Strengthening Financial Resilience in Agriculture
Knowledge Exchange Series Part 2

Disaster Risk Financing Solutions for Climate-resilient Livelihoods in the Agricultural Sector

Session 1:

Index Insurance and the State of Global Evidence

Disaster Risk Financing & Insurance Program

SUPPORTED BY WORLD BANK GROUP

USAID FROM THE AMERICAN PEOPLE

Structure of Webinars

Total of 4 Factsheets & 90-minute Webinar for each Factsheet

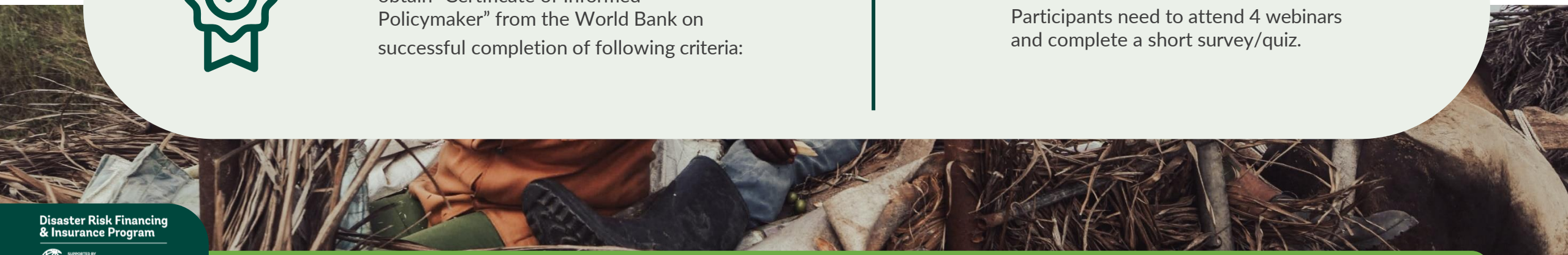
Different guest speakers

Q&A: Please share your questions via chat

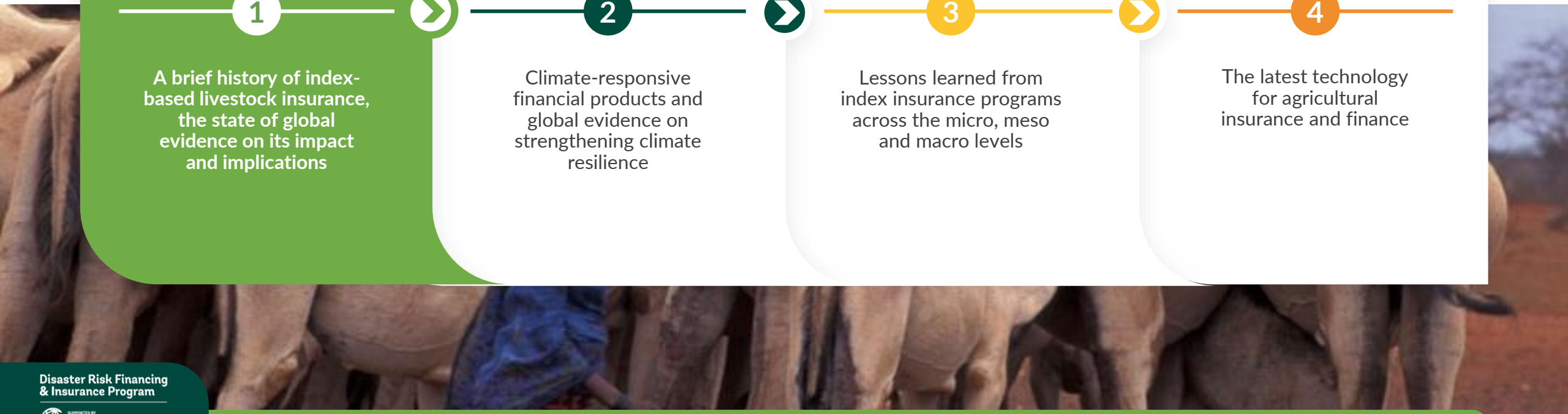
Participants will have an opportunity to obtain "Certificate of Informed Policymaker" from the World Bank on successful completion of following criteria:

Completion Certificate:

Participants need to attend 4 webinars and complete a short survey/quiz.



What will the four webinars cover?



1. **A brief history of index-based livestock insurance, the state of global evidence on its impact and implications**
2. Climate-responsive financial products and global evidence on strengthening climate resilience
3. Lessons learned from index insurance programs across the micro, meso and macro levels
4. The latest technology for agricultural insurance and finance

Session 1:

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Opening Remarks

Olivier Mahul

Practice Manager, Crises and Disaster Risk Finance, WB

Introduction Remarks

Lara Evans

Social Protection Advisor, USAID

Quick Recap of the previous series and 3 Key Messages

Qhelile Ndlovu

Financial Sector Specialist, Crises and Disaster Risk Finance, WB

Recap of Knowledge Exchange Part 1

SESSION

1

Introduction to DRFA

2

Managing Risks to Agriculture

3

Choosing the Right Financial Instrument

4

Deep Dive into Agricultural Insurance

5

Index Insurance

6

Introduction and Use of Data

7

Structuring a Financial Protection Scheme

8

Role of Government in DRF for Agriculture

3 Key Messages from the Previous Series

Key message 1:

There is wide range of market-based solutions that correspond to different levels of risk and population segments.

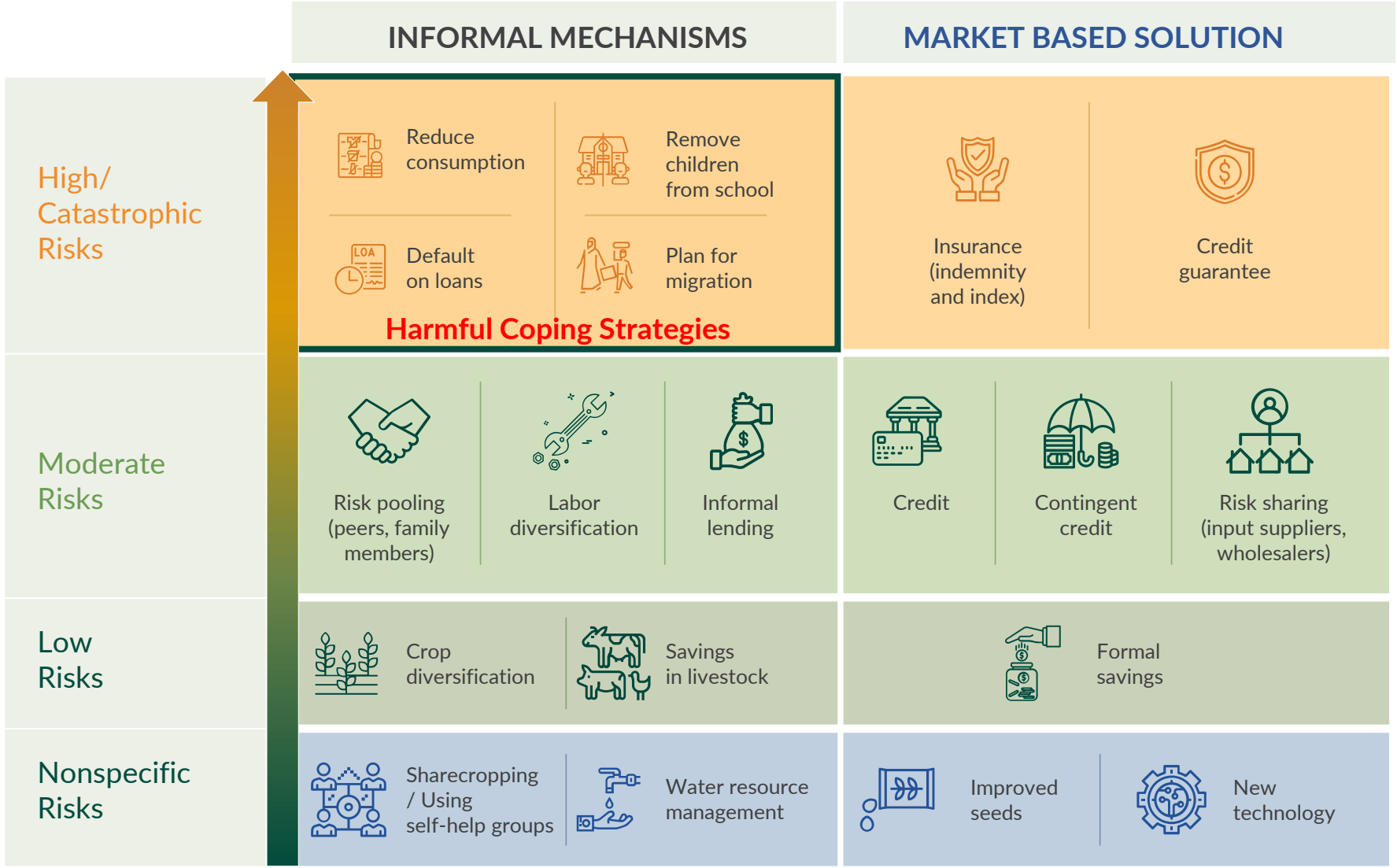
Key message 2:

Digital technologies have helped agriculture insurance evolve, enabling index-based insurance and making it more affordable and accessible; however, basis risk remains a challenge.

