agricultural insurance market, but the approach has achieved mixed results. Although a number of small-scale agricultural insurance pilots have been commenced, only one, the UAP Syngenta program, has so far scaled up. This program, currently in its fifth full year of implementation, now insures more than 87,000 farmers annually in Kenya (during long rains 2014) where crop WII and crop-credit provision are automatically linked. The reason why WII has not scaled up in Kenya—that is, why it has been difficult to establish viable

index insurance for smallholder farmers on a retail basis at scale—has partly to do with the absence of certain fundamental building blocks required by an agricultural insurance market: (i) improved access to inputs, husbandry, and irrigation; (ii) reliable access to weather data; and (iii) a supportive regulatory framework (FSD 2013).

But international experience suggests that the absence of these building blocks is not the only reason why agricultural insurance markets fail and pilots do not scale up.<sup>3</sup> Most of the following reasons are applicable to Kenya:

- **Lack of agriculture data.** As discussed below, there is very little reliable agricultural data available in Kenya. This is a serious constraint on the development of agricultural insurance products.
- **Lack of capacity, especially for catastrophe risk.** Insurers do not have the capacity to cover catastrophe risk associated with drought, flood, and other typical agricultural risks. Although international reinsurance is available, it is expensive, particularly where there is a lack of data.
- **High distribution costs.** Given that farms tend to be small and spread over wide areas, agricultural insurance typically carries very high distribution costs. These are exacerbated by the lack of established branch or agent networks in rural areas.

Photo Credit: Daniel Clarke



- **High loss assessment costs.** In relation to traditional indemnity insurance, the costs of assessing losses are usually extremely high. This is especially true for small insured farm units, where the premium volume generated is usually very low and insufficient to cover the costs of the loss assessment.
- **High development costs.** Although index insurance lowers the transaction cost, it carries extremely high development and other start-up costs. These start-up costs cannot Expensive premiums. Small farmers are unwilling, and may be unable, to pay for commercially priced agricultural crop and livestock insurance.
- **Poor understanding of insurance.** Farmers' poor understanding of agricultural insurance reduces demand and may lead to purchase of inappropriate products.
- **Lack of an enabling legal and regulatory framework.** As discussed below, Kenya's Insurance Act does not support index insurance,<sup>4</sup> and a regulatory framework for microinsurance is still being developed.

Furthermore, flaws in the design of post-disaster relief mechanisms often result in the crowding out of insurance. If farmers expect post-disaster relief from government, development agencies, or nongovernmental organizations, they have little incentive to purchase insurance.

International experience suggests that sustainable, scaled-up agricultural insurance programs are based on a strong public-private partnership—one involving engagement, innovation, and action from both partners. The failure of the agricultural insurance market in Kenya provides a clear justification for intervention by the government of Kenya (GoK), but that intervention is further justified by the severe challenges that public sector-only and private sector-only approaches face. These range from inefficient delivery, distribution, and claims settlement in the case of the former, and underinvestment in necessary data in the case of the latter. A strong partnership between the public and the private sectors will allow Kenya to build on each sector's comparative advantages.

## SECTION

## Public And Private Sector Functions

### Overview

Few functions belong exclusively to either the public sector or the private sector; rather, most are shared. For example, both the public and private sectors have separate functions in relation to data, marketing and outreach, and risk financing. The shared nature of the functions both strengthens the arguments for a PPP framework and influences the institutional framework’s design.

The PPP framework for agricultural insurance and wider risk management will need to support public and private sector institutions in identifying, developing, and distributing the appropriate risk transfer solution to each segment of the farming population.

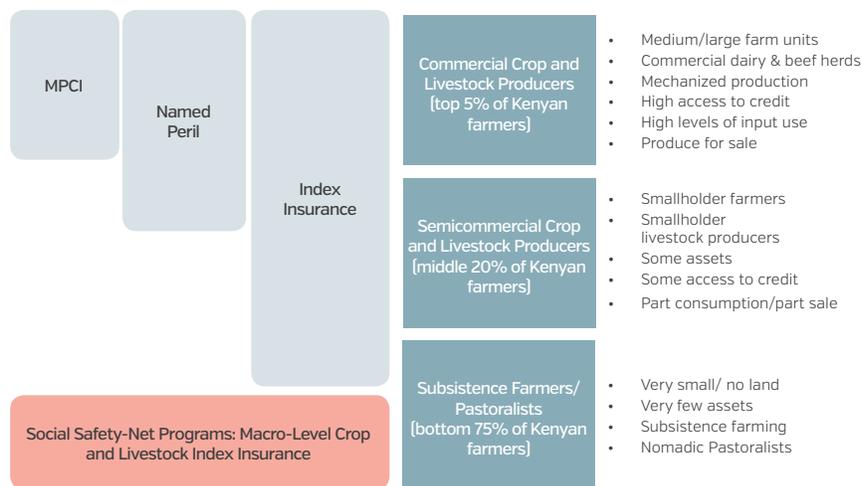
Currently, most traditional indemnity-based crop and livestock insurance in Kenya is targeted at small to medium-size commercial farmers and dairy cattle producers. On the other hand, index insurance is being promoted by the donors as a small-scale farmer

microinsurance or retail product, and most of these programs are not achieving scale.

Traditional indemnity-based multi-peril crop insurance (MPCI) is not well suited to the risk transfer needs of subsistence farmers and pastoralists. It is therefore necessary to identify other risk transfer solutions to meet these needs. In the short to medium term, potential linkages between existing social safety net programs and applications of macro-level index insurance programs could be explored as part of an integrated risk management framework (figure 1).

The Kenyan agricultural insurance market is subject to market inefficiencies that the GoK can help to overcome through a number of mechanisms. These include (i) collecting reliable agricultural insurance data, (ii) conducting appropriate outreach to potential policyholders, (iii) providing or supporting the risk financing of the catastrophic layer of reinsurance, (iv) supporting the design of appropriate insurance products, and (v) establishing and implementing an enabling legal and regulatory environment.

**Figure 1 –** Toward an integrated private risk management and insurance framework for different segments of Kenya’s crop and livestock producers



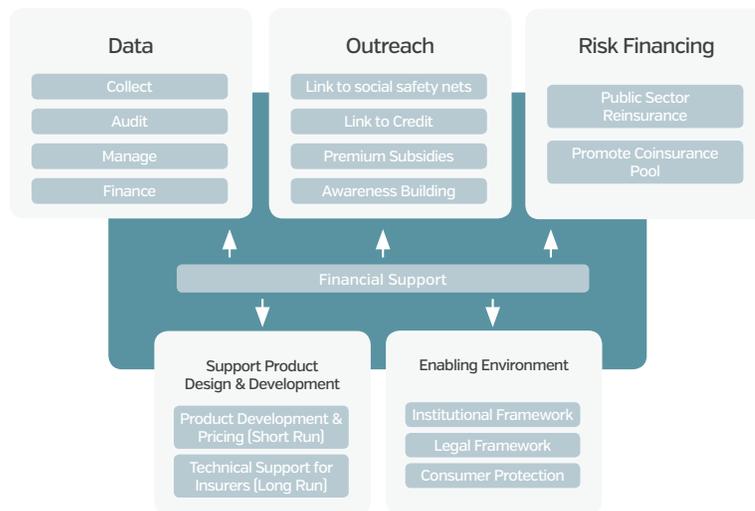
**The full participation of the private sector is critical for the successful implementation of an agriculture insurance program.** The following are considered to be principally private sector functions: (i) product design and rating, (ii) risk acceptance and underwriting, (iii) decisions about risk retention and reinsurance strategies, (iv) supplementary data collection, (v) the marketing of crop and livestock insurance products, and (vi) the distribution of these products. As indicated above, many functions are shared by the private and public sectors. The public sector plays a role in both risk financing and data collection; and although the private sector is responsible for product design and rating, the government will have a strong interest in the price of the product—and therefore in the product’s rating—where it provides a subsidy.

**Product development and ongoing technical support are costly.** Given the actuarial and other specialist expertise required to design and price new actuarially sound and sustainable agricultural insurance products, and to support their ongoing development, the costs are likely to impose a significant entry barrier to commercial insurers.

Insurers expect to recover product development costs over time through the premium paid. In the case of agricultural insurance, however, the high costs and the limited financial capacity of policyholders make this recovery unrealistic. Therefore, although product development and technical support are private sector functions, the support of government and development institutions (such as the International Livestock Research Institute [ILRI], World Bank, UK Department for International Development, and U.S. Agency for International Development [USAID]) is likely to be necessary, at least in the short to medium term.

**Care will need to be taken to mitigate the risk of crowding out private sector innovation or of subsidizing tasks that the private sector is able to undertake.** Once products have been developed and demonstrated to be actuarially sound, insurers should be able to support their continued development; and once agricultural insurance has reached scale, the premiums should be able to support the costs of developing new products without public sector support.

**Figure 2 – Potential public sector roles for GOK in support of agricultural insurance development in Kenya**



## Functions Of The Public Sector

### Data Collection, Auditing, And Financing

Effective insurance solutions require good-quality data; without such data, sustainable insurance markets are unlikely to develop.

For insurance purposes, data must be sufficient and adequate to enable the design and rating of products; they must be relevant, so that products offer reliable protection; they must be reliable enough to be accepted by international reinsurers, whether through audit or otherwise; they must be timely, so that claims can be paid quickly; and they must be cost-effective.

The different categories of risk and the different insurance schemes in Kenya require different types of, and investments in, data.

For example, crop insurance and livestock insurance require different types of data available from different sources (such as ground-based data or remote-sensing data, including satellite data, on agricultural production or weather variables). Investment in reliable data allows monitoring of risk dynamics

on an ongoing basis and informs risk management strategies and systems, and it offers other benefits as well: (i) reliable data can be used for Ministry of Agriculture, Livestock and Fisheries (MALF) policy decisions (about subsidies for fertilizer, water, seed, or irrigation); (ii) they can improve farm-level understanding of risks to empower farmers to undertake better risk management techniques (crowding in of good mitigation); and (iii) they can put a price on risk by (for example) informing farmers if they should stop growing a crop in a given location.

The GoK intends to play an important role in collecting agricultural insurance data, both for livestock and for crop insurance. Given that the collection and management of most data for agriculture insurance is expensive and nonrivalrous,<sup>5</sup> the function is usually more efficiently undertaken through a monopoly. For example, it does not make economic sense for every insurer to set up its own weather stations in the same area to capture the same data. Thus the public sector has a natural role to play. In Kenya, as in many countries, the

**Table 1–** Agricultural insurance data collected by GoK

Data Type	Public Institution in Charge of Collection
Meteorological data	Kenya Meteorological Department under the Ministry of Environment, Water and Natural Resources
Time series crop production and yield data	Kenya National Bureau of Statistics and Ministry of Agriculture, Livestock and Fisheries (MALF)
Crop and livestock damage data	MALF
Further livestock statistics	Arid Lands Resource Management Program (ALRMP) and USAID's Pastoral Risk Management Project

Source: Government of Kenya 2014a.

collection of agricultural insurance data is largely coordinated by government agencies. This is true for all agricultural insurance data apart from claims data, which insurers collect themselves (see below). There may be other sources of data, but the main responsibility for collection lies with public sector institutions (see table 1).

**The GoK intends to investigate the benefits of outsourcing some parts of the data collection to private providers.** This approach has been tried in India, for example, where crop-cutting experiments (CCEs) that support area yield indexes for insurance are outsourced by several state governments to private sector agents; it is too soon to judge whether this approach will be successful, however (World Bank 2011b). Outsourcing does not make the activity a private sector function but rather an outsourced public sector function. This is an important distinction, as ownership of the function suggests control; where public functions are outsourced, greater checks and balances will need to be built into the structure to protect the public sector interest.

**Most publicly collected agricultural insurance data are perhaps not of insurable quality.** Data are often incomplete, missing, or unavailable. The MALF report (GoK 2014a)<sup>6</sup> suggests various reasons for this:

1. Data collection coverage is low. The Kenya Meteorological Department operates 92 synoptic agrometeorological automated weather stations across Kenya, but they are mainly located in the major towns in the central and southern regions; total coverage of the country would require more than 1,250 automatic weather stations.
2. There has not been a farm-level census since 1999.
3. MALF field extension officers are underfunded.
4. MALF data on crop production seem to be unavailable or not systematically maintained.

**Given the current lack of high-quality agricultural data, Kenya requires a strong audit function to ensure data quality and access to international reinsurance markets.**

Agricultural shocks are covariate in nature, so it is important to off-load some of this risk outside the country through international reinsurance markets. But reinsurers have high standards for the data they use to develop and price insurance products, and they charge significantly higher premiums if they have concerns about how the data are audited. A transparent process for auditing insurance data will ensure the quality of the data and in turn allow local insurers to leverage international reinsurance markets.

**Some of the concerns about data quality are being addressed through a series of data collection guidelines developed by the GoK.**

These guidelines are currently under review and include the Kenya Agricultural Data Collection and Management Guideline, a complementary training manual, and a list of standards and guidelines for food and agricultural data collection. However, much work remains to be done, including (i) implementing the guidelines, (ii) providing for integrated databases of agricultural insurance data, and (iii) introducing clear protocols regarding access to and charges levied for use of agricultural insurance data.

**The discussion above suggests that considerable investment is required in the collection, management, and audit of data.**

To avoid wasted investment, it would be prudent to undertake a preliminary analysis of the data available from public and private sector sources in Kenya. This analysis could be used to:

1. Produce a data gap analysis.
2. Determine how to fill the data gap with agricultural insurance products whose design requires minimum investment in the data infrastructure.
3. Explore the extent to which data can be sourced externally as a substitute for local data (e.g., using satellite or remote-sensing data).



## Outreach

Photo Credit: Daniel Clarke

**The GoK intends to provide general outreach support in relation to agricultural insurance with the objective of expanding market awareness.** Achieving scale is fundamental to the sustainability of agricultural insurance programs because it helps to spread the cost of providing insurance among numerous policyholders.

However, low levels of financial literacy in the target market and poor understanding of the potential benefits of insurance often prevent programs from reaching scale. Although the marketing of specific insurance products is a function of the private sector, government can play a more general role aimed at building financial literacy among potential policyholders and at helping them understand the types and potential benefits of agricultural insurance.

**The government should exercise caution in this role, however.** Experience has shown that government consumer education and marketing campaigns may be unsuccessful and even counterproductive if the insurance products are not available (for example, because insurers do not have the necessary distribution channels in place) or if insurers are not trusted (for example, because of slow claims payment and low claims ratios). As the government develops any financial awareness

campaigns, it should ensure that associated products are developed and offered in tandem.

**The GoK will consider various ways to support outreach for agricultural insurance products:**

1. **Linking to rural lending.** Rural banks and microfinance institutions have the potential to reach a large number of rural farmers in Kenya. Linking agriculture insurance to rural credit may help to promote very broad outreach while at the same time deepening access to financial services (i.e., both credit and insurance). The imposition of a legal obligation to purchase insurance on taking agricultural credit can lead to poor incentives. However, banks may impose the requirement as part of the package they offer farmers, and this requirement can be supported by government.
2. **Conducting financial literacy campaigns.** Unless potential policyholders have a basic level of financial literacy, it will be difficult for insurers to sell agricultural insurance products. With a greater degree of financial understanding, farmers can better weigh the risks and benefits of insurance products. It is expected that county governments will play an essential role in this.

3. **Raising awareness of insurance.** Beyond basic financial literacy, potential policyholders need to understand the types and benefits of agricultural insurance if they are to purchase it. Raising awareness of insurance should be regarded as a shared role. Government may be better able than the private sector to utilize the media, but campaigns are unlikely to be effective unless the private sector also plays a role, specifically by providing effective training to insurance agents and by developing clear product documentation.
4. **Linking to the Hunger Safety Net Program (HSNP).** Linking livestock insurance to the HSNP should help to increase outreach by targeting based on poverty data that was collected as part of the HSNP. This linkage will also serve to lower transaction costs by enabling more efficient collection of premiums and distribution of claims.

Although the Insurance Regulatory Authority (IRA) is already engaged to a limited extent in raising public awareness of insurance, the GoK and the county governments also have roles to play. The GoK's role in financial literacy and market awareness campaigns is to develop a strategy; the role of the country governments is to lead implementation through the devolution process.

### Risk Financing

Given the high costs for development, distribution, claims assessment, and risk financing, agricultural insurance is unlikely to succeed without some public sector subsidy. Development costs are an upfront charge; distribution costs can be mitigated through the development and use of alternative distribution channels; and claims assessment costs can be mitigated through product design. The cost of financing the risk, however, is ongoing and must be met on a year-to-year basis. An insurance product cannot be sustainable unless the risk financing costs are fully met. It is therefore perhaps inevitable that the public sector will have to provide support for risk financing.

Insurance offers governments an efficient mechanism for providing financial support to vulnerable farmers and pastoralists in the event of crop failure or significant livestock losses. Well-designed insurance products are an efficient method of transferring extreme agricultural risk. But agricultural insurance is unlikely to be purchased by vulnerable farmers and pastoralists. Thus governments may decide that purchasing insurance on their behalf is more efficient than relying on other support mechanisms such as post-disaster relief.

Photo Credit: Daniel Clarke



Governments often provide support for the financing of risk through direct premium subsidies with the objective of incentivizing insurers to enter the market and increasing the take-up of insurance product. However, this approach has potential drawbacks, and there may be better ways for government to reduce the premium cost to farmers than direct premium subsidies, such as through risk financing.

**Providing public stop-loss reinsurance would build on international experience that has demonstrated the efficiencies gained by splitting the risk into layers.** For example, there are three layers of risk under the Mongolian livestock insurance scheme, which has now reached national scale:

1. The first layer of risk (up to 6 percent livestock mortality), which covers the more frequent low-impact events, is borne by the insured livestock herders.
2. The second layer of risk (between 6 percent and 30 percent livestock mortality) is covered by commercial insurers, through a pool, for which the policyholders pay a fully priced rate.<sup>7</sup> This is the noncatastrophic layer of risk.
3. The third layer of risk (over 30 percent livestock mortality) is covered by the government under a stop loss agreement entered into with the commercial insurers. This is the catastrophic layer of risk. The government does not charge for the stop loss agreement.

The commercial insurers reinsure part of their liability under the commercial layer to the international reinsurance market, while the government reinsures a portion of its risk under the catastrophic layer to the international reinsurance market (Mahul and Skees 2007).

This form of risk layering offers a number of advantages:

1. By covering the catastrophic layer of risk, *the government reduces the premium paid by agricultural producers*, as the premium does not include the price of the catastrophic risk.
2. *If the government decides to withdraw the subsidy, the nonsubsidized commercial layer can still continue to be sold on a sustainable basis*, as the noncatastrophic risk is fully priced. The commercial layer will cover all but the catastrophic risk.
3. *Significant efficiencies are obtained through the effects of risk pooling at the national level*, in both the commercial layer and the catastrophic layer.
4. *Government can optimize the cost of capital by managing the amount and type of reinsurance, or other types of risk transfer instruments, that it purchases.* Selectively transferring a portion of the catastrophic risk to the international market, and retaining the balance of the risk, lowers the government's total costs; an indirect premium subsidy costs significantly less than direct premium subsidy.

**This risk financing approach could be considered for crop insurance in the Kenyan context.** Given the limited availability of data and need to develop affordable products for farmers, the government's assumption of a role in risk financing could have significant benefits for a crop insurance program. In order to achieve the most efficient pricing for the risk, the government intends to consider in the medium term a risk layering approach— similar to that used in Mongolia—under which it provides support for the higher layers of risk.

**For livestock insurance, where the objective is to reduce the vulnerability of pastoralists, direct premium subsidy may be necessary in the short term.** In the initial years, any livestock insurance product should be based on high-quality satellite data; these products would not be subject to large increases in the premiums for poor data quality.<sup>8</sup> In addition, as the primary objective of the livestock insurance program is to reduce vulnerability of households in Kenya's arid and semi-arid lands (ASALs), the beneficiaries will be low-income households that would not be able to afford to pay for the insurance. Thus the provision of premium subsidies by the GoK could be considered a viable option; the GoK intends to make sure that subsidies are clearly targeted and options considered for their gradual withdrawal over time. In particular, the GoK will carefully consider the challenges linked to maintaining the long-term financial stability of the insurance scheme and will consider devising a clear exit strategy or long-term financing before embarking on premium subsidies.

**The provision of agricultural insurance through a coinsurance arrangement is recommended later in this chapter.** Although the establishment of nonstatutory coinsurance pools is a private sector function, the initial push for this effort may need to come from the public sector. (See below for more details.)

#### **Support for the Design and Ongoing Development of Insurance Products**

**As stated above, there may be need for public sector support in product development and on-going technical support in the short to medium term, with the support of Government together with development institutions (such as ILRI and the World Bank).**

**Product development and ongoing technical support are costly.** Given the actuarial and other expertise required to design and price new actuarially

sound and sustainable agricultural insurance products and to support their ongoing development, the costs are likely to impose a significant entry barrier to commercial insurers. Insurers expect to recover product development costs through the premium, over time. However, in the case of agricultural insurance, the high costs and the limited financial capacity of policyholders make this unrealistic. Thus although product development and technical support are private sector functions, the support of government, together with development institutions (such as ILRI and the World Bank), is likely to be necessary, at least in the short to medium term.

**Care will need to be taken to mitigate the risks of crowding out private sector innovation or subsidizing tasks that the private sector is able, and would otherwise be willing, to undertake.** Insurers should be able to support the continued development of products once they have been found to actuarially sound, and premiums should be able to support the costs of developing new products once agricultural insurance has reached scale.

#### **Setting And Implementing An Enabling Legal And Regulatory Environment**

**Efforts to establish an enabling environment for insurance should take a number of general considerations into account.** Traditional indemnity-based agricultural insurance should be regulated like any other line of insurance, although special regulatory provisions may be required in relation to catastrophe risk. Recognizing that the current Insurance Act and Regulations do not enable Kenya to comply with international standards, the IRA has led the process to develop a new Insurance Bill and Insurance Regulations that would enable substantial compliance with international standards.

**For index insurance, an appropriate legal framework needs to be established.** Given that index insurance pays against an agreed-upon index

rather than on the basis of actual losses, there is some question about whether index risk transfer products can be properly classified as insurance at all. As the current Insurance Act does not recognize index-based insurance, the introduction of index insurance products carries both legal and regulatory risk. Under the proposed new Insurance Bill, index risk transfer products can be classified as insurance, subject to certain general criteria. The bill also provides for supporting regulations concerning index insurance to be issued by the IRA. The enactment of the bill and issuance of regulations would significantly reduce the legal and regulatory risks associated with developing new index insurance products. The government intends to expedite the legislative process.

**The primary responsibility for the implementation of the legal and regulatory framework for insurance lies with the IRA.**

Once the new Insurance Act has been enacted, the IRA will need to issue appropriate regulations. We recommend that the IRA consider including at least the following in relation to index insurance:

1. Detailed criteria for determining whether an index product can be classified as insurance
2. Rules allowing for composite (i.e., index and traditional) products and dual-trigger products
3. General requirements in relation to indexes aimed at reducing basis risk
4. Restrictions on persons to whom index insurance may be sold (aimed at ensuring an appropriate insurable interest)
5. Key requirements for issues to be included in the policy document
6. Specific provisioning requirements
7. Consumer protection requirements

**Consumer protection is relevant to both traditional and index insurance.** Consumer protection concerns are often exacerbated in rural settings, where farmers lack financial literacy and a full understanding of both the product's details and its broader implications. We recommend that the IRA

issue consumer protection regulations that cover Poor-value products

- Lack of disclosure
- Unfair contract terms
- Delays in insurance payments

**A number of countries have specific agricultural insurance legislation.** This legislation is not usually intended to cover regulatory and supervisory issues, but rather to make statutory provision for a specific institutional framework (such as a statutory coinsurance pool or statutory reinsurance arrangements) and to govern the provision of subsidy. In relation to subsidy, the legislation may obligate government to provide a certain level of subsidy, to take the subsidy outside the usual budgetary process, and/or to establish a framework or arrangements that govern the use of the subsidy and ensure it is not mischannelled or used inefficiently. This framework could include a body to make decisions relating to the subsidy, audit processes, etc. Whether such legislation is required in Kenya will depend on the institutional framework that is eventually adopted and the level and types of subsidy that are to be provided for in the long term. It is therefore too soon to make any recommendations.

**Driving The Process For Change**

**Considerable work is required to build the necessary foundations for agricultural insurance, to design and market appropriate products, and to establish an appropriate institutional framework.** As discussed, these tasks will require an effective PPP. Without the active involvement of both the public and private sectors, it will not be possible to develop a mature, scaled-up agricultural insurance market in Kenya. However, it is unlikely that the process will even commence unless the GoK takes the initiative, encouraging insurers to engage and to collaborate, for example, through a coinsurance pool. The GoK intends therefore to mobilize and allocate adequate financial and human resources to lead this process.

## Functions Of The Private Sector

### Data

Together with the public sector, private sector insurers play a primary role in the collection of some product-specific data. Although the collection, management, and audit of aggregate weather and agricultural data are primarily public sector functions, commercial insurers have functions related to collecting and storing product-specific data, such as data relating to sales, distribution, and claims. Moreover, international reinsurance companies require a party other than the government to be involved in either collecting or auditing data to ensure independence and transparency. This leaves a key role for the private sector.

The private sector could also cover some or all of the cost of collecting and managing agriculture data. For example, an access fee could be levied on all parties that wish to use the data. This approach has been adopted for Motor Third-Party Liability in Turkey: the government is responsible for the collection and management of data, while all insurance companies that wish to use the data to develop and price insurance products must pay an (equal) access fee. What is important here is that the data are equally available to all users on the same terms, an arrangement that encourages competition.

As the design and rating of agricultural insurance products are also private sector functions, private sector insurers should play a role in advising the GoK on their data needs. That is, they should specify (i) the data they require; (ii) the form in which the data are required; and (iii) the quality of the data.

The private sector can play a key role in developing and providing commercially available data. Data that are publicly available at no charge or from commercial providers, such as remote-sensing data (including satellite data),

may be an acceptable substitute or proxy for data that are not available in Kenya (such as crop or weather data). For example, Normalized Difference Vegetation Index (NDVI) data are available from the U.S. National Oceanic and Atmospheric Administration. Where data in the public domain or available from commercial providers will enable product design, it may be more efficient to use these data than to establish systems for collecting, managing, and storing data in Kenya, even if the public sector contributes toward the cost. The feasibility of using such data should form part of the “data gap analysis” recommended above.

### Outreach

Outreach and product marketing are primarily private sector functions. As indicated, the public sector may have a role to play in raising financial literacy and general awareness of agricultural insurance, but outreach should be regarded as part of distribution, which is clearly a private sector function. Insurers sell insurance, and even if public sector agencies are used as part of the distribution process, distribution remains a private sector function. Furthermore, the private sector may be better able than the public to (i) employ innovative distribution channels;<sup>9</sup> (ii) leverage the significant outreach infrastructure in place; and (iii) respond quickly to shifts in the market. Most importantly, however, competition among private insurers can increase speed, scale, and the effectiveness of outreach.

### Design And Development Of Agricultural Insurance And Related Tasks

Insurers are responsible for the design and development of agricultural insurance products, although they may receive financial and other public sector support in the short to medium term. Such support may be necessary in the early years when the costs

would be unsupportable through the premiums.<sup>10</sup>

However, design and development remain private sector functions. Insurers are required by the regulatory regime in Kenya and elsewhere to take full responsibility for the insurance products that they sell, including the actuarial pricing of those products.

