The Potential for, and Uses of, Weather Index Insurance

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Natural Disasters and the Rural Poor

- Natural disasters (E.g., drought and flood) devastate poor communities
  - Natural disaster risk is spatially correlated
  - Rural areas are disproportionately affected because they tend to be dependent on agriculture
  - Entire communities can suffer when there is major crop failure and food prices increase
  - Poor HHs experience longer-term effects than more prosperous HHs
- Farming, livestock, off-farm labor, selling crafts, etc.
- Disasters affect HH livelihood portfolios and communities
  - Rural HHs diversify across a portfolio of livelihood strategies
  - In rural areas many livelihood strategies are directly or indirectly related to agriculture
  - Informal risk-sharing relationships tend to break down when everyone is affected

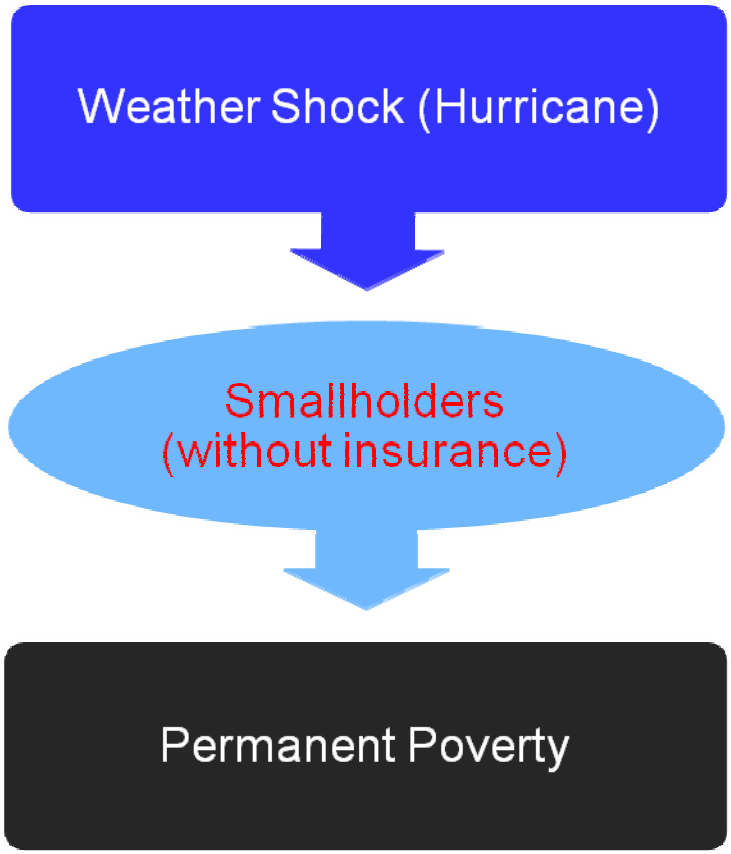
HH Consequences of Catastrophic Risk

- Catastrophic weather disrupts livelihoods (*Ex post* impacts)
  - Crops
  - Livestock
  - Off-farm income (E.g., working on another farm, etc.)
  - Local food costs may increase
- Risk of catastrophic weather (*Ex ante* impacts)
  - Low-risk, low-return livelihood strategies
  - Limited access to credit
  - Reduced investment
    - Durable productive assets
    - Less fertilizer use
    - Failure to adopt new technology
    - Less likely to use enhanced seed varieties

Catastrophic Weather Risk Are Generally Highly Correlated

- Drought, floods, typhoons, freezes, extreme hot spells, etc., can affect the lives of many people at the same time
- When many people are adversely affected by extreme weather at the same time, formal and informal systems of coping with or managing risk break down
- Creating efficient markets to transfer these correlated risks in a fashion that will benefit the poor is at the core of the GlobalAgRisk research and development program

Weather Shocks without Insurance: Poverty Traps (Carter and Barrett, 2006)



Smallholders in poverty forced to

- Deplete assets further, pushing themselves farther below the poverty line; and/or
- Reduce consumption, face long-term health and developmental consequences

Smallholders need to smooth household consumption over time

Index Insurance for the Rural Poor*

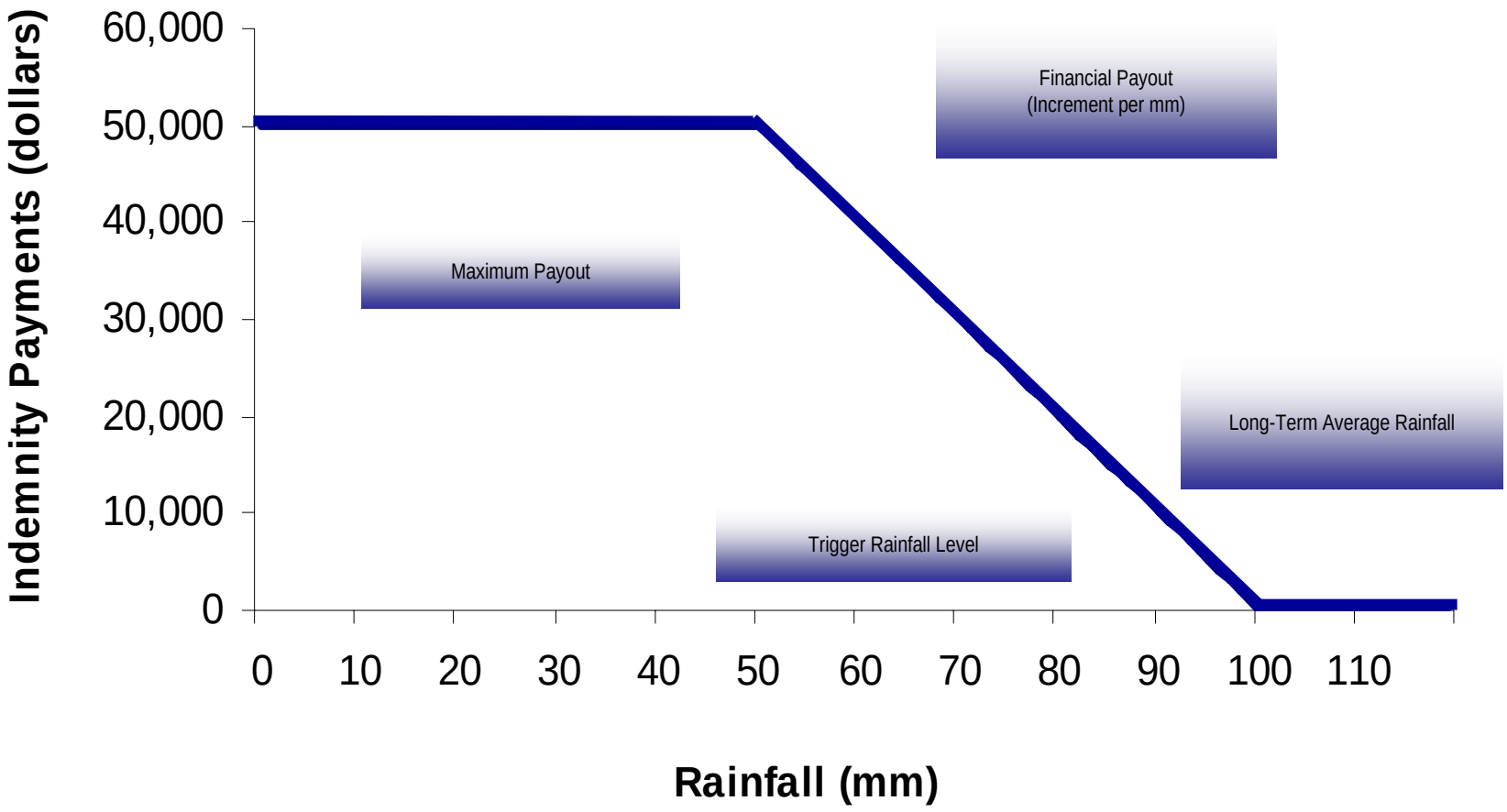
- Index insurance for weather risks is gaining interest as a cost-effective approach to agricultural insurance in lower income countries
- To date, 25+ index insurance projects for have been tested around the world
- A major advantage of index insurance can be quick cash payments to mitigate crisis as it develops
- Introducing insurance and banking services can enable rural poor to improve resiliency to risk
- There is value to these products, but developing weather insurance markets for the rural poor is still a challenge

*This slide and others in this presentation are from Murphy, 2008

Index-based Risk Transfer Product

- An instrument to transfer risk to markets
- Underwrites a risk that creates serious problems
- Payouts are based on an index (E.g., rainfall) associated with the risk (E.g., drought)
- The index is a proxy of loss
- When value of the index crosses a threshold
  - Event is likely creating losses (E.g., lower crop yields)
  - Indemnities are paid
- IBRTPs address many of the problems with traditional crop insurance
  - No costly claims adjusting
  - Less monitoring for moral hazard and adverse selection

Example: Rainfall Insurance against Drought



Index-based Insurance

Advantages

- Low moral hazard
- Low adverse selection
- Low administrative costs (No individual farm loss adjustments)
- Easy to understand
- Protects against correlated risk
- Structured rules — Avoids the politics of disaster payments
- No need for loss adjustments for small farms

Disadvantages of Weather Index Insurance

- Basis Risk

  The policyholder may experience a loss and yet receive no indemnity

  - Loss caused by different peril
  - Extreme weather event did not occur at weather station

- High Start-up Costs

  Data collection, agro-meteorological expertise, product design, etc.