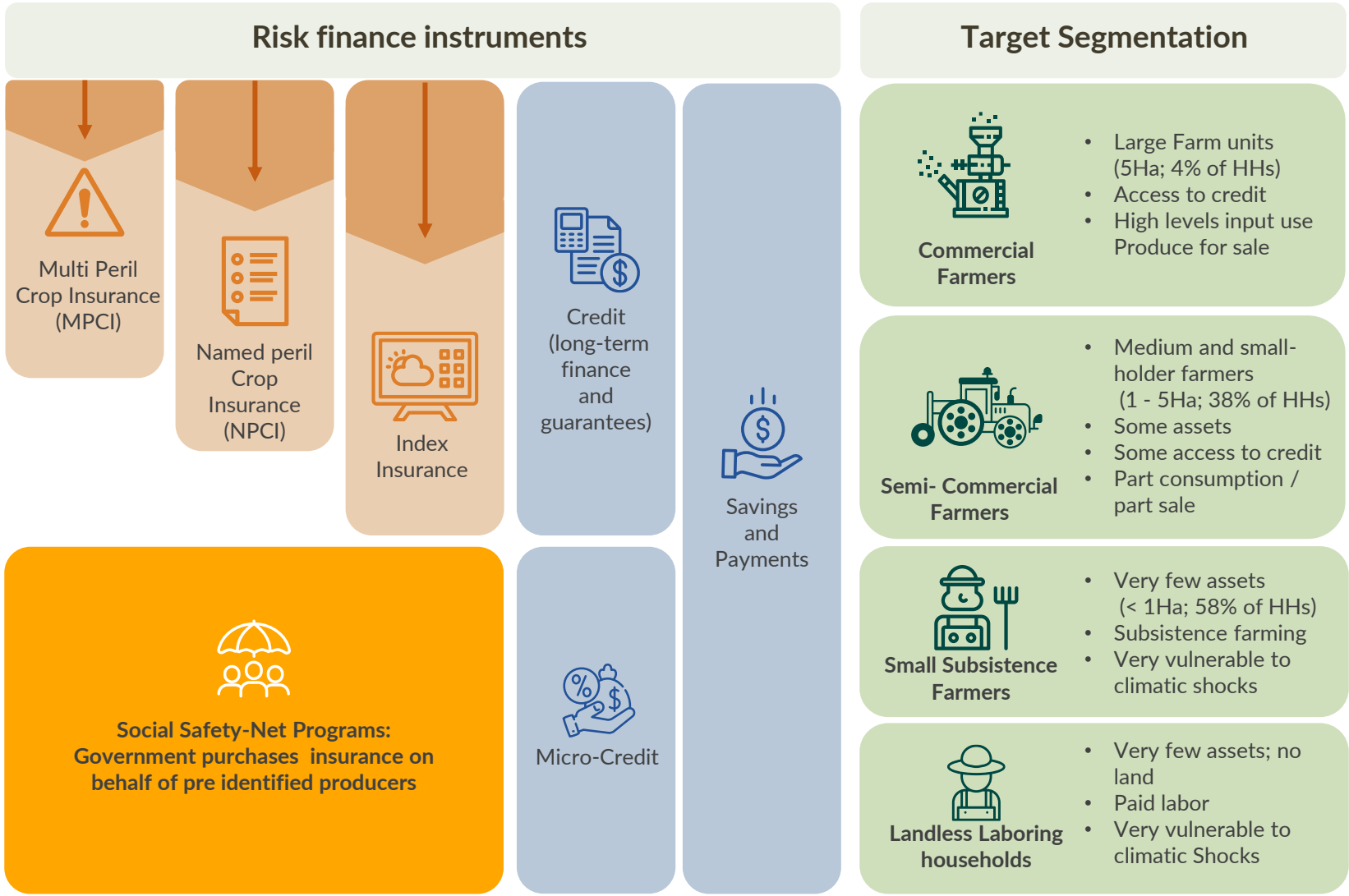
Key message 3:

International experience shows that delivering solutions at scale requires public-private partnerships (PPPs) to sustainably address market failures effectively and sustainably.

KM 1.2. Market-based financial solutions can complement informal mechanisms and are more effective in building resilience to shocks when part of a comprehensive risk management strategy.



KM 1.3. One size does not fit all: No single financial instrument is adequate to manage the risks; instead, households require integrated financial services based on their risk profiles.



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KM 2.1. Agriculture insurance is a major DRFA instrument with ample global experience and a history of innovation from which to learn and continue to innovate.

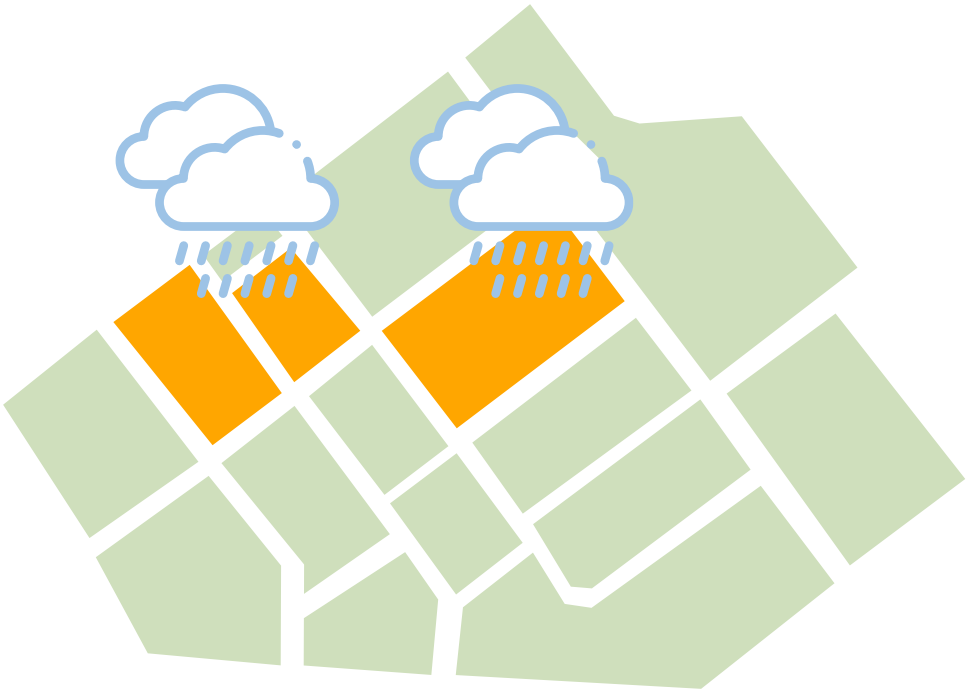
Indemnity insurance:

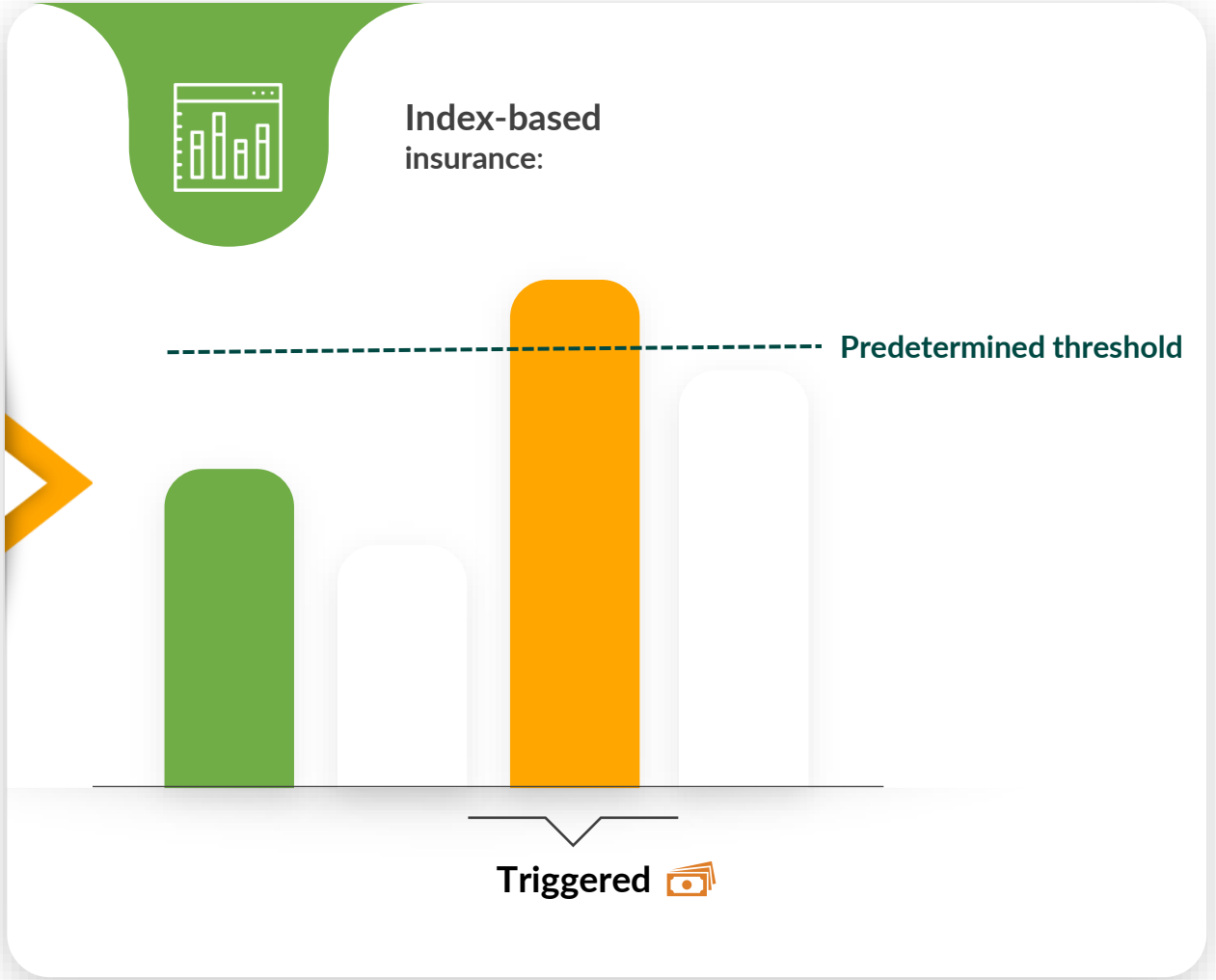
- Traditional
- Based on actual losses or damage
- Need inspection to evaluate losses
- High cost
- Moral hazard and Adverse Selection

Index-based insurance:

- Newer Insurance type
- Not based on actual loss or damage
- Based on Predetermined index (e.g., rainfall, soil moisture, windspeed, average yield)
- No need of field inspection
- Fast payout
- More Affordable

KM 2.2. Index insurance helps to address the major challenges of traditional insurance, but the imperfect relationship between the actual loss and the index can create a significant basis risk for farmers





KM 2.3. Both downside and upside basis risk can damage trust in insurance, further depressing demand for and limiting the supply of agriculture insurance; however, technology development can minimize this basis risk.

	Index triggered	Index not triggered
Affected by perils	 Loss is covered properly	 Downside basis risk
Not affected by perils	 Upside basis risk	 Normal yields

