

**Seventh Multi-year Expert Meeting on  
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**How to use weather index insurances to address  
agricultural price volatility?**

By

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The views expressed are those of the author and do not necessarily reflect  
the views of UNCTAD.

# **How to use weather index insurances to address agricultural price volatility?**

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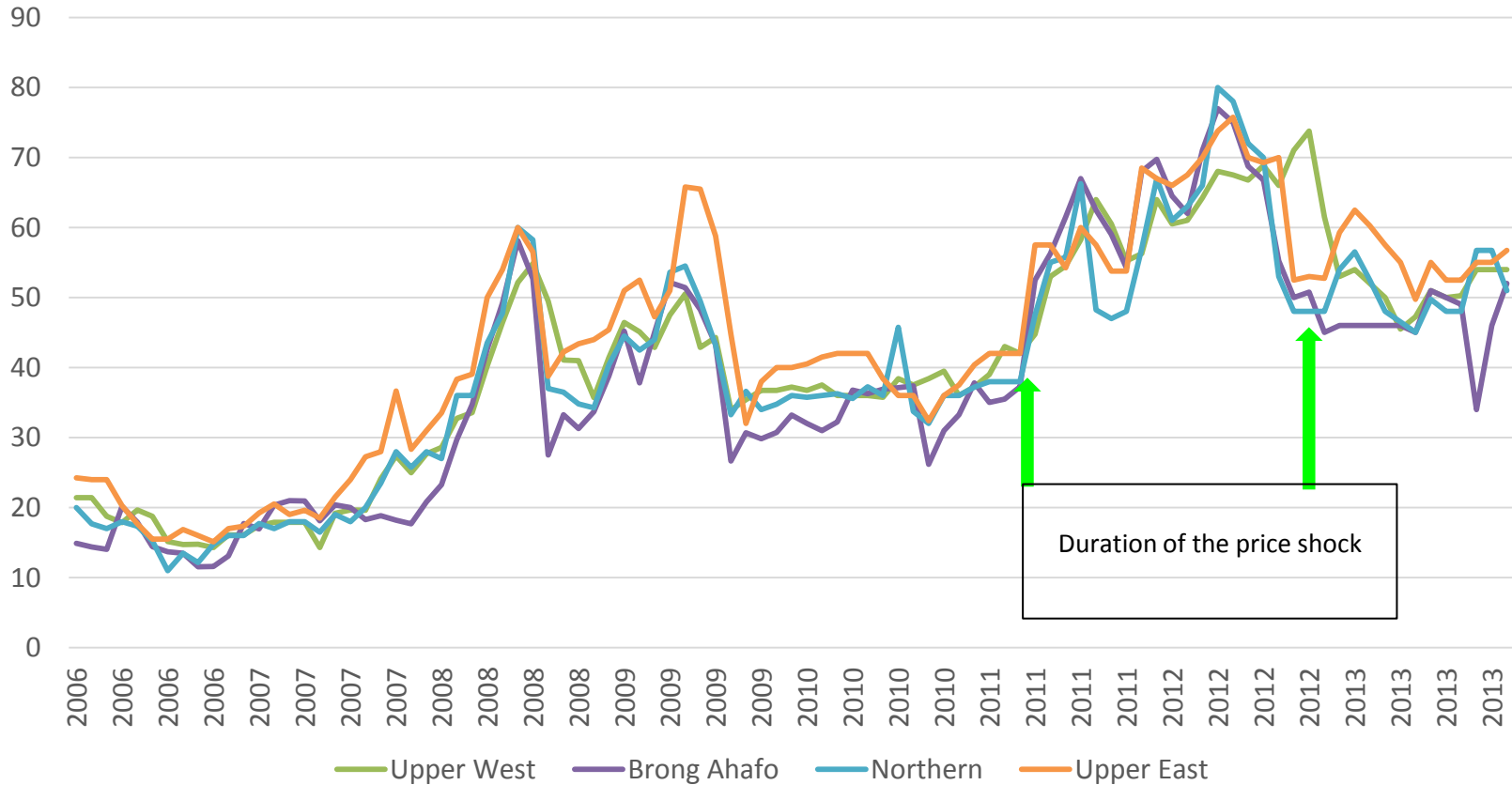
# Outline

- Motivation
  - Agricultural risks
  - Price volatility
- Index Insurance
  - How it works
  - Where is it used
  - Advantages and disadvantages
- Revenue index insurance
  - Properties
  - Advantages and limitations
- Way Forward

# Motivation

- Agricultural activities in Africa are largely practiced by smallholder farmers who are saddled with numerous risks; including:
  - Weather
  - Price uncertainties.
- Over the years, farmers have learnt to mitigate these risks. The literature mentions practices such as:
  - Crop diversification,
  - Strategic crop rotation, and
  - Conservation agriculture,
- Market risks, on the other hand, are managed via
  - Strategic storage,
  - Hermetic bags,
  - Collective marketing, and
  - The use of new technologies that reduce information asymmetries (ICT).