Examples of Index Insurance

- **Mexico — Drought Insurance**
  - FONDEN (Natural disaster fund) — Index insurance for drought
  - Agroasemex — Public reinsurance program
- **Mongolia — Index-based Livestock Insurance**
  - Sold to herders by local insurance agents from 4 companies
- **India — Rainfall Insurance**
  - Insurance sold to farmers through BASIX (MFI), underwritten by ICICI-Lombard (Insurer)
- **Malawi — Drought Insurance**
  - Index insurance covers loan to buy certified seed
  - Banks receive indemnity payments to cover the loan
- **Ethiopia — Drought Insurance for WFP**
  - Portfolio of rainfall stations trigger payment to get funds into Ethiopia early when there is going to be a disaster

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Select GlobalAgRisk Projects

- Peru — ENSO Insurance/ Global Research and Outreach Program
  - Bill and Melinda Gates Foundation 4/09 to 4/12
- Vietnam — Floods in Mekong Delta/ Drought in Central Highlands
  - Ford Foundation 7/09 to 12/10 and ADB 7/05 to 5/08
- Mongolia — Index-based Livestock Insurance
  - World Bank and gov't of Mongolia since 7/01
- Mali — Prefeasibility Study on Potential for Index Insurance
  - Save the Children 8/08 to 4/09
- Ethiopia — Drought Insurance for Emergency Food Aid
  - World Bank 8/03 to 8/04
- Mexico — Irrigation Insurance in the Rio Mayo
  - InterAmerican Development Bank 5/03 to 9/04

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Applications of Index Insurance

Index insurance can be sold to

- Individual farmers (US, Canada, India, Brazil, Peru Pilot — Area-yield insurance / India — Rainfall insurance
- Microfinance / Rural banks (Peru and Vietnam)
- Importers for famine relief (Ethiopia WFP — Food security)
- Governments for disaster aid (Mexico — FONDEN)
- Herders based on livestock deaths in an area (Mongolia — 14 percent of eligible herders are buying)
- Irrigators in a irrigation valley (Mexico — IDB project)
- Agribusinesses (Who are at risk — When their farmers have cash flow problems)
- NGOs for localized disasters that don't capture the attention of the international donor community

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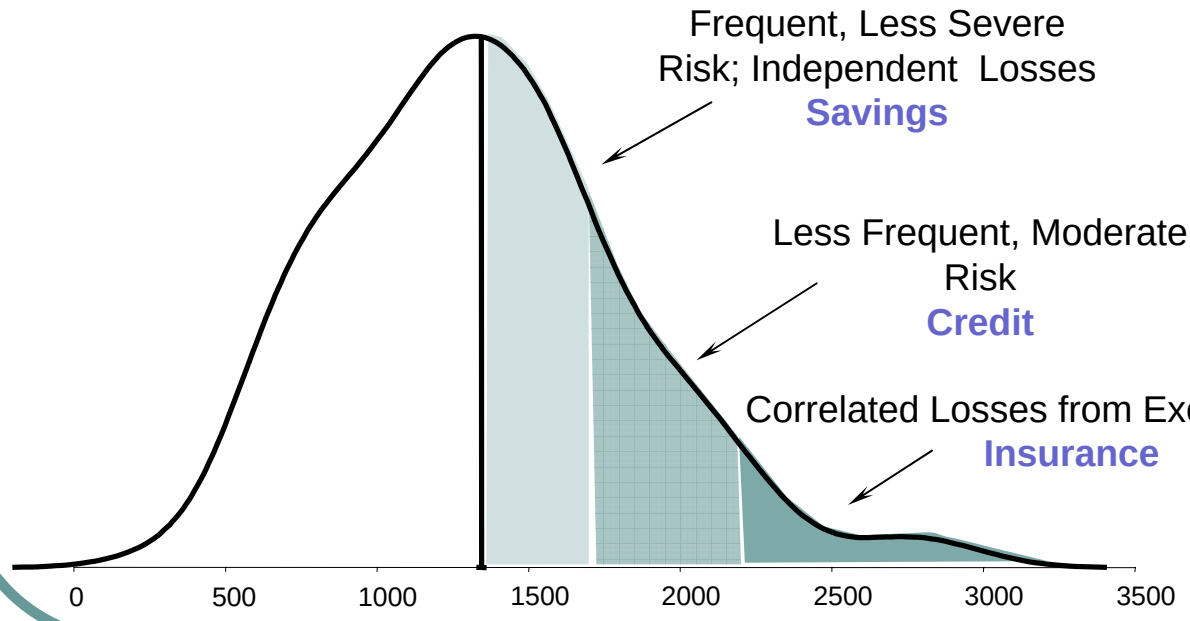
Financial Services and Correlated Weather Risk Management

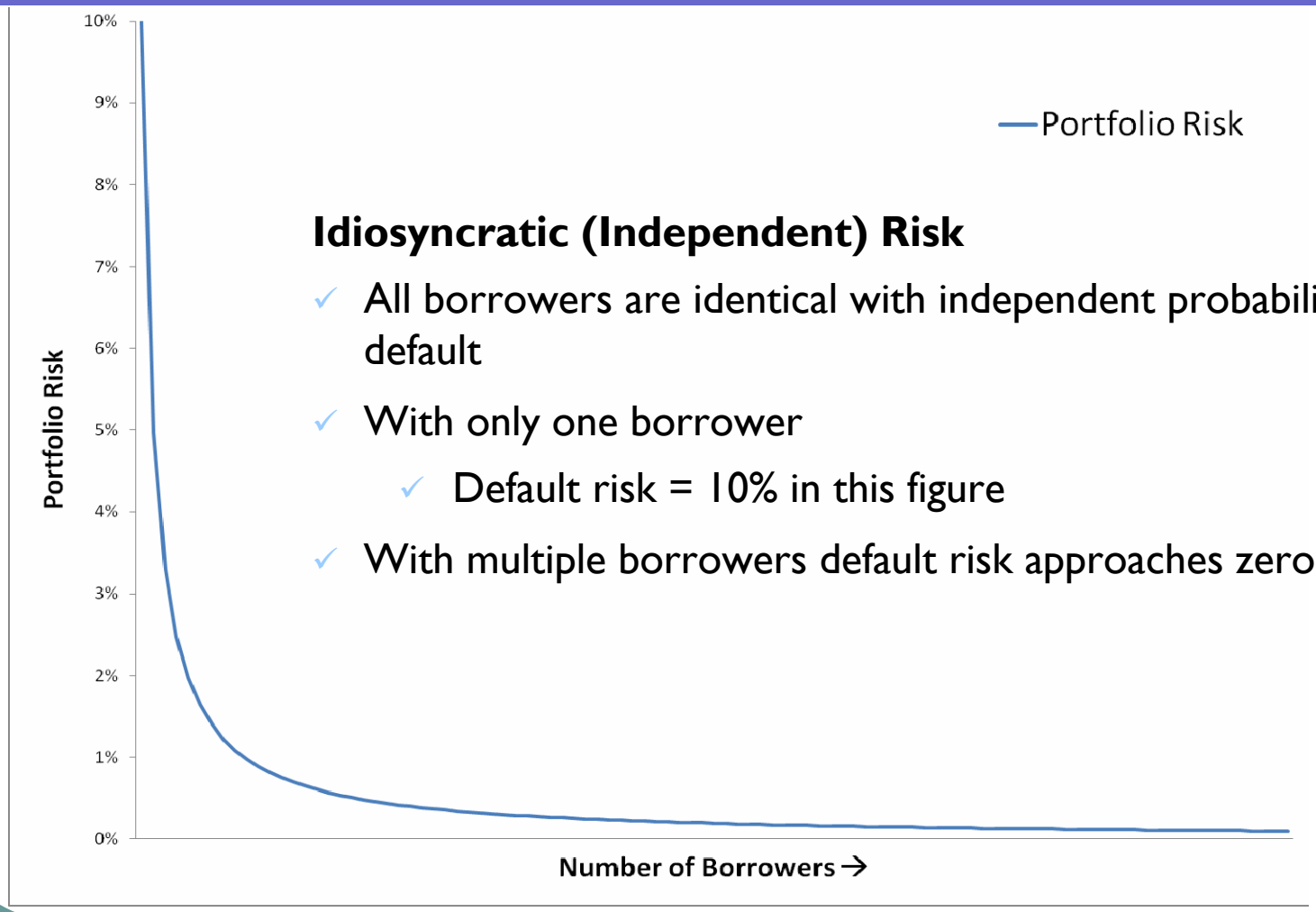
Financial services are complementary — A blend of savings, credit, and insurance is likely most effective for risk management

