DRF for Agriculture and Climate Resilient Livelihoods

Session 8:

Deep dive into Area Yield Index Insurance (AYII)

5-8 March 2024
Muldersdrift, South Africa

Disaster Risk Financing & Insurance Program

SUPPORTED BY WORLD BANK GROUP

- Eswatini
- Ethiopia
- Kenya
- Lesotho
- Namibia
- Rwanda
- Somalia
- South Africa
- Uganda
- Zambia
- Zimbabwe

Outline

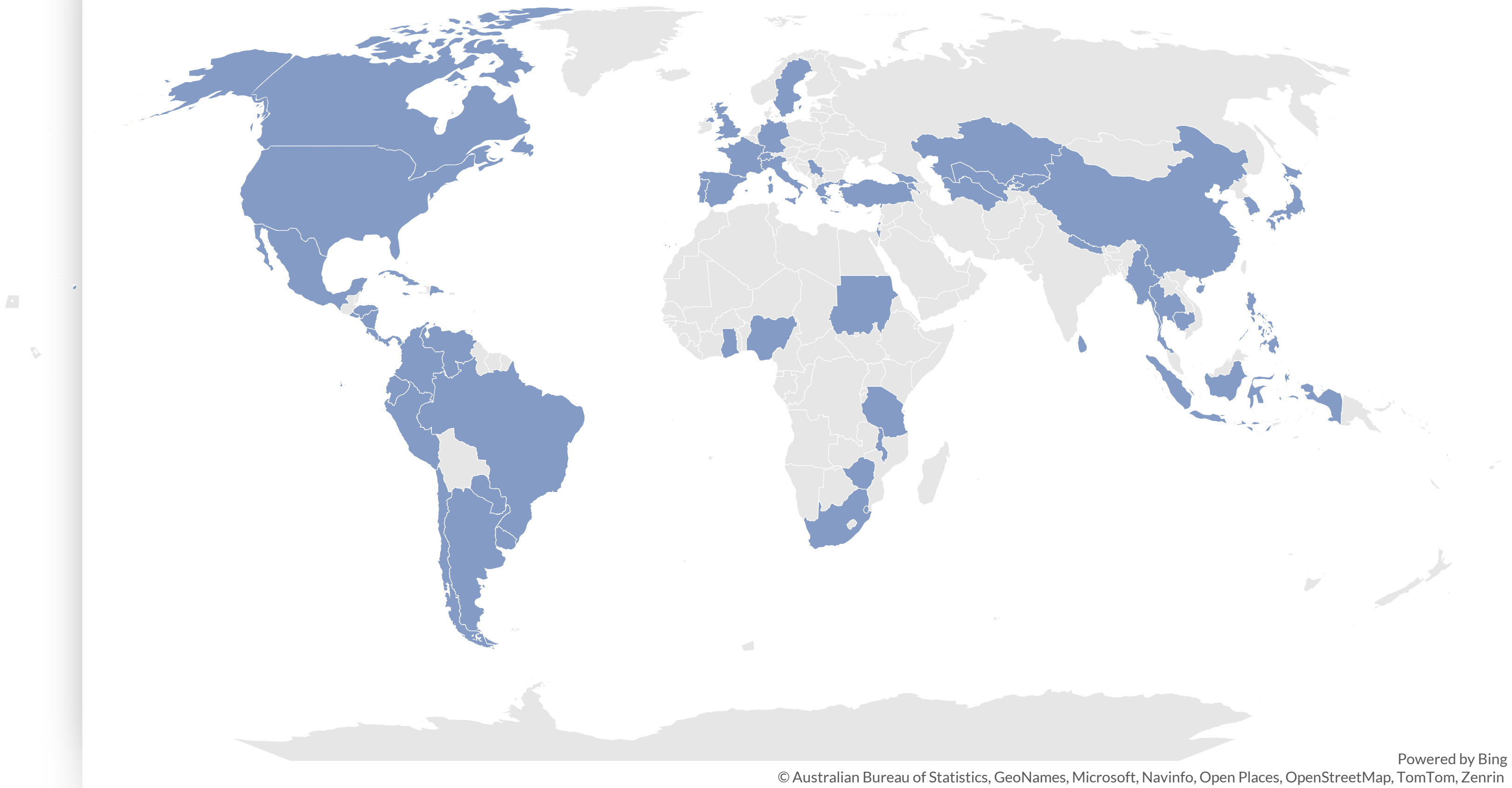
- Crop insurance landscape
- AYII: what and why
- AYII: implementation considerations
- AYII: product design & rating considerations
- Kenya experience
- Q&A

By the end of this session, you should understand more about:

- What is AYII and how does it work
- What are AYII advantages and disadvantages compared to other crop insurance products
- What are implementation and design considerations for governments
- How does an AYII scheme work in Kenya

Global landscape of crop insurance

Global presence of crop indemnity insurance



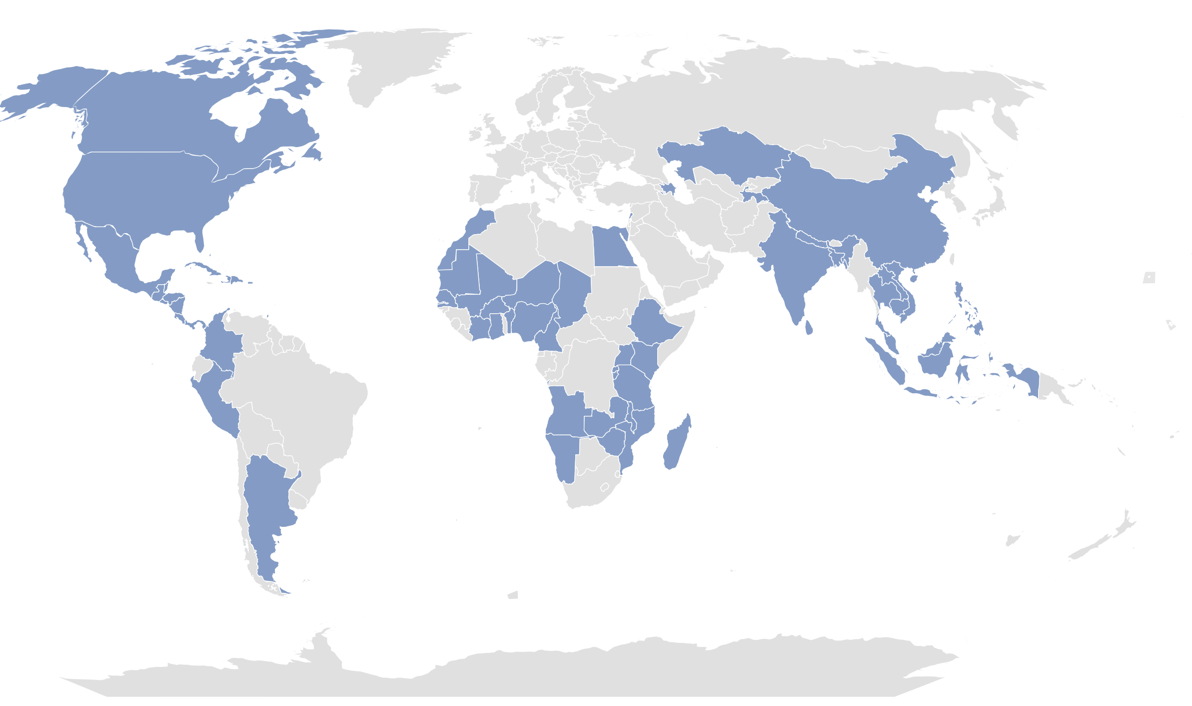
Key Takeaways

- Agricultural insurance premiums nearly doubled between 2008 and 2017 and has continued to rise.
- Emerging markets the crop protection gap is USD 88 billion Vs. USD 25 billion in advanced markets
- Globally MPCI is largest class by premium volume of all types of agricultural insurance