# Maize price dynamics (in Ghana cedis per 100 kg)



Source: GIEWS Online

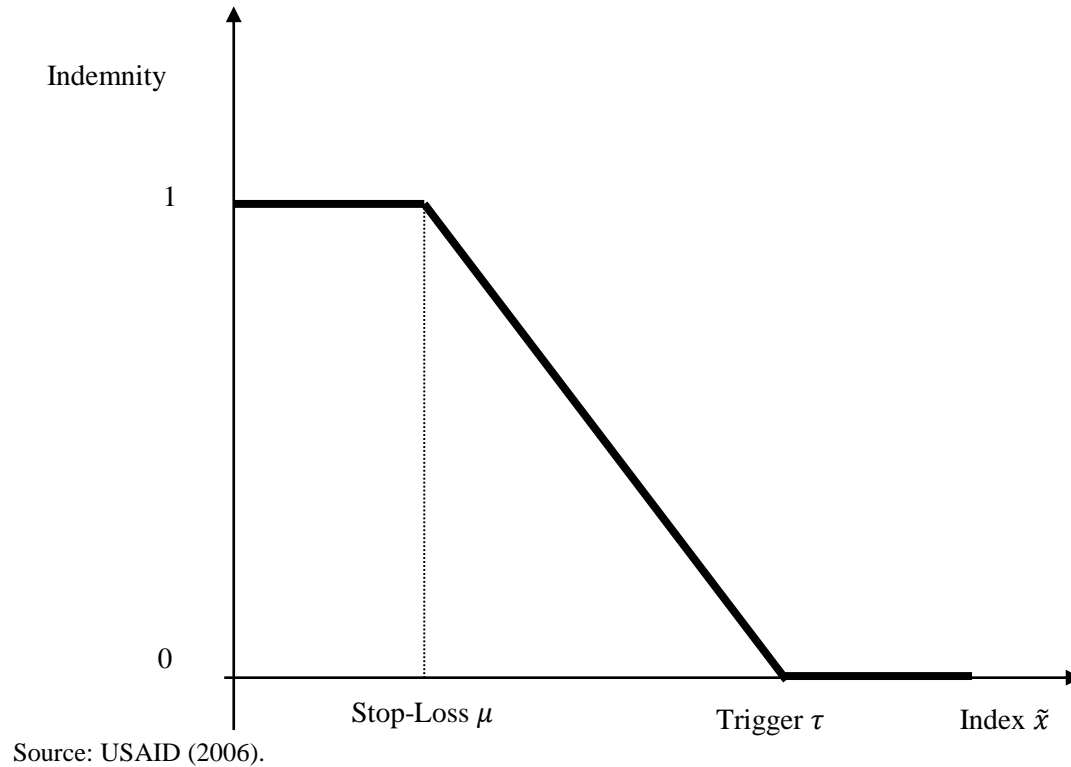
# Index insurance

Assumed same weather conditions at farm and weather station



- Index-based insurance (or index insurance) is a contract that pays for losses based on an index, an independent and objective measure that is highly correlated with losses such as extreme weather
- Rainfall measured at a weather station forms the basis of the insurance contract
- If rainfall measured at the weather station is below a certain threshold (trigger) (e.g. 25 mm in a given period) then the payout for all insured farmers within the 20 km radius is triggered

# Stop-loss Index insurance





# Stop-loss Index insurance

- Threshold: 100 millimeters of rainfall
- Limit: 50 millimeters of rainfall
- Liability purchased by the policyholder: \$50,000
- Payment rate:
  - = (threshold – actual value)/(threshold – limit)
  - = (100 – actual value)/(100 – 50)
- Indemnity payment: The payment rate multiplied by the total liability:
  - = (100 – actual)/(100 – 50) × \$50,000

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Total Rainfall (millimeters)	Indemnity Payment Due
110	None. The threshold has not been reached.
80	$(100 - 80)/(100 - 50) \times 50,000 = \$20,000$
50	$(100 - 50)/(100 - 50) \times 50,000 = \$50,000$
40	\$50,000. 50-millimeter limit has been exceeded.