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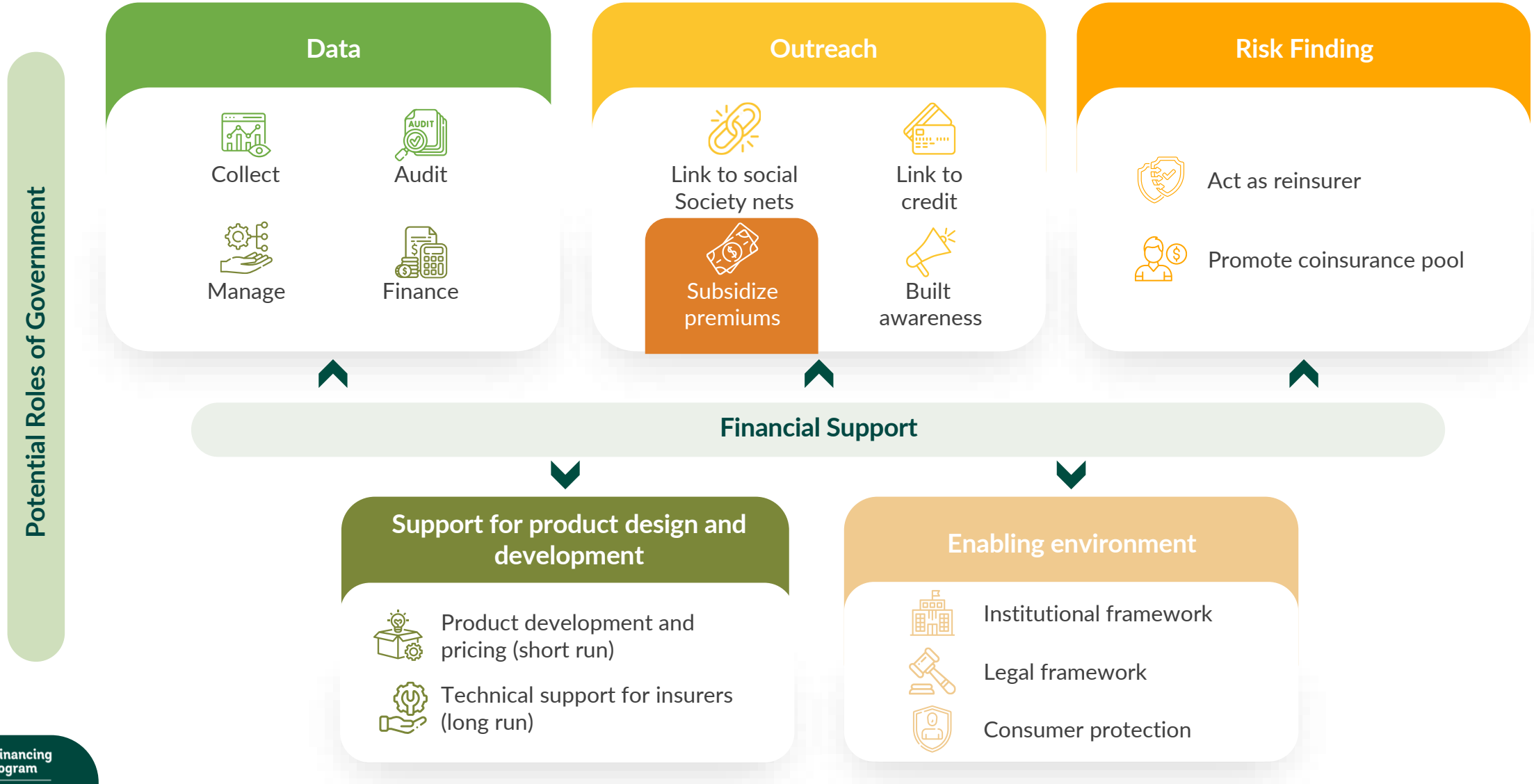
Key message 3:

International experience shows that delivering solutions at scale requires public-private partnerships (PPPs) to address market failures effectively and sustainably.

KM 3.2: Government support spans both technical and financial roles. Premium subsidies are the most common public intervention in both developed and developing countries.



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Knowledge Exchange Part 1 available

https://www.financialprotectionforum.org/knowledge-series-strengthening-financial-resilience-in-agriculture

Financial protection Forum RESILIENCE IN AGRICULTURE

Christopher B. Barrett

Stephen B. and Janice G. Ashley Professor of Applied Economics and Management, Cornell University

Cornell University

The origins and impacts of Index-Based Livestock Insurance

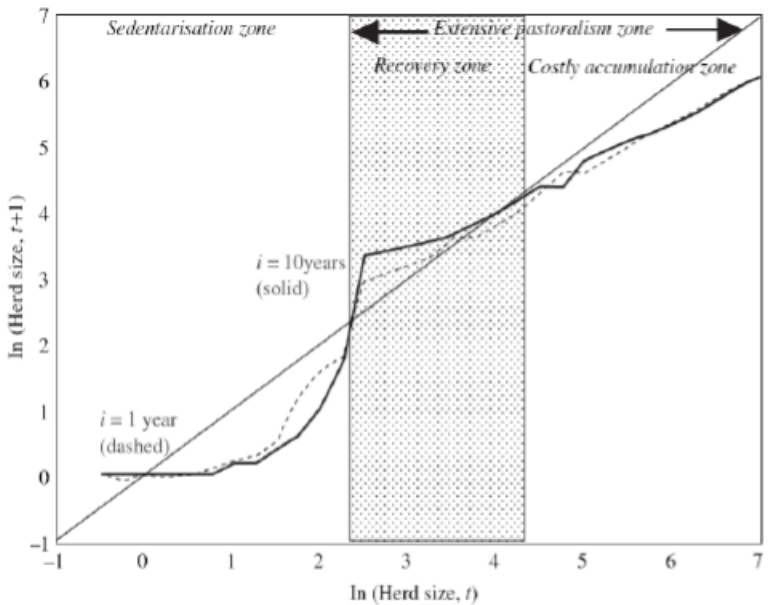
Prof. Christopher B. Barrett
Cornell University

World Bank webinar on Strengthening Financial Resilience in Agriculture Resilience Series
June 7, 2023

Why IBLI? Poverty Traps And Catastrophic Risk

Poverty traps exist in the arid and semi-arid lands (ASAL) of Kenya/Ethiopia. **Catastrophic herd loss risk due to major droughts is *the* major cause of these dynamics.** Puts a premium on drought risk management, both for individuals and for society.

Sources: Lybbert et al. (2004 *EJ*) and Santos & Barrett (2011 *JDE*, 2019 Barrett et al. UCP/NBER volume) on Boran in s. Ethiopia. Barrett et al. (2006 *JDS*), Chantarat et al. (2017 *WD*) for n. Kenyan pastoralists.



Nadaraya-Watson estimates using Epanechnikov kernel with bandwidth ($h = 1.5$)

In the presence of stochastic poverty traps, the 'paradox of social protection' implies high social returns to effective risk protection.

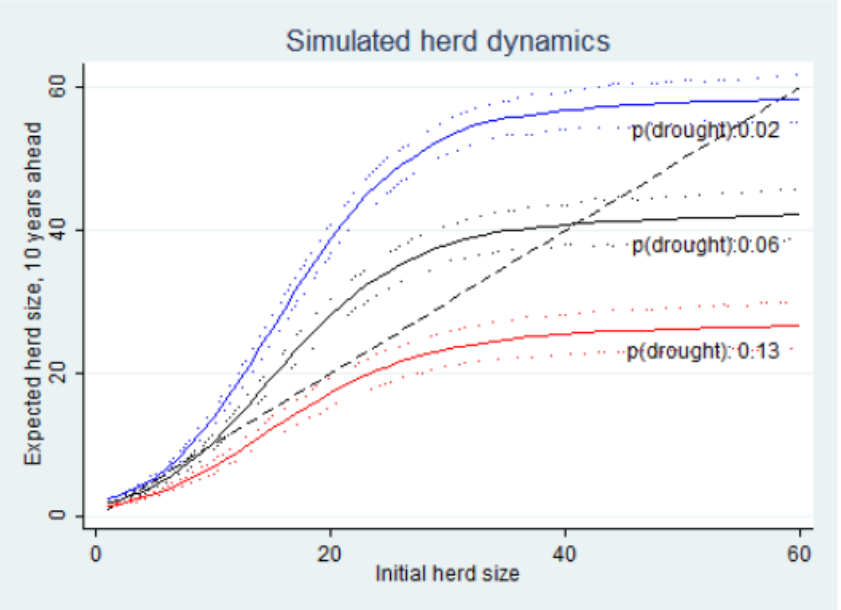
(Ikegami et al. 2019 Barrett et al. UCP/NBER volume).

Why IBLI? Increased Risk From Climate Change

Pastoralist systems evolutionarily adapted to climate regime. But resilient to a historically rapid climate shift? If frequency of drought (<250 mm/yr) rises, recovery times shrink and system shifts.

Modeling work that mixed herders' state conditional year-ahead herd growth expectations w/rainfall histories allowed us to simulate.

In southern Ethiopia, in expectation, doubling drought risk leads to system collapse in the absence of any change to prevailing herd dynamics or drought responses.



Source: Barrett and Santos (*Ecol Econ* 2014)

Why IBLI? Standard Responses Ineffective

Standard responses to major drought shocks:

1) Post-drought restocking: futile at low levels (Santos & Barrett 2019 chapter in Barrett et al. 2019 UCP/NBER volume)

2) Food aid is slow, expensive, can reinforce sedentarization, high rates of excess mortality (Nikulov et al. PLoS ONE 2016)

Moreover, if rising numbers of poor rural peoples turn increasingly to natural resource exploitation, a vicious cycle of reinforcing feedback may begin.

How? Original IBLI Product Design

The signal: Normalized Difference Vegetation Index (NDVI) collected by satellite

Original response function: regress historic livestock mortality onto transforms of historic cumulative standardized NDVI (*Czndvi*) data. Original index was predicted livestock mortality. Now, just use NDVI.

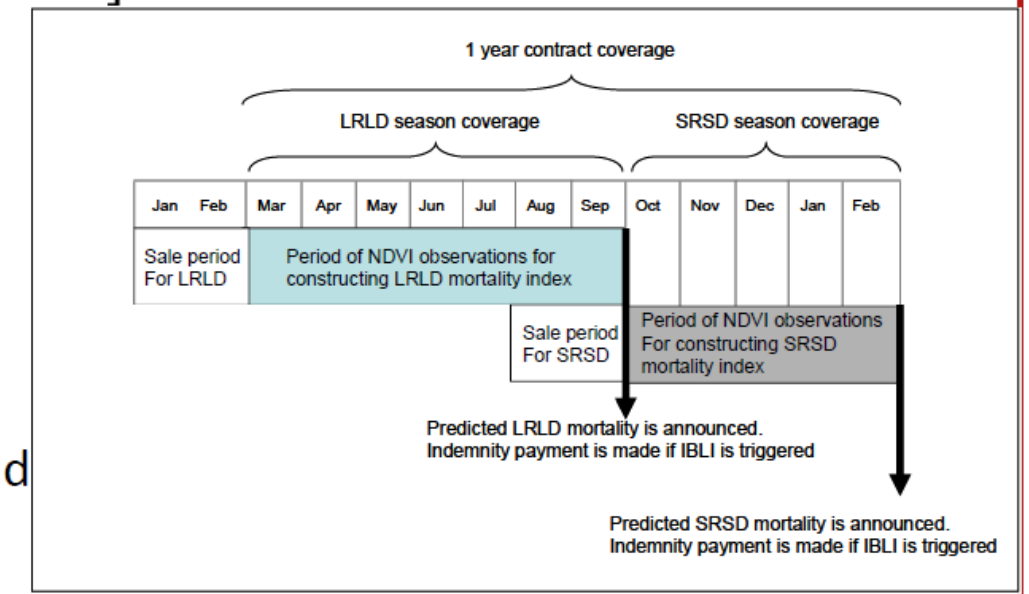
Indemnity payments: In Kenya, originally $\widehat{LM}$ >15% according to:

$$max\left[index_{d,t}(\bar{L}_{d,t}, \mu_{d,t}) - 0.15, 0\right] * value\ of\ livestock\ insured$$

Temporal Structure of IBLI contract:

12-month contract sold during 2-mo sales windows just prior to usual start of seasonal rains. Payouts originally Mar 1 and/or Oct 1. Now earlier