- Savings and credit best for small to moderate losses
- Insurance is best for catastrophic losses



Economies with banking *and* insurance markets grow faster than those with only banking services

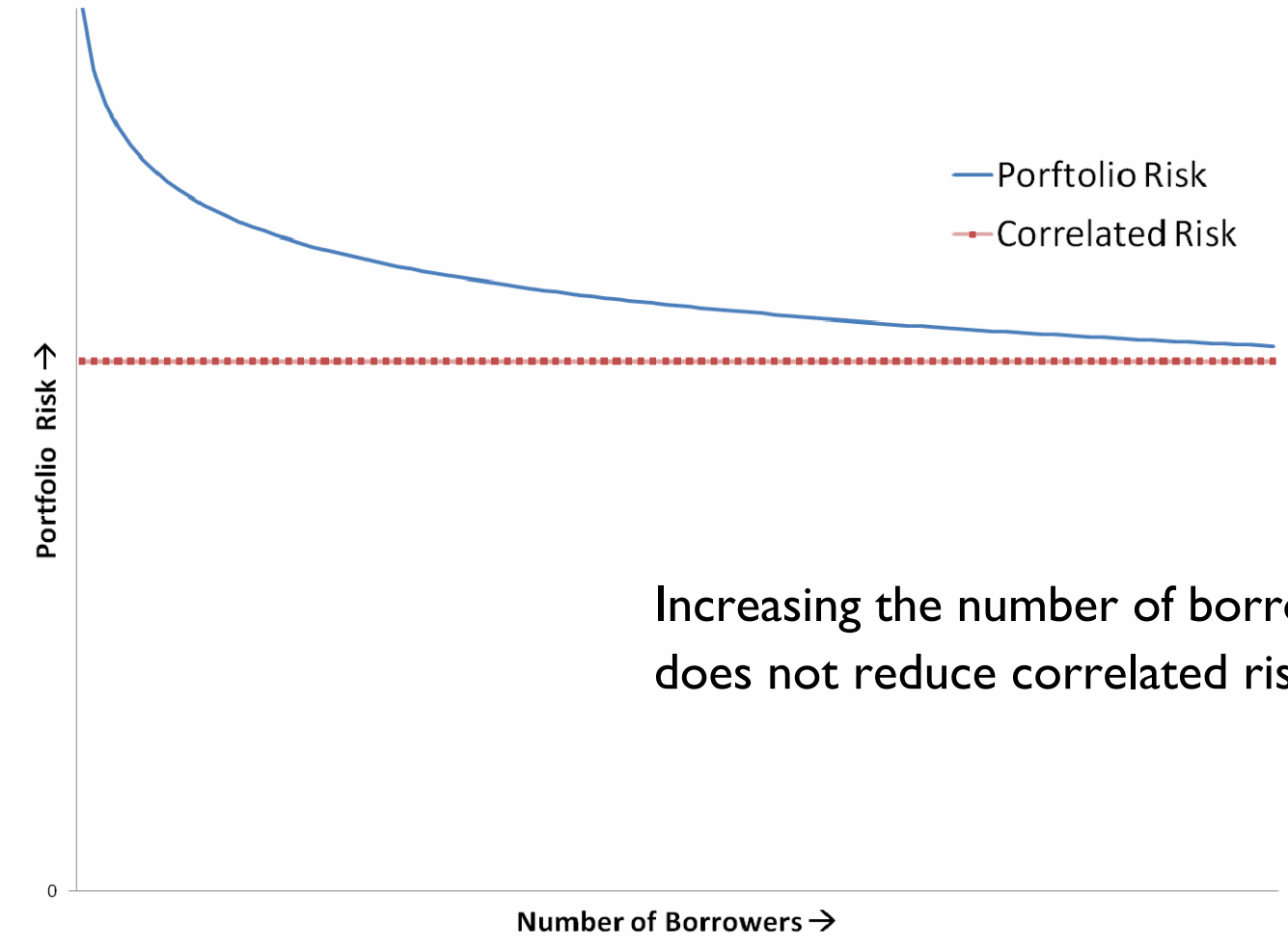
Traditional Portfolio Risk Management



Idiosyncratic (Independent) Risk

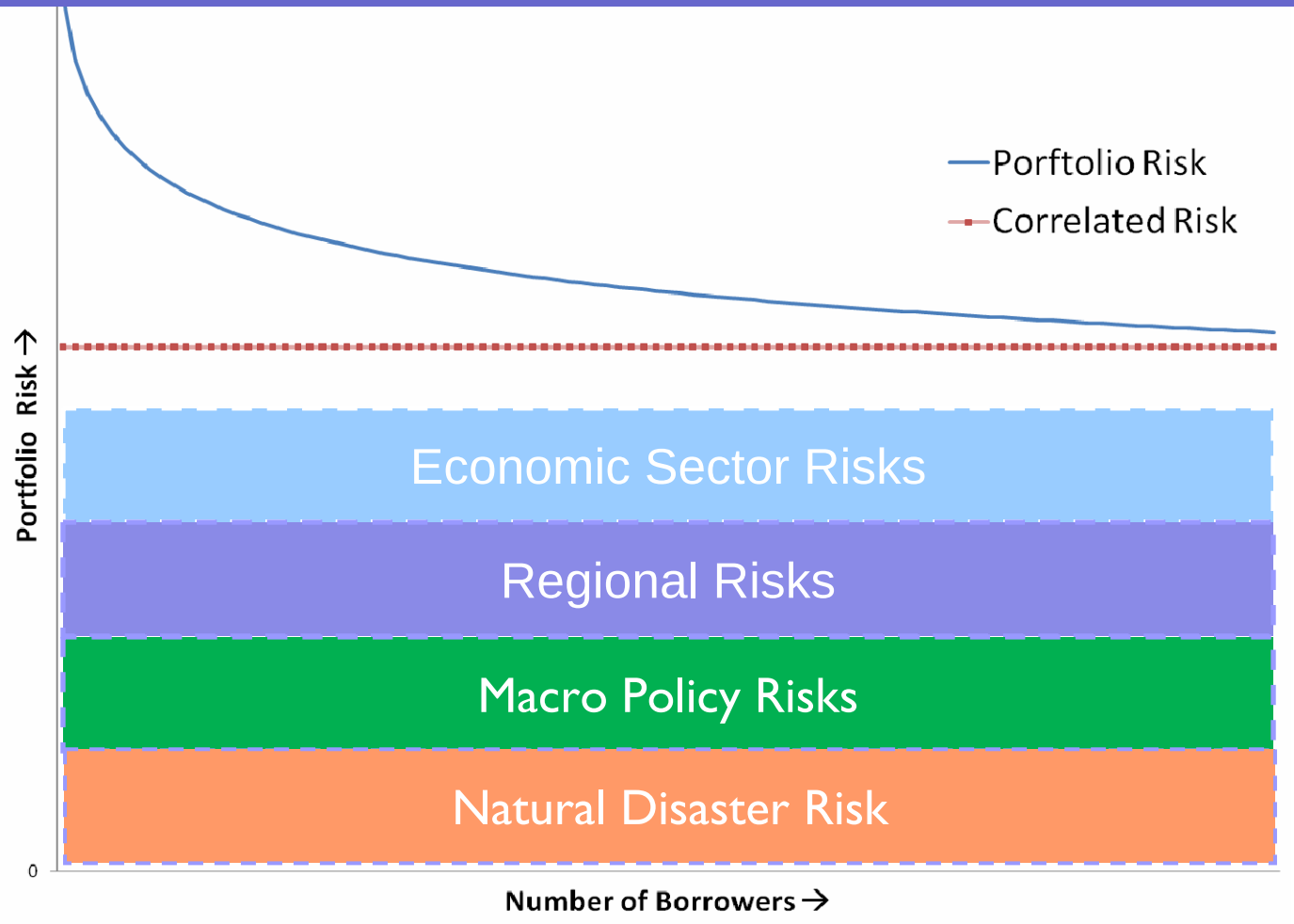
- ✓ All borrowers are identical with independent probability of default
- ✓ With only one borrower
  - ✓ Default risk = 10% in this figure
- ✓ With multiple borrowers default risk approaches zero