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Source: Skees (2008b).

- Index insurance products can also be classified according to the nature of the intended policyholder and their uses in risk management strategies.
  - “Micro” weather insurance contracts are designed to be held by farmers to help manage farm-level production risk.
  - “Meso” weather insurance contracts are designed to be held by businesses that provide financial intermediation to large groups of farmers (such as banks, input suppliers, processors, and cooperatives) who wish to protect the integrity of the loans or other financial and marketing arrangements that exist between them and their farmer clients.
  - “Macro” weather insurance contracts are designed to be used primarily by national governments, regional administrative agencies, and non-governmental organizations to finance centrally managed relief efforts during widespread catastrophes.

# Advantages and Disadvantages

## KEY ADVANTAGES

- Relatively affordable premiums
- Reduced transaction costs (no field assessment)
- Objective and transparent
- No moral hazard and adverse selection
- Provides timely payouts

## KEY DISADVANTAGES

- Basis risk – potential mismatch between losses and payouts
- Provides single risk protection
- Requires a good density of weather stations

# Basis Risks



# Index insurance contracts in developing countries

- Livestock insurance
  - Northern Kenya, Mongolia...
- Drought insurance
  - Ghana, Malawi, Ethiopia, Burkina Faso, India...
- Flood insurance
  - Peru...

# How Can Index Insurance Mitigate Commodity Price Volatility?

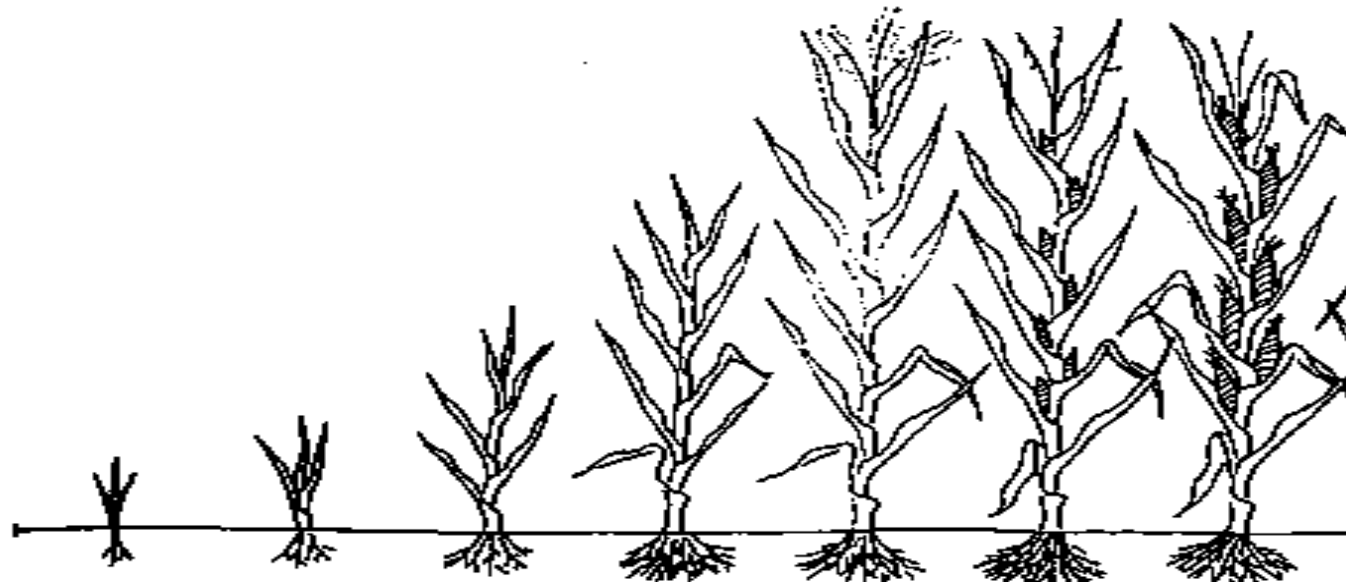
# Revenue index insurance

- A revenue index insurance contract could take many forms. However, let us consider a simple form that builds directly on current index insurance contracts and thus could be developed and marketed at low additional cost. The typical index insurance contract pays an indemnity

$$I_Y = f(\tilde{x})$$

- where  $\tilde{x}$  is a random vector of ground-level rainfall or satellite-based radiation measures taken over the growing season. The indemnity schedule  $f$  has been carefully designed to match regional yield shortfalls as much as possible without excessively complicating the indemnity schedule.