Specialized professional and technical skills and experience are required to design, develop, and price all insurance products, including agricultural insurance products. Where insurers do not have the resources in house, they are permitted to outsource them, but insurers remain fully responsible for all outsourced services, including those provided by or through the public sector. The institutional framework must be designed with this in mind.

**Claims adjustment and settlement are also private sector functions.** The comparative advantage of private insurers here is founded on their (i) existing outreach channels; (ii) knowledge of the clients (as they are responsible for distribution); and (iii) greater ability to innovate. A good example of private sector innovation is offered by India, where cell phone technology is used to video record, geotag, and upload the results of CCEs to a database, allowing insurance companies to access the data in real time (World Bank 2011b). This mechanism has improved the quality of the CCE procedure—by enabling insurance companies to witness the CCE being carried out, the video recording acts as an audit mechanism—and it has also made the CCE procedure more timely, which greatly speeds up the process of payouts for area yield index insurance (AYII). A final reason for the private sector’s comparative advantage is that it is better suited to respond to the potential complexity of claims adjustment processes.

**Private insurers must properly train their insurance and distribution staff.** Given the highly technical nature of insurance production, it is important that insurance staff have the required skills to carry out their tasks. It is particularly

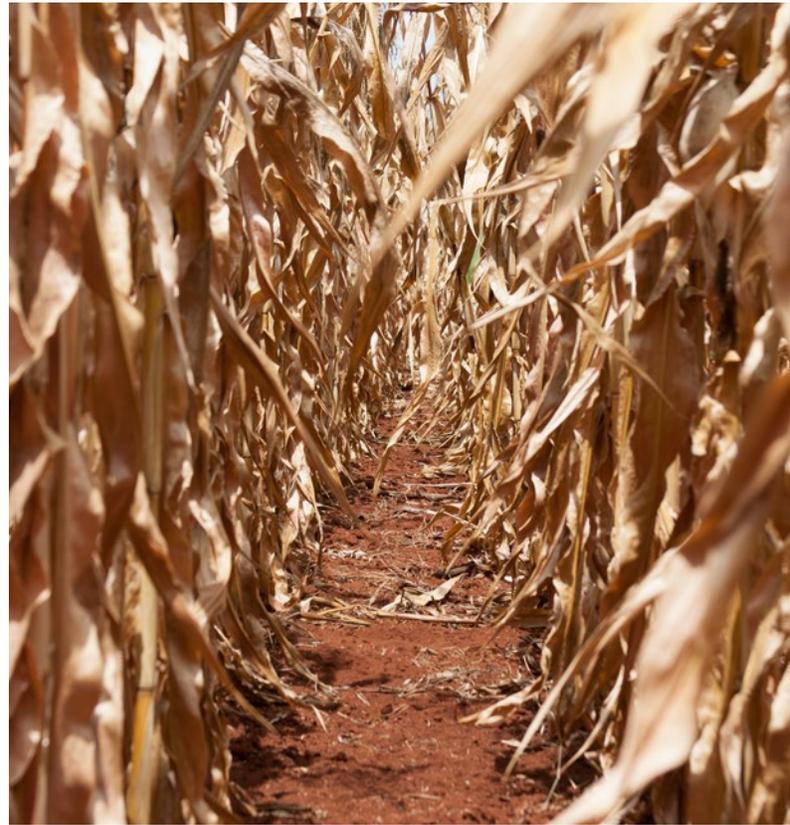


Photo Credit: Daniel Clarke

important that agricultural insurance underwriters and loss adjusters receive the appropriate specialist training. To ensure the long-term sustainability of the approach, and given the expertise of private insurers, this function should be taken on by the private sector. However, this is another area in which public financial and other support could be provided in the early years, particularly in relation to new and technical areas, such as index insurance.

### Risk Financing

**Underwriting agricultural insurance products and financing the risk is a core private sector function.** The insurance business involves the acceptance of insurance risk and the financing of that risk. Although the public sector may have some risk financing functions, the function primarily

Photo Credit: Daniel Clarke



belongs to private sector insurers. Insurers are required by the legal and regulatory framework, and the IRA, to take responsibility for the management and financing of their insurance risk.

**Through pooling and diversifying their insurance risk, insurers are able to reduce the price of the risk, which should result in lower premiums to policyholders.** By underwriting through a coinsurance pool, as elaborated later in the chapter, private insurers can significantly lower cost to policyholders.

**Insurers may reinsure their insurance risk with national, regional, or international reinsurers as a substitute for holding capital to support that risk.** The negotiation and conclusion of reinsurance contracts is part of insurers' risk management process. Thus even where the public sector offers risk financing support, for example in relation to catastrophe risk, insurers must decide whether that support is adequate to enable them to underwrite the products.

## SECTION

# 01

## Institutional Framework

### First Steps

#### Establishment Of A Coordinating Body

Although significant work on the institutional framework has already been undertaken, further work is required and important policy decisions must be made before the framework can be finalized. One issue, for example, involves how much financial and other support the GoK is prepared to provide to agricultural insurance in the short, medium, and long term. The considered views of stakeholders will need to be sought, including various GoK departments and agencies, county governments, the IRA, and insurers. The design of a firm and final institutional framework at this stage would therefore be premature.

International experience demonstrates that agricultural insurance is more likely to succeed under a PPP that is formalized within a well-designed institutional framework.

International experience has also demonstrated that the establishment of the institutional framework is a necessary precondition for the design of specific agricultural insurance products. One of the reasons why many donor-funded pilots fail to scale up is the lack of institutions to follow through once the donors or development agencies have left. It is important, therefore, to give priority to the institutional framework, even ahead of product design.

The government intends to establish a Program Steering Committee with representation from the GoK and the private sector that will examine options for an institutional framework and specifically consider the following:

- The appropriate functions of the public and private sectors
- The options for an institutional framework, building on those presented in the MALF report (GoK 2014a)

- The institutional frameworks already operating in other countries and the experiences and lessons learned in those countries
- The applicability of international experience in the Kenyan context
- The legal and regulatory implications, including whether specific legislation or regulations will be required

The work of the task force will contribute toward formulation of the National Agricultural Insurance Policy (NAIP), as recommended below.

### National Agricultural Insurance Policy (NAIP)

The MALF report recommended that the GoK expedite the policy process for formulating and finalizing the NAIP, which would serve as a guiding framework for developing the Kenyan agricultural insurance market (GoK 2014a). The NAIP should address the following:

- The GoK's objectives for agricultural insurance, including social objectives, such as preferential promotion and support programs for agricultural insurance for small and marginal farmers
- Definition of the functions, roles, and obligations of each party to the PPP
- Establishment of the institutions most suitable for delivering the functions the GoK wishes implemented

The GoK intends to make formulating the NAIP a priority. Once finalized, the NAIP will provide the blueprint for the institutional framework.

The formulation of the NAIP will be considered a process rather than a discrete task that can be completed in the immediate future. The work undertaken by the task force should therefore feed into the development of the NAIP, which should be regarded initially as a work in progress. As the work moves forward, the NAIP will be adjusted accordingly.

## Interim Framework

**Considerable work is required on product development.** This is likely to include an analysis of the data required and available, the costs of designing agricultural insurance products, the market demand (including the willingness and ability of potential policyholders to pay for the insurance), and the appetite of private sector insurers in Kenya and national, regional, and international reinsurers to participate in agricultural insurance.

**Existing institutions could be used on an interim basis to commence the work.**

The functions could then be absorbed into the institutional framework, once finalized. For example, the MALF report recommended the formation of a national agricultural insurance Web-based data and information iHub; this would link end-users, including agricultural risk managers, insurers, and MALF staff, with the main institutions involved in agriculture and agricultural risk management and with their databases (GoK 2014a). An iHub will be needed, whatever the institutional framework eventually will be, and work on it could start immediately. The MALF report specifically suggested that

“the starting point for the iHUB project would be to define exactly what minimum (priority) key data is required for agricultural insurance purposes and to then check with . . . organisations what data and information they currently hold in their own databases, and the software formats of this data and time-series available and missing data. This would result in the production of a data and statistics catalogue covering the data held by each organisation (GoK 2014a, 199).”

**Defining the priority key data for agricultural insurance could be used to undertake the gap analysis recommended above.** The detailed proposal is set out in GoK (2014a).

**Given that the data work is a foundation block for future product development, consideration**

**could be given to establishing the iHub as soon as possible within an existing institution, such as MALF.** The iHub’s function and work undertaken could then be transferred to another institution when the PPP is fully established (or remain with MALF).

## Coinsurance And Coinsurance Pools

**As it is unlikely that a fully competitive insurance market will be viable in Kenya, the task force should consider establishing a coinsurance pool.** A competitive Kenyan market is hampered by the high costs of designing and distributing agricultural insurance to small farmers. Hence some form of cooperation between insurers is needed. Establishing a coinsurance pool would meet this need and also enable the pooling of risk, which should result in lower insurance premiums. The concept of coinsurance is further elaborated on in Annex 1.

**There are many ways to structure a coinsurance pool, each with different features, advantages, and disadvantages. The core principles are detailed in box 2.**

### Box 2— Core principles for a coinsurance pool

1. Insurers share the costs of certain core activities, such as product design and pricing.
2. Certain administrative costs are shared, such as claims administration.
3. Other activities may be shared, depending on the pool design, including handling of distribution costs.
4. There is at least some risk pooling. This may include presenting a pooled portfolio of insurance to reinsurers, enabling a lower reinsurance cost. Risk pooling should reduce the cost of risk, which would then lower the cost of the premiums.



## Institutions

Photo Credit: Daniel Clarke

Given that public sector functions are spread between different GoK ministries, departments, and bodies, it is important to ensure that public policy on agricultural insurance is effectively coordinated. The MALF report recommended that the GoK consider establishing the Agricultural Risk Management Agency to coordinate public policy and support the individual private sector companies that sign up for the PPP (GoK 2014a). A separate entity of this kind would help to ensure that the GoK could effectively carry out its functions in the PPP. The task force will consider this and other possible options for ensuring that the policy agenda is driven forward and that the PPP is implemented. If a separate entity is established, costs should be kept to a minimum, meaning the entity will be small with a core staff of specialists.

Whether or not a separate entity is established, certain core functions will need to be undertaken. These include

- (i) coordinating the implementation of the PPP from a policy perspective;
- (ii) conducting original risk assessment and risk mapping studies on behalf of MALF;
- (iii) coordinating the implementation of the NAIP with the private sector insurers;
- (iv) assisting private sector insurers in product marketing and education programs for farmers, including the allocation of subsidies;
- (v) providing data and statistics and general assistance related to agricultural insurance products;
- (vi) conducting program research and development; and
- (vii) coordinating donor technical assistance programs for agricultural risk management and insurance in Kenya.

The institutional framework will need to cover monitoring, supervising, accounting, and auditing for any public sector subsidy provided as well as advising the GoK on the size of the subsidy. The National Treasury will have a key interest in this function, which could be housed within it or within the coordinating unit. The National Treasury clearly has strong experience in public financial management, but it would be necessary to ensure that the Ministry of Finance staff also has, or has access to, the technical capacity to undertake this function.

**Given the high costs of technical tasks related to agriculture insurance, the GoK should consider establishing a technical support unit (TSU) to house technical expertise centrally.**

As already discussed, technical functions belong to the private sector. Given their costs, however, there is significant advantage in having insurers coordinate and centralize these functions, and the GoK may choose to support them. TSUs are typically present in countries where some degree of competition exists among private insurance providers or distributors. A TSU can have a wide range of responsibilities, such as (i) data analysis; (ii) insurance demand assessments; (iii) product design and rating, including basis risk analysis; (iv) design of operating systems and procedures; (v) training for stakeholders; (vi) awareness campaigns; (vii) analysis of any public subsidies; and (viii) the development of catastrophe risk models and other risk assessment tools.

**However, the establishment of a TSU is not the only option.** For example, if the private insurers went the route of a fully incorporated, capitalized, and staffed pool insurance company, the TSU would not be required, since its functions could be performed by the managing underwriting unit of the pool.

# Livestock Insurance for Pastoralists Located in ASALs in Northern Kenya

## Context

### Kenya's Experience With Livestock Insurance

Kenya has a lengthy history of livestock accident and mortality insurance for the commercial livestock dairy sector, but until recently the insurance market did not offer any cover to meet the risk transfer needs of the many resource-poor pastoralists located in the arid and semi-arid lands (ASALs) of northern Kenya. Following the devastating drought losses in the livestock sector between 2008 and 2011—an estimated 9 percent of the national cattle herd was lost, with total livestock losses valued at K Sh 699 billion (GoK 2012)—the government has signaled its major commitment under the Second Medium Term Plan (2013–2017) to provide funding for a national livestock insurance scheme (MDP 2013).

Drought is the most pervasive hazard, natural or otherwise, encountered by pastoralist households in the ASAL regions; it can lead to widespread death of livestock and severely deplete livestock assets for the affected households. Many pastoralist households in the ASALs are now regularly hit by increasingly

severe droughts. Because they rely on livestock for their livelihoods, high livestock deaths can have devastating effects, rendering many of these households among the most vulnerable in Kenya. The economic analysis presented in section 2.4 shows that without any form of livestock insurance protection, the poorest households (<5 Tropical Livestock Units, or TLUs<sup>13</sup>) and vulnerable poor (5 - 10 TLUs) are very likely to lose all their livestock, and therefore their livelihoods, in severe drought events.

To help pastoralists manage drought risk and protect their animals, insurance solutions were developed by the International Livestock Research Institute (ILRI), together with its technical partners at Cornell University and University of California–Davis.

The logistical challenges of working in the ASAL regions suggested that an index-based insurance product would be appropriate. Developing the Insurance Based Index Product (IBLI) involved two years of comprehensive research aimed at designing, developing, and implementing market-mediated index-based insurance products that livestock keepers—particularly in the drought-prone ASALs—could purchase to protect themselves from drought-related asset losses. The IBLI product is based on a satellite Normalized Difference Vegetative Index

(NDVI)<sup>14</sup> cumulative-season drought index, which is combined with a predicted livestock mortality index to insure pastoralists against drought-related deaths to their livestock (cattle, camels, sheep, and goats). It provides full-value animal cover to enable the insured pastoralists to restock their herd after the drought event.

The commercial sale of IBLI was launched in Marsabit, northern Kenya, in January 2010 as a voluntary retail insurance product and was marketed to individual pastoralists. The IBLI demand assessment studies identified affordability as a constraint to uptake, and since launch in 2010 donor partners have financed premium subsidies in the order of 40 percent of the full premium costs. In 2010, UAP Insurance Company was the underwriter, while Equity Insurance Agency was the insurance agent. Swiss Re provided reinsurance for the product. The IBLI program has gone through various adjustments since it was launched, and APA Insurance Company became the underwriter for Marsabit and Isiolo Counties in August 2012 and August 2013 respectively. In Wajir County, a Sharia-compliant version of IBLI is currently being implemented by Takaful Insurance Company with support from Mercy Corps.

While the current program has driven innovation in IBLI product development, pricing, and distribution, several challenges remain to be met to achieve large-scale uptake. In 2010, when IBLI was first launched, pastoralists bought nearly 2,000 policies to insure about 6,000 TLUs (ILRI 2013). Since then, however, the program has struggled to achieve scale and sustainability in spite of making payouts to insured pastoralists in response to droughts in 2011 and again in 2012.

### State Department of Livestock Interest in Large-Scale Drought Insurance For Pastoralists in ASAL Regions

As part of its plans to promote and strengthen livestock insurance provision in the ASALs, the government of Kenya (GoK) has proposed creating a national livestock insurance scheme under the Second Medium Term Plan. An indicative budget of K Sh 2,000 million–2,500 million over the fiscal years 2013/14 to 2017/18 was identified to support the national livestock insurance scheme (MDP 2013).

With this objective in mind, the GoK, through the State Department of Livestock (SDL) within the Ministry of Agriculture, Livestock and Fisheries (MALF), approached the World Bank's Disaster Risk Financing and Insurance Program in 2014 to ask for technical support in developing a public private partnership (PPP) in livestock insurance to support pastoralists. The MALF-World Bank team partnered closely with ILRI and the Financial Sector Deepening (FSD) Kenya program to benefit from the considerable practical experience those institutions have in Kenya.



## Proposals For Large-Scale Livestock Insurance For Pastoralists Located In ASALs In Northern Kenya

### Livestock Insurance Options

Under the proposed plan, the SDL would collaborate with the National Drought Management Agency (NDMA) to develop a large-scale index-based livestock insurance program to cover pasture drought risk. In order to quickly build a critical mass of covered households, a macro-level product will form the foundation of a sustainable livestock insurance market. Grafted onto this will be the concrete provision of “top-up” cover for targeted beneficiaries who wish to expand their coverage, and a voluntary purchase cover for all nontargeted pastoralists.<sup>15</sup> This structure is designed to gauge the level of untapped demand for voluntary livestock insurance and to

support any transition in the medium term toward increasing contributions from targeted recipients and the pastoralist population at large.

*Under the plan*, SDL would be assisted in designing and implementing a macro-level pasture drought index insurance program; starting in 2015, SDL would purchase the insurance on behalf of approximately 71,000 vulnerable pastoralists located in the four Hunger Safety Net Program (HSNP) counties of Mandera, Marsabit, Turkana, and Wajir. The SDL would insure itself at the national level, with insurance payouts triggered by a satellite-based index at a local/pastoralist level. The SDL would then channel payouts to pre-identified pastoralists on the triggering of the index, or underwriting insurer(s) would provide payments to these pastoralists directly. An element of cost sharing between central and county governments will be explored, with the plan initially proposing that the entire cost of the compulsory coverage be paid by SDL.

**Start-up implementation of the SDL macro-level pasture drought index insurance program is recommended for the four HSNP counties because infrastructure systems and procedures are already in place there. This infrastructure allows for (i) verifying identification and registration of eligible pastoralists who will be the beneficiaries of this insurance; and (ii) delivering timely insurance payouts in kind or in cash to the individual beneficiaries.** In the HSNP counties, the NDMA Secretariat has partnered with implementing nongovernmental organizations to register 375,000 households and their dependents and to classify them into four main income/wealth status categories or poverty bands. The HSNP program is currently targeting the poorest 100,000 households under its regular program of bimonthly cash payments and plans to scale up this program in times of extreme drought. The goal is to complement the HSNP program by implementing the SDL insurance program with approximately 71,000 vulnerable pastoralists who are just above the poverty criteria for inclusion in the HSNP cash transfer program (see below for further discussion). In addition, the HSNP payment system might be used as a way to distribute the payouts (complementary to the use of mobile payment options).

**To supplement the macro-level pasture drought index product, the insurance program offers a top-up option for eligible pastoralists, plus voluntary policies that would be sold to all pastoralists on an individual basis.** The macro-level product as described above would be supplemented by top-up insurance policies to be purchased by pastoralists on a voluntary basis; the costs of any such top-up cover would be shared between the GoK and the pastoralists. This product would also be offered—and partially subsidized—for voluntary, individual purchase by all pastoralists, independent of whether they are covered by the macro-level product. The

government subsidies for the top-up and voluntary purchase options have tentatively been set at 50 percent and 25 percent, respectively, but these may change; final percentages will be guided by the program experience with partially subsidized voluntary contracts provided at the outset.

## Integrating Existing Social Protection and Insurance Programs for Pastoralists in the Target Counties

### Linkages Between Programs in the ASAL Region

**The overall framework for the insurance program should be mindful of various insurance products already being distributed and social protection measures currently being developed in the four HSNP counties.**

These include

- The ILRI-developed IBLI contracts currently being offered by APA Insurance and Takaful Insurance Africa on a voluntary basis
- The HSNP protection
- The new SDL-led IBLI initiative for macro-level as well as top-up and voluntary coverage

**To avoid overlap between the three programs, the HSNP classification of households according to wealth/poverty status should be used to target each insurance program to different poverty groups.** The poorest 100,000 households would continue to be covered by the HSNP under the regular bimonthly cash transfer program, which is 100 percent financed by the GoK and donors using a variety of funding mechanisms, including Africa Risk Capacity (ARC) index insurance payouts (see below for further discussion). Adopting the HSNP poverty ranking, the macro-level pasture drought index insurance program—funded entirely by the government—would apply to registered vulnerable pastoralists immediately above the HSNP's target

beneficiaries. Finally, relatively wealthier (though still low-income) pastoralist households could be covered by the top-up and voluntary SDL cover as well as ILRI’s IBLI product being marketed by APA Insurance and Takaful Insurance of Africa. This layering approach is illustrated in figure 3.

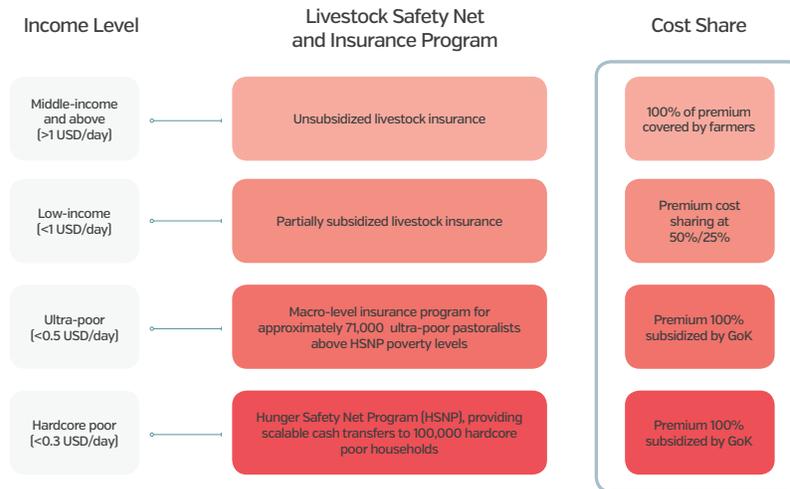
**The SDL macro-level product for the targeted vulnerable category of pastoralists should be linked with the ILRI-developed IBLI product currently being offered on a voluntary basis by APA Insurance and Takaful Insurance of Africa.** This approach will ensure that all pastoralists (not just those covered by the SDL program) can purchase livestock insurance. It will also allow the SDL and the GoK to do the following: (i) learn from the major technical design expertise and implementation experience gained under the

IBLI pilot over the past five years, (ii) offer choice to individual livestock producers not targeted by SDL for its program, (iii) enable an assessment to be made over the next two to three years of the voluntary demand for livestock insurance by individual pastoralists in the ASAL regions, and—based on the assessment findings—(iv) allow SDL to decide whether to introduce its own top-up and voluntary individual index-based livestock insurance products and programs.

**Possible Linkages with ARC**

In 2014, Kenya and four other African countries—Mauritania, Mozambique, Niger, and Senegal—joined a new African drought index insurance facility under the ARC initiative (ARC 2014).<sup>16</sup> ARC is an initiative of the Commission of the African Union’s Department of

**Figure 3 –** How government could support financial protection for different segments of the population: Example of pastoralists in the four current HSNP counties [Mandera, Marsabit, Turkana, and Wajir]



Note: Classification is based on distribution of livestock holding size for Marsabit County, which may not be similar in other HSNP counties

Rural Economy and Agriculture and the World Food Program, It aims to create a pan-African-owned pool index insurance fund to underwrite catastrophic weather events, initially to cover drought; in the future, coverage could be expanded to include other weather risks such as flood.<sup>17</sup> The program is insured by ARC Insurance Company Limited (ARC Ltd.), domiciled in Bermuda, and is reinsured by specialist international reinsurers of this class of business.

**In 2014, Kenya purchased protection from the ARC and determined that one of the primary purposes of the ARC program in Kenya would be to support the scalability mechanism of HSNP.** Coverage has been purchased for both the long rains/long dry season and the short rains season (maximum payout US\$30 million each). The primary use of the cover will be to lessen the fiscal burden to GoK of meeting the cost of scaling up the HSNP.

**SDL could consider exploring possible links between the SDL macro-level insurance coverage and the ARC program in Kenya.**

Given the clear complementarities between these programs, the synergies available should be leveraged.

### Eligibility and Subsidy

**The macro-level SDL product is intended to provide insurance to pastoralists who, at this stage, would not be able to afford commercial premiums.** The GoK therefore intends to provide a public subsidy for the product. Given the subsidy, eligibility criteria will be required to ensure that targeting is in line with the government's objective of supporting the most vulnerable pastoralist households. As eligibility and subsidy both affect product design, decisions are required on these issues before the product design can be finalized.

**In principle, the macro-level program under which SDL would finance 100 percent of the insurance premiums is targeted at poor and vulnerable pastoralist households who under**

**other circumstances would be too poor to afford insurance premiums.** The final decision on eligibility will involve technical input from the SDL and other ministries. However, eligibility for the public subsidy should be limited to vulnerable households that reside in the four pilot counties, where vulnerable households are defined as a specific, not-yet determined number of households ranked just above the eligibility cut-off point for benefits under the HSNP.

**For the macro-level index insurance program, the GoK should purchase 100 percent of cover for 5 TLUs per eligible household.**

The number of households covered will depend on the resources the SDL has available to support the scheme. For illustrative purposes the team has chosen annual to analyze three scenarios: budgets of K Sh 100 million, K Sh 200 million, and K Sh 300 million to analyze.

**For top-up coverage for eligible households, the amount of subsidy should be determined by the SDL.** An initial suggestion is that the GoK provide a subsidy for 50 percent of the actuarially calculated commercial premium, with the other 50 percent paid by pastoralists. This subsidy would be subject to a cap of 5 TLUs per pastoralist.

**For voluntarily purchased individual coverage, the GoK will need to decide whether it will also be subsidized and what cap per pastoralist will apply.** Over time, the GoK may plan to reduce the size of public subsidies. A 25 percent premium subsidy has been tentatively applied, subject to change going forward (see section 3.3).

### Design Options for SDL Macro-Level Livestock Index Insurance Product

For implementation in calendar year 2015, a macro-level livestock insurance product for the SDL is proposed: its central objective is to effect timely cash payouts to vulnerable pastoralists at the onset of drought in order to keep breeding stock alive. Under this scheme, the GoK would be the party entering the insurance contract. If it received a payout, it would in turn make payments to pastoralists as identified above.

For this macro-level cover, satellite data (NDVI) would be used to create a pasture drought index. This would enable the development of an index that measures the onset of drought-related pasture and grazing degradation and that triggers early payouts (so that pastoralists can purchase animal feeds to keep their core breeding animals alive). The advantage of this approach in comparison to the existing ILRI product (interim period) is that payouts could be triggered earlier in the season, i.e., during the onset of drought—before reduced pasture/grazing creates a disaster. Under this approach, pastoralists would not be forced into untimely sales of livestock at very reduced prices, and their animals would be saved from starvation, disease, and ultimately death. Pastoralists would use the funds provided to preserve livestock (through buying fodder, migrating, culling, etc.) rather than having to replace it. This approach enables a faster mobilization and increased effectiveness of the emergency response.<sup>18</sup> Among other important welfare gains it offers, such an approach could help facilitate income smoothing and reduce asset depletion; this protection of assets would increase household resiliency to future shocks.