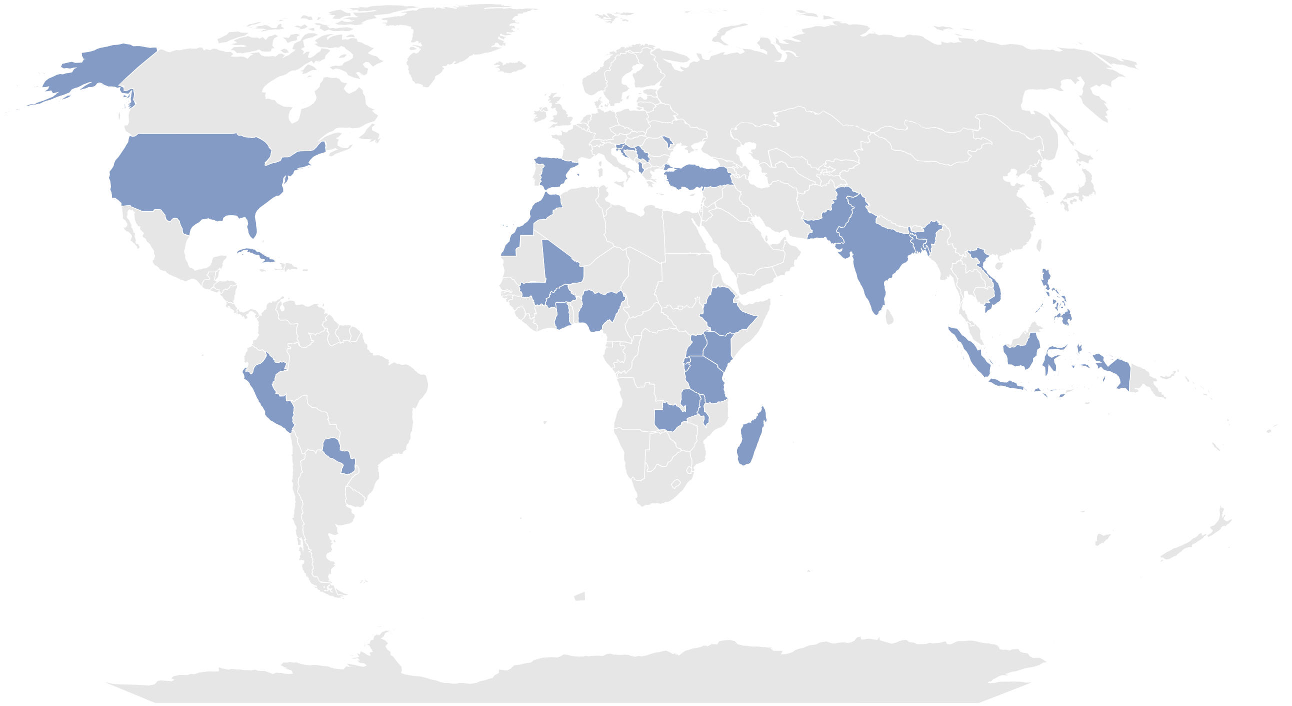
Sources: Stutley, DRF for agriculture, 2021; Swiss Re Sigma, 2023; Author

But crop index insurance quadrupled between 2009 to 2019

Global presence of WII



Global presence of AYII



Sources: Stutley, DRF for agriculture, 2021; Swiss Re Sigma, 2023; Author

What % does Africa contribute to of global agricultural insurance premiums?

Crop insurance in Sub-Saharan Africa

Presence of crop insurance in SSA by type of product (Indemnity, WII, AYII)

INDEMNITY — WII — AYII

KEY TAKEAWAYS

- **30 countries have crop insurance today** (including micro, meso, and macro) **vs. only 6 in 2008**
- 86 crop insurance schemes
- Most number of schemes are index insurance: 53 WII, 24 AYII
- **South Africa largest premium volume**: large crop-hail market and MPCI for commercial farmers
- **6 countries have the highest penetration of index insurance:** Kenya, Nigeria, Rwanda, Senegal, Uganda, Zambia

Area Yield Index Insurance What and Why?

What is AYII?

Comprehensive risk coverage, scalable for smallholders

Purpose and Function

Not for individual farm losses. AYII acts as yield shortfall guarantee at the area level:

- Payouts made if average yield in an area is enough below the expected/normal average yield & specified by trigger level in the index design

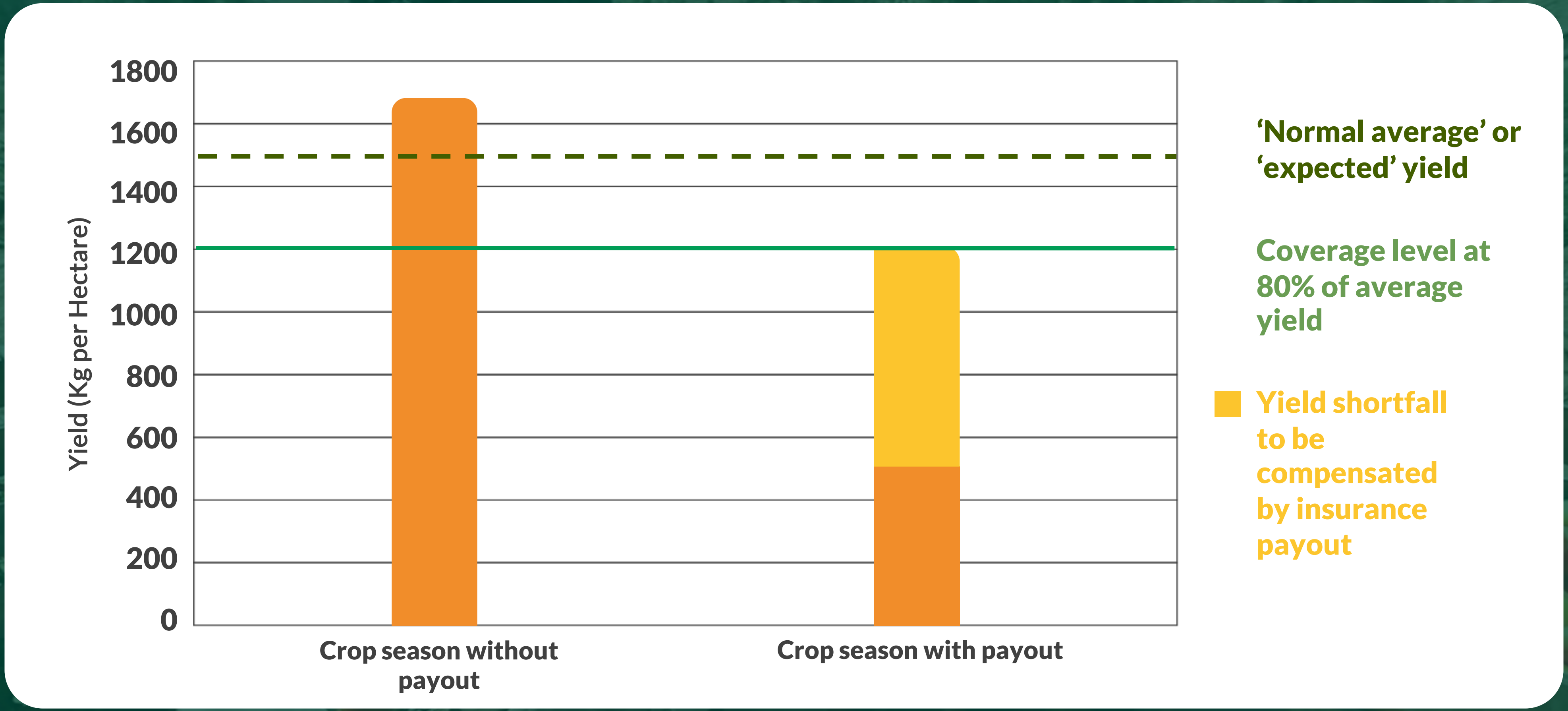
Key components

- Covers **multiple natural risks** that affects the crop production and yield in a defined insured area (UAI)
- Reduces moral hazard: farmers cannot influence payout
- Reduces adverse selection: farmers cannot influence yield outcome in a whole UAI