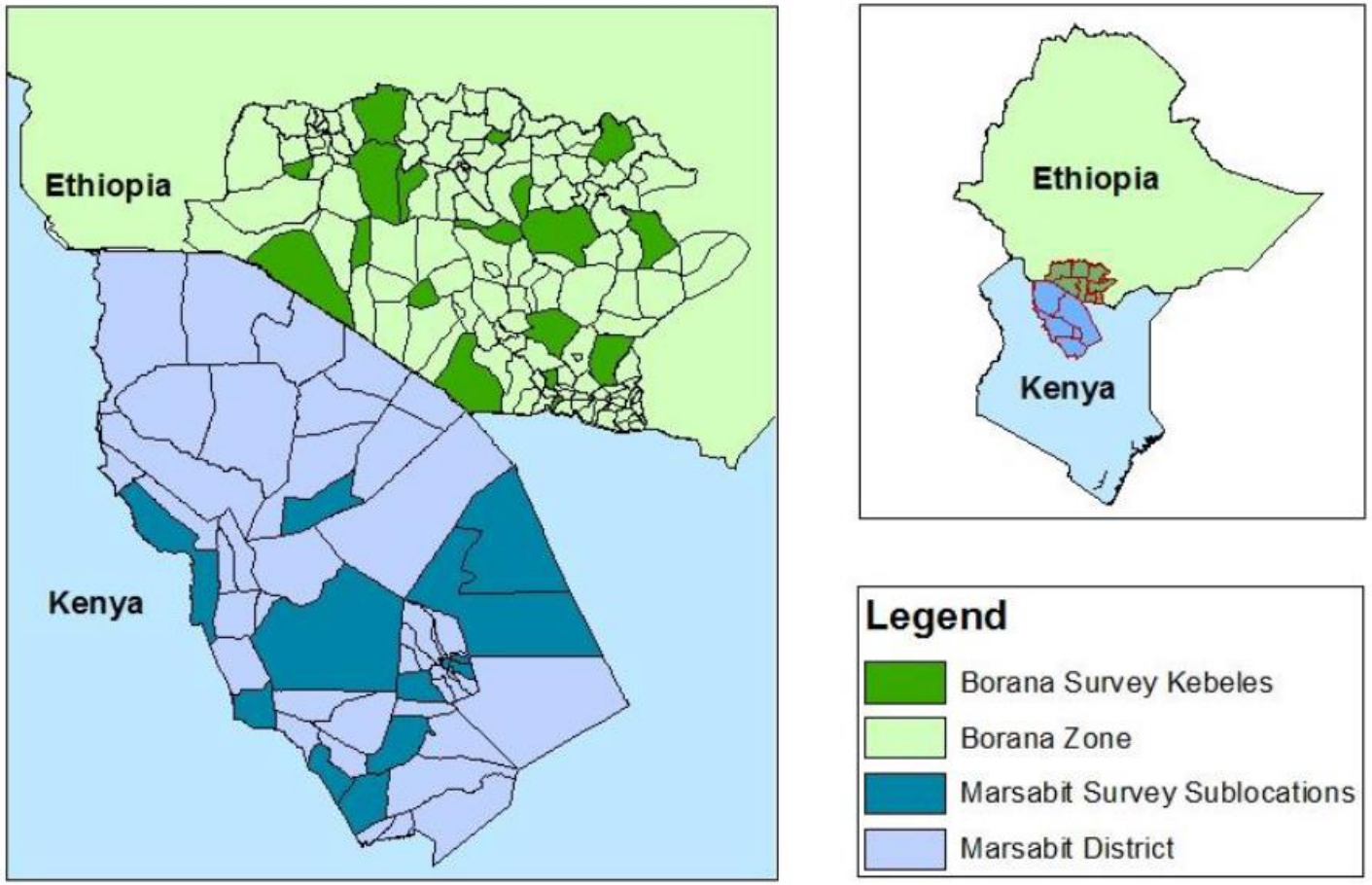
Later updated to (i) pure NDVI play and (ii) payments early … asset protection vs. asset replacement design.



See Chantarat et al. *JRI* 2013; Jensen et al. *Ecol Econ* 2019; Fava & Vrieling COES 2021

How? Pilots in Ethiopia and Kenya

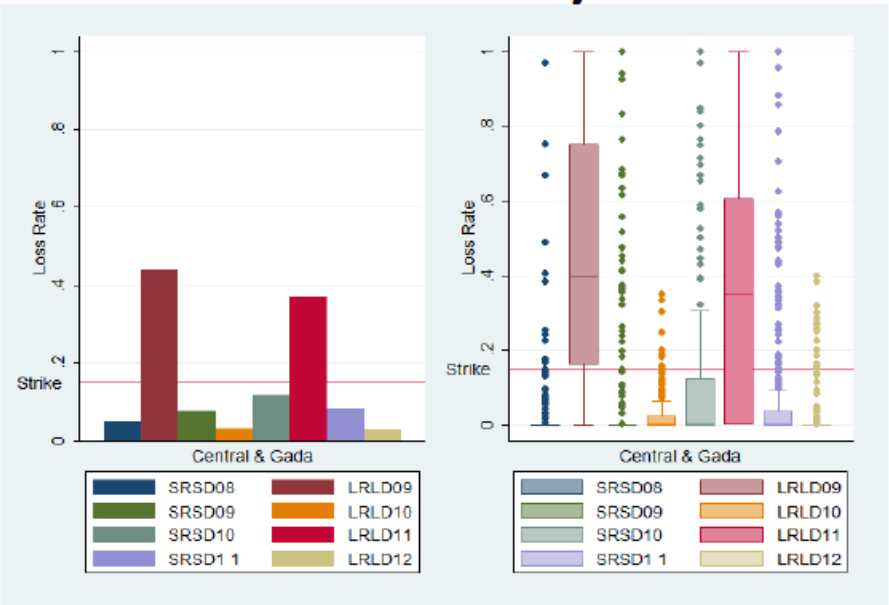
IBLI products (and IE surveys) launched in Marsabit, Kenya in Jan 2010 (Oct 2009) and in Borana, Ethiopia, in Aug 2012 (Mar 2012).



Kenya sampling overlaid with HSNP coverage and randomized premium discount coupon distributions as research design.

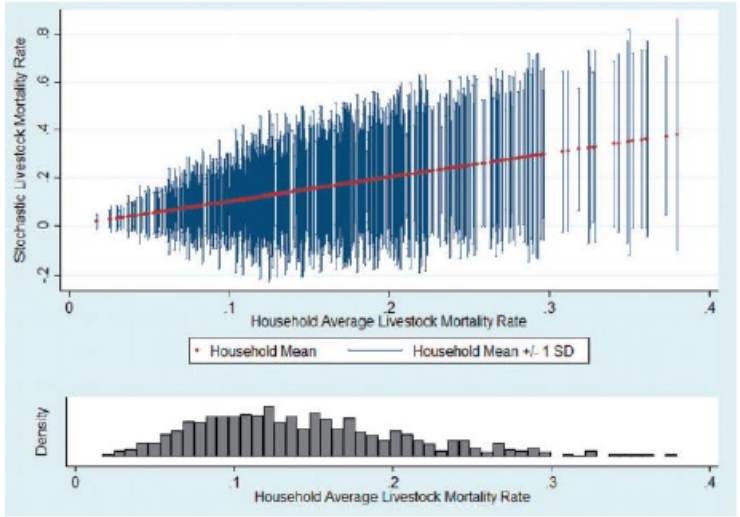
IBLI offers imperfect/incomplete risk transfer

Covariate risk is important but household losses vary a lot …



Notes: The left figure illustrates the covariate (average) loss rate in each season. The right figure illustrates the distribution of losses within each seasons. The boxes depict the interquartile range, the upper and lower adjacent values are either 3/2 the interquartile range or the value furthest from the median. The remaining observations fall outside the adjacent values.

… even for a given hh over time …



Notes: Household-season herd loss rate spreads (mean in red, ±1 SD in blue), ordered by hh avg loss rate (top), and distribution of hh avg loss rates (bottom).

Result: IBLI hhs still hold most risk: 62-77% of total risk exposure remains

Most basis risk is idiosyncratic and random, not targetable or correctable. So IBLI can't stand alone intervention.

Jensen, Barrett & Mude *AJAE* 2016;
Jensen, Mude & Barrett *FP* 2017

But yields consistently positive IBLI impacts

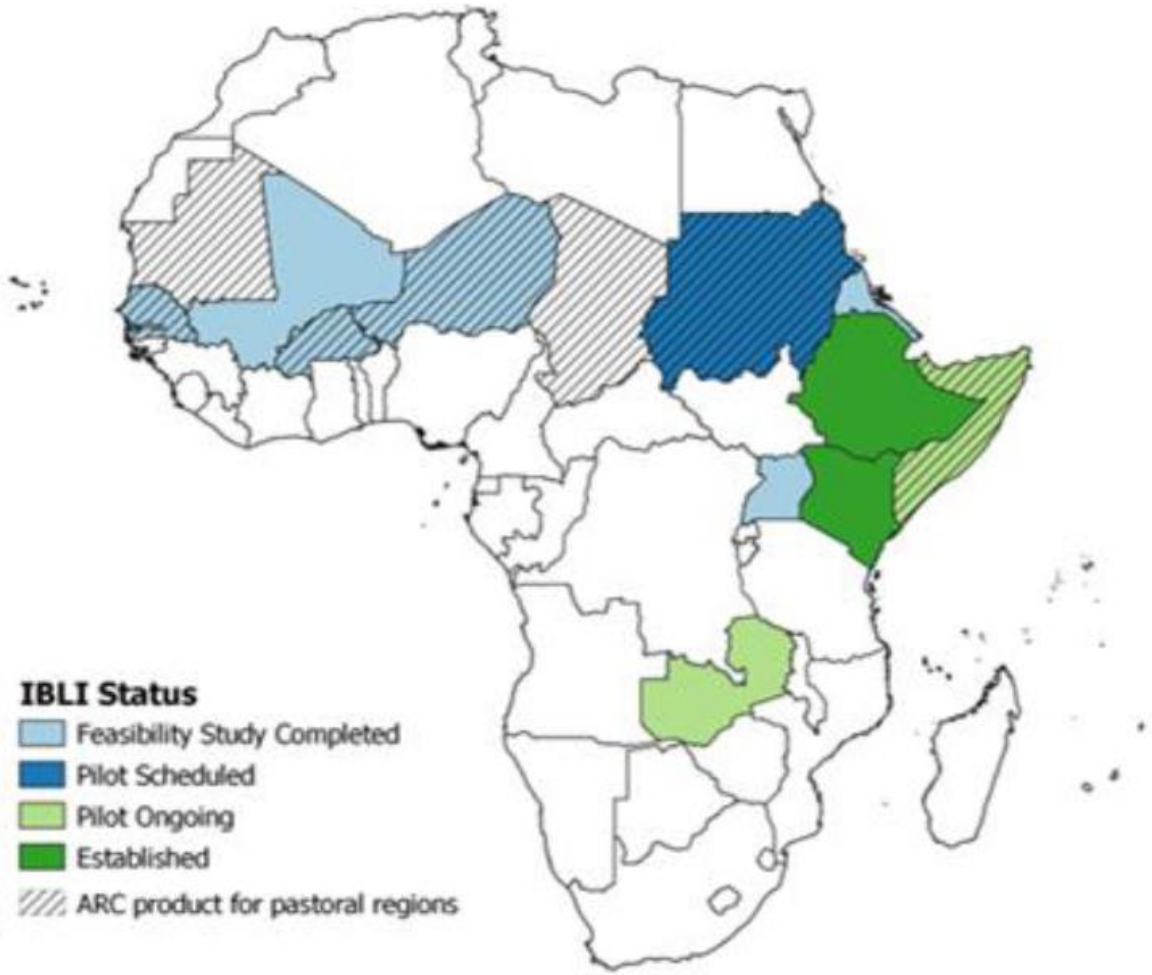
IBLI coverage:

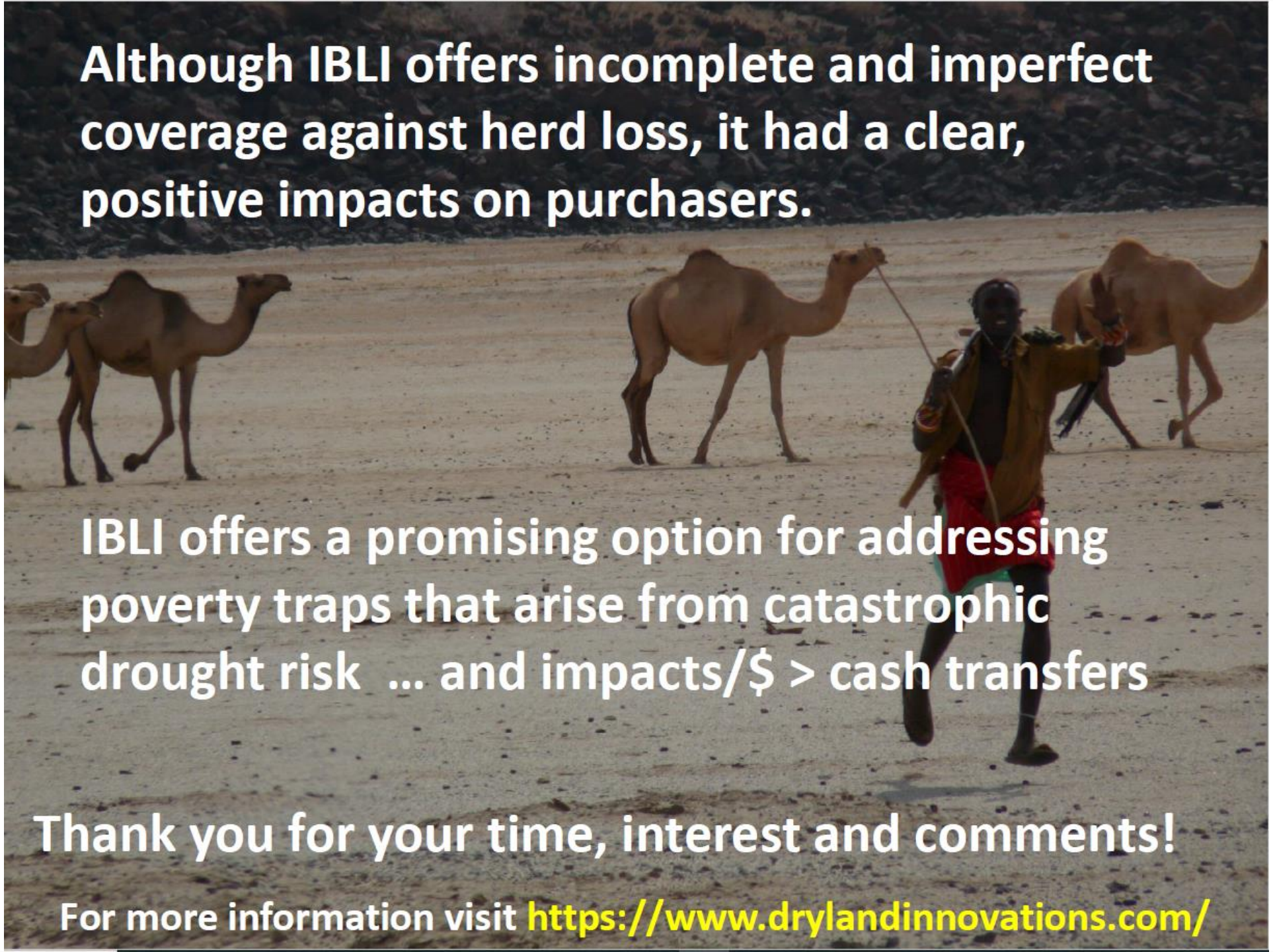
- Increased vet expenditures, milk income/TLU, total hh income, child MUAC; income and milk production in drought years.
- Reduced distress livestock sales, herd losses, slaughtering and meal skipping in response to indemnity payments
- Increased subjective well-being by far more than buyer's remorse effects of lapsed insurance that doesn't pay out.
- Crowded in informal transfers within communities, addressing basis risk issues and perhaps reinforcing traditional conflict resolution/social solidarity.

- **Marginal impact on income or MUAC is 6-45x that of HSNP cash transfers!**

Jensen, Barrett & Mude *JDE* 2017; Toth et al. 2018; ; Janzen & Carter; Tafere, Barrett & Lentz; Takahashi, Barrett & Ikegami - all *AJAE* 2019; Gebrekidan et al. *CRM* 2019; Matsuda et al. *GPRI* 2019; Noritomo & Takahashi *JDS* 2020

Sparked large IBLI scale-up/adaptation




Although IBLI offers incomplete and imperfect coverage against herd loss, it had a clear, positive impacts on purchasers.
IBLI offers a promising option for addressing poverty traps that arise from catastrophic drought risk … and impacts/$ > cash transfers
Thank you for your time, interest and comments!
For more information visit https://www.drylandinnovations.com/

Michael R Carter

Distinguished Professor of Agricultural and Resource Economics, University of California, Davis & Director, Feed the Future Innovation Lab for Markets, Risk and Resilience

FEED THE FUTURE INNOVATION LAB
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basis.ucdavis.edu

Defining and Using Economic Measures of Index Insurance Quality to Craft Better Contracts: Index Based Livestock Insurance in East Africa

Michael R Carter

University of California, Davis, University of Cape Town & NBER

World Bank Evidence Webinar: A Brief History of Index Insurance
7 June 2023

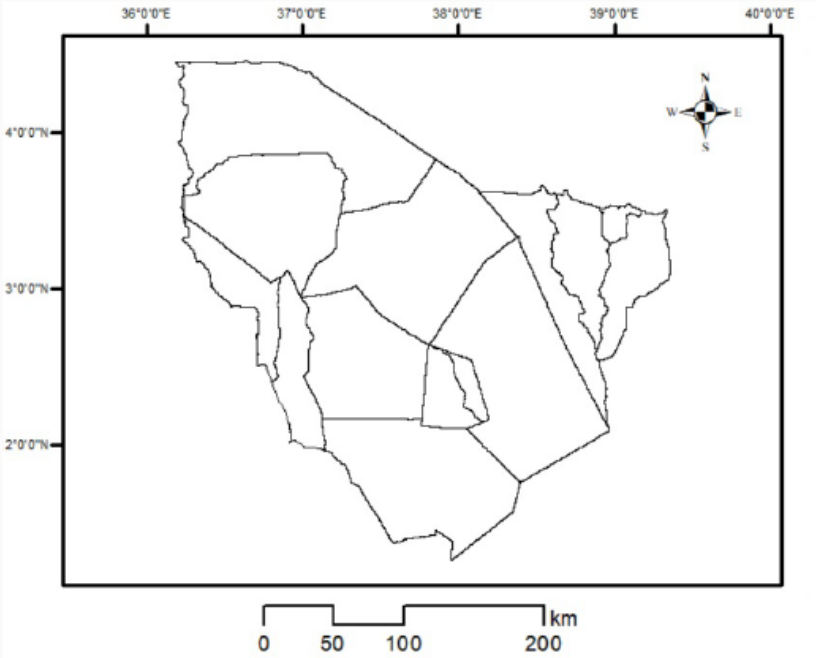
The Quality Challenge for Index Insurance: Measurement

- Pushback from unhappy insurance clients signals contract quality problems for index insurance
- But, to improve quality, we need to know how to measure it!
- The MRR Lab's Quality Index Insurance Certification (QUIIC) program, being implemented in collaboration with the CG system has devised a measure based on the impact of an insurance contract on the expected economic well-being of the insured (measured as the expected utility or certainty equivalent of the insured's income or wealth stream)
  - *Minimum Quality Standard (MQS):*
    If an insurance contract improves the insured's expected level of well-being, then the contract meets the MQS (pretty minimal!). Thumbs up, or thumbs down
  - *Relative Insurance Benefit (RIB)*:
    What fraction of the improvements in expected well-being that could be achieved with a *hypothetical* perfect insurance contract does the contract achieve. Useful for choosing the best amongst many *possible* contracts.

There & Back Again: Applying Quality Metrics to Marsabit, Kenya

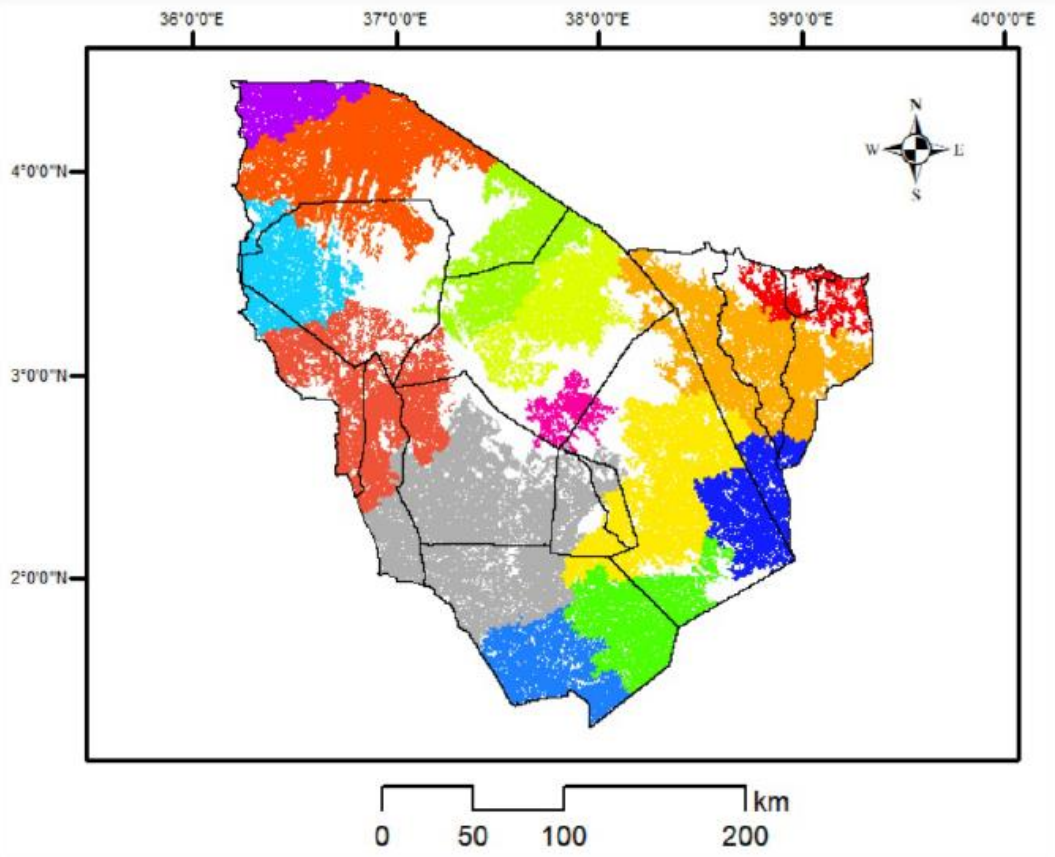
- To illustrate these ideas, return to Marsabit County Kenya where Chris Barrett & I devised the initial Index-based Livestock Insurance (IBLI) along with Andrew Mude and others at the International Livestock Research Institute
- Using RIB measure, will show today using data from Marsabit that:
  - Statistically optimized insurance zones (UAIs) can double insurance quality compared to current UAIs
  - Modestly increasing the number of UAIs can increases insurance quality by another 30%
- However, best RIB is well under 50%, meaning that there is a need to do better
  - Propose a hybrid contract based on remote sensing backed up by a mortality audit to reduce failures and push the RIB closer to 100%
- Also discuss options for using different satellites moving forward