Similar approaches have been implemented in the following countries:

- Spain, United States, and Canada.** In these countries, the NDVI pasture drought index insurance programs operate as voluntary micro-level individual livestock producer programs. The cover period is defined as the normal pasture/ grazing growing season (which usually coincides with the spring and summer rainy seasons of maximum pasture and biomass production), and the basis of the sum insured is usually calculated according to the nutritional requirements of the livestock/costs of purchasing supplementary livestock feeds in the event of loss of pasture and grazing due to drought. Regular payouts are made during the cover period for each month (or time period as defined) that the NDVI policy is triggered. All three programs attract heavy government premium subsidy support.
- Mexico.** The federal and state governments purchase macro-level NDVI/pasture drought cover used in the events of catastrophic losses in pasture and grazing to finance payouts to the many small, vulnerable livestock producers (owning <50 livestock units) who are eligible for state-funded natural disaster assistance under the CADENA program. One hundred percent of the premium cover is borne by federal and state governments together (80:20 ratio). Since the program was introduced in 2006, it has been massively scaled up such that in 2011, a total of almost 60 million hectares of grazing lands were insured in 21 states, and nearly 4 million head of livestock were protected (World Bank 2013a).
- Uruguay and Argentina.** In 2011–2013, the World Bank assisted the governments of Uruguay and Argentina in designing NDVI/pasture drought macro-level products protecting livestock and issuing early payouts (World Bank 2012, 2013b).

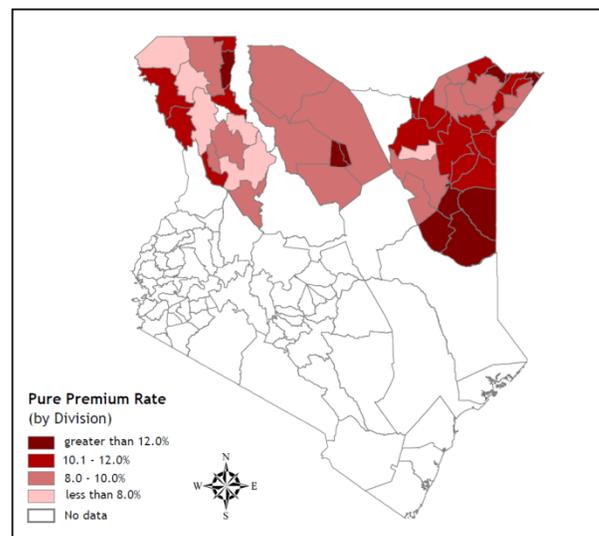
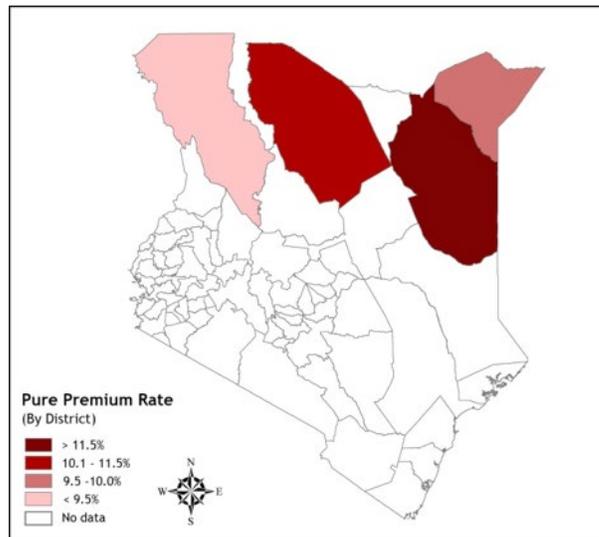
**Table 2–** Comparison of Uruguayan pasture NDVI cover and proposed Kenyan NDVI cover

Product feature	Approach taken in Uruguay	Considerations for Kenya
Index	NDVI/pasture index; 5km x 5km (2,500 ha).	Required index and data will be based on the existing NDVI database created and maintained by ILRI: NDVI/pasture index; 250m x 250m (eMODIS).
Cover period	Pasture growing season: 7 months (September-March).	Still being explored. Northern Kenya has two rainy seasons: long rains (March-June) and short rains (October-December); ideally both would be covered.
Insured unit	Police Section (equivalent to a municipality). Homogeneous NDVI signature and individual livestock herd data are registered at this administrative level for foot-and-mouth disease control purposes.	Still being explored. Preliminary discussions with ILRI indicate that index products could be more effective at a scale smaller than the division level.
Insured interest	Beef cattle (breeding cows and heifers only). Program has been designed to cover all registered beef cattle herds in Uruguay.	All households in the HSNP poverty census above the cut-off point for the regular program.
Sum insured	Based on nutritional requirements of insured cattle during the insurance cover period, assuming animals are fed on supplementary feed rations that can be purchased locally.	Still being explored. For example, more input is being collected from livestock experts on nutritional requirements, etc.
Payout parameters	Monthly payout frequency, because once pasture degradation is visible on NDVI, the insured cattle are already suffering from starvation.	Different payout frequencies being explored (monthly, every 3 months, seasonal basis); to be determined based on pastoralists' needs.
	Sum paid out along gradual trigger with entry and exit point.	Gradual and binary trigger options being explored, i.e., paying out either in full or not at all, for simplicity.

Source: World Bank 2013b

Note: eMODIS = enhanced Moderate Resolution Imaging Spectroradiometer.

**Figure 4 –** Illustrative calculated pure loss cost rates for 12-month NDVI asset protection cover at District and Division level



Source: World Bank

The SDL macro-level NDVI product is currently under development, and a prototype contract has been designed that will be presented to key stakeholders—including SDL and livestock producer associations in the ASAL regions—for review, refinement, and finalization. The product draws on the lessons and experience of the Mexican, Argentine, and Uruguayan livestock NDVI programs, while taking the local Kenyan context into account. A comparison of the Uruguayan macro-level NDVI cover and the proposed macro-level cover for SDL in Kenya is presented in table 2.

An example of the outputs of the macro-level prototype NDVI pasture drought index insurance cover is given in figure 4, which shows the calculated pure loss costs [average expected payouts] for an annual policy for the four HSNP counties at district and divisional levels.<sup>19</sup> The calculated pure premium rates are presented for the four HSNP counties (and their divisions)—Turkana, Marsabit, Wajir, and Mandera—and in general terms reflect the increasing drought risk exposure in natural rangelands from west to east as measured by eMODIS NDVI by month for the 13-year period 2001 to 2013. Decisions that will need to be taken with local stakeholders in due course include the size of insured unit (county or division) and whether to market top-up or voluntary cover using differential premium rates in each insured unit.

To determine whether the proposed macro-level NDVI pasture drought degradation cover, with its emphasis on early payouts to keep breeding animals alive, is appropriate to the pastoralist production systems of Kenya's ASALs, further research will be required into the following key areas:

- **Use of early payouts to protect breeding herds.** Focus groups discussions with pastoralists in the target HSNP counties are planned to shed

light on how early drought index insurance payouts could be used to support the protection of breeding herds (e.g., by buying fodder and animal feed supplements, migrating/transporting animals to other grazing lands, controlled destocking of animals, etc.).

- **The most appropriate definition of the insured unit.** In determining whether the insured unit should be the department, division, or a smaller area with homogeneous grazing/rangeland conditions affected in a similar way by drought, it will be important to take into account the seasonal migration patterns of the pastoralists as they move their nonbreeding herds to their dry season grazing lands, which may be outside the defined insured geographic unit where they normally reside. Setting the insured unit at a very small localized level may invalidate the operation of such an NDVI cover.
- **Ways to integrate any macro-index insurance program with NDMA and SDL drought-response plans for the livestock sector.** Possible approaches include controlled destocking programs, livestock watering, pasture and grazing conservation measures, government emergency livestock feed programs (if these currently exist), and veterinary support programs during times of drought. A key point is that under a macro-level index insurance program aimed at keeping animals alive, it will be important to avoid suggesting to pastoralists that they do not need to destock their herd in times of acute drought, as they will receive insurance payouts.
- **Presence of local public or private forage markets in times of drought in the ASALs.** These markets are essential, and could be (i) a GoK-SDL fodder supply program in place at the onset of drought; and/or (ii) a program under which private traders are incentivized to truck fodder from Kenya's surplus regions to drought-stricken regions.

## Registration and Distribution Channels

### SDL Macro-Level NDVI Program

Registering pastoralist households eligible for the GoK subsidy could be done automatically, through the existing HSNP database; this approach would be cost-effective and save time, but it could also present some complications: (i) Failure to explain the product to beneficiaries could lead to poor awareness of the benefits being provided and of claims procedures; (ii) if the program is not well known in the region, both political visibility and broader awareness of the product would be reduced; (iii) without insurance awareness creation, potential financial inclusion gains would be lost; (iv) confirming beneficiaries' inclusion in the program would be hard; and (v) beneficiaries might never understand the benefit being provided to them by the GoK.

It is preferable, therefore, to handle initial registration in person and not automatically. One option would be to enroll pastoralists into the insurance program when Equity Bank opens bank accounts with them and they receive their bank cards. All pastoralists registered under the HSNP poverty census are scheduled to receive a bank account and a bank card by end of the first quarter 2015. When pastoralists receive their bank cards, they could also get an explanation of the program, including benefits, payments procedures, issuance of cards and pins, confirmation of persons and identification details, awareness/education, and consumer protection issues.

Although more time-consuming and costly, this method will support the development of a sustainable market. It has the key benefit of ensuring that eligible households understand the insurance coverage they are being given and, further,

understand how the insurance product operates (how the triggers are based on satellite data, what the trigger points for payout are, etc.). Households must understand their coverage in order to promote the voluntary purchase market. Better understanding will also encourage voluntary take-up by spreading awareness of the product.



### Top-up and Voluntary Purchase Products

There will be significant distribution challenges beyond the subsidized cover, particularly as insurance will not be linked to credit. The challenges would emanate from potentially high operational costs associated with the sales and service process, which to date have been significant in northern Kenya. The distribution should primarily be the responsibility of the private sector. The top-up could potentially happen at the time of registration, when beneficiaries of the government-supported program could opt for additional coverage. This approach could utilize the proposed distribution channels, or the underwriter could devise a cost-effective model for distribution of this additional cover. Voluntary purchase could be done through developed or parallel network and infrastructure.

Ultimately, the registration and distribution process will be led by the private sector, though GoK support may be needed in the short term. A private sector-led initiative would demonstrate viable long-term business opportunities and hence be more sustainable. In the long run, it would also provide an opportunity for expanding more financial opportunities to the target communities, and the overall execution would cost less than if the initiative was government led. The private sector-led process would undertake fresh registration of beneficiaries and develop and manage payment infrastructure under contractual arrangement with the government. The tendering process would be used to select the provider(s) or consortium to offer registration and/or distribution processes.

### Legal and Regulatory Issues and the Role of Insurers

Both legal issues and regulatory issues [beyond consumer protection] must be considered during product design. The role of insurers and insurance intermediaries should also be considered. Ultimately, however, the regulatory framework is a matter for the Insurance Regulatory Authority (IRA), which should be kept informed as the product is designed.

The IRA regulates and supervises the insurance sector under the current Insurance Act. However, if the new principles-based Insurance Act under consideration is enacted, it will enable the IRA to develop new regulations that will foster an enabling environment for livestock insurance.

#### Contract Design (Macro-level Policy)

For the proposed SDL macro-level NDVI pasture drought index insurance policy, the insurance contract will be purchased by GoK-SDL, not by individual pastoralists. The policy would be set up as a macro-level policy, purchased by the GoK for the benefit of eligible pastoralists. Payment would be made either to the GoK (which would then pay covered pastoralists) or directly to the pastoralists. A point to note here is that a beneficiary does not have an automatic right to enforce a master policy against the insurer; this arrangement makes the program much easier to implement. Enforcement rights are dependent on the terms of the policy.

#### Contract Design (Voluntary Purchase Product)

The voluntary purchase product will be available to all pastoralists but will be offered as a voluntary top-up to those benefiting from the macro-level product. For these pastoralists, the top-up should operate as an

extension of the macro-level policy—that is, as an extension of the same “master policy.” This would be by far the most straightforward approach.

**For all other pastoralists, the freely purchased insurance policy would be more difficult to fit within the constraints of a master policy.**

However, issuing a series of individual policies would add to the transaction cost. Under this scenario, one option would be to allow pastoralists to enforce the policy against the insurer, though this option has possible cost implications, as the insurer might have to deal with pastoralists seeking payment on the basis of losses even though the index had not triggered. This possibility would need to be factored into the premium as an additional risk (which would be very difficult to cost).

#### **Form of Contract**

**Even though eligible pastoralists will not contribute to the premium payable under the macro-level policy issued to SDL, the insurance contract/policy should be kept as straightforward as possible.** There are a number of reasons for this:

- The contract/policy design will most likely become a precedent.
- Eligible pastoralists will be paying for the voluntary top-up.
- A similar contract form should be used for the master policy and for the individual policies.

**Other issues to consider will be the potential use of electronic policy acceptance.** This is not an issue directly covered under the current legal and regulatory framework, although there is precedent for it in relation to other products.

#### **Role of Private Sector Insurers**

**An effective PPP requires the engagement and willing participation of private sector insurers at an early stage.**

**The macro-level policy would need to be purchased from a local insurer or insurers.**

Under the Kenyan Insurance Act, insurance must be purchased through the local market unless there is insufficient capacity. If reinsurance is purchased, it could be placed into the international market after any compulsory cessions to national/regional reinsurers. The inability of the GoK to legally purchase directly from the international market would almost certainly add some transaction cost.

**The product design includes a single master policy plus a series of individual policies.**

Both the master policy and the individual policies would need to be purchased from a local insurer or insurers.

**Table 3–** Proposed livestock safety net and insurance program for Kenya's four HNSP counties

Form of financial protection against disasters	Income level of beneficiary	Number of pastoralists expected to be covered across four counties over next five years (out of 470,000 total)	Government's contribution to cost of premium or welfare payments (%)
Unsubsidized livestock insurance	Middle-income (US\$1/day or more)	0	0
Partially subsidized livestock insurance	Low-income (below US\$1/day)	15,000 (by 2019)	50, 25 <sup>a</sup>
Macro-level insurance program	Ultra-poor (below national rural poverty line of US\$0.5/day)	71,000	100 <sup>a</sup>
HNSP scalable cash transfers	Hardcore poor (below national food poverty line of US\$0.3/day)	100,000	100 <sup>b</sup>

Note: The four HNSP counties are Mandera, Marsabit, Turkana, and Wajir

a. Contribution is from State Department of Livestock, based on annual assumed budget of K Sh 300 million per year; the two figures refer to subsidies for the top-up and voluntary purchase options respectively,

b. Contribution is from National Drought Management Authority.

## Fiscal Costing Assumptions And Scenarios

The following assumptions underlie the illustrative estimation of the potential fiscal costs of the programs described above:

The macro-level NDVI-based index insurance product for livestock asset protection will target the poor “vulnerable pastoralists” who are above the poorest 100,000 beneficiaries of the HNSP program. The program will be implemented in the four counties covered by HNSP (Mandera, Marsabit, Turkana, and Wajir) and is expected to cover free of charge approximately 71,000 pastoralists.

The optional top-up coverage for pastoralists enrolled in the program will also be available from the outset of the program. In addition, pastoralists who are not part of the initial target group will also have the option to purchase the NDVI-based insurance coverage on a voluntary basis. The first layers of both the top-up option and the coverage for nontargeted pastoralists will be partially subsidized.

Table 3 shows the relationship of the SDL macro-level automatic NDVI livestock insurance and the voluntary top-up cover at year 3 with the HNSP cash transfer program. The figures used are indicative and subject to change as the insurance program is concretized.

**Table 4–** Fiscal costing projections for macro-level asset protection coverage

	SCENARIO KSh 100 million (US\$ 1.2 million)		SCENARIO KSh 200 million (US\$ 2.3 million)		SCENARIO KSh 300 million (US\$ 3.5 million)	
	Case A	Case B	Case A	Case B	Case A	Case B
Budget available for Macro-level asset protection coverage -K Sh	100,000,000		200,000,000		300,000,000	
No. of pasotralists eligible for livestock asset protection coverage	11,592	33,636	24,204	69,636	36,815	105,636

#### Estimated Financial Costs of the Macro-Level Livestock NDVI Program

Following specific indications from SDL, we analyze here three public support scenarios for the macro-level asset protection scheme: budgets of K Sh 100 million, K Sh 200 million, and K Sh 300 million. The projected fiscal costs of the programs are summarized in table 4 and table 5. For each budget scenario, two extreme cases are presented. Case A is structured by selecting, within a reasonable range of variation, the more costly extremes of the key parameters (i.e., higher values per TLU insured, a higher number of TLUs per policy, and a higher insurance premium estimate). This defines a lower bound for the number of potential pastoralists to be covered with the reference budget available. On the other extreme, Case B takes into account the less expensive options, thus identifying the higher bound for the number of potential pastoralists to be covered.

Depending on the policy choices made and the parameters selected, budgetary support ranging from K Sh 100 million to K Sh 300 million would provide coverage

to approximately 12,000 to 106,000 pastoralists. Specifically, a budget of K Sh 100 million would cover 12,000 to 34,000 pastoralists, a budget of K Sh 200 million would cover 24,000 to 70,000 pastoralists, and a budget of K Sh 300 million would cover 37,000 to 106,000 pastoralists.

To cover a reference target group of 37,000 to 106,000 (mid-point of 71,000) pastoralists under the macro-level insurance option, under which SDL would be the insured and responsible for payment of premium, fiscal resources of K Sh 300,000 (US\$ 3.5 million) or above would be required.<sup>20</sup>

#### Estimated Fiscal Costs of the Top-Up and Voluntary Livestock Insurance Programs

A partially subsidized top-up option for covering an additional 5 TLUs will be offered, with a budget requirement ranging from roughly K Sh 2 million in 2015 to K Sh 16 million in 2019. This scenario is estimated assuming a progression over five years from 1,000 to 10,000 pastoralists who voluntarily purchase the coverage, together with tentative public support of 50 percent of the premium cost.

The other option, for all nontargeted pastoralists, allows purchase of the NDVI asset protection coverage with tentative public support of 25 percent for up to 10 TLUs insured; this generates an additional budget requirement of K Sh 5 million to K Sh 16 million between 2015 and 2019. This projection assumes that in the five-year interval, 1,000 to 5,000 nontargeted pastoralists purchase the coverage.

The two additional insurance schemes to be implemented at year 3 of the program could in aggregate increase the budget requirements by roughly K Sh 6 million in 2015 and K Sh 31 million in 2019.

In summary, for the combination of (i) the macro-level asset protection coverage, (ii) the top-up option, and (iii) the expansion to nontargeted pastoralists, the estimated fiscal costs are estimated at around K Sh 306 million at program inception in 2015 and at around K Sh 331 million by 2019.

As next steps, SDL, MALF, and other key stakeholders will need to consider funding arrangements to cover the costs of premiums as well as design and implementation for the macro-level NDVI insurance program, and for the top-up and nontargeted pastoralist programs that carry premium subsidies. One option would be to use the proposed National Livestock Insurance Fund to finance the premiums and other program costs, including those for registration of beneficiaries, education and training programs, program design, and implementation and auditing.

**Table 5–** Fiscal costing projections for top-up and nontargeted pastoralists options

	2015	2016	2017	2018	2019
Cost of public support for top-up option (million K Sh)	1.6	5.1	8.6	12.1	15.6
Cost of public support for nontargeted pastoralists (million K Sh)	4.7	8.6	11.7	14.1	15.6
Total cost for GoK (million K Sh)	6.3	13.7	20.3	26.2	31.2
Total cost for GoK (million US\$ at 85 K Sh/US\$)	0.1	0.2	0.2	0.3	0.4

## Welfare Impacts Of Index-Based Livestock Insurance In HSNP Countries

The four HSNP counties are among the poorest counties in Kenya, with the majority of the population depending heavily on livestock both for income and food. As estimated by the HSNP household survey, the ultra-poverty rate in 2012 was 46.8 percent, with average consumption expenditure per capita per month of 1,746 K Sh.<sup>21</sup> The share of livestock income in total household economic income ranges from 25 percent to 80 percent, and the share is larger for the poorer quintiles. Livestock production is the key source of livelihood in this region. Alternative productive livelihood appears very limited, and is accessible only to the wealthiest. Alternative livelihoods for the poor majority are petty trading, casual labor, and small cropping.

**Livestock holdings provide a good proxy for welfare in this region, with the poor owning small herds but relying more heavily on livestock than those who are better off.** From the longitudinal monthly household survey by Arid Land Resource Management Project (ALRMP) in these counties, the average herd size owned by households was 10.4 TLUs during 1999–2013. On average, households in the two poorest quintiles own less than 5 TLUs, those in quintile 3, 4, and 5 own respectively 5–10 TLUs, 11–20 TLUs, and more than 20 TLUs. Livestock production systems could vary across and within the four counties, with relatively larger mobile pastoralists (i.e., those with larger herd size) in the relatively low and arid lands of northern Marsabit, Mandera, and Wajir.

**Livestock production in this region is prone to droughts that can cause catastrophic herd losses.** Extreme droughts have occurred four times over the past 10 years. According to ALRMP data for

1999–2013, average livestock mortality rates were 9–18 percent per year. As recurrent droughts reduce households' average herd size, they lead to increasing poverty and food insecurity in the region.

**To cope with droughts, households in this region rely heavily on food aid, risk sharing within communities, and other emergency response and welfare programs, but they are largely uninsured.** Under the HSNP, one of the key government welfare programs, households receive cash transfers of approximately K Sh 3,500 every two months. HSNP impact evaluation results find that the cash transfer has reduced poverty and that it was used as a safety net during the 2011 drought in the region. Other coping mechanisms appear very limited—for example, households are credit constrained and have limited access to financial services—leaving households uninsured against catastrophic herd losses from droughts.

**We have conducted a detailed economic analysis of the likely impact of livestock insurance on four categories of pastoralist: poorest, ultra-poor, poor, and nonpoor.** We develop a dynamic model to explore the potential varying welfare impacts on a representative pastoral household in each of the four wealth groups: the poorest with small herd, the ultra-poor with vulnerable herd, the poor with medium herd, and the nonpoor with large herd (see annex B.3). In the economic model, a household earns income each season from milk production and livestock off-take, which it uses for consumption and to accumulate herd for the next season. Normally, the own herd grows each season, but it sometimes decreases in size due to livestock mortality arising from various idiosyncratic factors (e.g., disease, sickness, accidents, as well as the covariate catastrophic droughts).



**The analysis considers the likely impact of asset protection livestock insurance.** For the asset protection product, we assumed design features similar to those of the IBLI asset replacement contract designed by ILRI, except that payouts were made early as opposed to at the end of the season. The analysis assumes that monthly insurance payouts could allow effective early interventions that enable the insured pastoralist to keep insured livestock alive. Sensitivity analysis was also performed with varying assumptions, and the key results did not vary significantly from our main assumption. Our analysis considers both short-term and long-term impacts of this livestock insurance, along with the proposed forms of government support, on the four distinct subsets of the population.

Catastrophic herd losses from droughts could have immediate welfare effects by reducing livestock income available for consumption. While severe droughts can immediately push the better-off poor and nonpoor into poverty, they can likewise push the ultra-poor and the poorest, whose livestock income is extremely low, into destitution. The black lines in figure 5 depict these impacts. Specifically, a 1-in-4-year drought could push livestock income of the poorest to the level of destitution (K Sh 13/day/person). A 1-in-8-year drought might also push income of the relatively better-off households below the food poverty line, and could bring the nonpoor households into poverty.

**We find that free provision of asset protection livestock insurance could reduce vulnerability but would not likely provide an immediate exit from poverty.** The long-dash red lines in figure 5 depict these patterns. This result is in contrast to the existing HSNP cash transfer program, which transfers approximately K Sh 3,500 to the poorest eligible households every two months. As the green lines show, direct cash transfers could potentially produce immediate poverty reduction effects for some groups, e.g., the ultra-poor, who have been boosted up above the food poverty line in some good years.

**By itself, direct cash transfer could still leave poor beneficiaries vulnerable to falling into poverty in extreme years. Complementing cash transfer with the free provision of livestock insurance might provide a more sustainable exit from poverty.** Especially for the ultra-poor, asset protection livestock insurance coverage could immediately protect cash transfer beneficiaries from falling into poverty in a 1-in-6 year extreme drought; see the long-dash and short-dash green lines in figure 5. This is the intention of the current plan to scale up from the HSNP.

The biggest impacts of livestock insurance are expected to be realized in the longer term, as the insurance helps pastoralists build up the herds over time and keep them at or above the viable size needed to stay out of the poverty trap. Existing academic research (e.g., Lybbert et al. 2004; Barrett et al. 2006; Chantarat et al. 2014) finds that a critical herd size of about 10–15 TLUs (see annex B.3) is necessary to sustain a viable herd accumulation in this region. Given limited productive nonlivestock livelihood options, and given the need for seasonal migration as adaptation to climate variability, pastoral households in this region consume a good portion out of their own herd each season (e.g., through direct slaughtering or off-taking for cash). This necessary consumption tends to slow down and disrupt natural herd growth, especially for very small herds. Households with small herd sizes (below the critical threshold) thus tend to deplete their herds over time. Furthermore, as poor households tend to be credit constrained, they are unable to restock their herds up to the economically viable and sustainable levels. With a small, collapsing herd size and low consumption, these households easily fall into the poverty trap that researchers have found in this vulnerable pastoral region.

**The existence of a viable herd threshold size implies that catastrophic herd loss from drought could be irreversible, especially when droughts have led to livestock losses below the viable level.** Figure 6 provides an example of common herd accumulation over time for different herd groups. It shows that especially for poor households with a vulnerable herd size around the viable threshold, a big 1-in-6-year herd loss could push herd size down to a level that will not recover without a restocking intervention. For small herds, extreme droughts could speed up herd collapse and move households toward destitution. For large herds, droughts could disrupt and slow down herd accumulation over time. Overall, just as the potential

impacts of droughts vary across different herd groups, so will the potential impacts of livestock insurance and related government support.

**Livestock asset protection insurance that is designed to keep the core breeding stock alive during severe droughts could have large long-term impacts, most notably by protecting poor households with vulnerable herds from a poverty trap.** As shown in figure 6, free asset protection insurance and top-up coverage might provide enough cash for effective early intervention and allow households to save and grow their viable herd, which otherwise could collapse. The overall impacts could be large when insurance coverage is offered with cash transfers, which could also relax the required consumption out of the own herd. Based on our simulation exercise with large numbers of replicated years, figure 7 further depicts the expected probability of falling into the poverty trap (losing viable herd) five years after being hit by drought-induced livestock losses at different magnitudes. It appears that free insurance and 50 percent subsidized top-up coverage could reduce the probability of falling into the poverty trap by up to 60 percent. And if these schemes were to be combined with cash transfer, altogether they could reduce the probability by up to 80 percent. This is in contrast to cash transfer alone, which could offer temporary poverty reduction while still leaving beneficiaries vulnerable to falling back into poverty in extreme drought years.