Preconditions

- Homogenous cropped areas with: low yield variation between farms; common farming practices & agroclimatic conditions
- **Historical data for insured areas:** crop sown area, production and average yield data, **ideally for the past 15 years+**
- **Low cost, timely, accurate system to estimate the actual average yield** in the UAI at the time of harvest and that is **acceptable to farmers, insurers and their reinsurers.**

AYII provides payouts when the yield of an area falls below a predetermined % of the 'normal average' or expected yield



- Area yield index insurance is a type of insurance which pays farmers with respect to the normal average or expected yield in the area
- Example shows: Insured Yield set at 80% of the Expected Yield (or normal average area yield)

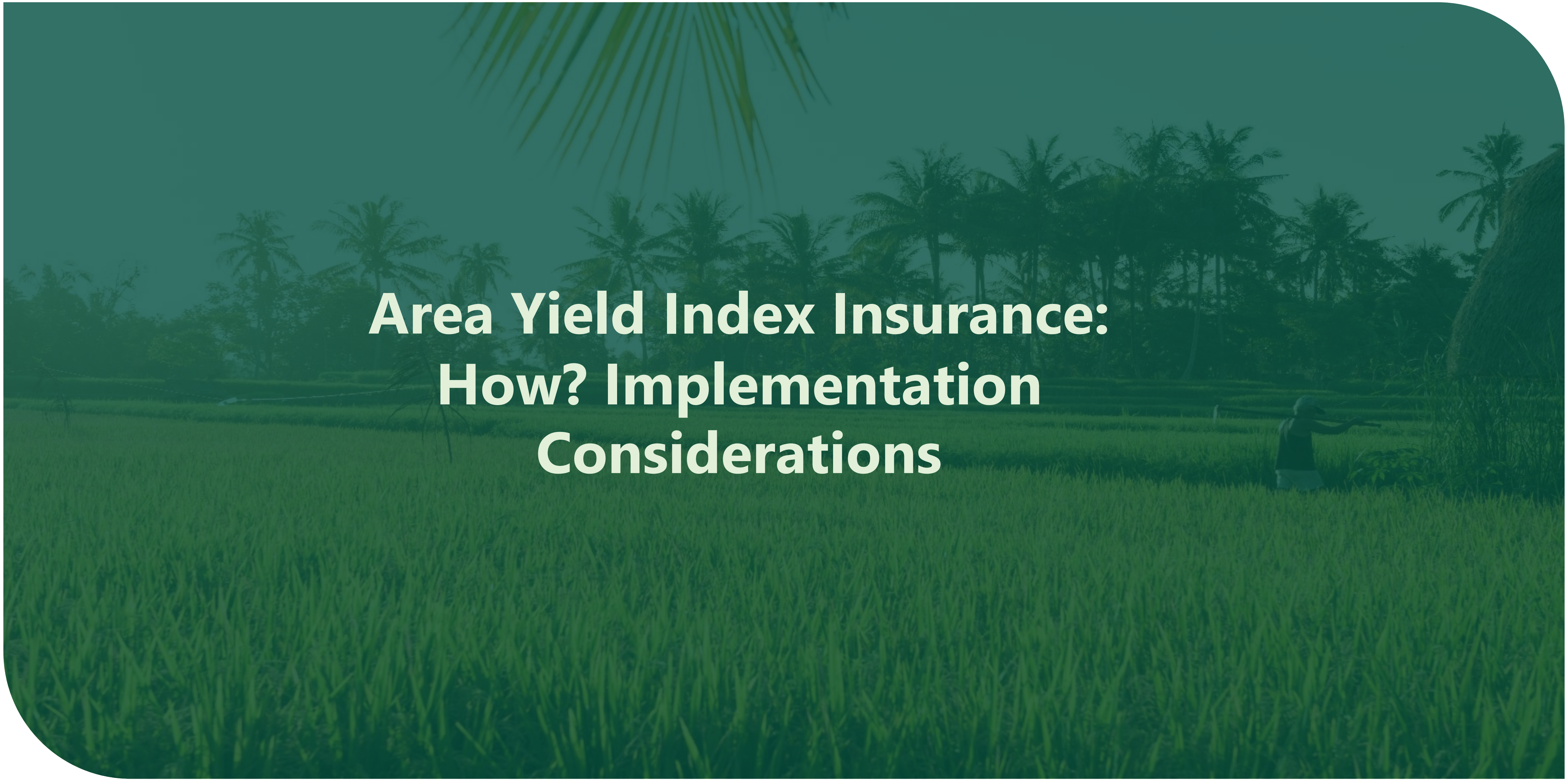
AYII is lower cost than MPCI and with less basis risk than WII

			Transaction costs	Moral hazard & adverse selection	Basis risk	Claims settlement time
Multi-peril crop insurance	Farm	Traditional indemnity insurance product against all perils. Payouts are determined through a farm-level loss assessment process				
Area-yield index insurance	Village	AYII is based on average losses at an area level, rather than farm level **It is most often based on crop-cutting experiments (CCEs)**				
Weather index insurance	Village	Based on weather parameters (such as rainfall, temperature, or soil moisture) correlated with crop loss Typically covers single, weather-related peril				

Why AYII compared to WII?

One size does not fit all: consider risks, crops, purpose

	AYII	WII
Value chain suitability	**Row crops:** E.g. Cereals, legumes, cotton.	Also applicable for **horticulture, tree, plantation and temperate** crops; and for pasture in **IBLI** products
Claims payout frequency	**Typically 1** at End of Season	**Multiple payout windows** covering key crop cycle phase e.g. 3 windows for rainfall cover: Germination/tillering; flowering/grain formation; maturity
Level & purpose	**Most applications have been for micro**, but meso and macro level is possible Linked to agricultural production risks	Has been applied for **micro, meso, macro.** **Not always linked to agricultural production risks**



Area Yield Index Insurance: How? Implementation Considerations

Defining the right Unit Areas of Insurance (UAIs) underpins design & implementation

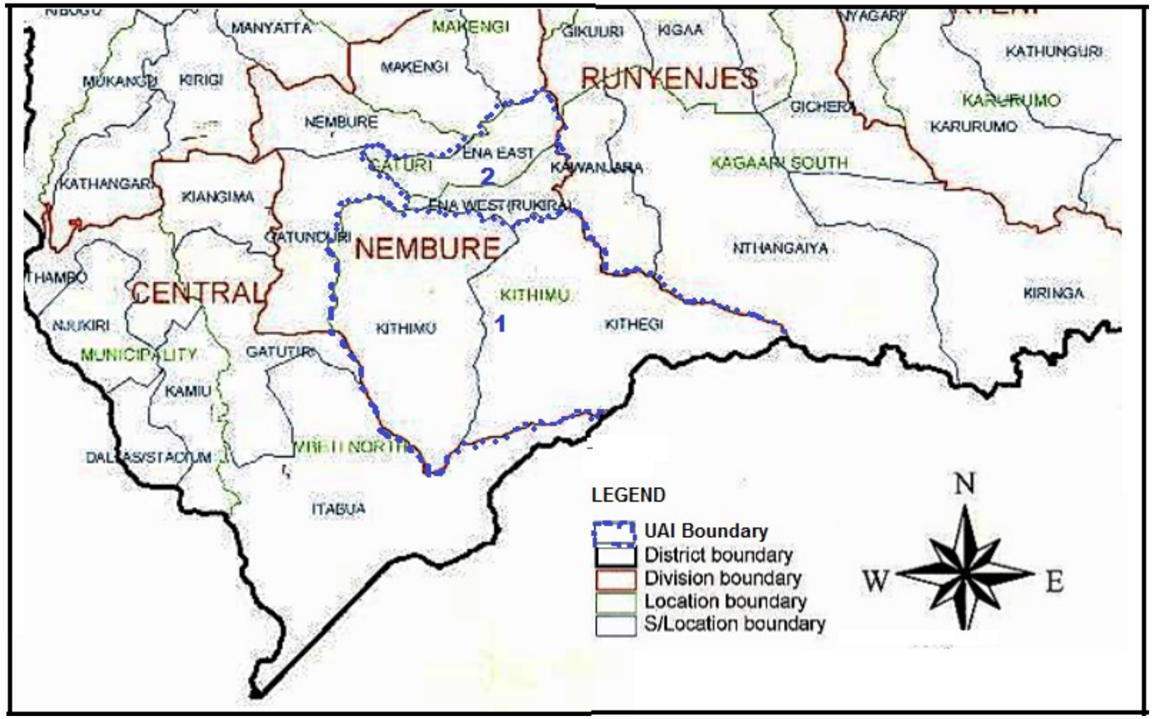
UAI = predefined area in which all fields are grouped and all farmers receive same policy and payouts.