The Problem of Insurance Zones



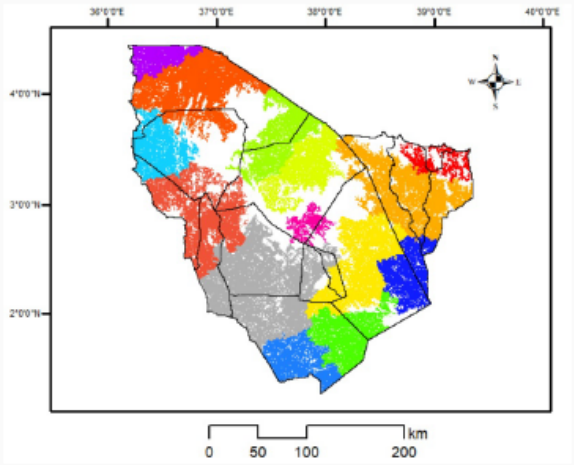
- Originally 5 insurance zones in Marsabit based on loose ideas of agro-ecological zones, species compositions of pastoralists and ethnic fault lines
- Later expanded to the 14 UAIs shown on map
- How much of low quality & client complaints are based on the fact that one end of these ad hoc zones, conditions are often bad, while they are good at the other end.
- We can take a scientific approach so that we form contiguous zones that minimize the probability that these unfortunate events take place

Optimized Insurance Zones for Marsabit



- The white areas are non-grazing land areas (according to the Sentinel satellite) and have been masked out of the analysis.
- Hiding a lot of big data complexity, our Optimal Zone Algorithm groups together pixels so that we minimize the problem of error,

Optimized Insurance Zones for Marsabit



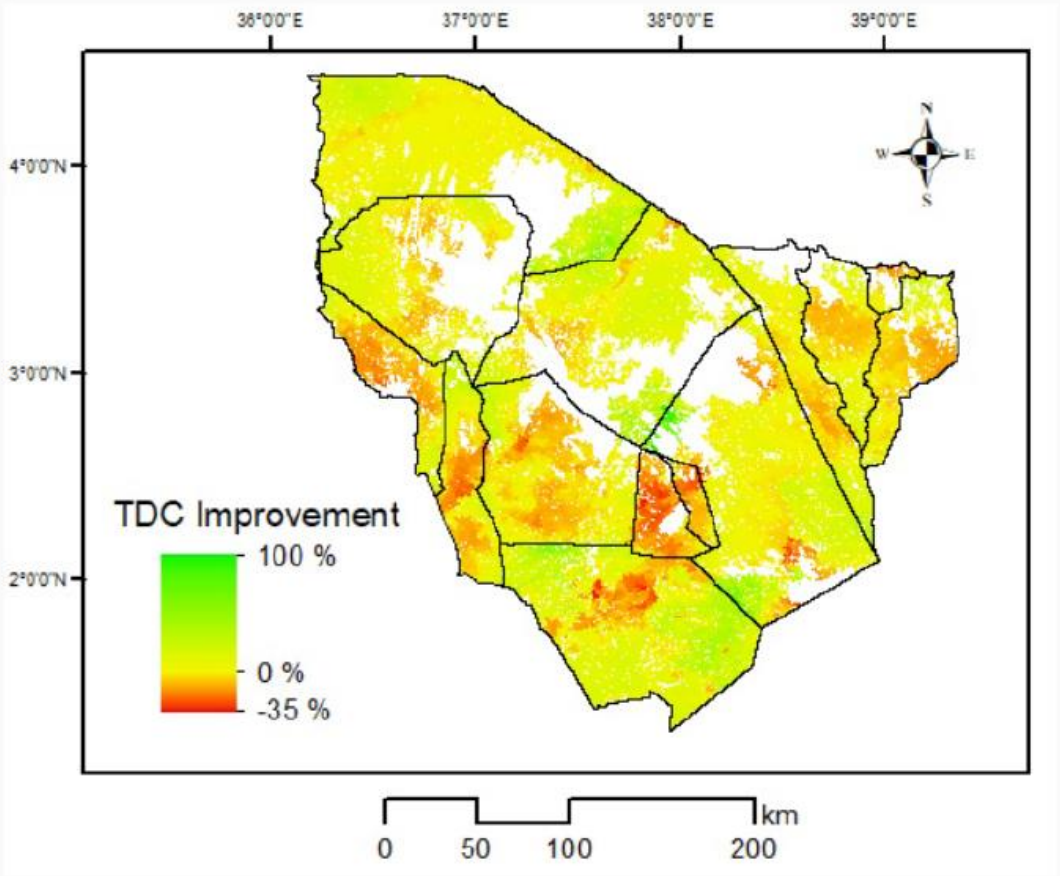
- More formally, we maximize conditional probability that insurance index for other pixels in the zone ia below the insurance trigger value when my "my pixel" is below the trigger value:

$$Prob[X < F_X^{-1}(t) | Y < F_Y^{-1}(t)]$$

where t is the NDVI trigger value of the contract and F_x is the cumulative distribution function for other's pixels and F_Y is the same for "my pixel"

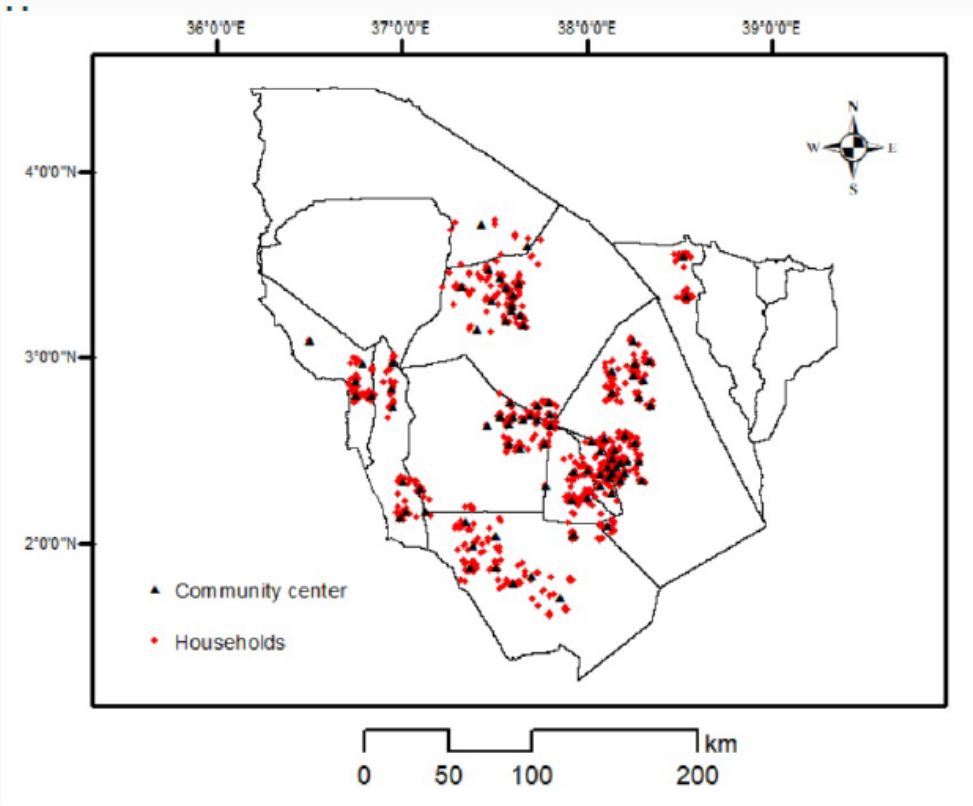
- In statistics & finance, this conditional probability is called "lower tail dependence." A good financial portfolio minimizes lower tail dependence, whereas a good UAI maximizes lower tail dependence for the "portfolio" of pixels included in a UAI

Statistical Gain from Optimized UAIs



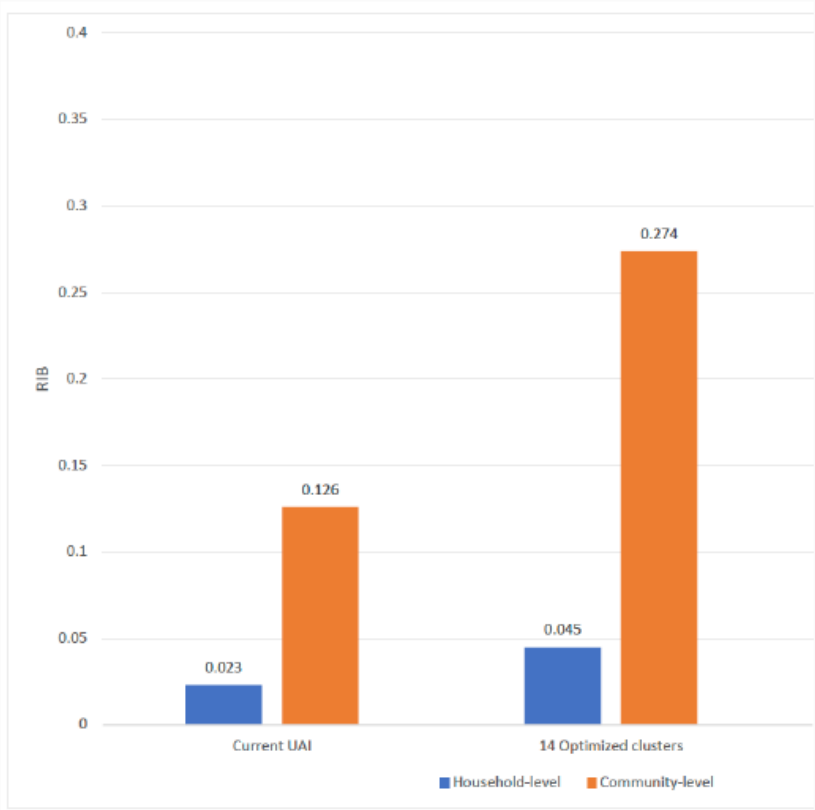
- Most (but not all) pixels improve lower tail dependence with rezoning
- But does this statistical gain in lower tail dependence create an economic gain for the insured?