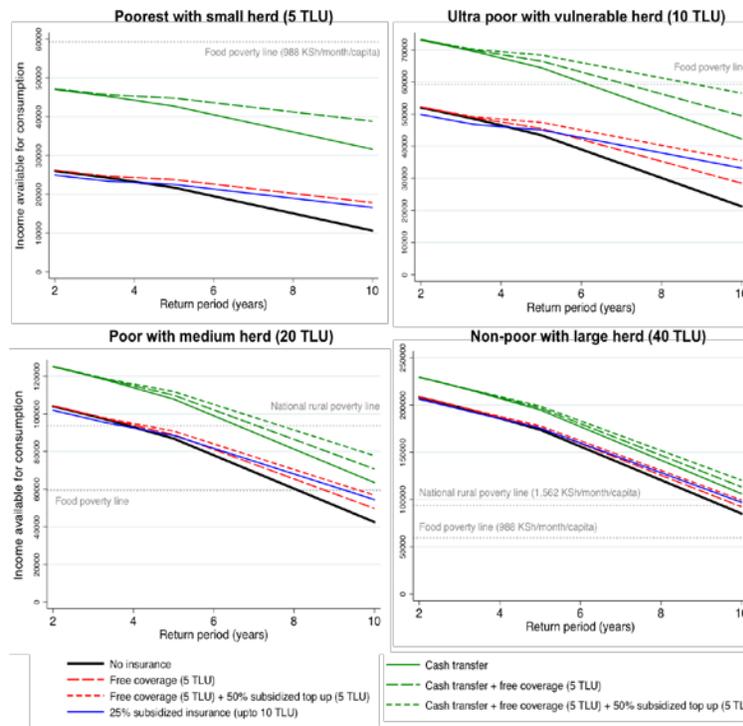
**For better-off households with medium and larger herds, livestock insurance could help to increase herds over time by stabilizing herd accumulation.** With a typical insurance policy, the insured might need to sacrifice his average income to pay for protection that reduced variability but did not increase productivity; but livestock insurance could have a productivity improvement effect through stabilizing herd accumulation. Figure 6 suggests that commercial asset protection

insurance could be attractive to better-off households, given that it could be less costly for the insurance contract to disburse early payouts to keep livestock alive than to replace lost livestock, and given the possible multiplier effects from protecting the critical breeding herd through herd accumulation.

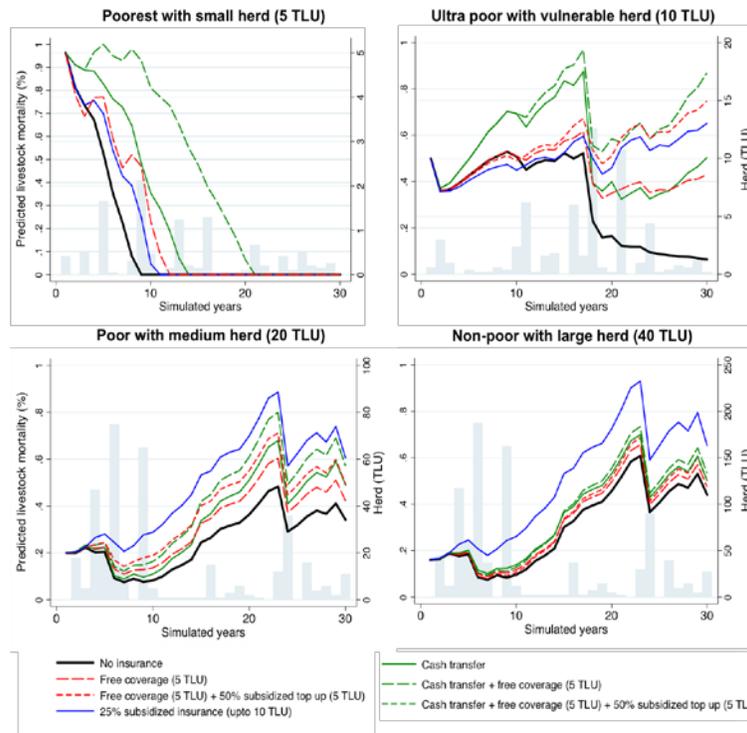
**Livestock insurance might have the smallest long-term welfare effects on the poorest (who own small and nonviable herds), since by itself livestock insurance is unlikely to help them to reach a viable herd size.** Figure 6 and figure 7 suggest that combining direct cash transfers with free livestock insurance might help stabilize the herds of the poorest households and slow down their herd collapse in the short run (e.g., cash transfer could potentially relieve necessary consumption out of owned herd), but the scheme might not alter the probability of falling into the poverty trap for this small-herd group.

Overall, these varying insurance impacts can be used to appropriately target public support for livestock insurance. Support mechanisms targeted to ensure an effective safety net among the vulnerable group could be very cost-effective in reducing poverty in the long run. As we see, poverty increases (and herds decline) in this region over time due to recurring droughts. A safety net intervention that can keep the vulnerable households from joining the ranks of the poor would allow the government to concentrate its limited resources on bringing the existing poor out of poverty. For the poorest, a combination of cash transfer and effective insurance could work to reduce vulnerability (and immediate poverty). But if the long-term goal is to move the poorest households out of poverty through pastoral production, complementing livestock insurance with interventions that promote restocking toward a viable herd could be critical. For the larger herd groups, promotion uptakes of the (potentially cost-effective) commercial livestock insurance could be effective.<sup>22</sup>

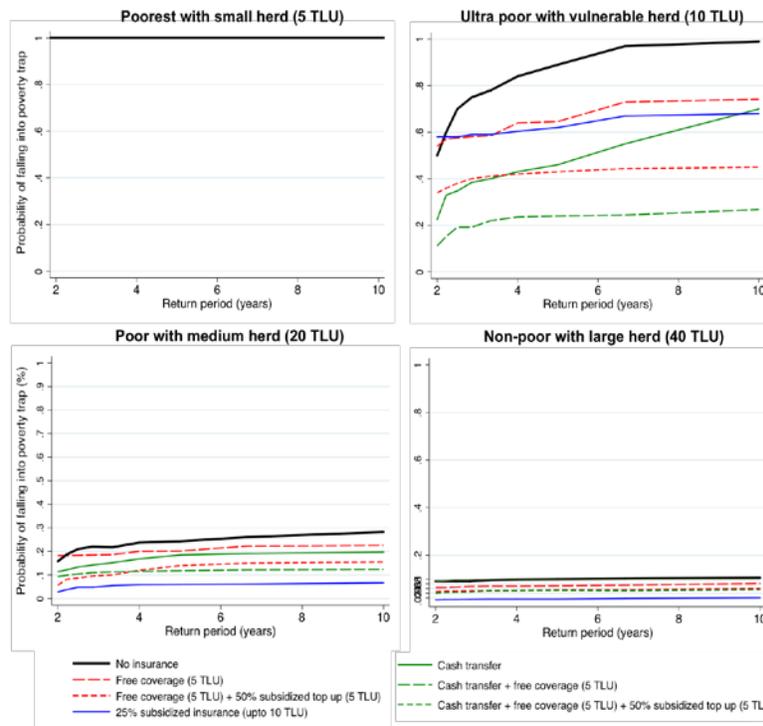
**Figure 5 – Potential short-term impacts of livestock insurance on income available for consumption**



**Figure 6 – Potential impacts of livestock insurance on herd accumulation**



**Figure 7 – Potential impacts of livestock insurance on probability of falling into poverty trap**



# Crop Insurance

## Context

### Kenya's Experience in Crop Insurance

As well documented in the recent Ministry of Agriculture, Livestock and Fisheries (MALF) report (GoK 2014a), Kenya has a long tradition of developing agricultural policy programs for risk management purposes.<sup>23</sup>

In Kenya, government support to agricultural insurance dates back to 1942, with the formation of the **Guaranteed Minimum Return scheme**. The objectives of this scheme were twofold: (i) to encourage food production to meet Kenya's basic food needs by providing seasonal crop credit to farmers growing strategic food crops (such as wheat and maize) through a system of guaranteed prices for output; and (ii) to provide these farmers with crop insurance in order to compensate them for droughts, pests, diseases, and other natural perils (Sinah 2012; Kerer 2013). The system operated for

more than 30 years until issues in performance and unsustainable financial losses led to its closure between 1977 and 1978.

**Interest in agricultural crop and livestock insurance reemerged in the mid-2000s.** Two main routes were explored: (i) the development of a Kenyan market crop insurance capability to underwrite traditional indemnity-based multi-peril crop insurance (MPCI) for medium- and large-scale commercial farmers, and (ii) the introduction of index-based insurance as a potential retail product to market to small and marginal crop and livestock producers (in situations where operating traditional indemnity-based crop and livestock insurance programs would be prohibitively expensive).

**The reemergence of interest in agricultural insurance in Kenya began in 2006, when four local private insurance companies came together to form a crop and livestock insurance consortium or pool agreement**



identified as Agricultural Insurance Manager (AIM). The role of the AIM consortium was to design, rate, and implement traditional indemnity-based crop and livestock insurance covers including MPCI. The pool operated from 2008 to 2010, when it was disbanded. Since 2010, several of the companies have continued to underwrite their own separate crop and livestock portfolios.

Kenya has subsequently witnessed an increased interest in developing a crop weather index insurance (WII) product. This effort is being led for the most part by the Syngenta Foundation for Sustainable Agriculture and the Financial Sector Deepening (FSD) Kenya program through a public sector and donor-sponsored initiative.<sup>24</sup>

### Government's interest in a new generation of agricultural insurance tools

In order to reduce risk and promote growth in the agricultural sector, the government of Kenya (GoK) is now placing new emphasis on the development of insurance solutions for agriculture. The GoK intends to foster a generation of innovative and widespread insurance products by addressing the conditions that so far have been hampering their development.

GoK's key assumption is that a well-structured agricultural insurance program, with participation by both public and private players, could unlock access to production credit and stimulate investment in productive inputs. It is now clear that, to be successful, an insurance scheme needs to reach a scale large enough to operate effectively, both in terms of the risk transfer objectives and of the insurance industry's commercial interests. International experience shows that this scale is rarely achieved without the active participation of government in building appropriate institutions and in providing financial support

to willing private sector players. An underlying assumption is that agricultural insurance is nested within the broader context of integrated risk management systems (such as improved extension for better asset protection, seed development, etc.).

The GoK proposes the development of a dedicated public-private partnership (PPP) in agricultural insurance and plans to invest resources in supporting it financially. From a program design point of view and for illustrative purposes, the approach analyzed below is that of area yield index insurance (AYII) for maize and wheat crops. AYII would be electively retailed through credit institutions via their lending operations for agricultural inputs.

Once the PPP framework for crop insurance has been implemented, appropriate solutions for other agricultural sectors could be also developed. The State Department of Agriculture (SDA) intends to extend future analyses to horticulture, coffee, and tea. Maize and wheat have been selected as the sectors to start with, given their relevance in terms of food security (maize in particular), their major contribution to agricultural value added, and the availability of readily implementable insurance solutions.

As discussed in detail below, AYII seems the appropriate tool for reaching the operational scale that would allow the GoK to meet its policy objectives in the grains sector. The case of India, which has the largest insurance program in the world per number of farmers insured (34 million farmers/20 percent of farmer households), offers an inspiring example of a PPP in agricultural insurance developed in an emerging country.<sup>25</sup>

## Description of Potential Agricultural Insurance Programs for Crops

### Rationale for Selecting AYII in an Agricultural Insurance PPP Framework

A PPP in agricultural insurance could make use of any of four types of insurance products for crops: multi-peril crop insurance, weather index insurance, area yield index insurance, and named peril crop insurance (NPCI) (see figure 8).

In a mature agricultural insurance program these four different contract typologies would not necessarily be alternative solutions, but could be complementary in offering a wide range of risk management tools to select from. However, in the case of a nascent PPP system, the GoK will need to concentrate efforts and resources on the approach that best suits its policy objectives, leaving other approaches to develop as the system gains momentum. Figure 1 and figure 8 summarize the conditions in which the use of the different products is more appropriate.

The GoK has chosen to promote the development of an AYII program for maize and wheat production. By definition, AYII is based on an indexed approach, where the underlying index is crop yield of a defined area called an insured unit. In AYII, the actual yield of the insured crop in the insurance unit is compared to the threshold yield. If the former is lower than the latter, all insured farmers in the insurance unit are eligible for the same rate of indemnity payout.

AYII provides wide peril coverage if designed appropriately: it is not affected by adverse selection and moral hazard, and it has a standardized design that can lead to rapid scalability. The main drawback of AYII is “basis risk” (explained below).

The more traditional NPCI products (e.g., those covering hail or frost) and MPCCI products (covering all risks combined) are already offered by several insurance companies in Kenya, but given the prevalent operating conditions in Kenyan agriculture, they may not be suitable for large-scale application. Such products are probably better suited for medium- and large-scale commercial agriculture than for small-scale subsistence farming, and they require a strong network of loss adjusters. In addition, the moral hazard and adverse selection challenges they pose are difficult to manage.

WII is an interesting innovation that has been extensively piloted in Kenya and is now starting to be retailed in niche markets. While not affected by moral hazard and adverse selection, WII covers essentially weather perils (mainly drought). Product design requires significant customized research and development activities that, together with its significant exposure to basis risk, limits the adoption of WII on a widespread scale.

GoK’s motivations for investing in a PPP based on an AYII scheme seem to be supported by the welfare impact analysis presented in section 3.4.

### AYII Operating Modalities

The key feature of AYII is that it does not indemnify crop yield losses at the individual field or grower level.<sup>26</sup> Rather, an AYII product makes indemnity payments to growers according to yield loss or shortfall against an average area yield (the index) in a defined geographical area. An area yield index policy establishes an “insured yield” that is expressed as a percentage (termed the “coverage level”—see figure 9) of the historical average yield for selected crops in the defined geographical area that forms the insured unit. Farmers whose fields are located within the insured unit may purchase optional coverage levels, or insurers may offer only one coverage option in the insured unit.

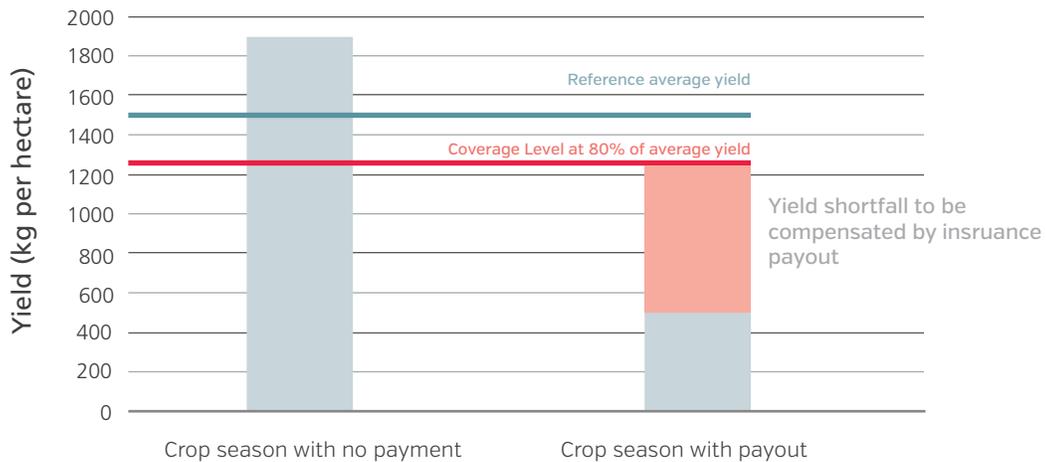
**Figure 8 – Types of Agricultural Insurance Products**

What are the various types of insurance products for agriculture?						
		What is it?	Transaction costs	Moral hazard and adverse selection	Basis risk	Claims settlement time
Multi-peril crop insurance	Farm	<ul style="list-style-type: none"> <li>Multi-peril crop insurance (MPCI) is a traditional indemnity insurance product against all perils</li> <li>Payouts are determined through a farm-level loss assessment process.</li> </ul>	High	High	Low	Medium
Area-yield index insurance	Village	<ul style="list-style-type: none"> <li>Area yield index insurance is based on average losses at the regional level, rather than farm level.</li> <li>It is often based on crop cutting experiments.</li> </ul>	Medium	Low	Medium	Medium
Weather index insurance	Village	<ul style="list-style-type: none"> <li>Weather index insurance is based on weather parameters (such as rainfall, temperature, or soil moisture) correlated with farm-level yields or revenue outcomes</li> </ul>	Low	Low	High	Low

\* Basis risk with index insurance arises when indices are imperfectly correlated with farmers' losses. Some farmers with losses may not receive payouts while some farmed without losses may receive payouts.

Source: Authors 2014

**Figure 9 – Coverage Level and Insurance Payouts in AY11**



Sources: Authors 2014



The actual average yield for the insured crop is established by a statistical sample of field measurement (usually involving crop cuttings) in the insured unit, and an indemnity is paid by the amount that the actual average yield falls short of the insured yield coverage level purchased by each grower.

The key advantages of the area yield approach are that moral hazard and adverse selection are minimized, and the costs of administering such a policy are much reduced. The policy responds to yield loss at a defined area level, and not at the level of the individual farmer, so if the insured unit is large enough, no farmer can influence the yield indemnity payments—minimizing adverse selection and moral hazard. Administration costs are also greatly reduced because there is no need for pre-inspections on individual farms, and loss assessment is not

conducted on an individual farmer and field-by-field basis, but rather according to a pre-agreed random sampling of crop yields on plots within the insurance unit.

The main drawback of AYII is basis risk, or the potential difference between the insured area yield outcome and the actual yields achieved by individual insured farmers within the insured area. Basis risk arises where an individual grower suffers severe crop yield losses due to a localized peril (e.g., hail, or flooding by a nearby river) that does not have a large impact on the area-level average yield. In such cases the farmer who has incurred damage does not receive an indemnity. Basis risk may also arise where individual farmer crop production and yields are highly heterogeneous (different) within the same department (that is, where an area-based approach invalid).

## SECTION

## 03

## Program Requirements

Developing a functional and effective AYII program for maize and wheat in Kenya requires two key steps: (i) define homogeneous producing zones (the insured units) with high levels of correlation between farmers of the same unit; and (ii) generate an accountable, reliable, and statistically accurate system of measuring actual average area yields in the defined insured unit, and define the basis for triggering payouts where actual yields fall short of the insured yield(s).

As for any agricultural insurance program, historical data for structuring and rating AYII are fundamental. Ideally, for each of the defined insured units, yield data for the past 15 years or more would be available. If such data are not available, logistical and financial support to the insurance industry will be critical. The GoK will likely need to help the private sector overcome challenges related to data in the inception phase. As the program develops, the data will be collected and compiled, thus generating the basis for a well-established and actuarially sound insurance program.

The data for AYII are usually collected through crop-cutting experiments (CCEs), in which samples of crops are harvested, dried, and weighed, and yield values are inferred. This work is usually carried out by government extension officers but could be outsourced to private entities if a great many CCEs are to be carried out. In this scenario, extension officers could play a key role in auditing the data collection activities. It is worth noting that SDA is currently in the process of improving its data collection system in order to harmonize it with international and regional standards. To this end, a dedicated set of guidelines was published in January 2014 (GoK 2014b). Efforts by the GoK to update and improve the data collection system (partly in response to the devolution process started in 2012) will certainly help in developing an AYII program.

Because data requirements for AYII are very specific, they may go beyond what a traditional system of agricultural statistics requires. Specific public support will likely be needed to allow for additional CCE activity.

For an AYII program, the value of defining appropriate insurance units and of developing a suitable data collection system is paramount. We therefore suggest that a specific multi-stakeholder study on how best to organize the data collection system be carried out. In addition to selected SDA officials, the team for such a study should also include staff from the Kenya Bureau of Statistics, agricultural research institutions, the insurance industry, and any other interested party. The study would need to cover items such as (i) risk profile-based identification of insurance units; (ii) statistical sampling methodology for identification of plots for CCEs; (iii) number of CCEs per insurance unit; (iv) procedures, roles, and responsibilities for carrying out CCEs, with a potential view to outsourcing the activities for which government personnel may be overtasked; (v) training and accreditation for government and/or private sector personnel to ensure consistency with international reinsurer data collection standards; and (vi) reliable auditing procedures to make sure that the national and international insurance community can have confidence in the quality of the data collected.<sup>27</sup>

Finally, those designing and implementing an AYII program for Kenyan agriculture must take into account lessons learned from similar programs in other countries, and should also take advantage of the latest developments in technology. Elements like real-time data transfer through mobile phone connections, digital video recording, remote-sensing performance indicators, GIS (geographic information system) mapping, GPS (Global Positioning System) georeferencing, etc. will increase the possibilities of assessing production losses in an efficient, effective, and transparent way.

## Fiscal Costing Assumptions and Scenarios

The objective of this section is to provide indicative references on the potential fiscal cost of developing an AYII scheme for maize and wheat producers. In order to develop such projections, it is necessary to estimate the potential cost of insurance policies and to define the key assumptions for potential policy choices and for the expected uptake of the proposed insurance products.

The cost of insurance is made up of several key components, such as the cost of risk [in technical terms, the “pure risk premium”] and the charges required to cover data collection, reinsurance fees, administration costs, tax, profits, and any other cost of doing business. Such charges are often estimated as a multiple of the cost of risk and, for the purpose of this analysis, we assume that they will double the pure risk premium. An approximated way of estimating the insurance premium is indeed to start from the pure risk premium and scale it up by a comprehensive loading factor defined as “premium multiple.” With the premium multiple set at 2, a pure risk premium rate of (for example) 6 percent in a particular area means that the final commercial premium rate in that area—the rate at which the policy will be sold—is 12 percent.<sup>28</sup>

A preliminary assessment of the pure risk premiums for both maize and wheat was carried out on the basis of historical production records provided by SDA at district level and assuming an 80 percent coverage level.<sup>29</sup> As indicated in more detail in annex C.1, the data were carefully analyzed, revised, and detrended.<sup>30</sup> Pure premium rates were then determined on the basis of the historical payout performance at the coverage level mentioned

above.<sup>31</sup> Figure 10 and figure 11 illustrate the spatial distribution of the estimated district-level premium risk rates for AYII policies for maize and wheat, respectively.

It is very important to note that the pure premium rates presented in this report are purely indicative and that the basic analysis carried out in this context aims only to highlight the diverse risk exposure of the different areas of Kenya. The responsibility to perform appropriate actuarial analyses for underwriting purposes lies with the insurance industry. In addition, we emphasize that the maize data used in the analysis are composed of annual yield values that do not account for production performance in the individual long and short rainfall seasons. This makes estimating yield variability in the individual seasons more difficult and increases the uncertainty in estimating the pure risk rate.

Despite the limitations in the production data available, it is still possible to identify rough operational estimates of the fiscal costs of an AYII program.<sup>32</sup> However, for potential implementation activities, specific care should be taken in developing seasonal-based contracts.

An essential assumption underlying this fiscal costing exercise is that the GoK will provide direct financial support to the AYII scheme.<sup>33</sup> The first means for channeling public support will be to finance the cost of risk. The analysis assumes that the GoK will cover a 50 percent share of such costs. Risk financing support can be structured in many ways, and for the purpose of this analysis we assume that it would come as a dedicated “risk financing fund” covering part of reinsurance costs, or as premium subsidies.

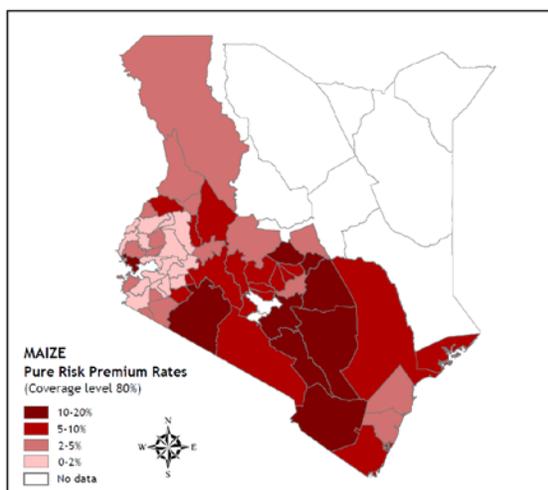
Public support for AYII will also entail providing resources to complement the data collection activities needed for operating the insurance scheme. The current fiscal scenarios assume that the GoK will cover the cost of the activities needed to complement the estimation process carried out by the public extension service, including costs for equipment, labor, management, and auditing.<sup>34</sup> However, more complex arrangements can be envisioned in which the private stakeholders also play relevant roles in supporting the data collection process.

The current costing exercise does not distinguish between commercial and subsistence farming, although different supporting schemes could be envisioned for the two farming typologies. For example, in the areas where agricultural production is carried out by smallholders at subsistence level, the program could be operated in a more socially oriented fashion by having higher levels of support (for example, near to full premium subsidy support). At the same time, in more commercially oriented production environments, specific limits to the

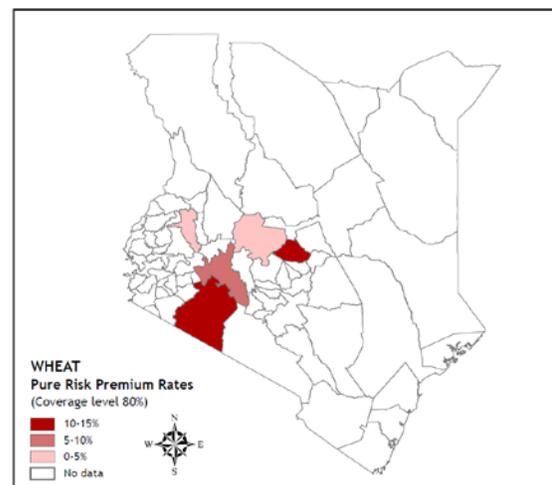
amount of subsidized insurance could be introduced. Differentiations could be also made between maize and wheat production activities, given that the latter are traditionally carried out in larger and more sustainable production units.

An important dimension to be defined for determining the value insured per district is the expected take-up rate of insurance products (identified, in insurance terms, as the “degree of penetration”). As a tentative reference, the fiscal scenarios have been developed by starting at 3 percent of cultivated area at the beginning of the program in 2016, and reaching 15 percent for maize and 25 percent for wheat in 2023.<sup>35</sup> The penetration rate is clearly difficult to predict, as it is a function of many variables, some under the control of the program and some not. These projections are based on the assumption that AYII will be retailed in connection with agricultural input credit operations that are currently accessed by less than 5 percent of farmers (see section 4.4). The availability of AYII should allow financial institutions to expand their agricultural lending operations, generating

**Figure 10** – Estimated AYII Risk Premium Rates for Maize at District Level



**Figure 11** – Estimated AYII Pure Premium Rates for Wheat at District Level



a mutually reinforcing process that could lead to a progressive increment in the take-up of both insurance and credit.

Under the assumptions presented in the analysis, and excluding expenses related to other support activities, the direct fiscal costs to be borne by the GoK for supporting the development of a national AYII program for maize and wheat would total approximately K Sh 140 million (US\$ 1.6 million) at the start of the program, and K Sh 740 million (US\$ 9 million) per year in 2021 assuming that

the program has reached significant scale [see table 7 for maize and table 8 for wheat, respectively]. The bulk of the estimated fiscal support—nearly 90 percent of resources provided by the GoK—would be directed to maize production.

### Box 3– Coverage Levels and Premium Rates

Table 6 provides an example of how the premium rates of hypothetical AYII contracts vary according to different coverage levels. In the simulations presented below, for a coverage level of 80 percent, the premium rate would be below the adopted 15 percent cap only for the district of Uasin Gishu. In order to meet the 15 percent threshold, it would be necessary to reduce the coverage level to 70 percent for Kajiado, and to 50 percent for Machakos. These simple examples show the clear tradeoff between cost and coverage of AYII policies. This tradeoff is driven by the underlying risk; and where risk proves excessive, insurance may not represent an economically viable proposition

**Table 6–** Variation of Premium Rates According to Different Coverage Levels

District	Coverage Level			
	80%	70%	60%	50%
Machakos	31%	26%	20%	14%
Kajiado	17%	11%	7%	4%
U/Gishu	4%	3%	3%	2%

The case of Machakos suggests how combining seasonal production data in one annual observation may distort the perception of the risk profile in the area. The extremely high premium rate estimated for Machakos is due to the inclusion of the March-May rainfall season, significantly drier than the October-December one. Seasonal production data would provide different insurance premium rates for the two seasons, leading to different risk management recommendations.