CCEs need to be conducted each season in a sample of fields in every UAI (5-15 CCEs typically taken per UAI).

UAIs for AYII principles:

- **Group fields with homogeneous** agroclimatic conditions, farming practices, crop yields, & exposure to production risks **to __minimize basis risk__**
- Follow aggregation of administration units as much as possible to aid implementation
- Some variability acceptable between farm yields within a UAI. But yields should vary in the same direction and in similar proportions.

Picking the right size. What are the trade offs between big UAIs Vs small UAIs?



Map: Kithimu Ward, Embu County, Kenya
Divided into 2 UAIs at ward level

Crop Cutting Experiments (CCEs) and Unit Areas of Insurance (UAIs)

Too big UAIs:
higher basis risk

Too small UAIs:
higher operational costs

India PMFBY AYII experience

Since 1980. Based on state-governed CCE system. Carried out by extension officers (Indian equivalent)

Operational challenges:

1. **Spatial basis risk →** reduced UAI size from the sub-district level (block of 6-8 villages) to individual village level.

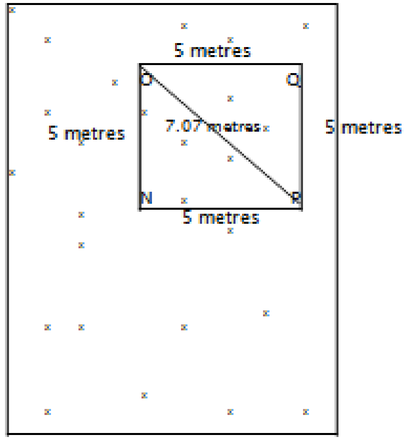
2. **Impact:** CCEs **quality deteriorated** and **major delays** in finalizing CCEs and settling claims payouts:
   - CCE numbers required: 4 CCEs per village for all major crops and 8 CCEs for minor crops
   - **Increased total annual number of CCEs required in the whole country from c. 2-3 million to about 6-8 million.**
   - Short time-frame to conduct CCEs
   - Extension officer overburdened with multiple activities
   - Insurance company agents and district agricultural dept. officials are supposed to be present to ensure integrity of CCEs, but in reality doesn't happen

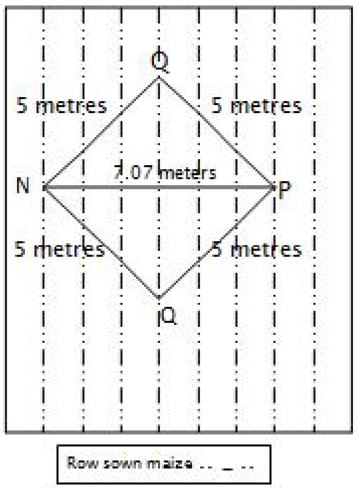
Crop Cutting Experiments (CCEs): what and how?

Key steps for estimating the average yield of an area through CCEs:

1. **Randomly sample a predetermined number of farms** in a Unit Area of Insurance
2. Locate **random sampled plots** in fields of selected farms
3. Mark out sub-plots and **harvest the crop yield**
4. Weigh the harvested sub-plots' crop
5. Process the data to establish the **average yield** of the local area (UAI) to determine payouts

- No fixed rules on size and shape of CCE
- To be determined type of crop & planting pattern





Cereals		Roots Tubers etc.	
Crop	**Plot Size**	**Crop**	**Plot Size**
Maize	6m X 6m	Cassava	4.5m X 4.5m
Rice	3m X 3m	Yam	9m x 9m
Millet	6m X 6m'	Cocoyam	4.5m X 4.5m
Guinea Corn	6m X 6m'	Plantain	9m x 9m

Table shows Ghana MoA plot sizes per crop

Crop Cutting Experiments (CCEs). Implementation considerations

	Decision points
Plot size	Larger Vs smaller size
Farms/Fields per crop (in UAI)	5-15 CCEs typically taken per UAI
Samples per field	1 to 2 (e.g. India, Pakistan, Kenya)
Number of visits Vs investment in equipment	Weighing wet and dry yield: • 2 field visits, 10 to 15 days to estimate dry yield Funding grain moisture metres: • CCE yield is calculated in 1 visit • Major cost savings in staff time • Results can be provided up to 15 days earlier

Accuracy Vs time and cost

Who carries out CCEs? Pros & cons

Government conducted CCEs

- ⊕ Government owns data
- ⊕ Data can be useful beyond insurance
- ⊕ Existing government staff and systems can be used
- ⊕ Can build on existing government stats. In Africa very few governments have historical CCE record but many have historical production and crop yield data

- ⊖ Government pays directly for CCE system: requires high investment and continued monitoring

E.g. India PMFBY, Kenya, Rwanda

Private Technical Service Provider or NGO conducted CCEs

- ⊕ Can create efficiencies
- ⊕ Can spur new solutions
- ⊕ Can be used for other schemes/clients (in absence of government programme)
- ⊕ In some models can use detailed data of 'client' e.g. NGO One Acre Fund

- ⊖ Data not owned/kept by Government
- ⊖ CCEs priced into premium

E.g. Ethiopia, Kenya, Nigeria, Uganda, Zambia

Government-led CCEs in India

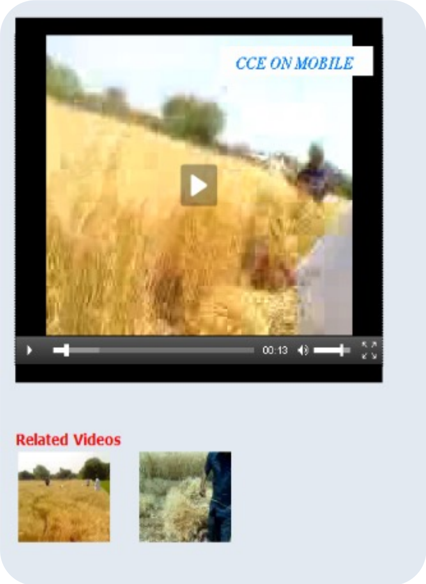
Solutions 2016+ under PMFBY

Technology investment & training to increase accuracy, reliability & allow processes to be finalized in real time:

Government funded technology & training

Enumerators smart phone & moisture metres to:

- Georeference sample plots
- **Geotag enumerators' visits**
- Georeference and timestamped **photographs** and crop cuts videoed
- Measure grain moisture in the field with moisture meters
- **Send data to central server directly** from the field
- Auditing of CCEs carried out in near real time.