Longitudinal Data to Measure Economic Gains from Optimized UAIs



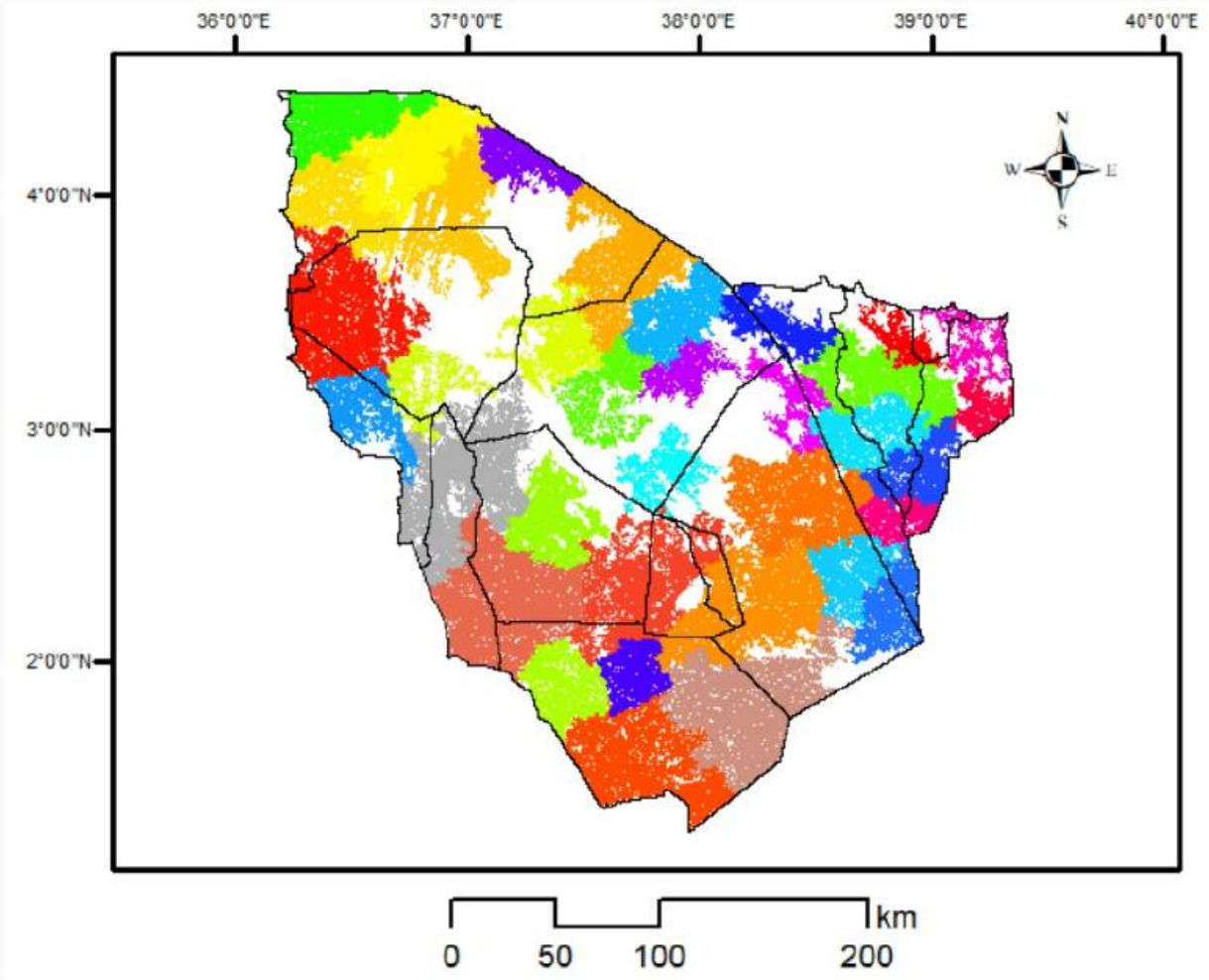
- 6 years (12 seasons) of mortality data on ~1000 households
- Compressed households into fictive composite households or communities
- Can calculate expected well-being for each community as they really experienced it without insurance
- Then can calculate expected well-being IF had had different insurance contracts (with different zones)

RIB Gains from Optimized UAIs



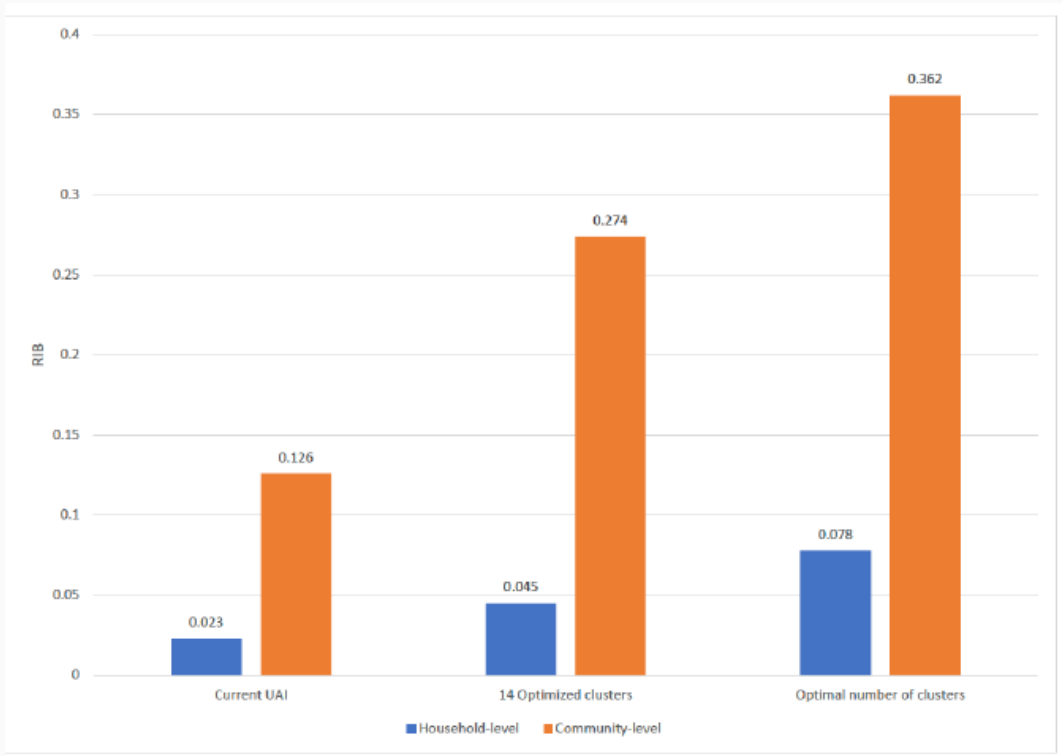
- Statistical gain in lower tail dependence within zones creates a 100% gain in insurance quality (RIB increases from 13% to 27%)

What if We Optimize Number of Insurance Zones?



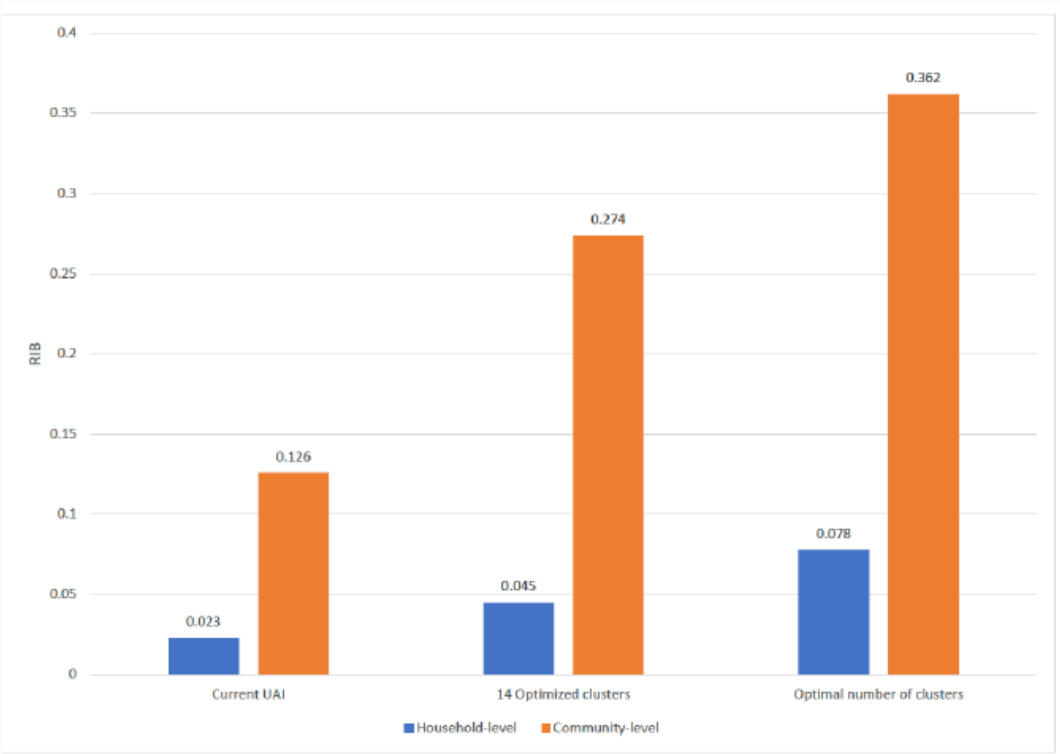
- Complexity of pastoralism and relationship between RIB & number of zones

RIB Gains from Fully Optimized UAIs



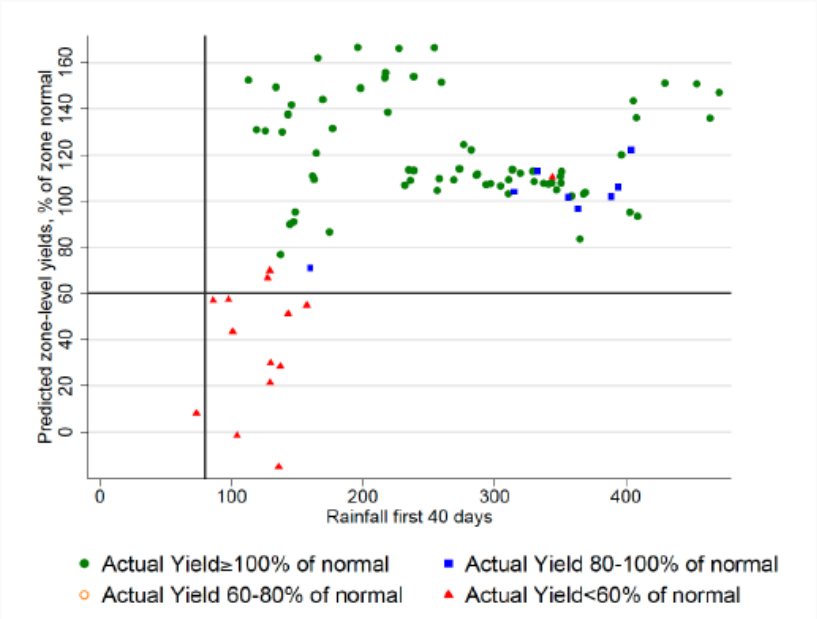
- Another 33% gain in RIB if increase number of zones (from an RIB of 27% to 36%)
- Getting beneficiaries assigned to the correct zone is a problem that has been solved for crop insurance via electronic contract activation
- Feasible for pastoralists?