**Table 7–** Fiscal costing projections for AYII for maize, 2016–2023

	2016	2017	2018	2019	2020	2021	2022	2023
Insurance Penetration (as a % of cultivated area)	3.0%	4.7%	6.4%	8.1%	9.9%	11.6%	13.3%	15.0%
Penetration [hectares]	61,517	96,670	131,822	166,975	202,128	237,280	272,433	307,586
Premium volume (million KSh)	253	398	543	687	832	977	1,122	1,266
Projected public support as a share of premium volume (%)	50%	50%	50%	50%	50%	50%	50%	50%
Cost of premium subsidy for GOK (million KSh)	127	199	272	344	416	489	561	633
Additional costs for data collection / yield estimation (million KSh)	0.2	0.6	1.2	1.7	2.3	2.9	3.5	3.8
Number of farmers covered (per season)	25,632	40,279	54,926	69,573	84,220	98,867	113,514	128,161
Total cost for GoK (million KSh)	127	200	273	345	418	491	564	637
Total cost for GoK (million USD at 85 KSh/USD)	1.5	2.3	3.2	4.1	4.9	5.8	6.6	7.5

**Table 8–** Fiscal costing projections for AYII for wheat, 2016–2023

	2016	2017	2018	2019	2020	2021	2022	2023
Insurance Penetration (as a % of cultivated area)	3.0%	6.1%	9.3%	12.4%	15.6%	18.7%	21.9%	25.0%
Penetration [hectares]	3,819	7,820	11,821	15,822	19,823	23,824	27,825	31,827
Premium volume (million KSh)	24	49	74	98	123	148	173	198
Projected public support as a share of premium volume (%)	50%	50%	50%	50%	50%	50%	50%	50%
Cost of premium subsidy for GOK (million KSh)	12	25	37	49	62	74	87	99
Additional costs for data collection / yield estimation (million KSh)	0.01	0.04	0.07	0.11	0.14	0.18	0.21	0.24
Number of farmers covered	1,273	2,607	3,940	5,274	6,608	7,941	9,275	10,609
Total cost for GoK (million KSh)	12	25	37	49	62	74	87	99
Total cost for GoK (million USD at 85 KSh/USD)	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2

## Welfare Impacts of Area Yield Insurance for Maize and Wheat in Kenya

Maize and wheat productions are crucial for the livelihoods and food security of smallholder and medium-scale farmers in Kenya. Maize-growing areas span the country and can be classified into three production zones with distinct production systems and socioeconomic conditions. The low-potential zone occupies low-yielding and high-risk production in Eastern and Central Provinces, where the majority of farmers are poor smallholders (median farm size is 1.5 hectares) who use subsistent production technology (we sometimes refer to this zone as the subsistent maize zone). The medium-potential zone occupies the relatively higher-yield, lower-risk regions of Nyanza and Western Provinces, where farmers are slightly better off but still smallholders. The high-potential zone occupies the high-yielding production regions of Rift Valley Province, with relatively larger-scale farmers (with 2.5 hectares of land on average). Maize production is one of the main livelihood bases and is mainly used for home consumption, especially in the low- and medium-potential zones. This is in contrast to the high-potential zone, where production is relatively more commercialized. Wheat production is concentrated in smaller regions of the Eastern and Rift Valley Provinces, is relatively more commercialized, and is practiced by relatively larger-scale farmers (with 3.0 hectares of land on average). (See annex C.2, table 18 for summary statistics of maize- and wheat-growing households.)

**Low investment in productive inputs and limited access to production credit have impeded efforts to improve productivity in both maize and wheat productions in Kenya. Data from a variety of sources—Tegemeo Institute’s household survey data (2000,**

**2004), Kenya Integrated Household Budget Survey data (2005)<sup>36</sup>, KARI (2009)<sup>37</sup>, and Tegemeo Institute (2010)<sup>38</sup>—show that 23–30 percent of maize and wheat farmers report using high-yielding technology and hybrid seeds. And while almost 50 percent of farmers reported using some kind of input credit, less than 5 percent of these farmers reported obtaining credit from formal financial institutions. Other sources of production credit include cooperatives, savings and credit cooperatives (SACCOs), local traders, input suppliers, and other informal financial institutions. Statistically, input loans have been relatively small, just enough to afford minimum input costs, and have been offered at interest rates of 8–19 percent per year. Among other things, limited access to agricultural credit has thus served as a key supply-side constraint to productive agricultural investment.**

**Maize and wheat productions are significantly exposed to extreme production risk. We used detrended district-level yield data for the 30-year period 1983–2012 (obtained from the MALF report [GoK 2014a]) to determine how often maize production falls below 80 percent of the district average. The analysis showed that these shortfalls are 1-in-3-year events in the low-potential zone and 1-in-4- to 1-in-5-year events in the other two maize zones and wheat region. The low-potential zone thus appears to have a larger exposure to production risk than the other zones, with significant drops in production—below 50 percent of the district average—occurring once in five years. While Kenyan farmers have established various informal risk-sharing mechanisms that allow unaffected farmers to help affected farmers reduce consumption shortfalls from shocks, these mechanisms tend to be ineffective against extreme production shocks, which generally affect whole communities.**

**Uninsured production risk could have significant welfare impacts on Kenyan maize and wheat farmers, not only by increasing their vulnerability but also by reinforcing both supply- and demand-side constraints on smallholders' adoption of productive inputs.** Extreme production risk directly affects welfare by reducing the income/food available for consumption, especially among the poor smallholders whose livelihoods rely extensively on these crop productions. Exposure to extreme production risk could further reduce investment incentives, especially among risk-averse poor farmers. Empirically, according to the household survey, farmers have always cited uninsured risks as one of the key reasons for their underinvestment in production. At the same time, as agricultural loan portfolios would also be exposed to large default risk following extreme production shortfalls, lenders tend to limit the supply of agricultural credit or offer credit at relatively high interest rates. Overall, through the direct effect on vulnerability and the indirect effect on productivity, exposure to uninsured risk could increase the probability that Kenyan farmers will fall into poverty.

**Our empirical analysis reviews the significance of, and variations in, exposures and welfare impacts of covariate production risk on representative farmers in the key maize and wheat production zones.** We develop a simple economic model to explore the potential welfare impacts on a representative farmer in each of the three distinct maize zones and overall wheat production region (see annex C.2). In each production zone, we assume that a representative farmer owns a farm of median size, produces with the zone-specific production system, and realizes zone-specific crop yields and variability. A representative farmer is credit constrained and so needs to take an input loan at the beginning of the cropping year to purchase required minimum inputs. The loan is repaid using crop income obtained after the harvest.

The model is then calibrated using a combination of 30 years of district production data from MALF and detailed household survey data from the Tegemeo Institute (2000, 2004)<sup>39</sup> covering key maize-growing areas of the country. Overall, maize yields vary significantly across the three production zones, with the highest CV<sup>40</sup> of 0.49 in the subsistent maize zone, following by 0.34 in the high-potential zone, 0.35 in the wheat region, and 0.29 in the medium-potential zone. Input costs vary from 50 percent to 75 percent of the expected crop revenues. For both crop productions, we thus assume that a farmer needs to take an input loan at a median rate of 60 percent of expected revenue and at a cost of 17 percent interest per year.

**Net income available for consumption and expected loan repayment rates vary greatly with frequency and severity of shocks in all zones.** The black lines in figure 12 reflect annual maize and wheat income after netting out input loan repayment and thus the net income that would be available for household consumption. Our simulations considered both price and yield variability, and thus variations in net incomes reflect variations of both. As expected, the net incomes (realized in 1-in-2-year frequency) are very low—lower than the national food poverty line (at K Sh 988 per capita per month) in the subsistent and medium-potential maize zones, and slightly above the food poverty line in the high-potential maize zone and in the wheat region.<sup>41</sup>

**Net incomes available for consumption could drop to or below zero at a frequency of once in three years in the subsistent zone and at a frequency of once in four years in others.** In these cases, the farmer has no income left for consumption and/or is unable to repay the full loan.



**A 1-in-10-year production risk could further force farmers in all production zones to accumulate debt of up to 80 percent of their expected income each year.** In reality, however, a farmer might not use all crop income to pay back a loan. To make this scenario more realistic, we computed the expected loan repayment rates assuming that a farmer will try to pay back the loan after meeting the necessary subsistent consumption at 30 percent of the food poverty line. As shown in annex C.2, table 19, the expected loan repayment rates in all zones could be reduced by extreme shocks.<sup>42</sup>

**Area yield index insurance could potentially stabilize consumption in the years when extreme shocks affect the entire community.**

We first explore the potential of high-coverage AYII that pays out based on a district-level yield index at a coverage level specific to each zone,

and that is possible within a 15 percent maximum commercial premium rate. Given differences in yield variations, insurance coverage varies across zones, with 50 percent, 85 percent, and 80 percent in low-, medium-, and high-potential maize zones respectively, and 75 percent in the wheat region. In figure 12, net income available for consumption is then plotted in red. As expected, AYII would reduce net income in good years, as a farmer would need to pay for the insurance premium, which is loaded at a multiple of 2. But the AYII payout could stabilize net income in bad years.

**Especially for households that rely extensively on crop production as their main consumption, AYII that reduces variability in crop production will also reduce households' vulnerability to food insecurity.** But when an extreme shock—one with at least a 1-in-4-year frequency—occurs, this high-coverage commercial AYII generally does not guarantee enough income for full repayment of input loans in any of the zones. There could several reasons for this: (i) commercial AYII is quite expensive; (ii) there is still basis risk associated with AYII because it provides protection only with respect to the district-level yield, not with respect to the individual yield; and (iii) there are other background risks due to uninsured variations in prices.

**AYII could potentially increase the ability of farmers to pay back input loans in the bad years and so increase expected loan repayment rates of rural lenders' loan portfolio [see annex C.2, table 19].** Commercial AYII could stabilize loan repayment rates in bad years and so increase expected loan repayment by as much as 10 percent when the farmer faces 1-in-10-year production risk relative to the case without AYII.

Public support that reduces the commercial premium rate could significantly improve the welfare impacts of AYII on maize and wheat households. We show that a 50 percent reduction in commercial premium [which allows the farmer to pay a fair premium rate], could potentially allow AYII to stabilize net income available for consumption above zero even with the extreme 1-in-10-year risk in all but the risky subsistent zone. Thus, for farmers who always use all crop income to repay their loan, fair AYII could ensure full loan repayment even in extremely bad years. Even if farmers meet their subsistent consumption level before repaying the loan, fair AYII could increase expected loan repayment by as much as 20 percent in extreme years relative to the case without AYII.

If insurance could further unlock access to agricultural credit and enhance farmers' investment incentives, even commercial AYII could potentially crowd in sustainable increases in productivity in line with a key recommendation of the Kenya Vision 2030. Various studies have documented positive effects of derisking agricultural production on productive investment and credit demand—e.g., Cai et al. (2009) in China; Galarza and Carter (2011) in Peru. Existing agricultural programs in Kenya have also successfully allowed banks to expand lending to farmers using insurance as a prerequisite for loans and/or by bundling insurance with credit directly.

Since the above analysis shows that AYII can remove some production risk from rural lending institutions and thus increase expected loan repayment rates, we explore the potential impacts of this effect by allowing insured farmers to access larger loans for investment in expensive but more productive inputs (hybrid seeds, fertilizer, equipment). We used the crop- and zone-specific evidence of expensive input cost markups

(relative to the average cost) and the expected yield improvement (relative to the average yield) from a detailed maize production study by the Kenya Agricultural Research Institute (KARI) in 2009 and from a wheat production's gross margin study of DASS (see annex C.2). Farmers who can afford to invest 126 percent and 138 percent more in productive inputs could improve maize yields by as much as 196 percent in the high-potential maize zone and 182 percent in the medium-potential zone, respectively. Similar but less significant evidence is also found for wheat farmers, for whom 133 percent more investment in productive input could enhance yield by up to 139 percent. The productivity gain from increasing productive investment, however, could be limited in the subsistent maize production zone by the zone's low production potential and scarce rainfall. Thus the extra cost of expensive input appears to outweigh the additional yield improvement.

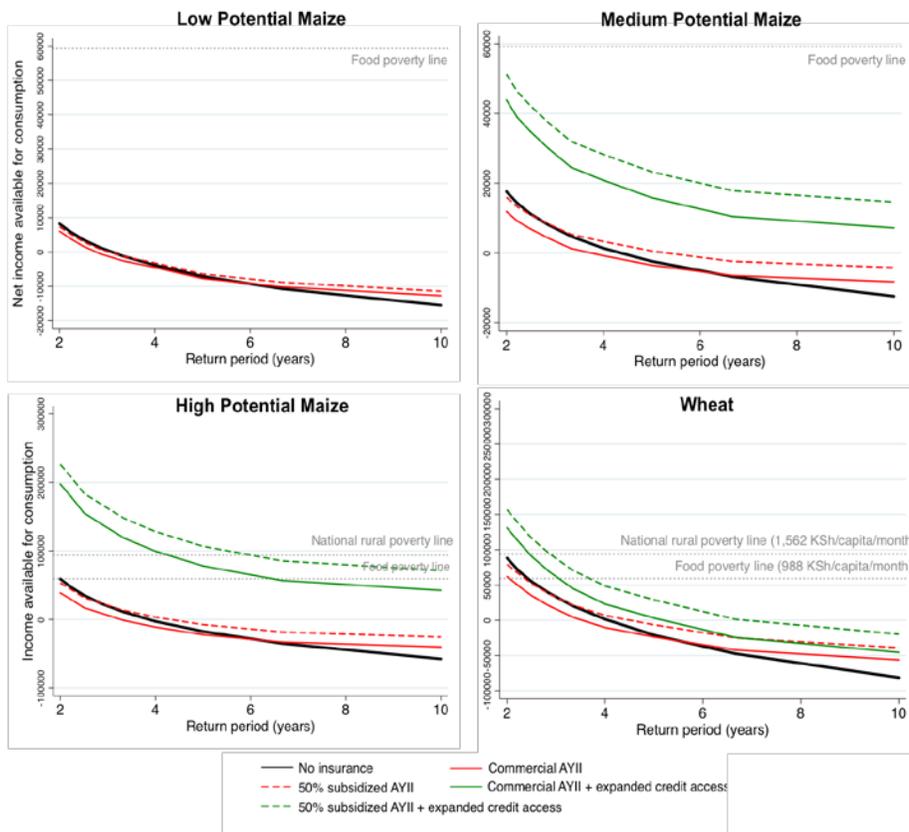
So while commercial AYII might be too expensive as a stand-alone insurance in this setting, if it could unlock access to credit, it could potentially crowd in significant improvement in income and reduce the probability of falling into poverty for farmers in all zones except the low-potential zone. As the green lines in figure 12 show, the crowding in effect of even the commercial AYII could improve expected net income available for consumption by more than double in the medium- and high-potential zones and by about 65 percent in the wheat region. The significant productivity gain from expanded credit with commercialized AYII could further result in 67 percent and 30 percent reductions in the probability of falling into poverty for farmers in the high and medium zones, respectively. This crowding-in effect could be smaller for the better-off wheat farmers, who already use relatively more expensive inputs and achieve relatively higher productivity.

The crowding in effect of AYII might be limited for farmers in the low-potential zone, however.

By subsidizing AYII and using AYII to crowd in productive input loans, the government could further ensure sustainable and significant increases in productivity and thus in agricultural GDP, and in this way contribute toward achievement of the Kenya Vision 2030. In turn, this approach could move many small- and medium-scale farmers in some production regions out of poverty. Subsidized AYII with extended productive input loans could potentially more than

double the production in high- and medium-potential zones, and almost double the production in the wheat region. The program could potentially reduce farmers' chance of falling into poverty by 78 percent, 39 percent, and 29 percent in the high-potential zone, medium-potential zone, and wheat region, respectively (see annex C.2, table 19). These poverty reduction effects come about as the AYII and credit enhance farmer's productivity, and as AYII acts as a safety net to protect yield shortfalls in bad years.

**Figure 12 – Potential impacts of AYII on net income available for consumption**



Note: The net income available for consumption depicted in the figure reflects crop income after any loan repayment. It does not account for the potential that households might use some part of this for saving before consumption. Thus this should be viewed as an upper bound of income that will be available for consumption.

SECTION

**Table 9–** Fiscal cost per household of achieving different policy goals in different insurance scenarios

Policy objectives	Crop zone	Public cost (KSh) per unit			
		Free provision of AYII	Subsidize AYII	Subsidize AYII + unlock credit	Cash transfer
1% reduction in poverty	Low potential maize	no effect	no effect	no effect	1,394
	Medium potential maize	27,453	no effect	118	1,169
	High potential maize	4,425	no effect	420	1,832
	Wheat	5,408	no effect	1,722	2,355
1% reduction in vulnerability*	Low potential maize	761	3,774	no effect	802
	Medium potential maize	937	1,328	255	1,206
	High potential maize	3,540	4,963	739	2,917
	Wheat	4,804	5,235	1,679	4,175
1 KSh increase in expected income	Low potential maize	2.01	no effect	no effect	1.00
	Medium potential maize	2.02	no effect	0.10	1.00
	High potential maize	2.01	no effect	0.08	1.00
	Wheat	2.00	no effect	0.19	1.00

\* Measured by probability of falling below zero net income available for consumption

Overall, the welfare impacts of AYII vary across production zones with different degrees of risk exposures, and AYII might not be suitable as an intervention to improve smallholders' productivity in the subsistent maize production region. Given this region's low expected yield and large exposure to production risk, AYII with large coverage could be too expensive to be useful for these farmers. But the coverage level (currently at 50 percent) affordable within a 15 percent commercial premium could also be too low to effectively insure net income and expected loan repayment against extreme shocks. Even with 50 percent premium reduction through public supports, extreme production shock could still cause serious shortfalls of consumption and expected loan repayment. AYII is unlikely to unlock credit access and so improve productivity for smallholders in this subsistent zone, where the potential for productivity

improvement through increased productive input use is low.

The welfare impacts of AYII could also vary slightly across different insurable indexes and coverage levels. Changing from a district-level yield index to a division-level index, for which correlations of individual yields with the measured area yield are potentially larger, could achieve a larger reduction in net income variability (see annex C.2, table 19). The performance of AYII in reducing income variability also declines as one moves from the high coverage, with 15 percent maximum premium rate, to the lower coverage level affordable within 10 percent commercial premium. This analysis assumes that there could be effective insurance demand even at the high commercial rate.

Government's support to development of an AYII program could be a cost-effective

**strategy for meeting various policy objectives.** To identify the most cost-effective types of support that can achieve different policy objectives targeted to different subsets of maize and wheat farmers, we compute the cost per household (in Kenyan shillings) per year of four types of support—explained below—to achieve three outcomes (see table 9): (i) 1 percent reduction in the poverty rate relative to the baseline without the program; (ii) 1 percent reduction in the vulnerability rate (measured by the probability of net income falling below zero); and (iii) an increase of K Sh 1 in net income available for consumption when targeted to each of the maize and wheat areas. The four types of support include (i) free provision of AYII, (ii) 50 percent subsidization of AYII, (iii) 50 percent subsidization of AYII and facilitation of access to input credit, and (iv) direct cash transfer program, the cost of which we compare to the costs of the first three interventions. For the high-coverage AYII program (at 15 percent maximum premium rate), the free provision of AYII could cost government from K Sh 2,642 per household per year (in the subsistent maize zone) to K Sh 34,448 per household per year (in the wheat region). The cost is thus reduced by half when the government subsidizes only 50 percent of AYII's premium cost.

**The types of public support that reduce AYII's commercial premium and unlock the agricultural credit market could be the cost-effective tools that allow government to reduce poverty and vulnerability and to improve productivity among the median farmers (smallholders) in the medium- and high-potential maize zones and the wheat region.** In the medium-potential zone, it would cost as little as K Sh 118 per household per year for the government to reduce the poverty rate by 1 percent through subsidizing AYII and crowding in input credit access. This compares to K Sh 1,169 per household per year if the government tried to achieve the same goal through cash transfer. It

would cost as little as K Sh 0.08 per household per year for the same scheme to improve productivity and so increase household income by K Sh 1. And this is clearly cheaper than direct one-to-one cash transfer. The combination of government subsidies for AYII and crowding in of input credit would not be an effective policy tool for smallholders in the subsistent maize zone, however.

**For a cost-effective tool to reduce vulnerability of smallholders in the subsistent maize zone, the government could freely provide AYII coverage as a social protection program.** This could lead to a 1 percent reduction in vulnerability (i.e., the probability of household's net income falling to zero) and would cost the government about K Sh 761 per household per year. This is cheaper for government than providing only a 50 percent subsidy for AYII (which could cost K Sh 3,774 per household per year) and the direct cash transfer (which could cost about K Sh 802 per household per year). If the policy goal is to reduce poverty, however, government's support through AYII would not be the appropriate policy tool relative to the direct cash transfer program.

# Conclusion

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This report provides a detailed technical analysis of how the government of Kenya (GoK) could develop agriculture insurance public-private partnerships (PPPs) to support rural livelihoods and help to raise Kenya to middle-income status, as described in Kenya Vision 2030. This report, written with the guidance of the GoK, analyzes possible PPP structures and explores the options for developing crop and livestock insurance programs in the short, medium, and long term.

This report is meant to guide the GoK in key policy decisions based on the potential fiscal cost and potential welfare benefits of developing an agriculture insurance PPP. Both the fiscal costing analysis, which estimates the resources required to develop the PPP, and the welfare analysis, which looks at how agriculture insurance could benefit farmers, are provided toward that end. Leading the way for the African continent, these decisions will help to establish an appropriate policy framework for an effective agriculture insurance PPP in Kenya.

On the institutional side, the report discusses key next steps toward developing a National Agricultural Insurance Policy (NAIP), in addition to the potential institutions to be established in support of the PPP's public aspect.

For crop insurance, investments in data and linkage to credit are key. Investments in data will be required to develop high-quality products that provide meaningful coverage to farmers, reduce basis risk, and ensure that payments are made when necessary. The welfare analysis has highlighted the importance of linking insurance to credit as a way of empowering rural farmers to make capital investments on their farms, raising household income, and increasing the size of farms. The main costs to the GoK include developing the data market infrastructure and some form of support for financing the cost of risk.

For livestock insurance, linking to the Hunger Safety Net Program (HSNP) in the four northern counties is the key initial step. Building on the scalable component of the HSNP, the analysis provides details of the costs and benefits of a GoK-funded livestock insurance scheme that will reduce the vulnerability of low-income families, in addition to laying the foundation for a politically sustainable livestock insurance market. Initially, it is envisaged that a macro-level product will be developed and given to vulnerable households. Over time, top-up coverage will be made available to the covered households, in addition to other households in the target counties.

Fiscally, the approach suggested in this report would entail certain costs to the GoK through its involvement in the PPPs. These are outlined in table 10.

**Table 10–** Illustrative fiscal costing for agricultural insurance programs, 2016 and 2019

Program Description [2016]	Annual fiscal cost [K Sh millions]	Estimated number of producers covered	Average cost per producer per year [K Sh]
<b>Maize:</b> area yield index insurance	127	25,632	5,000
<b>Wheat:</b> area yield index insurance	12	1,273	9,500
<b>Pastoralists:</b> satellite-based livestock protection insurance (fully subsidized)	300	71,000	4,200
<b>Pastoralists:</b> satellite-based livestock protection insurance (partially subsidized)	14	5,250	2,600
<b>TOTAL</b>	<b>453</b>	<b>103,155</b>	

Program Description [2019]	Annual fiscal cost [K Sh millions]	Estimated number of producers covered	Average cost per producer per year [K Sh]
<b>Maize:</b> area yield index insurance	345	69,573	5,000
<b>Wheat:</b> area yield index insurance	49	5,274	9,200
<b>Pastoralists:</b> satellite-based livestock protection insurance (fully subsidized)	300	71,000	4,200
<b>Pastoralists:</b> satellite-based livestock protection insurance (partially subsidized)	31	15,000	2,100
<b>TOTAL</b>	<b>725</b>	<b>160,847</b>	

## Annex A. Possible Options for Coinsurance Pools in Kenya

As discussed in chapter 1, it is unlikely that insurers will be able to compete within a fully competitive market for agricultural insurance. The purpose of this section is not to make detailed recommendations for a pool structure, but to demonstrate the variety of pool structures that could be considered.

### Nonstatutory Coinsurance Pools

Insurance pools can be statutory (i.e., established by specific legislation) or nonstatutory (i.e., not established by specific legislation).

Different structures are commonly used to establish nonstatutory insurance pools:

1. A coinsurance pool may be established by the participating insurers as an insurer in its own right, so that it is the pool itself that issues the insurance contracts and assumes the risk on behalf of the insurers. In this case, either the pool would sell its own insurance contracts or the insurers would sell insurance contracts as intermediaries (i.e., agents) on the pool company's behalf, the risk being underwritten by the pool company.
2. The insurance contracts may be written by the insurer pool members, on an individual basis, but with the risk ceded to the pool. In this case, the pool may be either (i) a special pool company established by the insurers; or (ii) an arrangement between the insurers whose terms are set out in a pool agreement.
3. The insurance contracts may be written by a lead insurer on behalf of the other insurers that are members of the pool. Again, under this scenario, the pool may be a special company established by the insurers or an arrangement between the insurers set out in a pool agreement.

If a coinsurance pool is established as an insurer, the pool company underwrites the risks directly in its own right. A pool company that underwrites risks must, of course, be licensed to write insurance business and must be fully capitalized as an insurer.

**Other coinsurance pools**, whether or not established solely by contract or as a special (noninsurer) company, usually share the following features:

1. Each insurer accepts a pre-agreed share in all the risks that are covered by the pool agreement.
2. All premiums are paid into the pool, less an amount to cover expenses.
3. The pool manager or administrator assesses and settles claims.
4. If there is an underwriting gain, the surplus (beyond any reserve retained in the pool) is paid to each insurer in accordance with its agreed share.
5. If there is an underwriting loss, the insurers contribute to the loss in accordance with their agreed share.



## Box 4– Benefits and limitations of coinsurance pool arrangements

Coinsurance pools offer these benefits:

**They achieve economies of scale through operating as a single unit with shared (pooled) administration and operating functions.** These lead to costs savings from (i) reduced staffing requirements (fixed costs); (ii) shared costs of product research and development, and actuarial services including rating; and (iii) reduced costs of underwriting and claims control and loss adjustment.

**There are cost advantages to companies when they purchase common account (pooled) reinsurance protection rather than trying to place their own reinsurance program.** The advantages arise from (i) a stronger negotiating position with reinsurers; (ii) larger and more balanced portfolio and better spread of risk; (iii) reduced costs of reinsurance due to pooled risk exposure; and (iv) reduced transaction costs (reinsurance brokerage, etc.).

**There is no competition on rates in a soft market, and pools can maintain technically set rates.** Most pools operate as the sole insurance provided or monopoly (as in Austria, Senegal, Spain, and Turkey, for example), and there is therefore no competition on pricing.