Correlated Risk in the Lending Portfolio

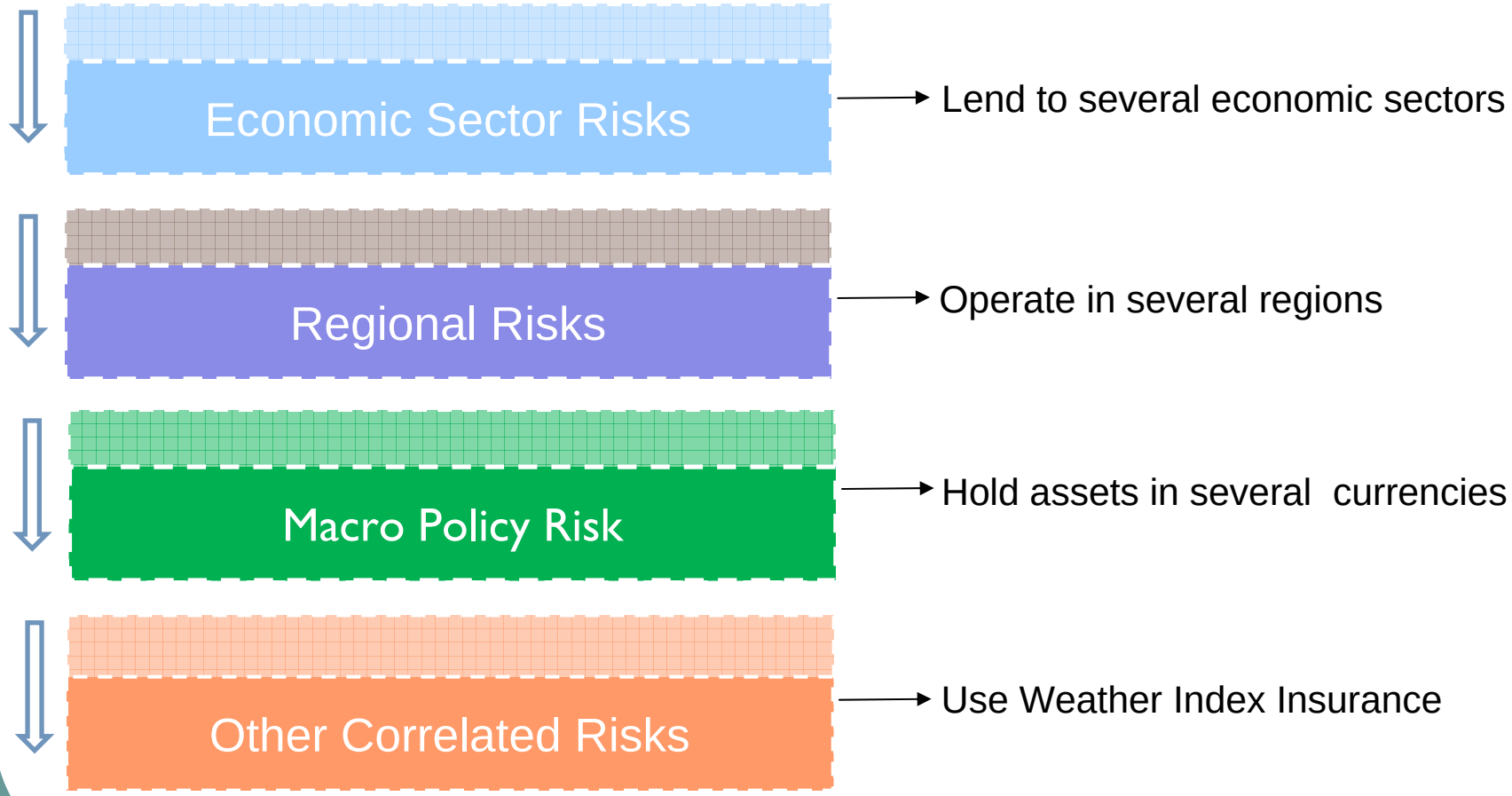


Increasing the number of borrowers does not reduce correlated risks

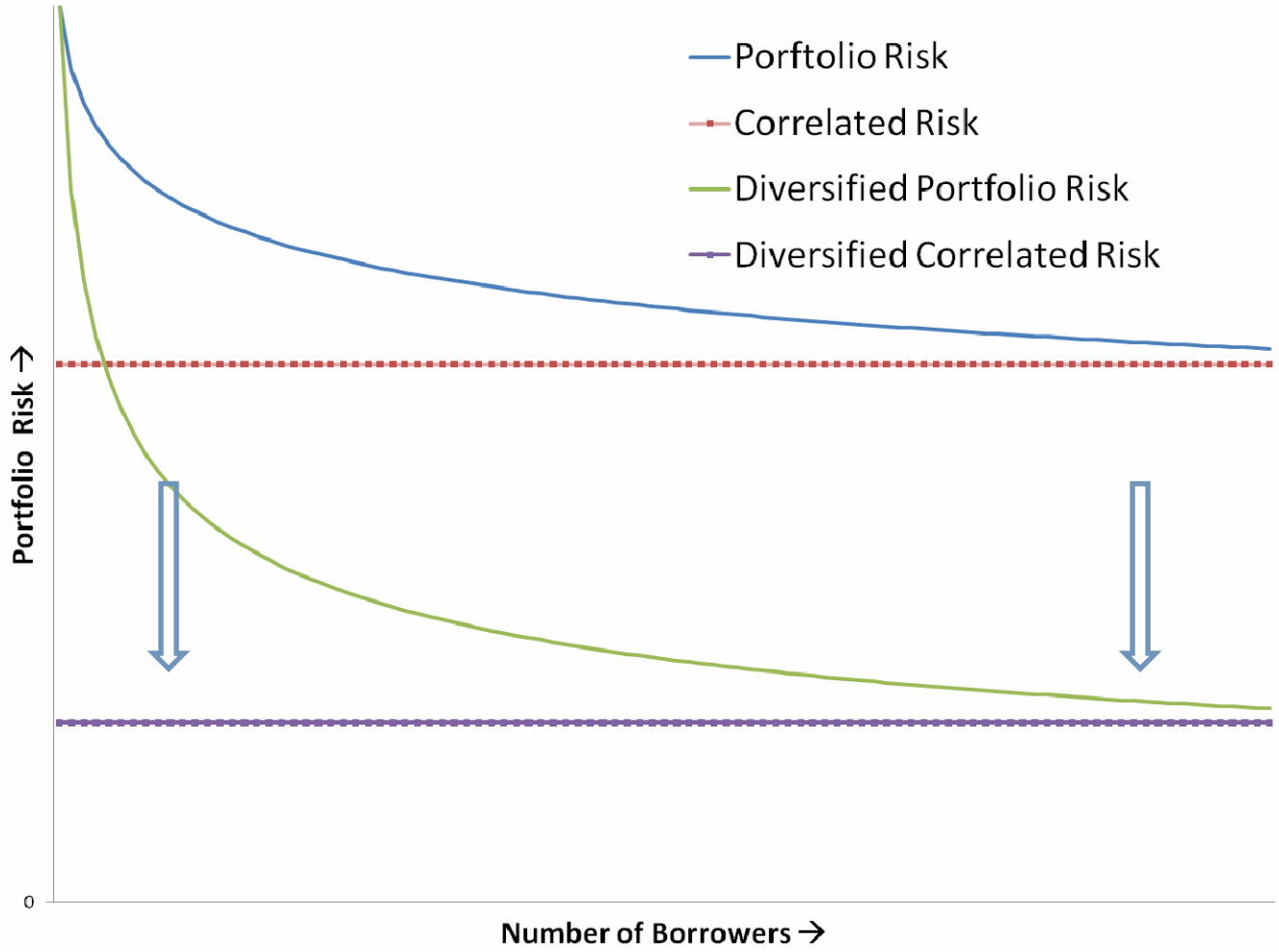
Correlated Risk in the Lending Portfolio



Diversification Can Reduce Correlated Risks



Diversification Can Reduce Correlated Risk in the Portfolio



Default Risk Significantly Affects Interest Rates!

$$\pi = p(1+i)L - (1+r)L \qquad i = \frac{1+r}{p} - 1$$

π – Expected profits
p – Exogenous probability of non-default
i – Interest rate
r – Lender's opportunity costs
L – Amount of funds loaned