Crop cutting experiment sample data	
Crop Name :	Wheat
Plot Size :	0.5
Cultivator Name :	Rabhaji kishan
Type of Crop :	Mono
CropRatio :	0
CCE Date :	2011-03-27
CCE_count :	CCE1
Weight(kg) :	25
Primary Worker : Name	Mayura gaikwad
Supervisor :	Deshmukh agrl office
Supervisor : Designation	Agrl officer
VillageCommity :	Sarpanch
NO.OF.Bundles :	40
Weight Of Bundles :	80
Cause :	No Low Yield
Department :	Zilla Parishad Department

New technology for improving yield estimates

Potential game changer for AYII - overcoming issues with CCEs leading to huge efficiencies

Remotely sensed average yield estimates

- ⊕ No CCEs or reduced CCEs
- ⊕ Moral hazard reduced
- ⊕ Timely availability of data

- ⊖ Relatively untested
- ⊖ Requires good historical yield data for calibration & validation
- ⊖ Farmer education is more important to avoid misunderstandings

E.g. Viet Nam, India

India: YES-TECH

YES-TECH Yield Estimation System based on Technology

- Government conducted R&D and approved roll-out in 2023
- Objective: blend technology-based assessment with manual CCE to eventually reduce dependency on manual methods in future and improve transparency
- Data used can be – remote sensing data, soil & weather data, crop yield, photo analytics, etc.
- Initiated with estimation of wheat and paddy, then expand
- Technology-based assessment will be blended with manual CCEs:
- Recommended that technology assessment should at least 30% weight
- National implementation partners and mentor agencies have been approved empaneled
- YES-TECH manual prepared by the committee under MoA to guide implementation
- 2 states have started pilot implementation and 2024+ expected scale-up in other states

Source: Deloitte, India

AYII How? Implementation Considerations Summary

- **What existing government data that can be built on** (CCEs/historical production and crop yield data) – for which crops, and down to which level?
  - **Phasing: can reduce UAI size as more CCEs are collected**

- **What method of CCEs should be defined?** (e.g. FAO; WBG best practice Crop Cutting Yield Estimation Procedures Guidelines)

- **Who should be responsible for conducting CCEs?**

- **Who should be responsible for auditing CCEs** required by insurers/reinsurers?

- **Who funds CCE costs:** staffing, equipment, technology, training, data management system, auditing; sensitization of farmers about CCEs?

- **What role should insurers play** in the CCE program?

Area Yield Index Insurance: How?
Contract Design & Rating Considerations

Steps in design and rating of an AYII Contract

After defining UAIs

Step 1
Collect historical crop yield data for each UAI

- Used to determine the reference yield level & the loss history of the UAIs.
- Ideally minimum of 15 -20 years historical annual average yield data for each UAI.
- Yield data for lowest administrative division available e.g. ward level in Kenya
- Once scheme is operational and dedicated yield series at UAI level will be developed progressively → helps make adjustments, e.g. to UAIs

Step 2
Detrend data

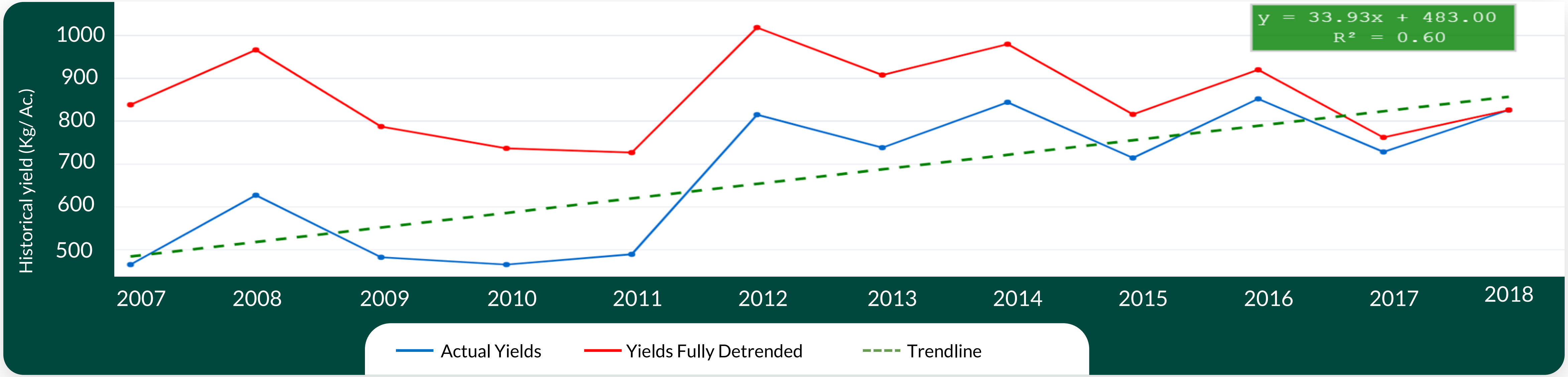
Step 3
Calculate the 'Normal Average' or expected yield for each crop and UAI

Step 4
Define insurance coverage level

Step 5
Conduct Historical Burning Cost Analysis

Step 6
Estimate Insurance Premium Rate

Step 2. Detrend data

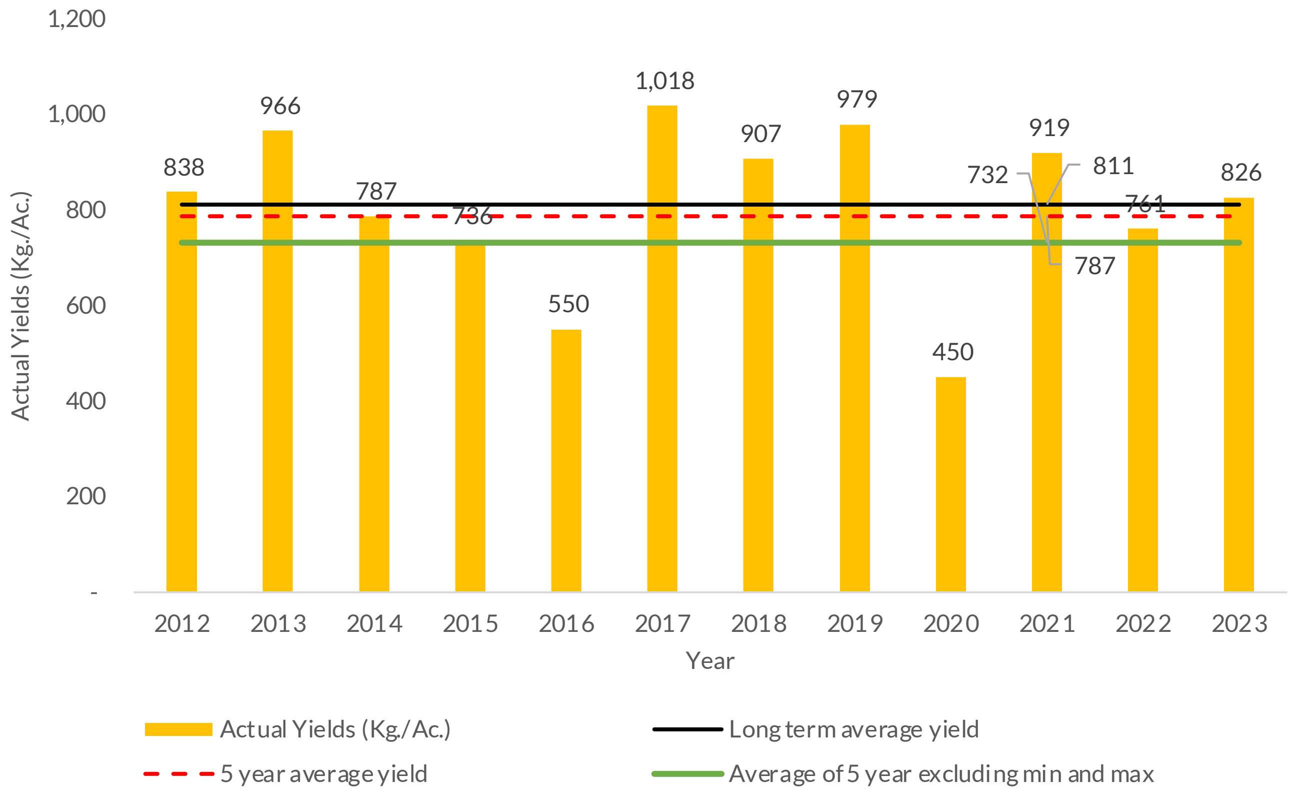


Key Takeaways

Key assumption is that past experience is a good guide to probability of future yields

Need to be careful: adjust for trends over time and look out for step changes (change in cropping practices or technology?)