**Pools are able to maintain underwriting and loss adjustment standards.** Under a pool monopoly arrangement, the pool manager can ensure that common and high standards are maintained in the underwriting of crop and livestock insurance and in the adjusting of claims. Where companies are competing against each other for standard crop insurance business, there is often a problem of varying loss adjustment standards between companies.

**Within a PPP, governments can more easily coordinate support to a pool than to individual insurers.** Governments seeking to coordinate national agricultural insurance policy and planning and specific support functions (e.g., provision of premium subsidies, research and development, education and training) can work more easily with a pool than with individual insurers, each of which may have very different priorities for agricultural insurance.

Coinsurance pools have these limitations:

**When a pool acts as the sole agricultural insurer, lack of competition in the market may result.** This could (i) limit the range of products and services offered by the monopoly pool underwriter; (ii) restrict the range of perils insured; (iii) restrict the regions where agricultural insurance is offered and/or the type of farmer insured; and (iv) lead to a lack of competitiveness in premium rates charged by the pool.

Source: Mahul and Stutley 2010.

If a pool is established solely through a contractual arrangement, the “pool” is not a legal person and does not have the power to contract. The pool could not, therefore, write insurance contracts.

If the insurers enter into their own individual insurance contracts, the insurance business is conducted under their individual licenses. The capital of the participating insurers supports the risk. The position may be rather more complicated if the insurance contracts are underwritten by a lead insurer on behalf of the other insurers.

It is important to appreciate that where the insurers write their own insurance contracts and cede the risk to the pool, each participating insurer typically accepts a pre-agreed share of all the risks ceded to the pool, not just the risks that the insurer has written.

**Management of a coinsurance pool**, where the pool is incorporated as a (noninsurance) company, involves the pool company acting as the pool manager or administrator. Where a special pool company is not incorporated, the pool

may be managed by a lead insurer; by a technical management unit contracted or employed by, or on behalf of, the participating insurers; or by a third party such as a broker, another nonparticipating insurer, or a reinsurer. The participating insurers typically share the management costs in accordance with their proportionate risk share.

### Statutory Coinsurance Pools

**Statutory insurance pools** are often, but not necessarily, corporate bodies. Usually, statutory coinsurance pools are part of a national or regional program and are established as part of a public-private partnership (PPP). Relevant legislation typically provides for the governance of the pool and sets out the pool's functions. The legislation may also cover other matters, such as the provision of some form of subsidy. Because they are established by legislation, statutory pools take many forms and may be structured very differently to a typical voluntary pool.

The legislation may establish a coinsurance pool, but not as a corporate body. For example, the pool may be established as a contractual arrangement between participating insurers. In this case, although the legislation would set out the functions of the pool, those functions would not usually include acting as an insurer, since the pool is not a legal person. Of course, the legislation may establish a corporate body to act as manager of the pool, but not to write insurance contracts.

The legislation establishing the pool would usually provide the pool with exclusive rights in relation to the business underwritten by the pool. This is necessary to prevent nonpool insurers undermining the pool by offering similar insurance products at a lower, nonsustainable, price.

Statutory coinsurance pools sometimes operate as hybrids, with some limited reinsurance functions.

### Benefits of an Agricultural Insurance Pool

All coinsurance pools offer benefits but also have limitations. These are summarized in box 4.

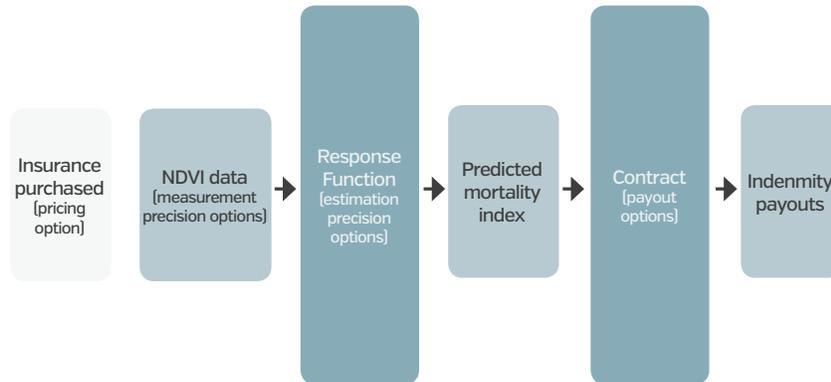
### International Precedents

If a Program Steering Committee is established to address the institutional framework for agricultural insurance, it could consider a number of precedents: (i) the Turkish Agricultural Insurance Pool (TARSIM); (ii) the Spanish Agricultural Insurance Pool (AGROSEGURO); and (iii) the proposed Mongolian Index-Based Livestock Reinsurance Company (which will have features of a pool and a reinsurance company).

The Turkish and Spanish pools are considered in more depth in the MALF report (GoK 2014a).

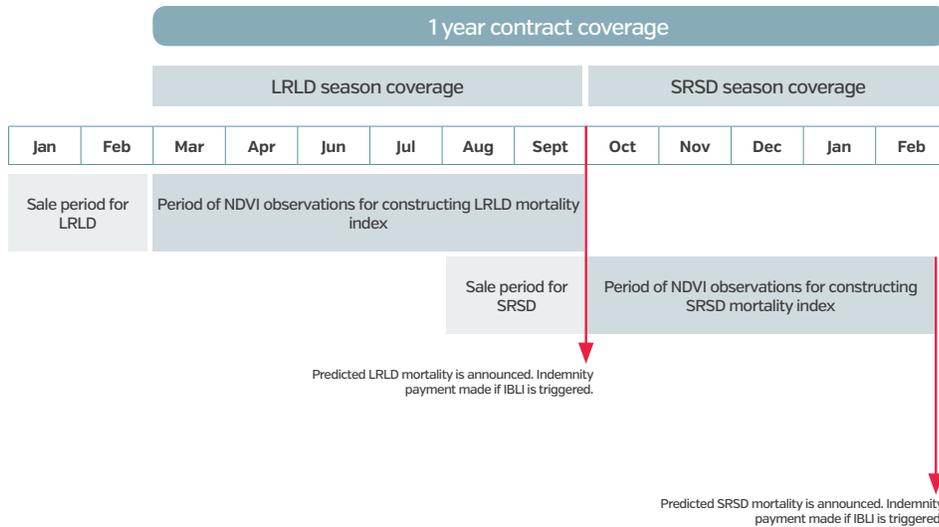
## Annex B.1. Index Based Livestock Insurance (IBLI) Program

**Figure 13** – Translating NDVI data into estimated livestock mortality and IBLI payouts



Source: ILRI 2014.

**Figure 14** – IBLI seasonal sales periods, contract cover period and contract payout dates



Source: ILRI 2013

Note: LRLD = long rain / long dry season; SRSD = short rain / short dry season.

**Table 11–** IBLI livestock insurance results, 2009-2012 (US\$)

Sales period	Year	No. contracts sold	No. Tropical Livestock Units insured (TLUs)	Total sum insured (TSI) (US\$)	Premium Paid by Herders (US\$)	Avg. no. insured TLUs per herder	Avg. sum insured TLUs per herder	Avg. premium rate (%)	Avg. premium per herder (US\$)
Jan/Feb	2010	1,974	5,965	1,118,437	46,602	3	187.5	4.2	23.6
Jan/Feb	2011	595	1,229	230,437	9,033	2.1	187.5	3.9	15.2
Aug/Sept	2011	509	836	158,750	6,122	1.6	187.5	3.9	12
Aug/Sept	2012	219	413	77,437	3,150	1.9	187.5	4.1	144
<i>Total</i>		<i>3,297</i>	<i>8,443</i>	<i>1,583,061</i>	<i>64,907</i>	<i>2.6</i>	<i>187.5</i>	<i>4.1</i>	<i>16.3</i>

Source: ILRI 2013

Note: Exchange rate: 1US\$ = 1 KShs 0.80.

## Annex B.2. Assumptions and Parameters for Fiscal Costing Scenarios for Livestock

### 1. Fiscal costing for the macro-level insurance coverage for asset protection

The fiscal costing scenarios for the macro-level Normalized Difference Vegetation Index (NDVI)-based insurance coverage for livestock asset protection have been developed in order to calculate the number of pastoralists covered on the basis of the budget references provided by the State Department of Livestock (SDL): K Sh 100 million, K Sh 200 million, and K Sh 300 million.

For each budget scenario, two extreme cases are presented (see table 12). Case A is structured by selecting, within a reasonable range of variation, the more costly extremes of the key parameters (i.e., higher values per tropical livestock unit [TLU] insured, a higher number of TLUs per policy, and a higher insurance premium estimate). This will define a lower bound for the number of pastoralists to be covered for the reference budget figure. Case B takes into account the less expensive options, thus identifying the higher bound of the number of

pastoralists to be covered on the basis of the given budget.

The parameters presented in table 12 are based on the following assumptions and considerations:

- **Sum insured per TLU:** Each TLU is valued at K Sh 7,000 in Case A, and at K Sh 5,000 in Case B. Values lower than K Sh 5,000 are not considered meaningful.
- **Number of TLUs insured per vulnerable pastoralist:** The number of eligible TLUs has been set at seven in Case A and at five in Case B. Five TLUs are considered the level below which insurance coverage would not provide useful support to pastoralists' livelihoods.
- **Sum insured per pastoralist:** The reference sum insured per pastoralist is obtained by multiplying the number of TLUs to be covered by the selected value of 1 TLU. The parameters selected in table 12 determine a range of sums insured between K Sh 49,000 (Case A) and K Sh 25,000 (Case B). The difference between the two extremes is significant because it highlights how the policy choices that go into selecting the relevant parameters influence the support provided to pastoralists.
- **Premium rate:** As the NDVI asset protection product is still in the design phase, actual

estimates for the potential premium rates of the program are not available. Hence, while the necessary elaborations are being carried out, the current average premium rates of the Index Based Livestock Insurance (IBLI) products are used. The IBLI scheme allows pastoralists to select between two trigger options. The average premium for the products with the lower trigger (hence the version that provides payouts more frequently) is 16.06 percent, while the average premium for the higher trigger option is 9.24 percent. Hence, approximating such figures, the premium rate for Case A has been set at 15 percent and the premium rate for Case B at 10 percent.

- **Premium per pastoralist:** The premium per pastoralist is obtained by applying the selected premium rate to the sum insured per pastoralist. The premium amount for Case A is set at K Sh 7,350 and for Case B at K Sh 2,500. Again, the spread between the two figures is quite significant, and this has relevant implications for the cost of the program.
  - **Cost of registration and enrollment per pastoralist:** The cost for registration and enrollment has been set at K Sh 500 for Case A and at K Sh 250 for Case B. The target pastoralists belong to the Hunger Safety Net Program framework, and they could therefore be registered automatically without generating any specific cost. However, the technical analysis presented in chapter 2 suggests that registration for households eligible for GoK subsidy should not be automatic but rather done in person. In-person registration helps to create a sustainable market for livestock insurance by ensuring that pastoralists understand the details of how the scheme operates. In addition, these activities could help spread awareness of the insurance product, which could both promote the purchase of the top-up option and encourage nontarget pastoralists to take up the insurance product.
  - **Cost of education and training:** The cost for education and training has been set at K Sh 5 million for Case A and at K Sh 4 million for Case B.
  - **Cost of payout distribution:** Given that the enrolled pastoralists will all be equipped with bank accounts, costs for distributing the payouts should be minimal (i.e., the cost of the bank transfer operation), and could be included in the costs budgeted by insurance companies. However, raising awareness about program payouts is important, so a lump sum of K Sh 2.0 million for Case A and of K Sh 1.5 million for Case B will likely be used for dedicated information campaigns on payout distribution.
  - **Cost of contract design and data processing:** Costs of K Sh 1 million have been assumed for handling NDVI data processing and monitoring the contract.
  - **Cost of auditing:** An auditing cost of 1 percent of the value of the program has been assumed.
- ## 2. Fiscal costing for the top-up and nontarget purchases
- As mentioned above, optional top-up coverage for pastoralists enrolled in the program will be made available in year 3 of program implementation. In addition, pastoralists who were not part of the initial support program will also have the option to purchase the NDVI-based insurance coverage as a nontarget group of pastoralists. The first layers of both the top-up option and the nontarget group coverage will be partially subsidized.
- The suggestion to make the top-up and nontarget group coverage available at year 3 of program implementation is motivated by the significant challenges to be faced when moving beyond a fully subsidized coverage scenario. In addition, because the NDVI-based asset protection scheme is still in the design phase, its performance will

**Table 12–** Fiscal costing projections for macro-level asset protection coverage

	Scenario: K Sh 100 million (US\$ 1.2 million)		Scenario: K Sh 200 million (US\$ 2.3 million)		Scenario: K Sh 300 million (US\$ 3.5 million)	
	Case A	Case B	Case A	Case B	Case A	Case B
Budget available for macro-level asset protection coverage [K Sh]	100,000	100,000	200,000	200,000	300,000	300,000
Sum Insured per Tropical Livestock Unit (TLU) [K Sh]	7,000	5,000	7,000	5,000	7,000	5,000
No. of TLUs insured per vulnerable pastoralist	7	5	7	5	7	5
Sum Insured per pastoralist [K Sh]	49,000	25,000	49,000	25,000	49,000	25,000
Premium Rate (as a share of sum insured)	15.00%	10.00%	15.00%	10.00%	15.00%	10.00%
Premium per pastorarist [K Sh]	7,350	2,500	7,350	2,500	7,350	2,500
Cost of registration and enrollment per pastoralist [K Sh]	500	250	500	250	500	250
Cost of education and training (lump sum) [K Sh]	5,000,000	4,000,000	5,000,000	4,000,000	5,000,000	4,000,000
Cost of payout distribution (lump sum) [K Sh]	2,000,000	1,500,000	2,000,000	1,500,000	2,000,000	1,500,000
Cost of contract design and data processing (lump sum) [K Sh]	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Cost of auditing (lump sum) [K Sh]	1,000,000	1,000,000	2,000,000	2,000,000	3,000,000	3,000,000
No of pastoralists eligible for livestock asset protection coverage	11,592	33,636	24,204	69,636	36,815	105,636

need to be carefully assessed before it is launched on a semicommercial basis. Thus it remains to be determined whether for these additional options the GoK may support the asset protection structure, the IBLI product, or both. However, for the purposes of this analysis, given that the values of selected parameters have been defined on the basis of the IBLI experience, the simulations would apply in any case.

The parameters presented in table 13 are based on the following assumptions and considerations:

#### Top-Up Option

- **Reference premium cost per pastoralist:** The reference premium cost per pastoralist has been obtained by assuming the average standard conditions developed for the macro-level coverage. Hence, the K Sh 3,125 value derives from a sum insured per TLU of K Sh 5,000, five additional TLUs to be covered, and a premium

rate of 12.5 percent (average of rates assumed for the macro asset protection).

- **Number of vulnerable pastoralists to purchase top-up option:** The assumed take-up progression for the top-up option starts with 1,000 policies in year 1 and reaches 10,000 policies after five years of implementation.
- **Premium volume:** The premium volume is obtained by multiplying the premium cost by the number of pastoralists purchasing the coverage.
- **Projected public premium support:** It is assumed that the government of Kenya (GoK) will cover 50 percent of the cost of the coverage.

#### Expansion to Nontarget Pastoralists

- **Sum insured per TLU:** In analogy with the top-up option, the value of a TLU is set at K Sh 5,000.

**Table 13–** Fiscal costing projections for top-up and nontarget pastoralists options

	2015	2016	2017	2018	2019
<i>Top-Up Option</i>					
Reference premium cost per pastoralist (K Sh)	3,125	3,125	3,125	3,125	3,125
No. of vulnerable pastoralists to purchase top-up option	3,000	3,250	5,500	7,750	10,000
Premium volume (K Sh)	3,125,000	10,156,250	17,187,500	24,218,750	31,250,000
Projected public premium support (%)	50%	50%	50%	50%	50%
Cost of public support for top-up option (K Sh)	1,562,500	5,078,125	8,593,750	12,109,375	15,625,000
<i>Expansion to non-target pastoralists</i>					
Sum insured per Technical Livestock Unit (TLU) (K Sh)	5,000	5,000	5,000	5,000	5,000
Maximum no. of eligible TLUs per pastoralist (K Sh)	10	10	10	10	10
Values of additional sum insured per pastoralist (K Sh)	50,000	50,000	50,000	50,000	50,000
Premium Rate (as a share of sum insured)	12.5%	12.5%	12.5%	12.5%	12.5%
Premium per pastoralist (K Sh)	6,250	6,250	6,250	6,250	6,250
No of non-target pastoralists to purchase coverage	1,000	2,000	3,000	4,000	5,000
Premium volume	6,250,000	12,500,000	18,750,000	25,000,000	31,250,000
Projected public premium support (%)	25%	25%	25%	25%	25%
Projected public premium support (K Sh)	1,562,500	3,125,000	4,687,500	6,250,000	7,812,500
Costs for implementation as a share of premium support (%)	200%	175%	150%	125%	100%
Costs for implementation (K Sh)	3,125,000	5,468,750	7,031,250	7,812,500	7,812,500
Cost of public support for non-target pastoralists (K Sh)	4,687,500	8,593,750	11,718,750	14,062,500	15,625,000
<b>Total cost for GoK (million K Sh)</b>	<b>6.3</b>	<b>13.7</b>	<b>20.3</b>	<b>26.2</b>	<b>31.3</b>
<b>Total cost for GoK (million USD at 85 K Sh/USD)</b>	<b>0.1</b>	<b>0.2</b>	<b>0.2</b>	<b>0.3</b>	<b>0.4</b>

- **Maximum number of eligible TLUs per pastoralist:** Pastoralists not belonging to the original target group will be able to purchase supported coverage for a maximum of 10 TLUs.
- **Value of additional sum insured per pastoralist:** The reference sum insured per

pastoralist is obtained by multiplying the number of TLUs to be covered by the selected value per TLU.

- **Premium rate:** Same as for top-up option.
- **Premium per pastoralist:** Same as for top-up option.

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- **Number of nontarget pastoralists to purchase coverage:** The assumed take-up progression for the nontarget group purchases starts with 1,000 policies and reaches 5,000 policies after five years of implementation.
- **Premium volume:** Same as for top-up option.
- **Projected public premium support:** It is assumed that the GoK will cover 25 percent of the cost of the coverage.
- **Projected public premium support:** The projected public premium support is obtained by applying the share of premium that will be supported by the GoK to the estimated premium volume.
- **Costs for implementation as a share of premium support:** Implementation costs refer to extension, marketing, capacity building, training, and infrastructure deployment. They are estimated by referring to the IBLI experience and to the parameters that International Livestock Research Institute (ILRI) researchers have developed for future projections.

The ratio of implementation costs to premium support cost is 5:2 in the short term, and nearly 1:1 in the medium term. These are the references that have been adopted for estimating these costs.

- **Costs for implementation:** The actual costs for implementation are obtained by applying the assumed percentage share to the projected premium support figures.
- **Cost of public support for nontarget pastoralists:** The cost is the sum of the projected premium support and the costs for implementation.

## Annex B.3. Summary of Modeling and Simulations of Welfare Analysis for Livestock

### A. A Dynamic Economic Model

#### 1. Household consumption and livestock accumulation:

Consider a dynamic model of a representative pastoral household, whose livelihood relies primarily on livestock production. At the end of each season  $t=LRLD,SRSD$  where *LRLD* refers to long rain-long dry season (March-September) and *SRSD* refers to short rain-short-dry season (October-February), this household earns and consumes from total income from milk production  $m(H_t)$  out of their own livestock  $H_t$  of which they can sell the milk at the on-going market price  $p_t^m m$ . The income available for consumption each period is thus  $p_t^m m(H_t)$ .

If milk production income is not enough for consumption, household can also consume out of their own herd by off-taking (sale or slaughter) some of their livestock at the ongoing market price  $p_t^h$ . Household can also use left over milk production income to invest more in its herd by buying livestock at the ongoing market price.

Household makes intertemporal decisions by choosing optimal consumption and herd investment each period to maximize their expected lifetime utility function, of which they draw welfare gain from consumption as well as livestock.<sup>44</sup> Let  $\beta$  represent the rate at which household discounts future. Let  $o_t$  represent the net livestock off-take (the number of herd sold and slaughtered netting out herd purchased) at the end of each season, we write household's intertemporal decision as

$$\max_{c_t} E \sum_{(t=0)}^{\infty} \beta^t u(c_t, H_t) \text{ subject to } c_t = p_t^m m(H_t) + p_t^h o_t$$

$$H_{(t+1)} = (1 + b_{t+1} - m_{t+1})(H_t - o_t)$$

At the end of each season, household herd—netting out net herd off-take—would be accumulated toward the next season herd. Herd can grow at natural biological birth rate  $b_{t+1}$  and is also subjected to mortality shock in that period  $m_{t+1}$ .

Droughts that could lead to catastrophic livestock mortality could thus affect household herd, which could have immediate effect on reducing current milk production income and longer-term effect on disrupting herd accumulation in the following periods.

## 2. Poverty trap and economically viable herd in arid and semi-arid land (ASAL) region

With limited productive nonlivestock livelihood options and the need for seasonal migration as adaptation to climate variability, pastoral households in the ASAL region consume a good portion out of their own herd each season (e.g., through direct slaughtering or off-taking for cash). This necessary consumption out of own herd each season tends to slow down and disrupt natural herd growth, especially for very small herds. Existing academic research (e.g., Lybbert et al. 2004; Barrett et al. 2006; Chantarat et al 2014) has thus identified the existence of a critical herd size of about 10–15 Tropical Livestock Units (TLUs), which is necessary for sustaining a viable herd accumulation in this region. Households with small herd sizes (below the critical threshold) thus tend to deplete their herds over time.

We stylize our model to replicate this empirical evidence and simplify household's dynamic problem by imposing a minimum subsistent consumption such that household's decision becomes

$$\max_{c_t} E \sum_{t=0}^{\infty} \beta^t u(H_t) \quad \text{subject to } c_t = p_t^m m(H_t) + p_t^h o_t$$

$$H_{(t+1)} = (1 + b_{t+1} - m_{t+1})(H_t - o_t)$$

$$c_t \geq \bar{c}, H_t \geq 0.$$

So each period a household will try to first meet subsistent consumption  $\bar{c}$  by drawing out of own

herd (e.g., selling off herd for consumption or slaughtering herd), then it will try to accumulate livestock to maximize its herd size.

The optimal herd off-take each season can thus be written as 
$$o_t = \frac{\bar{c} - p_t^m m(H_t)}{p_t^h}$$

And the optimal herd accumulation dynamic is thus

$$H_{t+1} = (1 + b_{t+1} - m_{t+1})(H_t - \left( \frac{\bar{c} - p_t^m m(H_t)}{p_t^h} \right))$$

Those with small herd will meet by off-taking out of own herd at the rate faster than the net herd growth. Their herd thus tends to decline—instead of grow—over time. The herd accumulation dynamic above could thus imply the existence of an economically viable herd  $H^*$  necessary to sustain seasonal herd growth each period:

$$E \left( \frac{dH_{t+1}}{dH_t} \right) \geq 0 \quad \text{if } H_t \geq H^*$$

$$< 0 \quad \text{if } H_t < H^*$$

Furthermore, as poor households tend to be credit constrained, they have difficulty restocking their herds up to the economically viable and sustainable levels. So while we should expect household with  $H_t \geq H^*$  to grow herd over time, those with  $H_t < H^*$  will unavoidably decumulate herd over time and tend to be trapped in small herd size and low consumption—the poverty trap researchers found in this vulnerable pastoral region.

## 3. Risk

Livestock rearing in this region is prone to various shocks leading to mortality  $m_t$ . Livestock mortality could be caused by idiosyncratic factors (e.g., disease, sickness, accidents) as well as covariate catastrophic droughts. With the presence of viable herd, mortality rate that leads to herd collapse below  $H^*$  could have the long-term consequence of trapping households in the irreversible collapsing herd dynamic, instead of the growing one without shock.

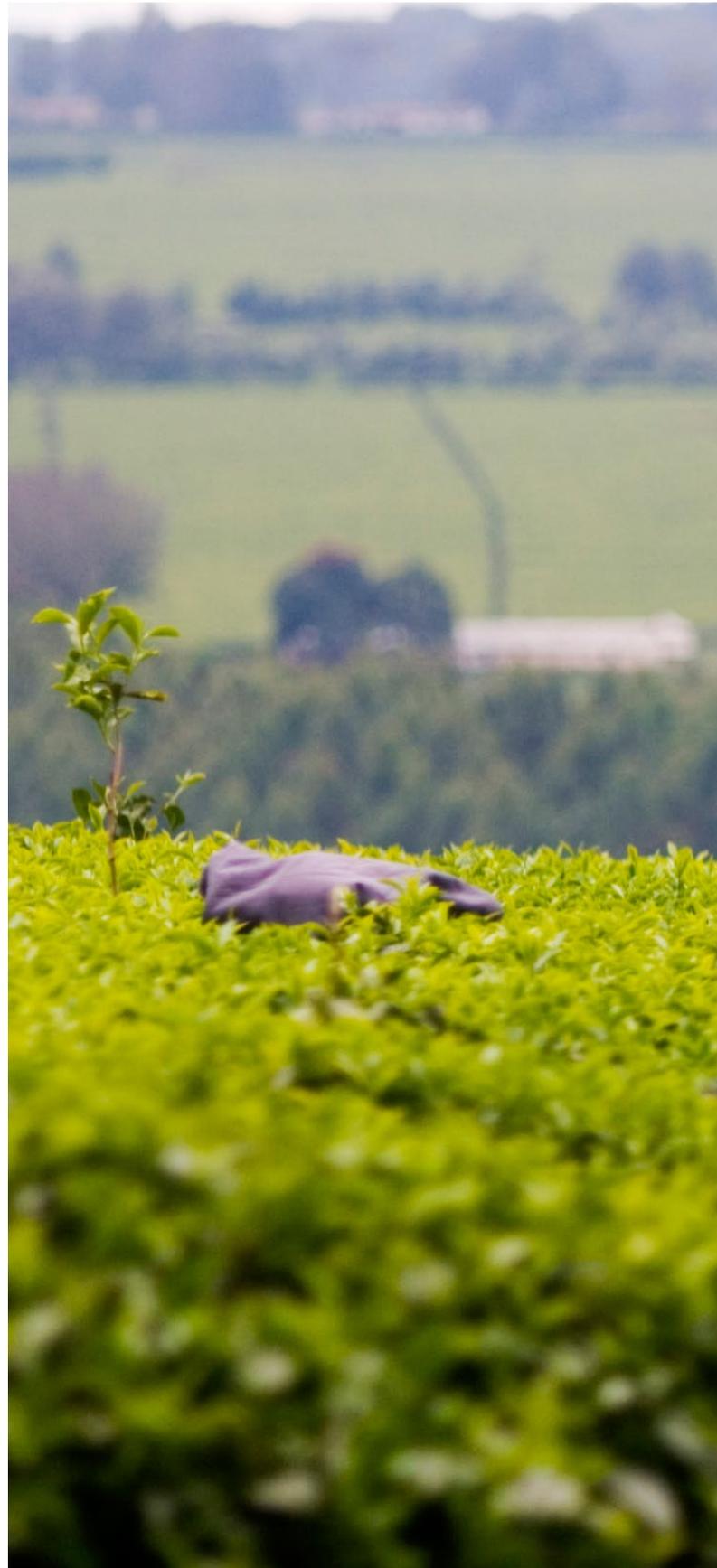
Normalized Difference Vegetation Index (NDVI) has been used to monitor the onset and intensity of droughts in the region. The International Livestock Research Institute (ILRI) has used NDVI series observed throughout each season in a particular division to try to quantify through spatial econometric technique the potential livestock losses due to drought in each season in that division.<sup>45</sup> The constructed 'NDVI-based predicted division-averaged livestock mortality'  $m(NDVI_t)$  for each division in each season thus reflects the division-averaged livestock mortality due to drought. As widespread droughts have been one of the key causes of livestock mortality in this region, we should expect individual livestock mortality experience  $m_t$  to move together with  $m(NDVI_t)$ .