Example (No default risk)
r = 10%
p = 100%

$$i = \frac{1+0.10}{1} - 1 = 0.10$$

Example (10% default risk)
r = 10%
p = 90%

$$i = \frac{1+0.10}{0.90} - 1 = 0.22$$

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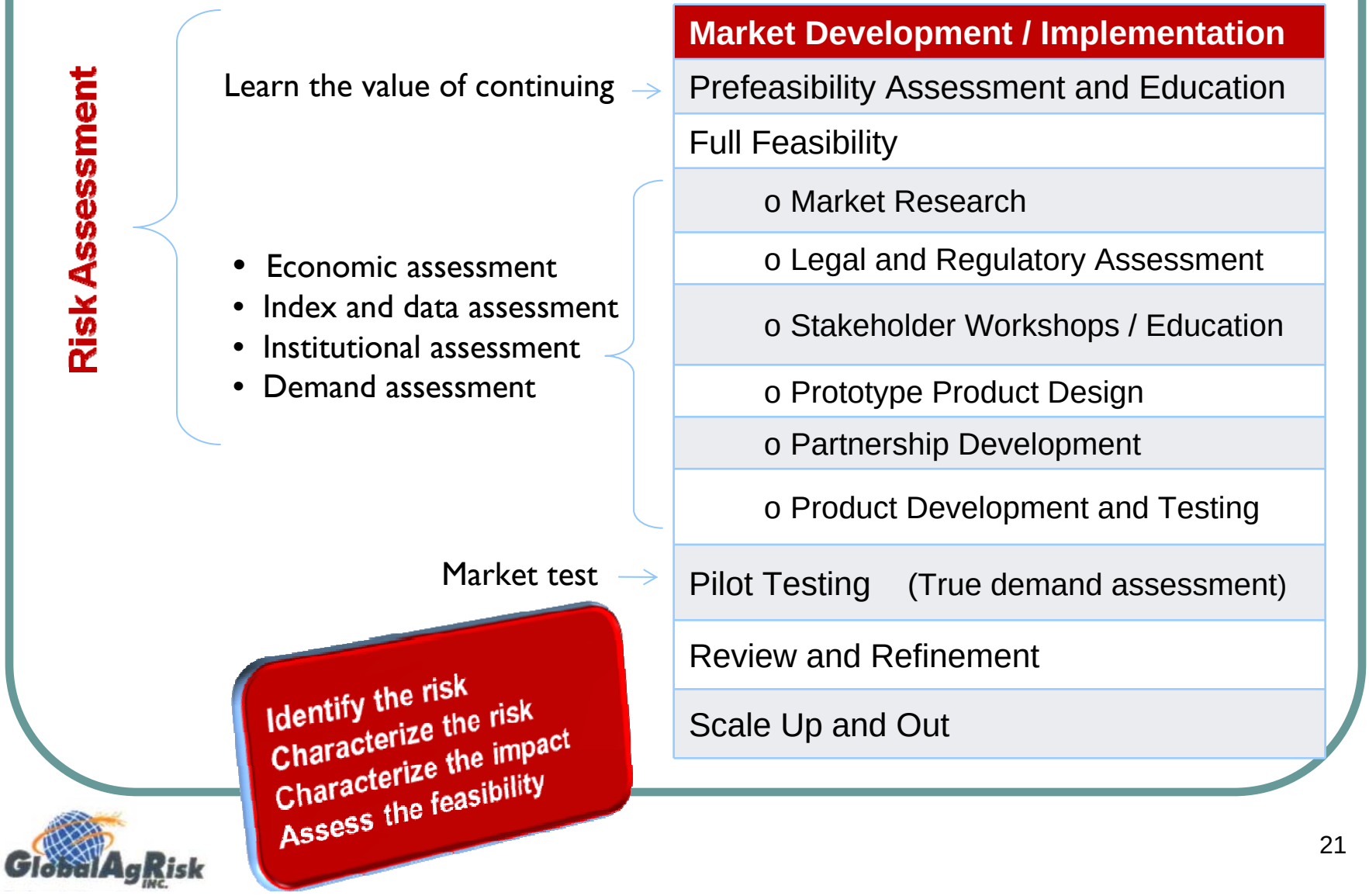
GlobalAgRisk Market Development Model Overview



Our experience suggests…

- Many one-off experiments that are working on innovations in index-based weather insurance
- One-off experiments are costly, and it has proven difficult and time-consuming to build a market for micro products
- More critical thinking and research are needed to integrate these products into the financial sector and to create long-term sustainable products that remain after donor interest has waned

Two Strategies for Using Index-based Weather Insurance to Address the Default Problem

- **Individual —** The logical focus should be on a micro product for the borrower that would give them indemnity payments to pay off their loans — Loan-linked products
- **Risk Aggregator —** Index insurance can be used to help the lender manage the consequential losses and added costs associated with the spike in defaults

Challenges for Developing Micro Products
Mali Case Study

- Work supported via Save the Children in their longer-term investigation of insurance to protect assets (Funded by USAID and an anonymous donor)
- Focus…Agriculture (Maize) in southern regions
- Problem…MFIs don't lend because of highly correlated drought risks; MFIs have problems attracting capital; farmers slow to adopt better technology because of risk; low-risk/low-return strategies are used; slow economic development

Can index based weather insurance help individual farmers or rural lenders release the credit constraint and protect their livelihoods?

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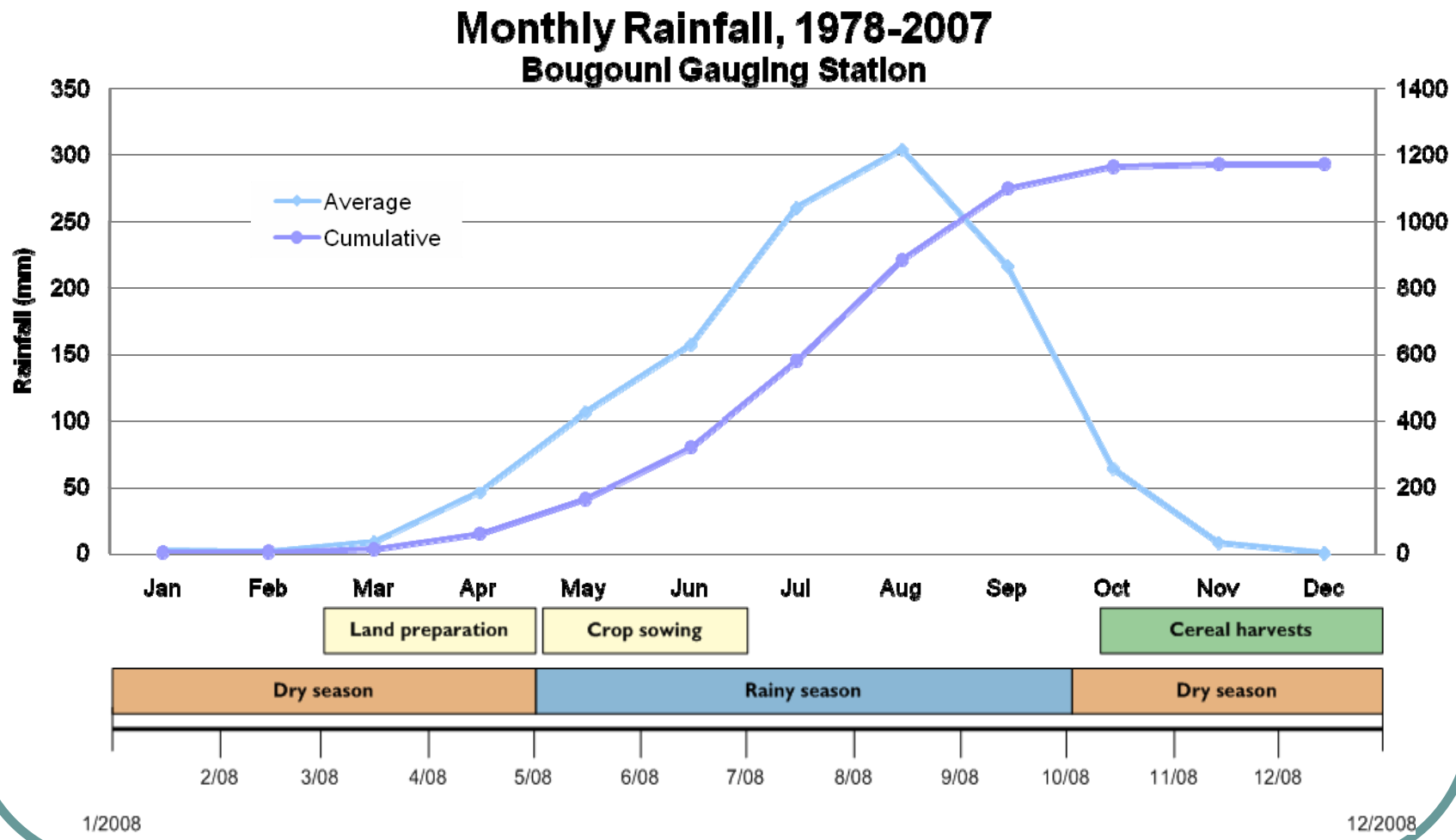
Mali Prefeasibility Study Area