Step 3. Calculate the average or expected yield per insured crop and UAI



Simplest approach: take average of past 3 or 5 or 7 years' actual area yields.

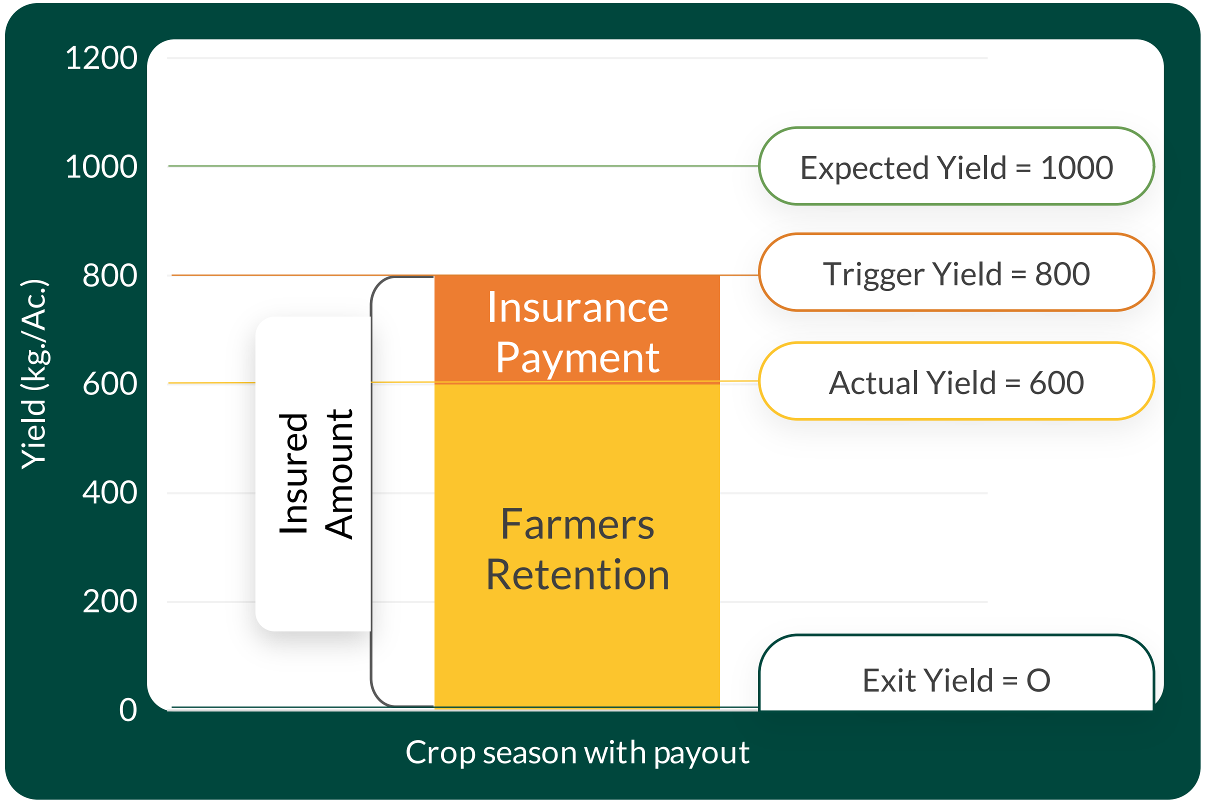
- E.g. India. In past used average of the middle 3 of past 5 years (after eliminating years with the highest and lowest annual yields). BUT found 5 years not always representative. Now uses average of 7 years (after eliminating 2 bad years).

Alternative approach: statistically detrend time-series. Necessary when crop yields are increasing (or decreasing) over time

Key Takeaways:

- Expected yield is a key driver of payouts and premiums → informs trigger thresholds
- **Too short yield data time-series:** can distort average → leading to no or low payouts, or the opposite.

Step 4. Define insurance coverage level



The trigger yield is an agreed % of the expected yield

Process:

1. **Agree on trigger yield** that will be offered to **farmers:**
   - Coverage level can **range from 50% to 90% of the expected yield.**
2. If Trigger Level = 80%,
   Expected Yield = 1000 Kg./Ac.
   - Trigger yield = 1000 * 80% = 800 Kg./Ac.
3. When setting trigger yield think about: vulnerability, affordability, economics of growing crops, source of financing (e.g. credit)