In order to understand this empirical relationship, we describe joint distribution of individual herd mortality  $m_t$  and the predicted division-average livestock mortality due to drought  $m(NDVI_t)$  with a bivariate truncated normal distribution

$$f(m_t, m(NDVI_t)) \sim N(\mu_{m_t}, \mu_{m(NDVI_t)}, \sigma_{m_t}, \sigma_{m(NDVI_t)}, r(m_t, m(NDVI_t))),$$

where  $\mu_{m_t}, \mu_{m(NDVI_t)}$  represent long-term average levels of individual herd mortality and predicted drought-related division-averaged livestock mortality rates,  $\sigma_{m_t}, \sigma_{m(NDVI_t)}$  describe long-term standard deviations of the two mortality series, and  $r(m_t, m(NDVI_t))$  represents correlations of the two series observed in the empirical data. In the areas with large exposure to droughts, we should expect individual herd mortality to move together with the drought-related division mortality and thus  $r(m_t, m(NDVI_t)) \rightarrow 1$ .

Livestock prices are also uncertain. During droughts that could cause large livestock mortality, animals tend to be weak, and together with lower demand in the local market this could cause livestock price to drop. We thus describe a joint relationship among  $p_t^m, m_t, m(NDVI_t)$  in a joint multivariate normal distribution with a correlation matrix capturing meaningful correlations of these three series.



While milk prices could also be uncertain, we observe relatively stable prices across different seasons in each area. We thus assume that they are deterministic at their mean level.

#### 4. NDVI index based livestock insurance

Using objectively measured NDVI data to trigger insurance payout, NDVI-based livestock insurance for the Hunger Safety Net Program (HSNP) counties could be of two forms:

- (i) **An asset replacement insurance.** This form aims to compensate insured household for livestock losses by making payout at the end of each season if  $m(NDVI_t)$  is above a predetermined strike level  $m^*$ . Thus the seasonal indemnity payout per insured TLU is  $\pi^r = \max[m(NDVI_t) - m^*, 0] \times p$  where  $p$  is a replacement cost per TLU. The product was already designed by ILRI and has been on sale in two of the four HSNP counties.
- (ii) **An asset protection insurance.** This form aims to provide timely cash to allow insured household to engage in actions (e.g., purchase forage supplement or water, or migrate to better forage/water sources) to save its livestock from the slow-onset drought. It makes payout as early as possible at the end of every month in the coverage season when monthly NDVI falls below a predetermined strike level  $NDVI^*$ . The seasonal payout is thus the sum of the monthly payout

$$H_{t+1} = (1 + b_{t+1} - m_{t+1}) \left( H_t - \left( \frac{c + \rho^p H^p - p_t^m m(H_t)}{p_t^h} \right) \right) + \delta(\pi^p) H^p$$

where  $exit$  is the minimum level of NDVI that will allow insured household to receive 100% payout each month and  $c$  represents the cost to keep animal alive each month.

Actuarial fair premium per insured TLU for these contracts is equal to the expected indemnity payout. Insurance company will however add some premium multiple  $x > 1$  to the commercial premium to cover

other fixed administrative costs. Total premium per insured TLU is

$$\rho^i = xE(\pi^p) \text{ where } i = r, p.$$

As household needs to increase herd off-take to pay for insurance premium when the cost is beyond the milk production income, we can write the optimal herd accumulation dynamics with asset protection insurance insuring  $H^p$  unit of herd as

$$\pi^p = \sum_{met} \max \left[ \frac{NDVI^* - NDVI_m}{NDVI^* - exit}, 0 \right] \times c,$$

where  $(\pi^p)H^p$  reflects the amount of insured herd that household could save using asset protection's early indemnity payout. Thus  $(\pi^p)$  reflects the effectiveness of early intervention, made possible through early indemnity payout  $\pi^p$  in keeping the insured herd that survived from drought-related mortality.

If  $(\pi^p) = m(NDVI_t)$ , early intervention would be very effective in keeping all the insured herd that survived from drought-induced mortality. If  $(\pi^p) = \max[m(NDVI_t) - m^*, 0]$ , asset protection contract would thus make equivalent payout to the comparable asset replacement contract. And if this effective early intervention can be achieved with comparable payout frequency and intensity, asset protection insurance would be cheaper and so more cost effective than the asset replacement counterpart.

*Basis risk:* Note that both forms of livestock insurance are written NDVI not actual mortality rate. Basis risk – when indemnity payment deviates from or could not allow household to save their individual herd losses – would exist. The value to farmers will thus depend on the how closely individual herd mortality tracks that of  $m(NDVI_t)$  especially for the case of asset replacement and so insurance will be valuable to pastoral household as  $r(m, m(NDVI_t)) \rightarrow 1$ .

#### 5. Public supports

We assume that public support could result in  $s\%$  reduction in insurance premium rate (the free provision of macro-level asset protection will have

s=100%) and will cover up to a prespecified herd size. Total public cost per household i is thus

$$S = s\rho H_i$$

**B. Calibrating Economic Model with Actual Data**

**Livestock production**

1. Sublocation and division seasonal livestock mortality (%) and livestock price

$$f(m_i, m(NDVI_i), p_i^m) \sim N(\mu_{m_i}, \mu_{m(NDVI_i)}, \sigma_{m_i}, \sigma_{m(NDVI_i)}, \sigma_{p_i^m}, r)$$

- Sublocation mortality  $m_i$ :  $\mu=0.11, \sigma=0.15$
- NDVI-predicted division averaged livestock mortality  $m(NDVI_i)$ :  $\mu=0.11, \sigma=0.13$
- Division averaged TLU price (K Sh):  $\mu=19,843, \sigma=5,981$
- Common correlation matrices for the three variables

	Sublocation	Division	Livestock Price
Sublocation	1		
Division	0.5	1	
Livestock Price	-0.4	-0.2	1

Our analysis was done on a representative pastoral household at the sublocation level with the assumption that perfect risk sharing exist at this level. Sublocation average yields were thus used to represent mortality of our representative household.

Long-term mean and standard deviation of the NDVI-predicted division averaged livestock mortality were obtained from ILRI’s constructed mortality indexes, which IRLI used to underwrite its asset replacement contract. The series were constructed for each and every division in the four HSNP counties from 1982-2013. Long-term mean and standard deviation of the subdistrict-averaged seasonal mortality rates and division

averaged livestock prices were obtained from 2005-2012 household survey data collected by Arid Land Resource Management Project (ALRMP) in all four counties.

2. Milk price (K Sh/liter):  $p_i^m = 49$   
Mean inflation adjusted milk price obtained from 1999-2012 ALRMP household survey data in all four counties.
3. Milk production (liter/season):  $m(H_i) = \% \text{ milking animal} \times \text{averaged milk produced /TLU/ day} \times 180 \times \text{TLU} = 0.28 \times 1 \times 180 \times \text{TLU}$   
Parameters obtained from ILRI’s index-based livestock insurance impact evaluation household survey in Marsabit, 2009-2012.
4. Natural herd growth rate (% per season):  $b_i = 0.2$   
Obtained from ILRI’s index-based livestock insurance impact evaluation household survey in Marsabit, 2009-2012.
5. Herd distribution (TLU):  $H_i$  obtained from HSNP impact evaluation household survey 2009-2012 in all the four counties.

**NDVI index based livestock insurance**

6. Index: Our analysis considered the impact of asset replacement that triggers monthly payout based on monthly NDVI. Since the actual design of monthly trigger is still in progress, we assume that this asset protection contract triggers payout based on ILRI’s predicted livestock mortality index
7. Coverage level: When predicted livestock mortality index is above 15% similar to ILRI’s product
8. Sum insured (K Sh/TLU/season):  $c=4500$   
Drawing on discussion with some officials at the Ministry of Agriculture, Livestock and Fisheries and based on the recent droughts experience in Wajir, Taita and Laikipia, we estimate that it would cost 25 K Shs per day to keep 1 TLU alive during drought.

9. Pure premium rate = 9% per year
10. Premium multiple (% of fair rate):  $x=200\%$   
This is a common rule of thumb in the industry
11. Effectiveness of asset protection in reducing livestock mortality:  $\pi^i = \max[m(NDVI_t) - 15\%, 0]$   
We assume that monthly insurance payouts could allow for effective early interventions, which would enable the insured pastoralist to perfectly avert all the predicted drought-related mortality beyond 15% of insured livestock.
12. Minimum subsistent consumption:  $c$  is assumed at 30% of annual food poverty line of a representative farming household with 4.7 adult equivalent members (according to the HSNP household survey data) calculated at national food poverty line of rural regions at K Shs 988 per month per adult equivalent.
13. Government supports represented as premium reduction (%):  $s=100\%, 50\%, 25\%$

means, standard deviations and correlation matrices obtained above.

3. For each simulated year in each replicate, we estimated key outcome variables for four levels of starting herd sizes: 5 TLUs, 10 TLUs, 20 TLUs, and 40 TLUs.
4. Finally, we calibrated our economic model using empirical data and estimated 100 replicates of 100-year series of key outcome variables of the representative households in the scenarios with and without insurance and across government supports.

### C. Simulations

We took the following steps to simulate key outcome indicators:

1. In order to describe the joint distributions of the seasonal sublocation-averaged livestock mortality rates, NDVI predicted division averaged livestock mortality rates and division average TLU prices, we first computed their long-term means, standard deviations and correlation matrices of the deviation of mortality rates from their location-specific long-term means. These statistics were calculated using variations over the 16 seasons from 2005 to 2012, when ALRMP and ILRI's index overlap.
2. We then simulated, 100 replicates of 100 years series of these three levels of area yields assuming that their joint distribution follows 3-variable truncated multivariate normal distribution with

**Table 14–** Summary statistics of pastoral households in four HSNP counties

Socioeconomics *	Mean	SD	Mandera	Marsabit	Turkana	Wajir
Household member [adult equivalent]	4.7	1.8	4.7	4.5	4.5	5.275697
Monthly consumption expenditure/adult eq.	1746	789	2133	1363	1346	2202
Poverty headcount [2005 National poverty line]	47%		18%	72%	73%	20%
% with seasonal food shortage	60%		33%	45%	78%	71%
% receiving food aid	71%		69%	91%	51%	72%
<i>Main Source of Income</i>						
Livestock production [rearing, sale of livestock/ product]	47%		41%	54%	41%	53%
Casual Labor	17%		29%	18%	3%	19%
Employment/Salary	2%		4%	3%	0%	1%
Business and trade	6%		3%	4%	7%	8%
Petty trade	18%		12%	5%	42%	13%
Remittances and gifts	8%		9%	14%	4%	5%
<i>Statistics by income quartile</i>			<i>Q1</i>	<i>Q2</i>	<i>Q3</i>	<i>Q4</i>
% households who own livestock	89%		78%	89%	96%	93%
% engage in livestock production	51%		61%	59%	54%	31%
% share of livestock in total economic income	68%		63%	67%	74%	68%
Mean number of livestock owned by household [TLU]	10.5	14.9	5.1	9.0	11.4	14.8
<i>Livestock production **</i>						
<i>Mean</i>						
Herd size	10.4	14.9	11.5	11.7	9.0	11.6
<i>Herd composition</i>						
% Cattle	23%	19%	33%	36%	14%	42%
% Camel	18%	0%	44%	36%	30%	43%
% Smallstock	15%	0%	44%	28%	56%	15%
% Milking animal	28%	18%				
<i>Livestock mortality and price statistics</i>						
<i>Sub-location TLU mortality [%]</i>						
	0.15	0.18	0.18	0.09	0.14	0.12
S.D.			0.20	0.13	0.14	0.17
<i>Division NDVI-predicted TLU mortality [%]</i>						
	0.15	0.11	0.20	0.10	0.18	0.11
S.D.			0.09	0.14	0.08	0.11
<i>Division averaged TLU price [KSh/TLU]</i>						
	19,844	5,981	18,075	20,412	19,129	24,448
<i>Division averaged milk price [KSh/liter]</i>						
	49	17	51	56	48	45

\* From Hunger Safety Net Programme (HSNP) Impact Evaluation 2009-2012 panel household survey in 4 counties.

\*\*From Arid Land Resource Management Project (ALRMP) Monthly Drought Monitoring Survey 1999-2012 in 4 counties

Milk and livestock prices are inflation adjusted using 2013 as base year

## Annex C.1. Assumptions and Parameters for Fiscal Costing Scenarios for Crops

The fiscal analysis presented in section 3.3 is based on annual production data for maize and wheat at the district level provided by the State Department of Agriculture. The administrative classification refers to the 73 “pre-2012” districts (see table 15 for the list of districts). In such a data set the number of observations per district is quite heterogeneous, and there are many gaps. For maize, complete series ranging from 1983 to 2012 are available for only 50 percent of the districts; in the remaining 50 percent of districts the series are shorter (as few as six observations in some instances). However, for 15 districts—accounting for over 50 percent of the maize cultivated area—the time series are acceptably long and start at the latest in the mid-1990s. One significant limitation of the maize data set is that it is composed of annual yield values, which make accounting for yield variability in the biannual production areas impossible. While this limitation would be more problematic in a potential implementation phase, from a fiscal analysis perspective the data can still provide the basis for initial rough operational estimates of the fiscal costs.

The data for wheat also shows many gaps; unfortunately, data are missing for 2008 and 2009, which were critical years for wheat production (2009 in particular). The presence of these gaps in recent and sensitive years has a significant impact on the quality of the simulations. The wheat data set is smaller than the maize data set, as 95 percent of cultivated area is concentrated in five districts only (Meru Central, Laikipia, Narok, Nakuru, and Uasin Gishu). Given that wheat production in other districts is sparse and of low quality, the analysis has focused only on the five main production districts (see table 16).

Both the maize and wheat series presented data reporting issues (e.g., confusions between metric tons, kilograms, and bags), so data were revised and corrected when compiling mistakes were evident.

The assumptions adopted in the analysis are the following:

- The reference figures for cultivated area are equivalent to the average of the latest five years available. For yields, reference is made to the average yield recorded in the period 2008–2012 for maize, and in the period 2011–2012 for wheat (data for the 2008–2010 wheat campaigns were mostly not available).
- Yield data have been detrended with respect to a trend reference composed of an average of linear, exponential, and moving average trends.
- The price at which maize and wheat production have been valued is K Sh 34/kg for maize and K Sh 46/kg for wheat.
- The coverage level was set at 80 percent.
- Progressively increasing insurance take-up has been projected, with a rate of 3 percent assumed at the beginning of the program in 2016, and rates of 15 percent for maize and 25 percent for wheat reached by 2023.
- The number of farmers involved in the program has been estimated by dividing the projected cultivated area by the median farm size, respectively 1.5 ha for maize and 3.0 ha for wheat. The reason for selecting the median, and not the average, is linked to the possible introduction of caps in the number of hectares per farm insured under the supported program. In addition, for maize, the biannual production pattern in 75 percent of cultivated area has been accounted for by dividing the estimated number of farmers by 1.6, also considering that in the biannual production regions cultivated area may be lower in the less favorable season.

**Table 15–** Yield, Area, and Premium Rate Data for Maize

	Province	District	Yield (kg/ha) Avg '08-'12	Cultivated Area (ha) Avg '08-'12	Pure Risk Premium Rate x District	Capped Insurance Premium Rate x District
1	Central	Thika	N.A.	N.A.	N.A.	N.A.
2	Central	Kiambu East	1,442	4,778	6.6%	13.2%
3	Central	Kiambu West	N.A.	N.A.	N.A.	N.A.
4	Central	Kirinyaga	1,108	20,671	8.4%	15.0%
5	Central	Murang'a North	697	19,508	10.8%	15.0%
6	Central	Murang'a South	1,443	30,085	8.6%	15.0%
7	Central	Nyandarua North	2,038	8,892	6.3%	12.6%
8	Central	Nyandarua South	2,152	2,171	1.8%	3.5%
9	Central	Nyeri South	741	13,332	7.5%	14.9%
10	Central	Nyeri North	N.A.	N.A.	N.A.	N.A.
11	Coast	Taita Taveta	880	16,599	12.8%	15.0%
12	Coast	Kwale	1,265	45,120	5.5%	10.9%
13	Coast	T/River	1,484	8,893	6.7%	13.5%
14	Coast	Mombasa	777	1,264	8.5%	15.0%
15	Coast	Lamu	1,890	18,065	6.1%	12.2%
16	Coast	Malindi	970	15,853	4.8%	9.5%
17	Coast	Kilifi	885	52,811	4.9%	9.9%
18	Eastern	Embu	1,390	19,722	6.4%	12.8%
19	Eastern	Isiolo	543	736	1.8%	3.5%
20	Eastern	Kitui	700	43,463	14.9%	15.0%
21	Eastern	Machakos	713	140,485	15.6%	15.0%
22	Eastern	Makueni	640	95,984	12.0%	15.0%
23	Eastern	Marsabit	N.A.	N.A.	N.A.	N.A.
24	Eastern	Mbeere	709	26,326	3.1%	6.2%
25	Eastern	Meru central	1,739	37,104	10.0%	15.0%
26	Eastern	Meru North	1,519	59,291	4.7%	9.3%
27	Eastern	Meru South	1,405	15,262	7.8%	15.0%
28	Eastern	Moyale	299	456	1.8%	3.5%
29	Eastern	Mwingi	514	37,160	15.1%	15.0%
30	Eastern	Tharaka	1,135	12,033	10.7%	15.0%
31	North Eastern	Ijara	128	145	1.8%	3.5%
32	North Eastern	Garrisa	580	356	1.8%	3.5%
33	North Eastern	Wajir	222	785	1.8%	3.5%
34	North Eastern	Mandera	329	1,385	18.9%	15.0%
35	Nairobi	Nairobi	N.A.	N.A.	N.A.	N.A.

**Table 15–** Yield, Area, and Premium Rate Data for Maize [continued]

	Province	District	Yield [kg/ha] Avg '08-'12	Cultivated Area [ha] Avg '08-'12	Pure Risk Premium Rate x District	Capped Insurance Premium Rate x District
36	Nyanza	Bondo	1,134	19,921	13.5%	15.0%
37	Nyanza	Gucha	2,240	17,894	4.4%	8.7%
38	Nyanza	H/Bay	1,429	41,438	1.8%	3.5%
39	Nyanza	Kisii	2,258	37,678	1.8%	3.5%
40	Nyanza	Kisumu	1,394	18,140	1.9%	3.8%
41	Nyanza	Kuria	2,277	13,533	2.9%	5.9%
42	Nyanza	Migori	1,515	56,209	1.8%	3.5%
43	Nyanza	Nyamira	2,019	61,632	1.8%	3.5%
44	Nyanza	Nyando	1,502	9,243	1.8%	3.5%
45	Nyanza	Rachuoyo	1,432	15,220	1.8%	3.5%
46	Nyanza	Siaya	1,316	35,740	3.0%	6.0%
47	Nyanza	Suba	1,263	7,569	2.2%	4.3%
48	Rift Valley	Baringo	1,848	18,593	7.4%	14.7%
49	Rift Valley	Bomet	1,938	34,234	8.4%	15.0%
50	Rift Valley	Bureti	2,288	16,164	1.8%	3.5%
51	Rift Valley	Kajiado	1,819	16,173	8.4%	15.0%
52	Rift Valley	Keiyo Marakwet	1,696	39,364	9.4%	15.0%
53	Rift Valley	Kericho	2,730	28,775	1.8%	3.5%
54	Rift Valley	Koibatek	1,748	10,021	4.0%	8.1%
55	Rift Valley	Laikipia	2,068	31,902	4.3%	8.6%
56	Rift Valley	Marakwet	2,829	17,592	2.8%	5.5%
57	Rift Valley	Nakuru	2,183	71,375	9.9%	15.0%
58	Rift Valley	Nandi	2,768	77,603	1.8%	3.5%
59	Rift Valley	Narok	1,849	38,884	12.3%	15.0%
60	Rift Valley	Samburu	1,649	795	1.8%	3.5%
61	Rift Valley	T/Mara	3,070	60,325	4.8%	9.5%
62	Rift Valley	T/Nzoia	3,829	101,272	5.3%	10.6%
63	Rift Valley	Turkana	1,319	1,631	3.7%	7.3%
64	Rift Valley	U/Gishu	3,588	86,650	1.8%	3.5%
65	Rift Valley	W/Pokot	2,068	23,416	4.7%	9.4%
66	Western	Bungoma	2,529	79,872	1.8%	3.5%
67	Western	Busia	1,219	30,416	1.8%	3.5%
68	Western	Butere	1,899	4,366	1.8%	3.5%
69	Western	Kakamenga	2,026	50,140	2.3%	4.5%
70	Western	Lugari	2,921	19,359	1.8%	3.5%
71	Western	Mt. Elgon	2,969	15,718	2.6%	5.2%
72	Western	Teso	1,255	7,930	1.8%	3.5%
73	Western	Vihiga	1,217	33,513	3.1%	6.3%

**Table 16–** Yield, Area, and Premium Rate Data for Wheat

Province	District	Yield [kg/ha] Avg last available 5 years	Cultivated Area [ha] Avg '11-'12	Pure Premium Rate x District	Capped Insurance Premium Rate x District
Eastern	Meru central	2,264	16,078	12%	15%
Rift Valley	Laikipia	2,178	5,468	3%	5%
Rift Valley	Nakuru	2,850	26,111	6%	11%
Rift Valley	Narok	2,681	49,982	10%	15%
Rift Valley	U/Gishu	2,703	29,668	2%	3%

As mentioned in section 3.3, the fiscal scenarios include the provision of public support for additional data collection activities that should complement the government of Kenya procedures for estimating production and area data operated at county level. Although many different arrangements can be envisioned, including the possibility of outsourcing some functions to the private sector, the present analysis assumes that the additional crop-cutting experiments (CCEs) required would be carried out by the public extension service.<sup>46</sup> Hence, in terms of costing, the government of Kenya will cover expenses for equipment, labor, management, and auditing. The calculations that lead to the estimation of the supplementary data collection costs are presented in table 17. For simplicity, reference is made to an area of 10km x 10km (10,000 hectares), for which a hypothetical number of 10 additional CCEs would be foreseen. It is estimated that a team of two people can carry out four CCEs per day, and that a man-day salary for such an activity could be set at K Sh 2,500. The cost of the supplementary CCE activity is obviously a function of the area to be covered. In the beginning the CCEs can be carried out in the areas where the AYII programs are piloted; but if the programs are to expand significantly, all the areas should be surveyed and yield databases developed for them. This is why, despite the fact that the projected penetration of AYII in 2022 is 15 percent for maize and 25 percent for wheat, the area covered

by the extra CCEs should be 100 percent. In order to account for equipment, management, and auditing costs, an approximated overhead of 50 percent has been added to the cost of carrying out the CCEs.

## Annex C.2. Summary of Modeling and Simulations of Welfare Analysis for Crops

### A. A Simple Economic Model

#### 1. Crop production

Consider a one period model in key crop regions with many farmers. Each period, farmers' crop production yields  $y_i$  kilograms per hectare of land and can enjoy total income of  $y_i p_i$  K Shs per hectare of cultivated land, where  $y_i$  is the crop price per kilogram.

At the beginning of each season, farmers are credit constrained and so needs to take out loan  $L$  K Shs to purchase inputs (e.g., seeds and fertilizer). Farmers then pay back the loan at the end of the harvest with crop income.

#### 2. Risk

Both crop price and yield are uncertain. Crop price  $p_i$  is assumed to follow a uniform distribution,  $U(p_i, p_h)$ . Crop production also faces various kinds of risk including both farm-specific risk (e.g., disease

or illness of farm labor) and covariate risk (e.g., droughts and floods that tend to affect all farmers in the area). With the presence of common covariate shocks, we should thus expect individual crop yields to track average yields in their area to some extent.

In order to understand this empirical relationship, we describe joint distribution of individual yield  $y_i$  and the average yield across all farmers in the area  $\bar{y}$  with a bivariate normal distribution as

$$f(y_i, \bar{y}) \sim N(\mu_{y_i}, \mu_{\bar{y}}, \sigma_{y_i}, \sigma_{\bar{y}}, r_{y_i, \bar{y}})$$

where  $\mu_{y_i}, \mu_{\bar{y}}$  represent long-term average levels of individual and area-averaged crop yields,  $\sigma_{y_i}, \sigma_{\bar{y}}$  describe long-term standard deviations of the two yield series and  $r_{y_i, \bar{y}}$  represents correlations of the two series observed in the empirical data. In the areas with large exposure to common covariate shocks, we should expect individual yields to move together with the area-averaged yield and thus

$r_{y_i, \bar{y}} \rightarrow 1$ . On the other hand, when farm-specific shocks dominate the covariate ones,  $r_{y_i, \bar{y}}$  will deviate largely from one.

### 3. Area yield index insurance (AYII)

The contract is designed to protect farmers from covariate shocks that could affect all farmers in the area and that are not effectively managed by existing ‘mutual risk sharing mechanisms’ within the community. Specifically, AYII compensates insured farmer at an expected crop price  $p$  per kilogram when area averaged yield  $\bar{y}$  falls below a prespecified coverage level  $y^*$ . Indemnity payout per insured hectare can thus be written as

$$\pi = \max[0, y^* - \bar{y}] \times p$$

where the coverage level is set as some percentage of the expected area yield, i.e.  $y^* = \text{coverage} \times \mu_{\bar{y}}$ .

Actuarial fair premium per insured hectare for this contract is equal to the expected indemnity payout. Insurance company will however add some premium multiple  $x > 1$  to the commercial premium to cover other fixed, administrative costs. Total premium per insured hectare can be written as

$$\rho = xE(\pi)$$

With AYII offering protection of income shortfall from area yield variability, farmer’s insured crop income per hectare can thus be  $y_i p_i + \pi - \rho$ .

*Basis risk:* Note that insurance is written on area yield, not individual yield. While this resolves

**Table 17–** Estimation of potential cost of additional data collection activities for AYII

No of hectares in an area of 10km x 10km	10,000
Number of CCs per 10km x 10km area	10
Number of people on a CC team	2
Number of CCs carried out in a day by a CC team	4
Number of man-days needed to cover each 10,000 ha	5
Man-day cost in KSh	2500
Cost of labor in KSh for each 10,000 ha	12500
Maize: Reference total cultivated area	127,306
Wheat: Reference total cultivated area	127,306

	2016	2017	2018	2019	2020	2021	2022	2023
Share of area covered by additional CCs	5%	15%	30%	45%	60%	75%	90%	100%
Overhead for equipment, management, auditing, etc.	50%	50%	50%	50%	50%	50%	50%	50%
Maize: Additional costs of yield data collection (million KSh)	0.192	0.577	1.153	1.730	2.307	2.884	3.460	3.845
Wheat: Additional costs of yield data collection (million KSh)	0.012	0.036	0.072	0.107	0.143	0.179	0.215	0.239

asymmetric information and reduces transaction cost, it also could limit the value of insurance to individual farmers because of basis risk, which occurs when indemnity payment deviates from individual losses. The value to farmers will thus depend on the how closely individual yields track that of area average. AYII will be valuable to farmer as  $r_{y_i,y} > 1$ .