- Population 12m — 70 percent involved in agriculture
- Small-scale traditional and subsistence farming dominates

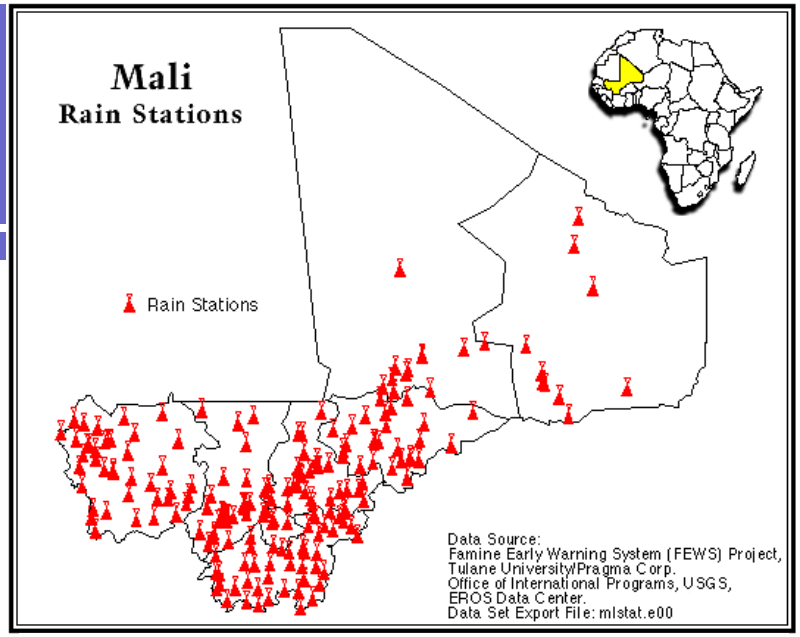
- < 2% of rural households have access to formal credit
- Southern half is arable / agro-pastoral
- Primarily manual labor technologies
- Farm size dependent on mechanization: 2–7 hectares manual / ~30 with traction
- Millet, sorghum, maize, rice, cotton, fonio
- Among largest cotton producers in Africa
- Cotton area declined after 2005 with low prices and CMDT parastatal collapse
- Sorghum and maize expanding into land formerly planted to cotton

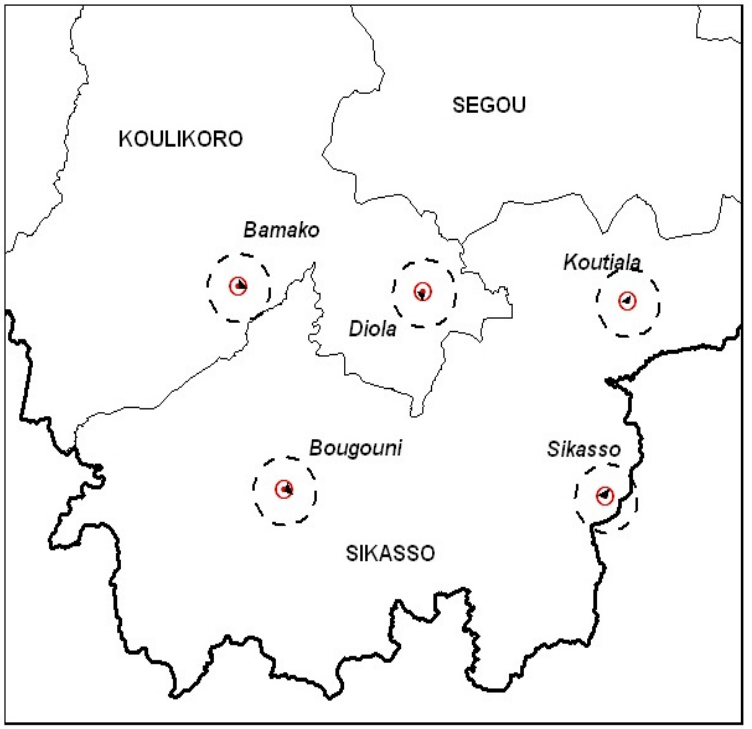
Rainfall / Production Interaction



Meteorological Service

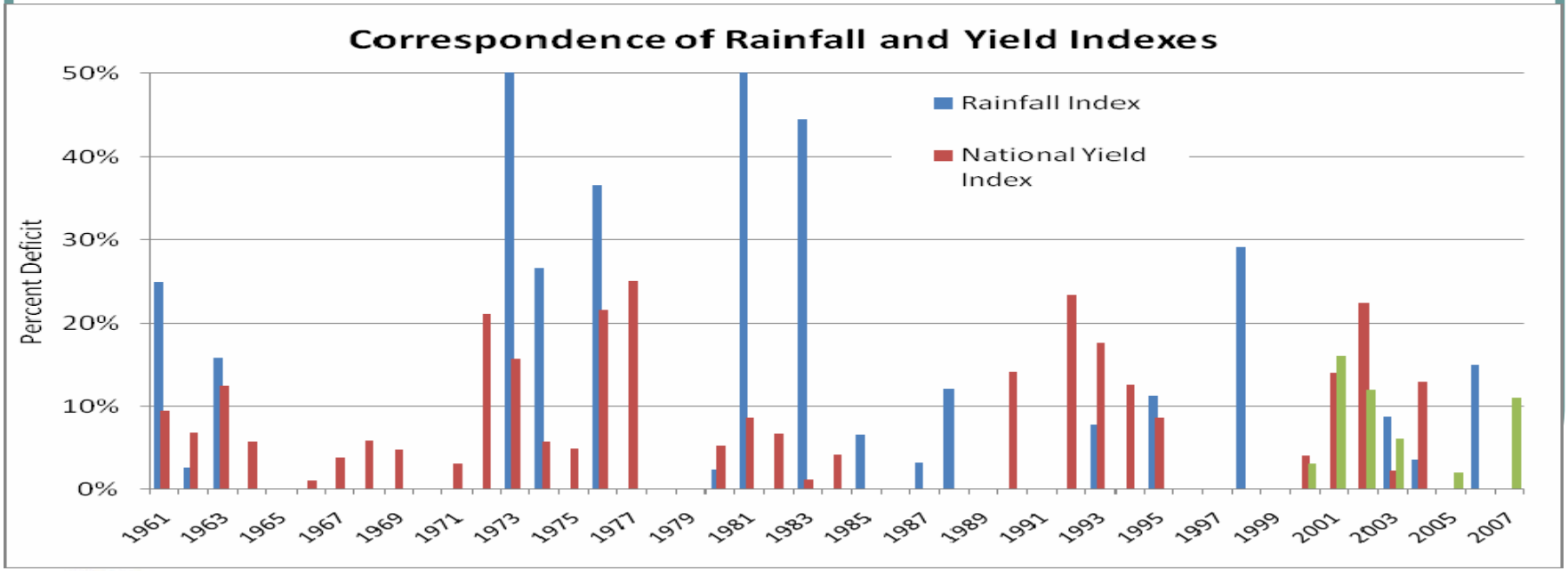
- Weather station infrastructure
- Officially: Bamako and South
  - 4 synaptic stations
  - 13 agro-climate stations
  - 57 rainfall stations
- Most stations not current and have significant gaps
  - 5 active stations
  - Daily rainfall 1954–2007 for Bougouni and Sikasso stations





Correspondence for Catastrophic Loss

- Search available data for any possible relationships between rainfall shortfalls and yield shortfalls
- 10-month rainfall deficit contract between April and August for both available weather stations
- Very little correlation — Why?