# Payout triggered or f(.)



LATE MAY – EARLY JULY

1 Germination Cover

1 or more good rainfall event (>25 mm) to sow in one dekad

> 13 consecutive dry days (<2.5 mm)

MID JUNE – MID SEPT

2 Crop Growth Cover

>13 consecutive dry days with < 2.5 mm rainfall

EARLY AUG – EARLY SEPT

3 Flowering Cover

>125 mm of rainfall during the period

Source: Ghana Agricultural Insurance Pool



A simple revenue contract could easily be crafted so as to pay an indemnity of the form

$$I_R = f(\tilde{x}) \cdot g(\tilde{p})$$

where  $\tilde{p}$  is the reference price. Here, the price adjustment factor  $g$  would be a positive, non-increasing function of the reference price such that the expectation of  $g(\tilde{p})$  equals 1. Thus, the revenue index insurance contract pays more than the yield index insurance when prices are low and pays less when prices are high.

The price adjustment schedule  $g$  could be conservatively bounded to limit the insurer's liability. For example,  $g$  could be structured so that it always lies between, say, 80% and 115%. Placing bounds such as these would protect insurer against dramatic price swings, such as might arise due to unforeseen government interventions in the market.

- The primary benefit of revenue index insurance is that it embodies less basis risk than yield index insurance. Farmers that market their output are interested, not simply in the yields they obtain, but rather the income they receive from their output.
- A farmer, after all, is no worse off when he experiences a 20% reduction in yield, if it is compensated by a simultaneous 20% increase in price that leaves his income unchanged.
- As such, the basis risk embodied by an agricultural index insurance product properly should be measured, not by how well indemnities track yield shortfalls, but rather how well they track revenue shortfalls.

- The optimal design of the revenue insurance will depend on the target population of insured.
  - If the insured grows crops mainly for sale, then they welcome high prices and suffer from low ones.
  - Conversely, if the insured grows crops mainly for household consumption, then they welcome low prices and suffer from high ones, given that they would have to purchase crops on the market to address production shortfalls on the farm.
    - The price adjustment factor  $g$  would need to be a non-decreasing function of the reference price

# Is revenue index insurance's premium more expensive than yield index insurance?

If prices vary independently from the yield estimates generated by  $\tilde{x}$ , then the fair premium for the proposed revenue index insurance contract would be the same as that for the yield index insurance contract.

If price is negatively correlated with the yield estimates generated by  $\tilde{x}$ , then the fair premium for the revenue index insurance contract would likely be a little lower than that of the yield index insurance contract.

Thus, to keep things simple, the revenue index insurance contract could be conservatively marketed at the same premium as the yield index insurance contract.

In fact, the two products could effectively be marketed as a single product: a yield (rainfall) index insurance contract with a “price coverage option” that could be elected by the purchaser of the index insurance contract at no additional cost to him.

Designed and marketed in this manner, the revenue index insurance could easily be made available without introducing a new, more complicated product that would significantly increase insurers’ development and marketing costs.

# Caveats

- Revenue index insurance will not affect price volatility. It will only reduce farmer's vulnerability to price volatility
- Revenue index insurance is only implemented in the USA. No example exist of its used in developing countries.
- The price used in the design of a revenue index insurance contract must satisfy several conditions.
  - First, the price must be publically observable in an objective, transparent, and timely way.
  - Second, it must not be possible for either the insurer or the insured to materially affect the observed reference price.
  - Third, there must be sufficient data of acceptable quality to allow for the reliable rating of the revenue index insurance product.

# Further limitations

- First, adverse selection could arise if the insured can condition his expectations of the prices used to settle the indemnity using information available during the insurance sales period.
- This form of “intertemporal” adverse selection would have to be addressed either by making the closing date earlier or adjusting premiums just before the sales period begins to account for available conditioning information.

# Way Forward



- Consider introducing revenue index insurance where drought insurance has been adopted.
  - The first question to be addressed is whether acceptable reference prices exist to support the development of the new product.
  - Determining the reference period for price determination
  - Pilot the new product to test its impact

Thank you