KEY TAKEAWAYS: Trade-off

Lower average yield = less frequent payouts

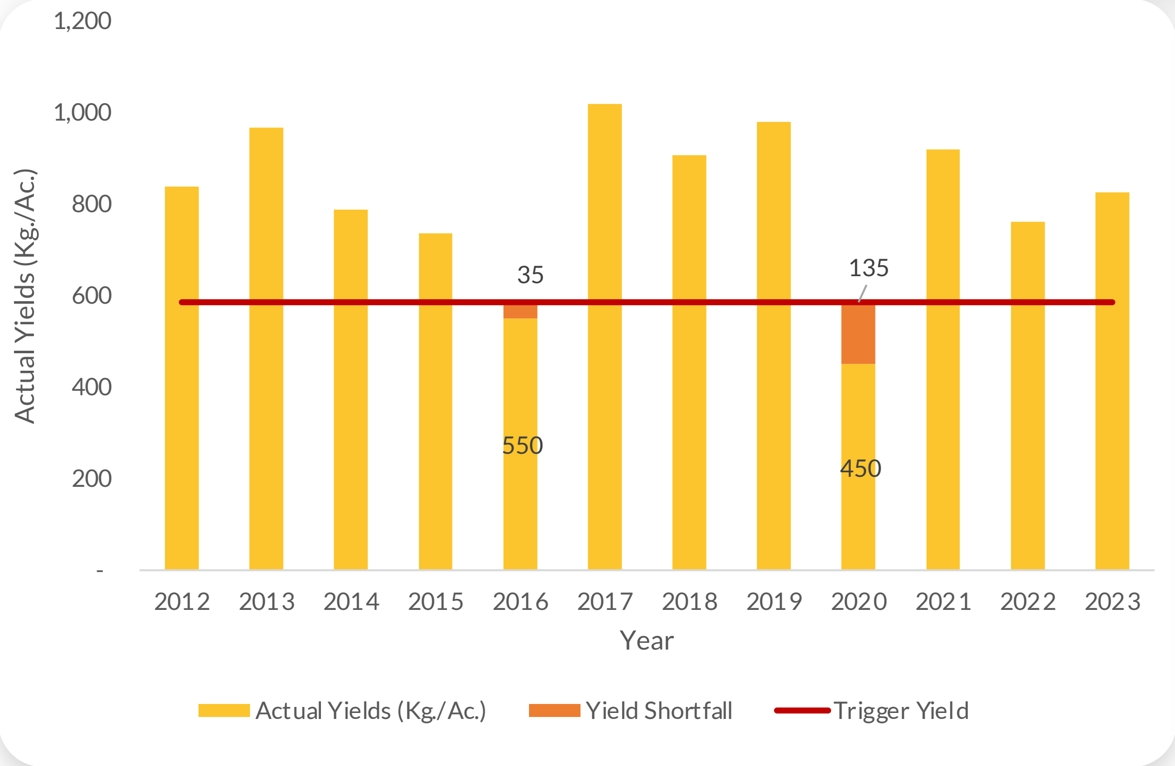
Higher average yield = higher premium

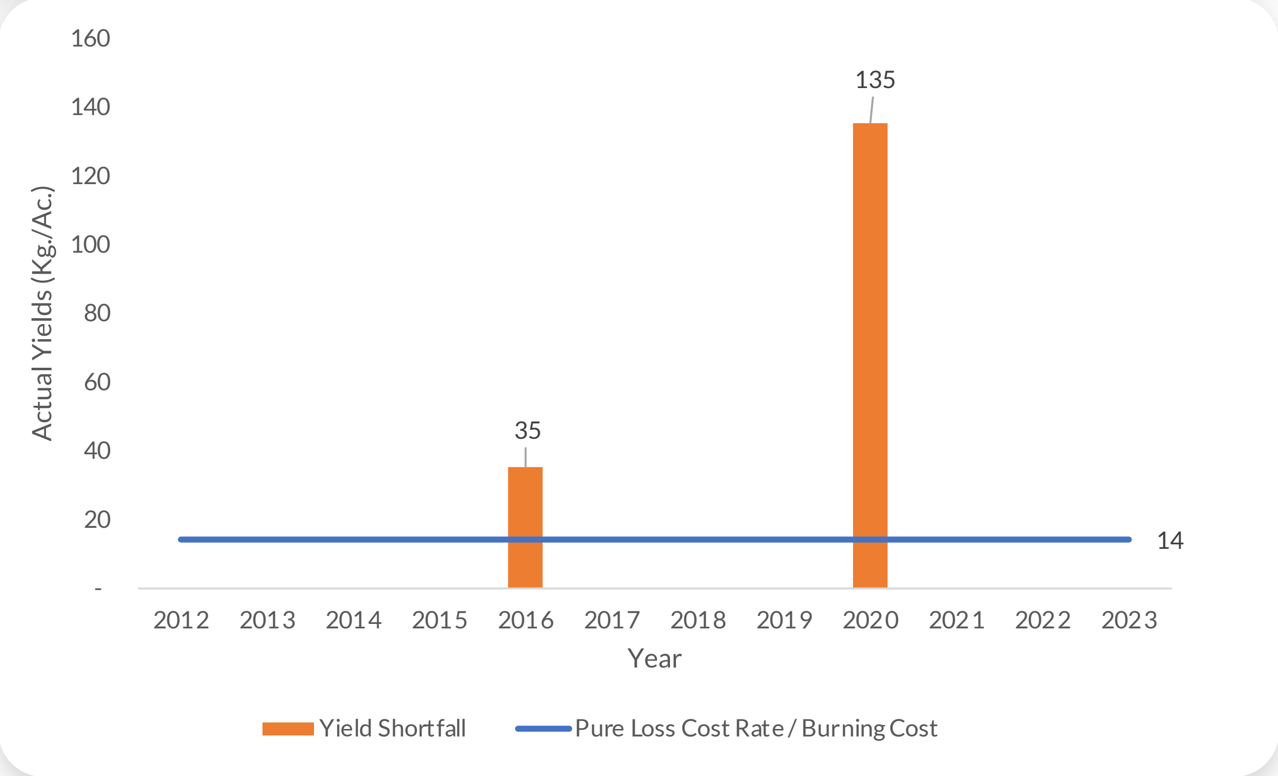
Step 5. Understand likely cost of payouts based on historical yields: Historical Burning Cost (HBC) rating method

What are the steps to price insurance policy with HBC?

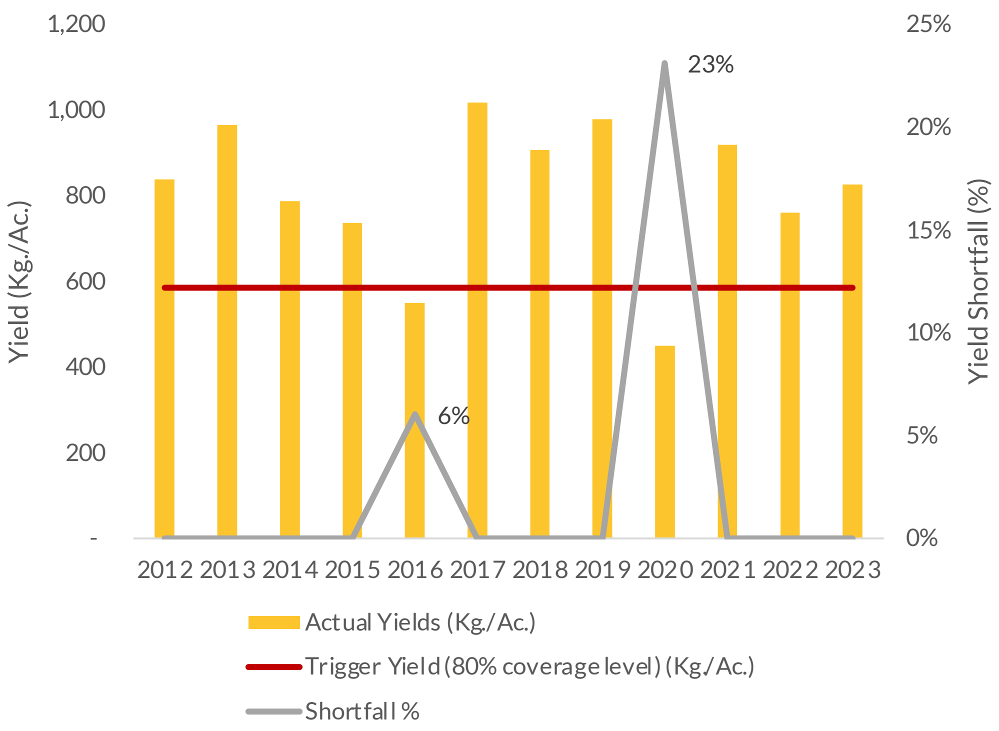
Step 1: for historical years (ideally 15-20 years), for each crop and UAI: calculate when actual yields fell short of the trigger yield and the amount of yield shortfall.

Step 2: calculate the average annual shortfall as a percentage of the total insured amount = **pure loss cost rate or burning cost.**





Step 5i. Calculate pure loss cost rate with trigger yield set at 80% of average



585-550=35

35/585=6%

Year	Actual Yields (Kg./Ac.)	Trigger Yield (80% coverage level) (Kg./Ac.)	Exit Yield (0% Exit level) (Kg./Ac.)	Amount of yield shortfall (Kg./Ac.)	Shortfall %
2012	838	585	-	-	0%
2013	966	585	-	-	0%
2014	787	585	-	-	0%
2015	736	585	-	-	0%
2016	550	585	-	35	6%
2017	1,018	585	-	-	0%
2018	907	585	-	-	0%
2019	979	585	-	-	0%
2020	450	585	-	135	23%
2021	919	585	-	-	0%
2022	761	585	-	-	0%
2023	826	585	-	-	0%
				14	**2%**

Burning cost

732*80%= 585

135/ 585 = 23%

585-450=135

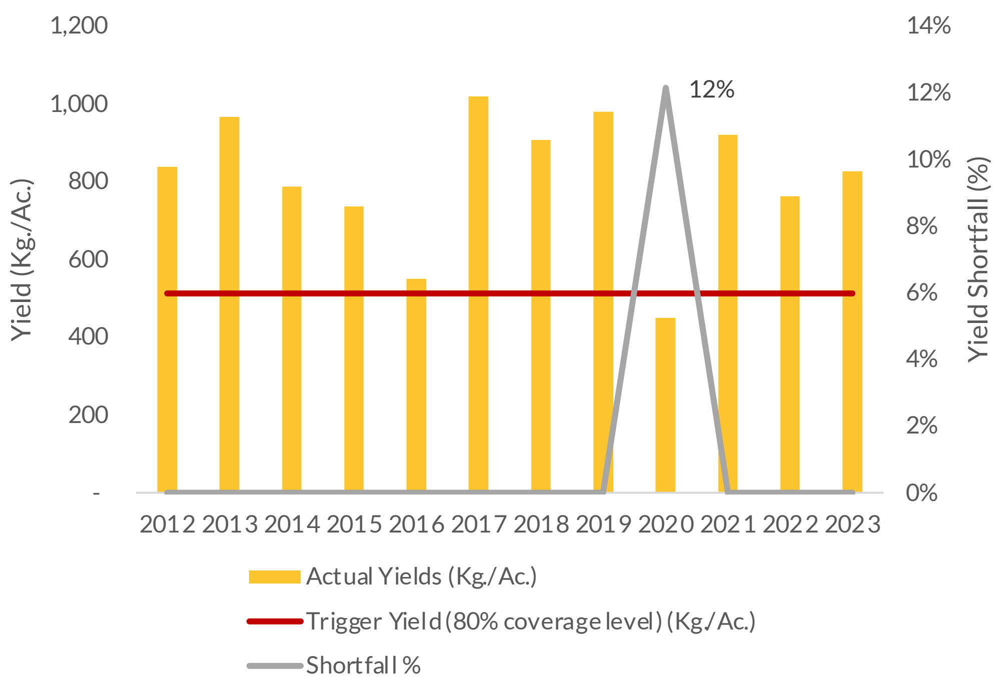
Key Takeaways:

- Trigger yield below 80% in 2016 & 2020 = payouts
- 2020 exceptionally bad year
- The pure loss cost is 2% = (6% +23%) / 12

If Actual Yield < Trigger Yield: then:

$$\text{AYII Payout}\left(\frac{PKR}{ac}\right) = \frac{\left(\text{Trigger Yield}\left(\frac{Kgr}{ac}\right) - \text{Actual Yield,}\left(\frac{Kgr}{ac}\right)\right)}{\left(\text{Trigger Yield}\left(\frac{Kgr}{ac}\right) - \text{Exit Yield}\left(\frac{Kgr}{ac}\right)\right)}$$

Step 5i. Calculate the pure loss cost with trigger yield at 70% of long-term average



Year	Actual Yields (Kg./Ac.)	Trigger Yield (80% coverage level) (Kg./Ac.)	Exit Yield (0% Exit level) (Kg./Ac.)	Amount of yield shortfall (Kg./Ac.)	Shortfall %
2012	838	512	-	-	0%
2013	966	512	-	-	0%
2014	787	512	-	-	0%
2015	736	512	-	-	0%
2016	550	512	-	-	0%
2017	1,018	512	-	-	0%
2018	907	512	-	-	0%
2019	979	512	-	-	0%
2020	450	512	-	62	12%
2021	919	512	-	-	0%
2022	761	512	-	-	0%
2023	826	512	-	-	0%

Burning cost

732*70%= 512

62 / 512 = 23%

512-450=62

If Actual Yield < Trigger Yield: then:

$$\text{AYII Payout}\left(\frac{PKR}{ac}\right) = \frac{\left(\text{Trigger Yield}\left(\frac{Kgr}{ac}\right) - \text{Actual Yield,}\left(\frac{Kgr}{ac}\right)\right)}{\left(\text{Trigger Yield}\left(\frac{Kgr}{ac}\right) - \text{Exit Yield}\left(\frac{Kgr}{ac}\right)\right)}$$

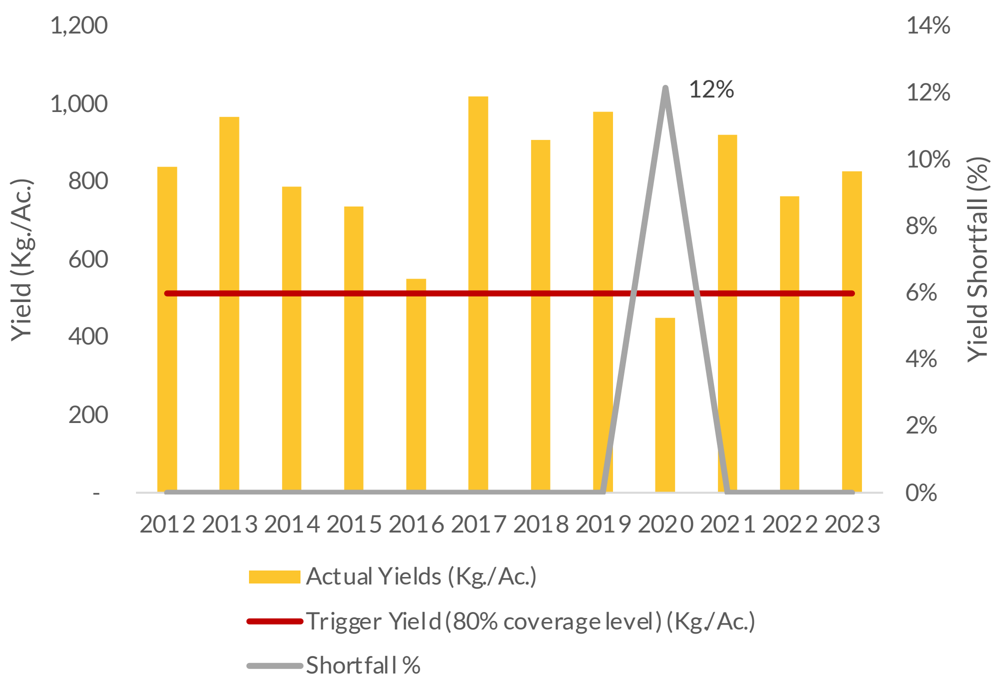
Step 5i. Calculate the pure loss cost with trigger yield at 70% of long-term average

Go to menti.com

Enter code: 4428 3064

- Question: what is the pure loss cost rate?
- Choose one option:
  a. 0.5 %
  b. 1 %
  c. 2 %

Step 5i. Calculate the pure loss cost with trigger yield at 70% of long-term average



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2020	450	512	-	62	12%
2021	919	512	-	-	0%
2022	761	512	-	-	0%
2023	826	512	-	-	0%
				5	**1%**
Burning cost					

732*70%= 512

62 / 512 = 23%

512-450=62

Key Takeaways:

- **The pure loss cost is reduced to 1%** = 12% / 12 with a lower coverage level of 70%
- 2016 shortfall is no longer covered when coverage level drops to 70%

If Actual Yield < Trigger Yield: then:

$$\text{AYII Payout}\left(\frac{PKR}{ac}\right) = \frac{\left(\text{Trigger Yield}\left(\frac{Kgr}{ac}\right) - \text{Actual Yield,}\left(\frac{Kgr}{ac}\right)\right)}{\left(\text{Trigger Yield}\left(\frac{Kgr}{ac}\right) - \text{Exit Yield}\left(\frac{Kgr}{ac}\right)\right)}$$

Step 6. Estimate Insurance Premium Rate

Original Gross Premium

- Profit
- Cost of capital
- Reinsurance
- Operational costs
  - Administrative and Operational Cost
  - Acquisition costs
  - Loss Adjustment cost

Technical Premium

- Security margin
- Catastrophe margin
  - Loading to cope with the risk of using unreliable data
  - Loading to cope with unpredictable and unforeseen losses

Pure Loss Cost Premium

- Loss cost
  - As calculated in step 5

Key Takeaways

- Guideline final commercial premium = pure loss cost x 1.4 to 2.0
- Some margins can be reduced with better operations, data, and product design
- Overall viable rates for SSA could be in the range of 5 to 10%

Source: Stutley, C. Rural and Agriculture Finance Programme

Summary on AYII for smallholder farmers in SSA

2000 to 2010 nearly all focus was on micro-level WII pilots in Africa, but most failed due to contract design and spatial basis risk.

Many practitioners argued AYII in Africa was not possible because of:

- The mixed cropping farming systems of most smallholder farmers
- Lack of accurate historical area, production and yield data at local (e.g. ward) level) to construct index, and
- The lack of a capability in the public sector to conduct CCEs at time of harvest to establish the actual average yield for payout purposes.

But over past 7 to 8 years it has been shown to be possible.

Now both public and private sectors are investing in CCE capabilities.

AYII is showing to be an insurance product which overcomes many of the drawbacks of MPCI and WII and this benefiting small scale farmers in SSA

Going forward machine learning, AI, RS technology, smart sampling and drone technology are likely to support AYII expansion and to rationalize the number of CCEs required. India under revamped PMFBY is at the forefront of this technological revolution.

DRF for Agriculture and Climate Resilient Livelihoods

Thank You

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