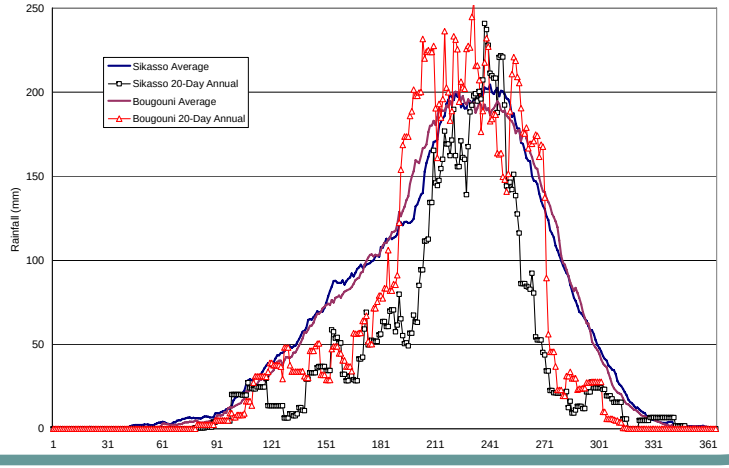


Possible Explanation: Back to Basic Agronomy

- Soil degradation trends are such that soil organic matter is low
- Organic carbon rich soil acts as a moisture reservoir and buffer
  - Reduced water infiltration
  - Reduced water retention properties
  - Contributes to fertilizer and further soil erosion
  - Plant growth even more dependent on the timing of rainfall
  - Rainfall intensity is more likely to be idiosyncratic
- Documented loss of organic carbon (SOC) in African soils
  - Randomness of yield outcomes to rainfall outcomes
  - Explains why drought and flood are both mentioned as risks

Challenges in Risk Identification

- Challenges using limited crop yield and weather data
  - Correlations low with aggregation
  - Lack of data a significant difficulty
- Soil characteristics may dominate much perceived weather risk
  - High aggregate rainfall
  - High frequency of rainfall
  - Magnifies sensitivity to timing and intensity
- Slow or slow start to rainy season still important
  - Independent of soil characteristics
  - Replanting costs significant



Summary of Mali Challenges

- Lack of infrastructure for weather stations
- Soil depletion making it more difficult to design a workable weather index
- Basic message — Like many developing countries, it will take a significant effort and time to develop effective micro-level markets…faster progress can be made with products for risk aggregators (E.g., lenders)

Risk Aggregator Strategy: Addressing the Spike in Defaults Created by Extreme Weather Event

- Perform risk assessment to learn the maximum probable loss
- Lending institutions have many ways of managing these risks (E.g., provisions, restructuring loans, etc.)
- For simplicity, assume that the initial position should be using an index insurance that protects 50 percent of the maximum probable loss

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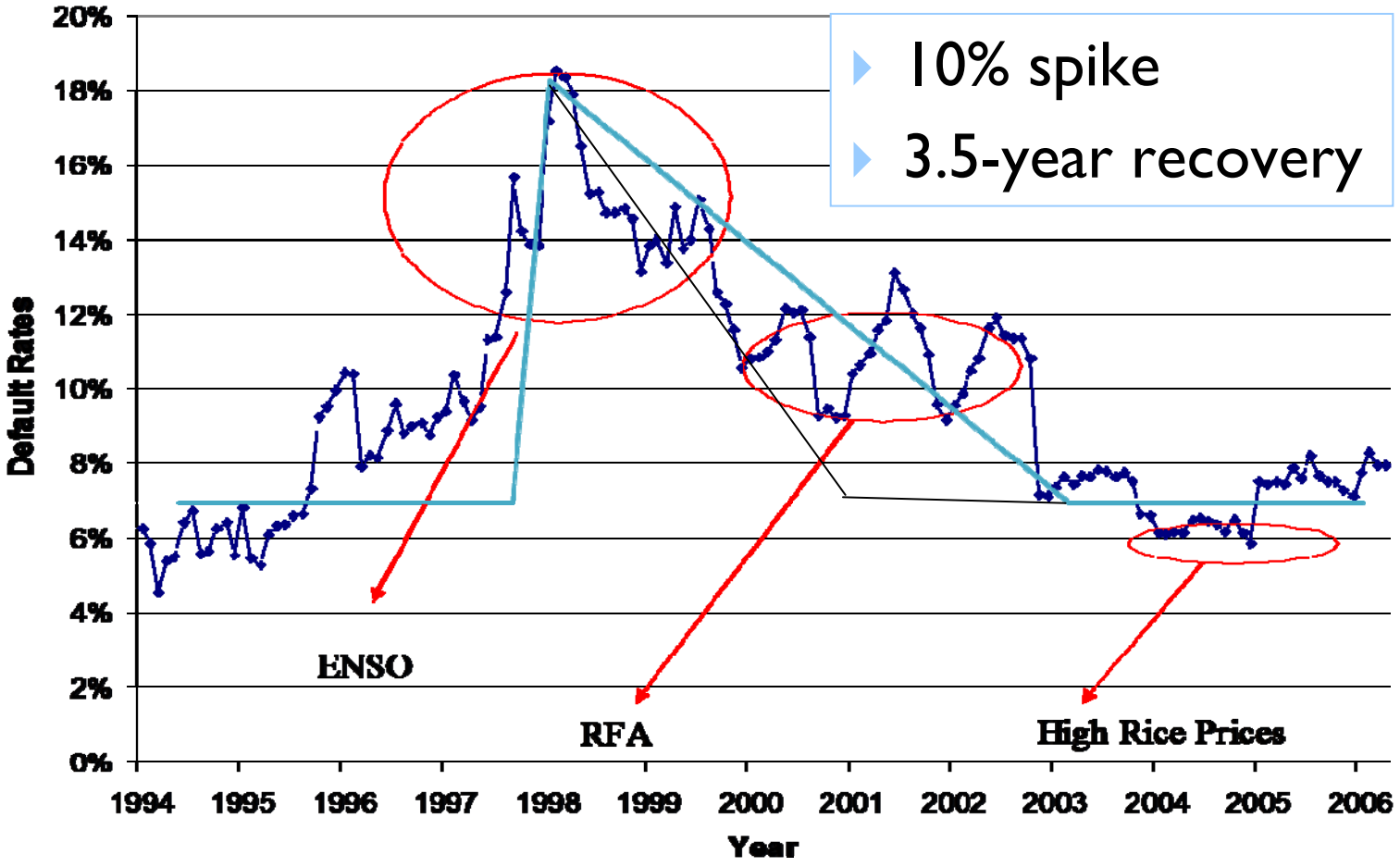
1997–1998 El Niño Spike and Recovery