But Even Optimized Insurance has Low Absolute RIB



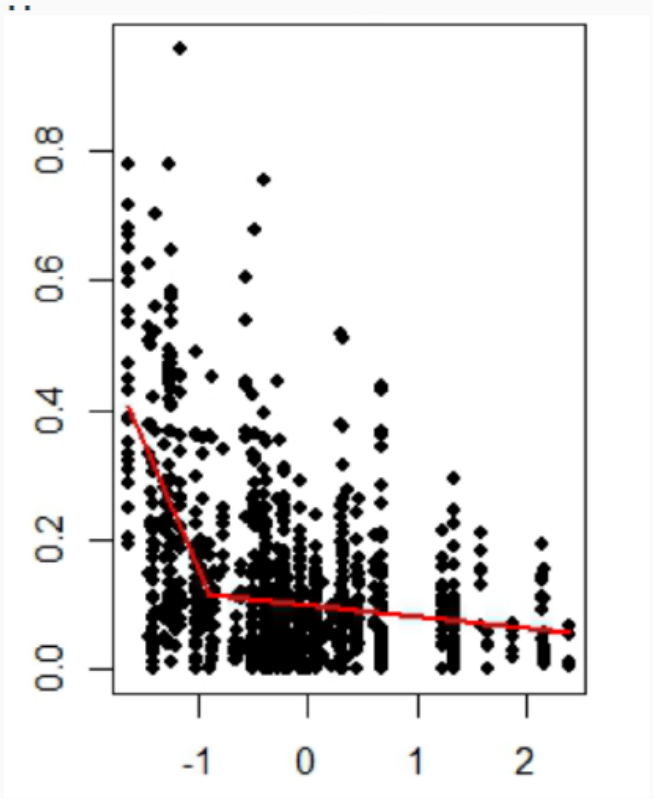
- Situation even more dismal if we look at individual households rather than synthetic communities/households
- Caveats here
- Clear that there is a lot of space to improve the quality of coverage offered by IBLI

A Fail-Safe, Audit Based Approach for Maize



- Red triangles above the line expected to trigger discontent & audit, crop cut in this case
- Calculated probability of audit-triggered payment and rolled into premium
- Insurance not charity

Towards A Fail-Safe, Audit Based Approach for IBLI



- We can see auditable events (and price them), but what it the equivalent of a crop cut for pastoralists?
- IBLI-Mongolia provides hints as was based on a mortality survey
- Could do the same with a sample of UAI members
- Consider reliability checks, perhaps with smart phone photos and geo-reference
- Confirm (or threaten to do so) with drone

For Further Reading

- Benami, Elinor, Zhenong Jin, Michael R. Carter, Aniruddha Ghosh, Robert J. Hijmans, Andrew Hobbs, Benson Kenduiywo, and David B. Lobell. 2020. "Uniting Remote Sensing, Crop Modeling, and Economics for Agricultural Risk Management." *Nature Reviews: Earth and Environment*.
- Benami, E. and M.R. Carter (2021). "Can Digital Technologies Reshape Rural Microfinance? Implications for Savings, Credit & Insurance," *Applied Economics Perspectives and Policy*.
- Clarke, Daniel, Olivier Mahul, Kolli Rao, and Niraj Verma. 2012. "Weather Based Crop Insurance in India." *Policy Research Working Paper* 5985, World Bank, Washington, DC.
- Kenduiywo, B.K., Michael R. Carter, Aniruddha Ghosh, and Robert J. Hijman (2021). "Evaluating the Quality of Remote Sensing Products for Agricultural Index Insurance." *PLoS One* 16(10).
- Jenson, N. et al. (2023). *Escaping Poverty Traps and Unlocking Prosperity in the Face of Climate Risk: Lessons From Index-Based Livestock Insurance*, Cambridge University Press.

Karlijn Morsink

Associate Professor of Economics at the Utrecht University School of Economics

Impacts of Index Insurance on Household Welfare? A Review of the Literature

Dr. Karlijn Morsink
Utrecht University School of Economics

with John Luke Plevin, World Bank Disaster Risk Financing and Insurance Program

June 6, 2023

Index insurance as a risk management tool?

Households in low-income countries remain vulnerable to aggregate shocks, such as drought, floods, and natural disasters

- despite using a variety of risk-management strategies [Fafchamps and Lund, 2003]
- threatening short-run consumption [Townsend, 1994] and long-run poverty [Hoddinott and Kinsey, 2001, Maccini and Yang, 2009, Dinkelman, 2017, Shah and Steinberg, 2017]

Index insurance (II) as a complementary risk management tool?

- providing protection *ex ante* shocks through *ex post* claim payments
- reduce transaction costs, moral hazard and adverse selection
- conditional on product quality and implementation, e.g., basis risk

1. What are the potential impacts of II on household welfare?
2. What does the empirical evidence actually tell us?
3. What does this imply for policy and programme design?

Take-up is not a sufficient measure of welfare

Take-up is the most commonly used measure of success of an index insurance programme

- Easy to collect rigorously based on administrative data
- Actuarially fair indemnity insurance increases "consumer welfare" for risk averse individuals [Pratt, 1964, Arrow, 1965]

When would take-up be informative about index insurance welfare:

- No basis risk ✗
- Understanding of the product ✗
- Actuarially fair ✗ ✓

Studying take-up can contribute to an understanding of drivers of welfare

Premium subsidies substantially increase take-up

Study	Sample	Baseline/ control take-up	Discount	Take-up after discount
Ahmed, et al., 2020	Ethiopian Cooperatives	0% control, 0.5% treat	10%, 30%, or 50%	+27 ppts
Casaburi and Willis, 2018	Kenyan contract farmers	5%	30%	+1 ppts
Cole, et al. 2007	Indian Farmers	23%	5Rs.	+3.25 ppts
			30Rs.	+15.75 ppts
Hill et al., 2016	Indian smallholder farmers	4.0% - 6.8%	10%	+1.3 ppts
Janzen & Carter, 2019	Kenyan pastoralists	8%	10/20/30/40/50/60% on the first 15 TLU (av=19%) (non-cumulative)	+25 ppts
Jensen et al. 2017	Kenyan pastoralists	~0%	10/20/30/40/50/60% on the first 15 TLU (cumulative)	+42 ppts
Karlan et al., 2014	Ghanain Smallholder farmers	11%	50% (approx. actuarially fair)	+31 ppts
			75%	+56 ppts
Matusda et al. 2019	Ethiopian Pastoralists	~0%	10/20/30/40/50/60/70/80 (non-cumulative)	+4 ppts per 10%
Mobarak & Rosenzweig, 2012	Indian smallholder farmers	15%	50% (approx. actuarially fair)	+23 ppts
			75%	+45 ppts
Son, 2021	Kenyan pastoralists	~0%	10/20/30/40/50/60/70/80 % on the first 15 TLU	+36 ppts

Reduction of basis risk increases take-up and welfare

To measure basis risk we need to structurally collect data on household losses [Jensen et al., 2016]

- IBLI reduces exposure to *covariate risk* by an average of 63%...
- ... but of the original risk, 69% remains as a result of *idiosyncratic risk*.

If not explained explicitly, consumers' appear unaware of basis risk [Jensen et al., 2016]

- After explicit education, basis risk is negatively correlated with demand, as it should.

Lower basis risk increases demand for insurance substantially

- Rainfall at rain stations and yields are not significantly correlated if stations are not within villages Mobarak and Rosenzweig [2012]
- Farmers located $<$ 5 km away from a weather station are four times as sensitive to prices as farmers located $>$12 km away Hill et al. [2016]

Consumer understanding is necessary, but not sufficient

Many farmers and pastoralists who are targeted by index insurance are not financially literate

Consumer education is difficult and takes time

- Brief explanation by an insurance promotor [Cole et al., 2013] ✗
- Explanation of trigger and its link to payouts [Cole et al., 2013] ✗
- 2-day interactive simulation game [Gaurav et al., 2011] ✓
- Learning kit with comics and audio tapes [Takahashi et al., 2016] ✗

Consumer education may increase knowledge and insurance purchase, but not necessarily welfare [Harrison et al., 2022]

Income smoothing and a reduction in harmful coping

When shocks happen, index insurance:

- helps maintain production and income levels [Matsuda et al., 2019]
- reduces distress livestock sales [Janzen and Carter, 2019, Jensen et al., 2017]
- minimizes herd losses [Janzen and Carter, 2019, Noritomo and Takahashi, 2020]
- reduces the cutting of food consumption [Janzen and Carter, 2019]
- lowers child labor [Son, 2021]

These results are all based on the Index-Based Livestock Insurance in Ethiopia and Kenya

For individuals who are already at subsistence, reducing these strategies may not be an option

An increase in productive investments

The risky nature of agriculture may make risk averse farmers reluctant to invest [Boucher et al., 2008, Emerick et al., 2016]

Being insured – irrespective of claim payments – leads to increases in:

- credit uptake (supply-side rationing) [Belissa et al., 2020, Mishra et al., 2021]
- veterinary expenditure [Jensen et al., 2017, Matsuda et al., 2019]
- milk production [Jensen et al., 2017, Matsuda et al., 2019]
- fertilizer use [Karlan et al., 2014, Boucher et al., 2023]
- total area under cultivation [Karlan et al., 2014, Hill et al., 2019, Stoeffler et al., 2022, Boucher et al., 2023]
- investment in higher return crops [Cole et al., 2017, Cole and Xiong, 2017, Hill et al., 2019, Stoeffler et al., 2022, Boucher et al., 2023]
- irrigation and fencing [Stoeffler et al., 2022]
- children's education [Son, 2021]

None of these studies assess the optimal level of investment [Castaing and Gazeaud, 2022]

- Farmer pays a premium, invests, loses their crop and investment, and, due to basis risk, does not receive a claim payment.

Conclusion

A sustainable and gradually expanding insurance market can only be achieved if products truly generate welfare

- We must go beyond take-up, and also collect data on product and infrastructure quality
- Invest in consumer education, product quality and minimization of basis risk
- Monitor consumer understanding, satisfaction, and basis risk

Measuring a portfolio of welfare measures, some at larger and some at smaller scale, is the optimal research strategy

The gap in data collection on welfare has prevented systematic learning about index triggers, products, and product delivery.

- With one major exception, the Index-Based Livestock Insurance programme

Impacts beyond short-run household welfare

Does insurance reduce long-run impacts of aggregate shocks?

- Change in productive strategies; higher completed education [Barrett et al., 2023]

Are communities better protected against risk?

- Crowding-in of informal insurance [Berg et al., 2022, Takahashi et al., 2019] or crowding out of redistribution [Anderberg and Morsink, 2020]

Does insurance promote growth and development?

- Does it move people out of poverty traps? [Lybbert et al., 2004, Karlan et al., 2014]
- Does it correct occupational misallocation?

Do insured communities attract more business investment?

- Is there an "insurance multiplier?"

Does insurance promote adaptation to climate change?

- Does insurance prevent occupational adaptation?

Does insurance mitigate conflict?

- Reduced likelihood of engaging in conflict-prone strategies?
- Crowding-out of informal networks of support? [Riley, 2018]

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What will the four webinars cover?

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2

Climate-responsive financial products and global evidence on strengthening climate resilience

3

Lessons learned from index insurance programs across the micro, meso and macro levels

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