#### 4. Loan repayment

Input credit is obtained at the interest rate  $r$ . If farmers always pay back their loans using crop income as much as possible, then net income available for consumption for farmer  $i$  who cultivates a median farm size  $A_i$  hectares of maize will be

$$C_i = (y_i p_i + \pi - \rho - (1+r)L) \times A_i$$

Loan default is however possible and can be partial or total. While full repayment is an option, we more realistically assume that farmer will try to payback their loan as much as they can after meeting their subsistent consumption  $c$  (set at 30% of food poverty line).<sup>47</sup>

Farmer  $i$ 's loan repayment will be

$$LR_i = \max [(1+r)L, y_i p_i + \pi - \rho - c] \times A_i$$

#### 5. Public supports

We assume that public support could result in  $s\%$  reduction in insurance premium rate and will cover the whole cultivated farm of representative farmer. Total public cost per farmer  $i$  is thus

$$S = s\rho A_i$$

Cost-benefit analysis of public support to agricultural insurance program assumed that in the very first years, development of insurance program would be possible only with public support and that one of the program's key policy objectives was to reduce poverty among smallholder farmers. We then computed K Sh cost per farming household per year that could

reduce poverty rate by 1% (based on national food poverty line, 2005) relative to the baseline without the program in these production zones. Direct cash transfer program to the poor was further used as counterfactual program for cost-benefit analysis. The K Sh cost per farming household per year that can reduce poverty rate by 1% was computed as (poverty gap x poverty line)/poverty rate.

#### 6. Values of AYII

- **Value to farmers** AYII reduces vulnerability by providing buffer against sharp drop of net crop income available for consumption in the event of severe shocks
- **Value to lenders:** Based on our assumption that farmers will try to pay back loan after meeting required consumption, AYII thus will increase loan repayment rate on average. To make this assumption more realistic, lenders can make insurance a prerequisite for obtaining loan and/or link insurance with loan directly. With increasing loan repayment, lenders could eventually be willing to extend more credit to farmers.
- **Potential crowding in value of AYII through credit market:** In the medium term, insurance could enhance agricultural productivity by promoting smallholder farmers' adoption of productive inputs (e.g., new technology, hybrid seeds). This could be true when AYII relaxes demand-side constraint (i.e., enhancing farmer's investment incentives and credit demand when agricultural production is derisked) as well as supply-side constraint (i.e., allowing lenders to increase credit supply to farmers). Farmer  $i$ 's net income available for consumption when AYII unlocks access to credit allowing him to afford more expensive but productive input with yield markup  $\alpha_y > 1$  per hectare and higher cost (and larger loan size) relative to the current required level with mark up of  $\alpha_L > 1$ :

$$C_i^h = (\alpha_y (y_i p_i + \pi - \rho) - \alpha_L (1+r)L) \times A_i$$

## B. Calibrating Economic Model with Actual Data

### Crop production

1. Sublocation, division and district yield (kg/ha):

$$f(y_i, y) f(y_i, \bar{y}) \sim N(\mu_{y_i}, \mu_{\bar{y}}, \sigma_{y_i}, \sigma_{\bar{y}}, r_{y_i, \bar{y}})$$

$$\text{with } \mu_{\text{subl}} = \mu_{\text{div}} = \mu_{\text{dist}} = \mu \text{ and } \sigma_{\text{subl}} = \sigma_{\text{div}} = \sigma_{\text{dist}} = \sigma$$

- Low-potential maize zone:  $\mu=703$ ,  $\sigma=347$
- Medium-potential maize zone:  $\mu=1426$ ,  $\sigma=414$
- Low potential maize zone:  $\mu=2892$ ,  $\sigma=991$
- Wheat region:  $\mu=2505$ ,  $\sigma=881$
- Common correlation matrixes for all zones

	Sublocation	Division	District
Sublocation	1		
Division	0.85	1	
District	0.75	-0.81	1

Our analysis was done on a representative farmer at the sublocation level with the assumption that perfect income risk sharing exists at the sublocation level. Sublocation average yields were thus used to represent yields of our representative farmer.

Mean and standard deviations obtained from detrended annual district yields are from the Ministry of Agriculture, Livestock and Fisheries from 1983 to 2013.<sup>48</sup> Correlation metric is from 2-year Tegemeo panel household survey in 2000 and 2004. Survey covers 15-60 representative households in representative sub-locations, locations, divisions and districts in all production zones. Sample size varies by relative populations. Districts selected for analysis in all zones are those with large maize and wheat-growing areas with available data in both Tegemeo's household survey and district-level yield data.<sup>49</sup>

2. Producer price (K Sh/kg):  $p_i \sim U(p_l, p_h)$

- Maize:  $p_l=22.7$ ,  $p_h=45.5$
- Wheat:  $p_l=34.9$ ,  $p_h=58.1$

Country-level average maize producer prices (1991-2011) obtained from FAOSTAT and 2012-2013 from Regional Agricultural Trade Intelligence Network (RATIN). Prices were inflation adjusted with 2013 as base year.

3. Working capital loan (% of expected revenue):  
 $L_i = 60\% \mu_y \bar{P}$

From gross margin studies (KARI 2009, etc.), total input costs range from 50% to 75% of average crop revenue. This figure was also similar to total working capital loan reported in Tegemeo household survey. The median level is 60%.

4. Yield and cost markup rates with respect to high-cost, more productive input invested (% of expected yield and cost):  $\alpha_y, \alpha_L$  vary across crops and production zones. They were estimated from the ratio of yields and costs of high versus low input crop productions of three to five representative small-scaled farmers with less than 4 hectares of land in some key growing provinces in each zone. Maize data were derived from KARI (2009)'s Assessment of Costs of Maize Production, Marketing and Processing in Kenya: A Maize Grain-Maize Meal Value Chain Analysis. Wheat data were obtained from DASS's (2010) gross margin analysis.

Crop zone	Studied county	Markup [% of average]	
		Yield	Production cost
Low-potential maize	Machakos, Eastern	233%	308%
Med-potential maize	Kirinyaga, Central	182%	138%
High-potential maize	Laguri, Western	200%	123%
	Narok, Rift Valley	193%	129%
	Mean	196%	126%
Wheat	Narok, Rift Valley	139%	132%
	Nakuru, Rift Valley	139%	133%
	Mean	139%	133%

5. Farm size (hectare):

$$A_{\text{low}} = A_{\text{medium}} = 1.5, A_{\text{high}} = 2.5, A_{\text{wheat}} = 3$$

This was obtained from Tegemeo household survey.

#### Area yield index insurance (AYII)

6. Indexes:  $\bar{y}$ , we constructed both division and district average yields, as the goal was also to evaluate the AYII with these two different indexes.
7. Premium multiple (% of fair rate):  $x=200\%$ .  
This is a common rule of thumb in the industry.
8. Coverage level:

Zone	High coverage [15% maximum rate]		Low coverage [10% maximum rate]	
	Coverage	Fair premium	Coverage	Fair premium
Low-potential maize	50%	7.30%	30%	4.50%
Medium-potential maize	85%	6.60%	75%	4.20%
High-potential maize	80%	7.40%	65%	4.20%
Wheat	75%	6.60%	65%	4.50%

9. Interest rate on working capital loan (% per year):  
 $r=17\%$   
Weighted average commercial bank lending rate as of April 2014 obtained from Financial Sector Deepening.
10. Minimum subsistent consumption:  $\bar{c}$  is assumed at 30% of annual food poverty line of a representative farming household with five adult equivalent members (statistics from Tegemeo survey) calculated at national food poverty line of rural regions at K Shs 988 per month per adult equivalent.
11. Public supports represented as premium reduction (%):  $s=50\%$

### C. Simulations

We took the following steps to simulate key outcome indicators and zone-specific longitudinal series of representative and area yields and prices from their joint distribution:

- Using the two-year Tegemeo household data, we constructed two years of annual area-average yields at sublocation, division and district level by averaging individual yields across households in each area in each year.
- In order to describe the zone-specific joint distributions of the three levels of yields, we computed zone-specific means, standard deviations and correlation matrices of sublocation, division and district yields. These statistics were calculated using variations over the two years and across respective area yields within each zone.<sup>50</sup>
- The relatively short temporal coverage of household data could have resulted in underestimation of temporal variations of these series. We thus complemented the data with longitudinal detrended district-level yield data and computed zone-specific moments. While means of these three levels of area yields were comparable within each zone, standard deviations were a lot smaller in the two-year data. Means and standard deviations of these sublocation, division, and district yield series in each zone were then assumed to be similar to that estimated from the 1983–2013 district yield series.
- For each production zone, we simulated 100 replicates of 100-year series of these three levels of area yields assuming that their joint distribution followed 3-variable multivariate normal distribution, with zone-specific means and standard deviations obtained from 1983–2013 district yield data and correlation matrixes obtained from the variations within the two-year household data.

**Table 18–** Summary statistics of maize and wheat growing households

	Mean	Median	SD	Min	Max
Household member (adult equivalent)	5.2	5.1	1.9	0.6	13.2
Poverty headcount (national rural poverty line [2005])	41.5%				
<i>Yield and price statistics*</i>					
Maize in low potential zone (kg/ha)	703	671	347	18	2,085
Maize in medium potential zone (kg/ha)	1,426	1,342	414	159	3,165
Maize in high potential zone (kg/ha)	2,892	2,790	991	397	5,325
Wheat (kg/ha)	2,505	2,617	881	26	4,581
Aggregated maize price (Ksh/kg)	34	34	7	23	45
Aggregated wheat price (Ksh/kg)	46	45	8	35	58
<i>Maize producing households</i>					
Cultivated land size (ha)	2.5	1.5	4.5	0.1	110.0
Low potential zone	2.2	1.5	2.9	0.1	21.0
Medium potential zone	1.7	1.5	1.6	0.1	11.5
High potential zone	2.9	2.5	6.0	0.1	110.0
% households who own land	52%	67%	48%	0%	100%
% with two cropping seasons a year	42%	39%	38%	0%	100%
% use purchased hybrid seed	23%	19%	33%	0%	100%
% households with maize sale	18%	0%	27%	0%	100%
Low potential zone	8%	0%	18%	0%	100%
Medium potential zone	7%	0%	17%	0%	100%
High potential zone	28%	20%	31%	0%	100%
% maize income from total econ income	29%	23%	20%	3%	100%
Low potential zone	70%	70%	10%	50%	100%
Medium potential zone	28%	31%	20%	3%	100%
High potential zone	28%	23%	20%	4%	100%

5. For each simulated year in each replicate, we also randomly drew one price realization from a uniform distribution specified with 10-year minimum and maximum national aggregate, inflation-adjusted price observed empirically from 1991 to 2013.

6. Finally, we calibrated our economic model using empirical data and estimated 100 replicates of 100-year series of key outcome variables for the representative farmer in each zone in the scenarios with and without AYII and across contract variations.

[continued]

<i>Wheat producing households</i>					
Cultivated land size [ha]	7.6	3.0	23.6	0.0	240.0
% households who own land	60%	100%	48%	0%	100%
% with two cropping seasons a year	0%	0%	0%	0%	0%
% use purchased hybrid seed	26%				
% households with wheat sale	78%	90%	30%	0%	100%
% wheat income from total econ income	29%	23%	20%	0%	86%
<i>Credit access*</i>					
% households with input credit	46%	39%	14%	0%	100%
Purpose of credit					
Fertilizer	81%	79%	21%	0%	100%
Seed	9%	9%	41%	0%	100%
Other equipments	10%	3%	43%	0%	100%
<i>Credit source</i>					
AFC	1%	1%	6%	0%	14%
Commercial banks	1%	1%	3%	0%	8%
Cooperatives/Saccos	25%	39%	21%	0%	100%
Local trader/companies	10%	10%	14%	0%	100%
NGOs/MFIs	1%	1%	5%	0%	11%
Money lenders	2%	1%	32%	0%	100%
Friend/relatives, ROSCAs, etc.	6%	6%	26%	0%	100%
<i>Lending rates</i>					
Commercial banks [5-yr statistics]	16%	15%	2%	14%	20%

\* From 30 years detrended district-level yield data from 1983-2012 obtained from the Ministry of Agriculture

Inflation adjusted aggregated producer prices FAOSTAT and Regional Agricultural Trade Intelligence Network

\*\* Household data from 2000, 2004 household survey of Tegemeo Agricultural Monitoring and Policy Analysis Project

National rural poverty line is 1,562 KSh/capita/month

\*\*\* Data from Kenya Integrated Household Expenditure Survey 2005

\*\*\*\* Monthly FSD data on commercial bank's weighted average lending rates from 2005-2014

**Table 19–** Summary of key impact indicators by contract variations

Impact indicators	District-level yield index								
	No insurance	High coverage				Low coverage			
		Commercial AYII	50% subsidized AYII	Commercial AYII w/ increased investment	50% subsidized w/ increased investment	Commercial AYII	50% subsidized AYII	Commercial AYII w/ increased investment	50% subsidized w/ increased investment
<b>Maize - Low potential zone</b>									
<i>Coverage = 50%, fair rate = 7.3%</i> <i>Coverage = 30%, fair rate = 4.5%</i>									
Net income available for consumption per year [Ksh]. Std.Dev in parenthesis	10,721 (18,940)	9,408 (17,713)	10,721 (17,713)	-	-	10,234 (18,383)	10,721 (18,383)	-	-
Probability of falling into poverty*	100%	100%	100%	-	-	100%	100%	-	-
Loan repayment [%] after min. consumption	59%	56%	59%	-	-	58%	59%	-	-
<b>Maize - Medium potential zone</b>									
<i>Coverage = 85%, fair rate = 6.6%</i> <i>Coverage = 75%, fair rate = 4.2%</i>									
Net income available for consumption per year [Ksh]. Std.Dev in parenthesis	21,723 (25,840)	17,647 (23,250)	21,723 (23,250)	54,342 (41,500)	61,753 (41,500)	19,447 (24,075)	21,723 (24,075)	57,615 (43,210)	61,753 (43,210)
Probability of falling into poverty	90%	95%	90%	60%	55%	90%	90%	60%	55%
Loan repayment [%] after min. consumption	84%	82%	86%	95%	97%	83%	85%	96%	97%
<b>Maize - High potential zone</b>									
<i>Coverage = 80%, fair rate = 7.4%</i> <i>Coverage = 65%, fair rate = 4.2%</i>									
Net income available for consumption per year [Ksh]. Std.Dev in parenthesis	73,582 (99,641)	58,965 (85,534)	73,582 (85,534)	237,515 (168,014)	266,227 (168,014)	66,847 (92,757)	73,582 (92,757)	252,999 (180,753)	266,227 (180,753)
Probability of falling into poverty	45%	50%	45%	15%	10%	50%	50%	15%	10%
Loan repayment [%] after min. consumption	91%	90%	93%	98%	99%	91%	92%	98%	98%
<b>Wheat</b>									
<i>Coverage = 75%, fair rate = 6.6%</i> <i>Coverage = 65%, fair rate = 4.5%</i>									
Net income available for consumption per year [Ksh]. Std.Dev in parenthesis	104,466 (136,714)	87,274 (117,954)	104,466 (117,954)	169,047 (176,345)	194,750 (176,345)	94,179 (125,404)	104,466 (125,404)	179,372 (185,782)	194,750 (185,782)
Probability of falling into poverty [%]	35%	40%	35%	30%	25%	40%	35%	30%	25%
Loan repayment [%] after min. consumption	92%	92%	94%	95%	96%	92%	94%	95%	96%

[continued]

Impact indicators	Division-level yield index (with reduced basis risk)								
	No insurance	High coverage				Low coverage			
		Commercial AYII	50% subsidized AYII	Commercial AYII w/ increased investment	50% subsidized w/ increased investment	Commercial AYII	50% subsidized AYII	Commercial AYII w/ increased investment	50% subsidized w/ increased investment
Maize - Low potential zone									
		Coverage = 50%, fair rate = 7.3%				Coverage = 30%, fair rate = 4.5%			
Net income available for consumption per year [Ksh]. Std.Dev in parenthesis	10,721 (18,940)	9,402 (16,483)	10,717 (16,483)	-	-	10,227 (17,289)	10,717 (17,289)	-	-
Probability of falling into poverty*	100%	100%	100%	-	-	100%	100%	-	-
Loan repayment (%) after min. consumption	59%	55%	58%	-	-	57%	58%	-	-
Maize - Medium potential zone									
		Coverage = 85%, fair rate = 6.6%				Coverage = 75%, fair rate = 4.2%			
Net income available for consumption per year [Ksh]. Std.Dev in parenthesis	21,723 (25,840)	17,652 (21,765)	21,733 (21,765)	54,346 (39,530)	61,766 (39,530)	19,450 (23,075)	21,733 (23,075)	57,615 (41,151)	61,766 (41,151)
Probability of falling into poverty	90%	95%	90%	60%	55%	95%	90%	60%	55%
Loan repayment (%) after min. consumption	84%	82%	86%	95%	97%	83%	85%	96%	97%
Maize - High potential zone									
		Coverage = 80%, fair rate = 7.4%				Coverage = 65%, fair rate = 4.2%			
Net income available for consumption per year [Ksh]. Std.Dev in parenthesis	73,582 (99,641)	58,952 (84,314)	73,579 (84,314)	237,492 (154,653)	266,224 (154,653)	66,837 (90,487)	73,579 (90,487)	252,980 (178,876)	266,224 (178,876)
Probability of falling into poverty	45%	50%	45%	10%	5%	50%	50%	15%	10%
Loan repayment (%) after min. consumption	91%	91%	94%	98%	99%	92%	93%	99%	99%
Wheat									
		Coverage = 75%, fair rate = 6.6%				Coverage = 65%, fair rate = 4.5%			
Net income available for consumption per year [Ksh]. Std.Dev in parenthesis	104,466 (136,714)	87,271 (111,404)	104,462 (111,404)	169,044 (173,571)	194,745 (173,571)	94,185 (123,509)	104,462 (123,509)	179,380 (183,904)	194,745 (183,904)
Probability of falling into poverty [%]	35%	40%	35%	30%	25%	40%	35%	30%	25%
Loan repayment (%) after min. consumption	92%	93%	95%	96%	97%	93%	94%	96%	96%

\* At national food poverty line (2005) at KSh 988 per month per adult equivalent. For a representative household of 5 equivalent adults, food poverty line is calculated at  $988 \times 12 \times 5 =$  Ksh 59,280 per year.

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# Endnotes

<sup>1</sup> World Development Indicators, World Bank, Washington, DC (accessed November 3, 2014), <http://data.worldbank.org/data-catalog/world-development-indicators>.

<sup>2</sup> See Mahul and Stutley (2010) for a comprehensive review of government support to agricultural insurance.

<sup>3</sup> See in particular Kerer (2013).

<sup>4</sup> Support for index insurance is included in a proposed bill for a new Insurance Act.

<sup>5</sup> Nonrivalrous goods are those that may be consumed by many at the same time at no additional cost (e.g., national defense or a piece of scientific knowledge).

<sup>6</sup> This report, issued by the GoK, was based on data supplied by MALF and was developed with technical assistance from the German Agency for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit, or GIZ).

<sup>7</sup> The fully rated price includes the full price of the risk and an administrative loading to cover the ongoing costs of the insurers, although not the development costs.

<sup>8</sup> Reinsurance companies add potentially large “data uncertainty” increases to insurance premiums if they have concerns about the data quality, thus significantly increasing the cost for farmers.

<sup>9</sup> A good example is the Kilimo Salama scheme in Kenya, which is supported by the Global Index Insurance Facility and which uses mobile phones as a point-of-sale device. Other distribution channels include cash-based retailers, utility companies, or third-party bill payment providers. For a discussion of innovative distribution channels, see Smith, Smit, and Chamberlain 2011.

<sup>10</sup> See the discussion above.

<sup>11</sup> Possible options for coinsurance pools are set out in annex A.

<sup>12</sup> Countries that have TSUs include Brazil, Chile, France, Ghana, Italy, Mexico, Poland, the Russian Federation and Spain.

<sup>13</sup> An adult cow or 10 goats are equal to 1 TLU; a camel is equal to 1.43 TLUs.

<sup>14</sup> NDVI is a very good indicator of pasture growth, grazing quality, and the impact of drought on pasture degradation over time.

<sup>15</sup> The main differences between a micro-level individual pastoralist pasture/grazing-drought NDVI index insurance program and a macro-level program are these: (i) under the micro-level program, individual pastoralists purchase their own policy and are the insured for their declared number of animals (TLUs), while under the macro-level program the insured is government (or another appointed entity), which purchases a single policy on behalf of a defined target audience of pastoralist households (termed the beneficiaries); (ii) under a macro-level policy, premium payments are usually fully covered by the insured (government), and the beneficiaries do not contribute at all toward the costs of insurance premiums; and (iii) under the macro-level policy, the beneficiaries have no legal rights to make any claim against the policy, as they are not deemed to be insured.

<sup>16</sup> See ARC, “First Risk Pool,” <http://www.africanriskcapacity.org/countries/risk-pool-1>.

<sup>17</sup> This initiative is being supported by the Rockefeller Foundation, the UK Department for International Development, the Global Facility for Disaster Reduction and Recovery, and the International Fund for Agricultural Development.

<sup>18</sup> According to Clarke and Hill (2013), compared with an emergency assistance baseline in which cash or food is provided seven to nine months after harvest, an early payout when combined with improved contingency planning will lead to substantial speed, cost, and targeting gains. Speed benefits could be as large as a nine-month improvement.

<sup>19</sup> Under its old constitution, Kenya comprised eight provinces, each headed by a provincial commissioner. The provinces (mikoa in Swahili) were subdivided into districts (wilaya). There were 69 districts at the 1999 census. Districts were then subdivided into 497 divisions (taarafa). The divisions were further subdivided into 2,427 locations (kata) and 6,612 sublocations (kata ndogo). Under the Constitution of 2010, the districts became counties (there are now 46) and the divisions became subcounties (there are 290).

<sup>20</sup> A full description of the assumptions and the parameters adopted in the fiscal costing scenarios for the livestock insurance options is presented in annex B.2.

<sup>21</sup> The ultra-poverty rate is based on a national rural poverty line equivalent to US\$0.5/day.

<sup>22</sup> These results are parallel to findings in Chantarat et al. (2014) and Barrett et al. (2012).

<sup>23</sup> For further discussion of Kenya's experience with agricultural insurance, see GoK (2014a), which is the source of the information presented in this section.

<sup>24</sup> GoK (2014a) details the different schemes and product approaches and thoroughly explains why these faltered or were inappropriate. Some of the key challenges were the lack of entrepreneurship of the insurance companies involved, and potentially the costs of the products.

<sup>25</sup> For more details on the National Agriculture Insurance Scheme of India and its modifications see, World Bank (2011b).

<sup>26</sup> The material presented in this section has been adapted from World Bank (2011a).

<sup>27</sup> Along these lines, some of the suggested topics to be covered in the revision analysis of India's National Agriculture Insurance Scheme were the following: (i) establishment of a standardized national manual on CCEs; (ii) systematic training and certification of loss adjusters; (iii) commission of randomized, independent, high-quality CCE audits to be conducted alongside the standard CCEs; (iv) standardized statistical approach to handle outlier yields in the calculation of the area yield; and (v) implementation of an auditing system, such as video recording, satellite imagery, and/or additional CCEs on plots adjacent to the official CCE plots (World Bank 2011c).

<sup>28</sup> In insurance transactions it is customary to refer to "premium rates" where the cost of the policies is expressed as a share of the value insured.

<sup>29</sup> The coverage level determines the cases in which a payout is triggered; e.g., any time the recorded yield level in a specific area falls below 80 percent of the reference average yield, a payout is issued. See figure 9 for a graphical representation of the role of the coverage level.

<sup>30</sup> Annex C.1 also presents the district breakdown adopted in the analysis.

<sup>31</sup> In technical terms this process is defined as a historical burn analysis.

<sup>32</sup> The selected coverage level (80 percent) generates premium rates that for some districts would be excessive and not sustainable. Hence in order to generate more realistic projections, commercial premium rates were capped at a maximum of 15 percent. In a potential implementation phase, it will be important to assess the tradeoff between the cost of the policies and their actual coverage capacity. In districts where the capping is binding, the coverage

level is de facto reduced to lower levels (see box 3 for a more detailed discussion).

<sup>33</sup> See section 3.4 for more detailed argumentation on the need for public support.

<sup>34</sup> A detailed description of how these costs have been estimated is presented in annex C.1.

<sup>35</sup> A higher take-up rate has been assumed for wheat since farming units are generally larger than for maize, and the value chain is generally more integrated with the financial environment.

<sup>36</sup> Data underlying GoK 2006

<sup>37</sup> <http://www.kalro.org/>

<sup>38</sup> <http://www.tegemo.org/>

<sup>39</sup> <http://www.tegemo.org/>

<sup>40</sup> The CV, or coefficient of variation, is the standard deviation divided by the mean and expressed as a ratio or percentage variation around mean.

<sup>41</sup> Since maize and wheat households would potentially earn income from other sources of livelihood, poverty measures based on household crop income relative to either the national food poverty line (K Sh 988 per capita per month, according to the Kenya Integrated Household Budget Survey [KIHBS 2005]) or the national rural poverty line (K Sh 1,562 per capita per month, according to KIHBS [2005]), would reflect only the upper bound of poverty incidence in the region. Since maize income constitutes the majority of economic income of those households in the low-potential areas, poverty measures for this group could well reflect their actual poverty incidence.

<sup>42</sup> We note that our model assumes away the potential that farmers can save in a good year and draw on their saving to consume and pay back loans in a bad year. Our results for the expected loan repayment rate should thus be interpreted as the lower bound of the potential rate.

<sup>43</sup> This annex draws in part on GoK 2014a.

<sup>44</sup> This reflects the reality of the pastoral households in the regions, where livestock also provides intrinsic value beyond just serving as store of wealth.

<sup>45</sup> See Woodard et al. 2012 for detail.

<sup>46</sup> This leads to a conservative cost estimate, in particular if compared to situations in which CCEs would have to be outsourced to a private entity and extension officers would mainly have an auditing function.

<sup>47</sup> This should capture the important feature from reality that farmers will prefer to satisfy their basic needs before relaying any loan.

<sup>48</sup> Longitudinal district yield data were detrended assuming an average combination of linear, exponential, and moving average trend (Stutley's method). We also used estimated trends in the longitudinal data to detrend the two-year yield data.

<sup>49</sup> Districts considered in low-potential maize zone include Kitui, Machakos, and Makuani in Eastern Province and Muranga, Kirinyaga, and Nyeri in Central Province. Districts in medium-potential maize zone include Kisumu, Siaya, and Nyamira in Nyanza Province; Vihiga and Busia in Western Province; and Meru in Eastern Province. Districts considered in high-potential maize zone are Nakuru, Trans Mara, Trans Nzoia, and Uasin Gishu in Rift Valley Province and Bungoma and Kakamenga in Western Province.

<sup>50</sup> Because our temporal coverage was limited and could result in underestimation of actual temporal variations, we decided to exploit spatial variations of the area yield within each zone as well as with the assumption that variations in area yields within each homogenous zones could represent variations of yield realizations over time in that zone.



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