With this event every 1 in 15 years, 300 basis point must be added

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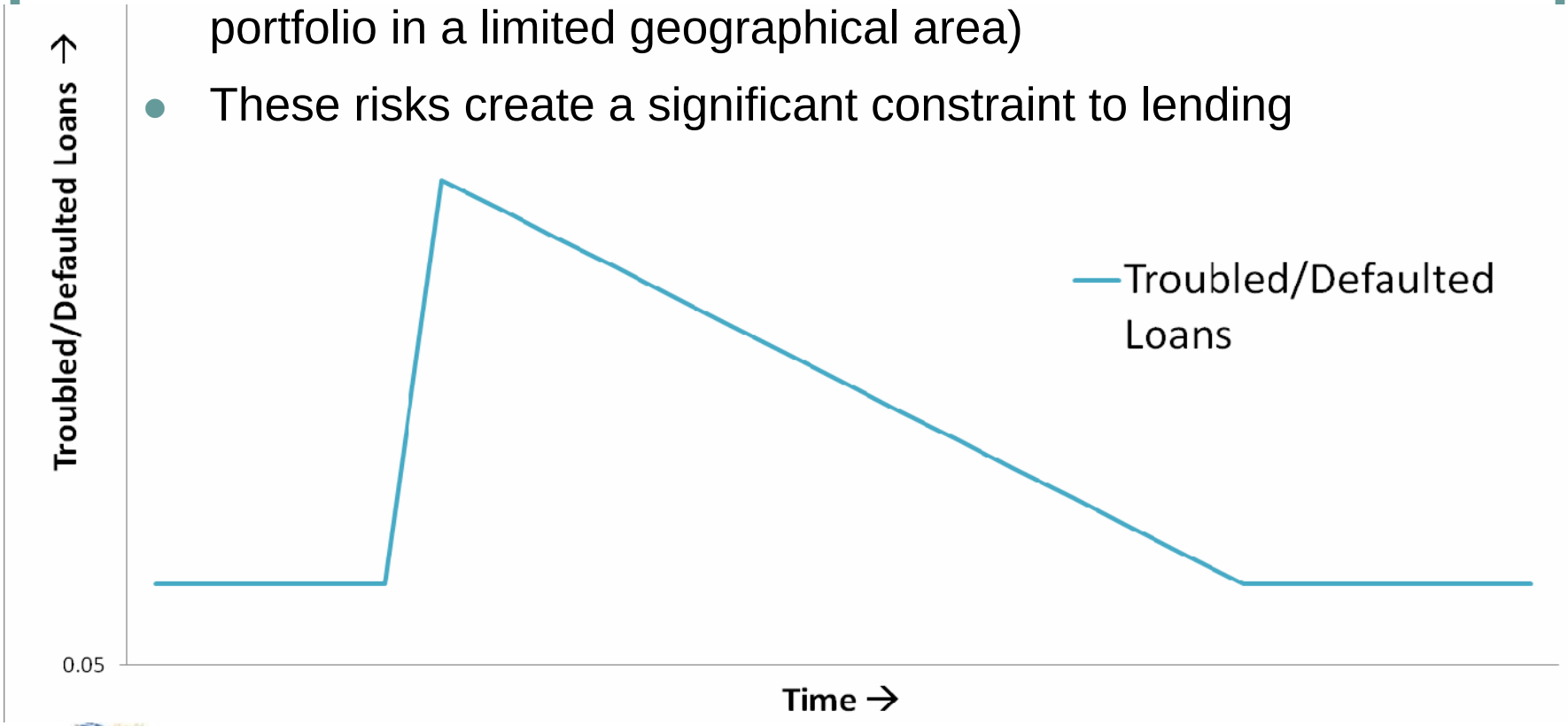
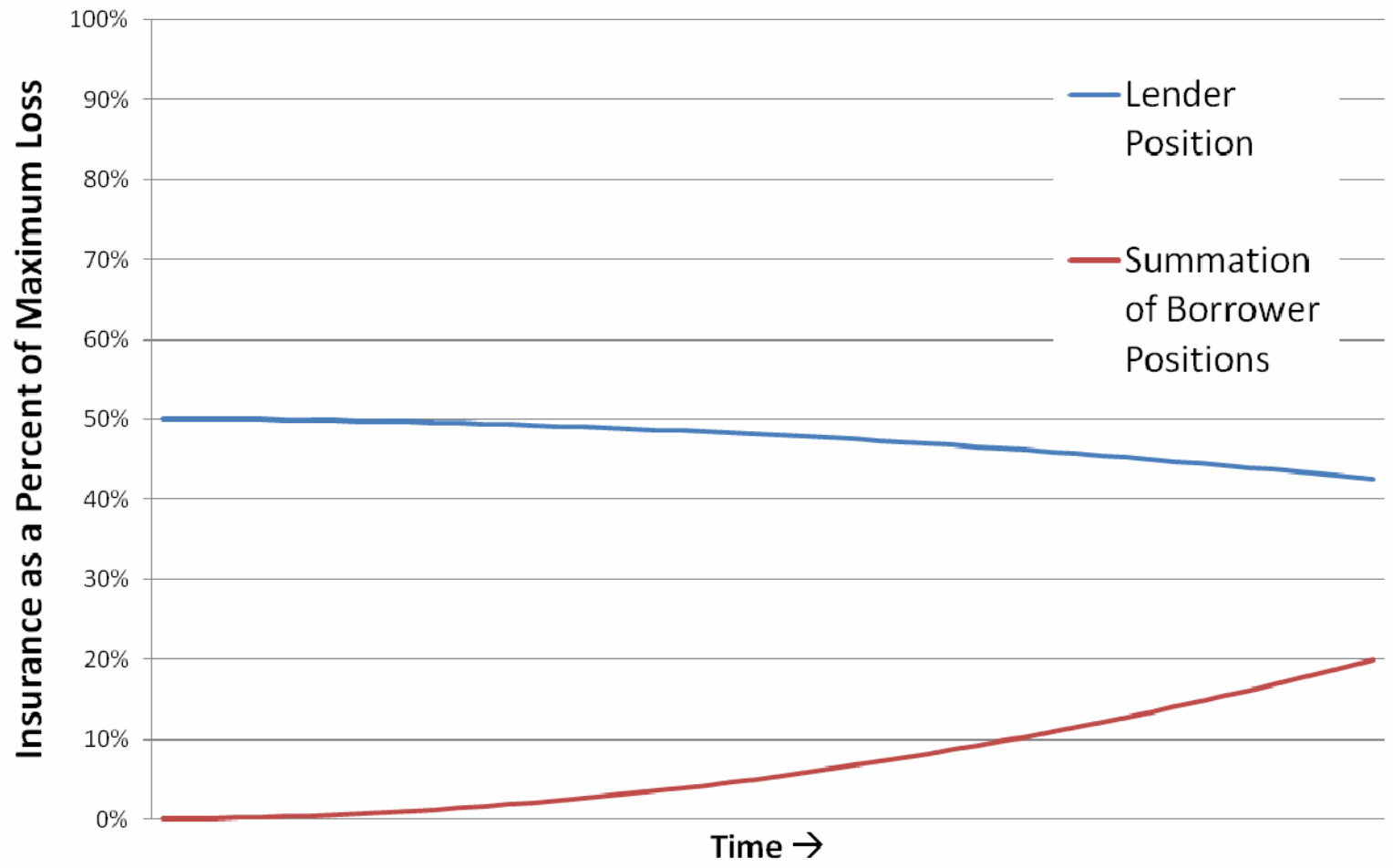
Managing a Catastrophic Weather Risk

Risk Assessment

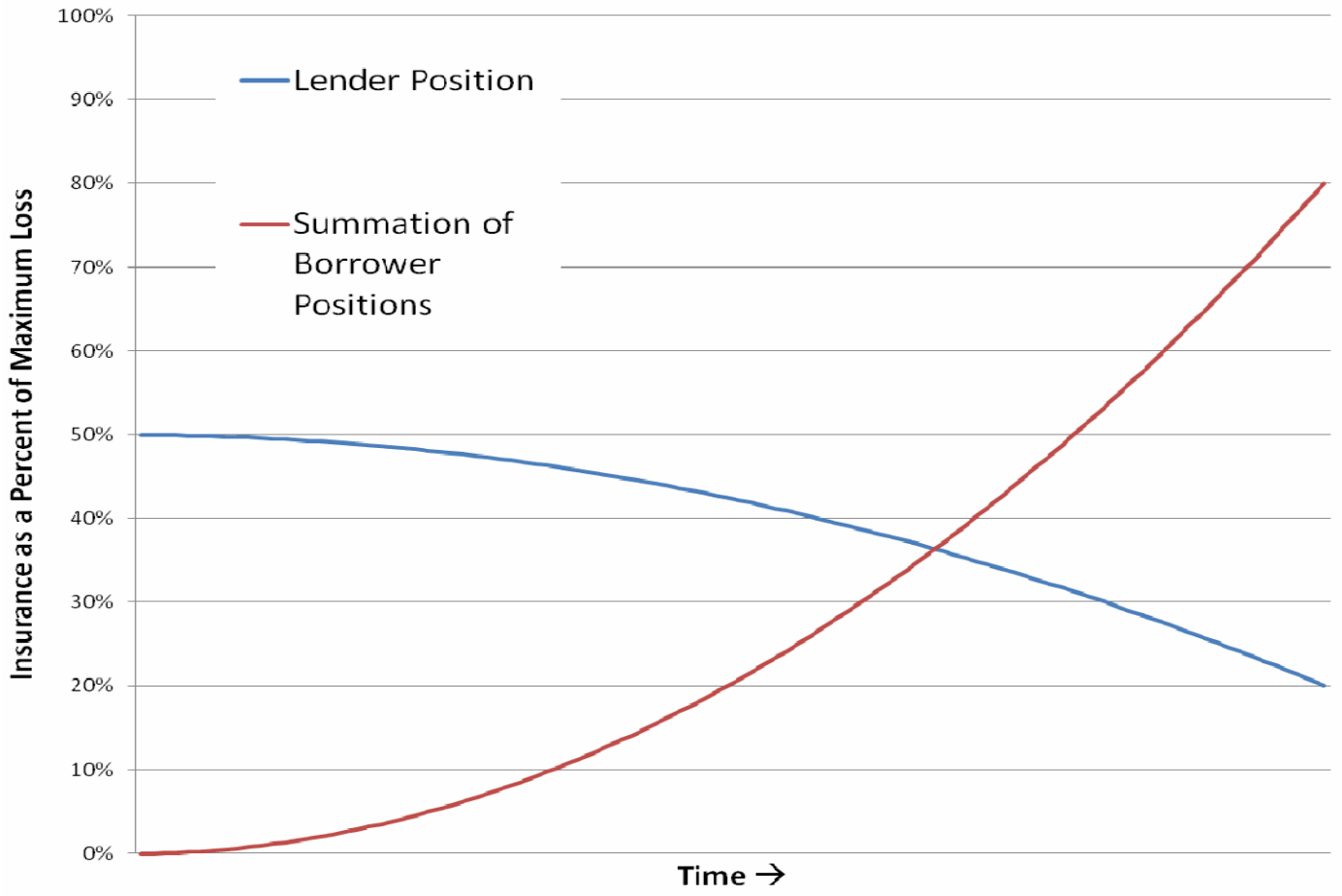
- Weather risk event is expected to cause default risk to spike by 10 percentage points (Common problem for an agricultural portfolio in a limited geographical area)
- These risks create a significant constraint to lending



The Market Development Process *Intermediate Timeframe*
Insurance as a Percent of Maximum Probable Loss



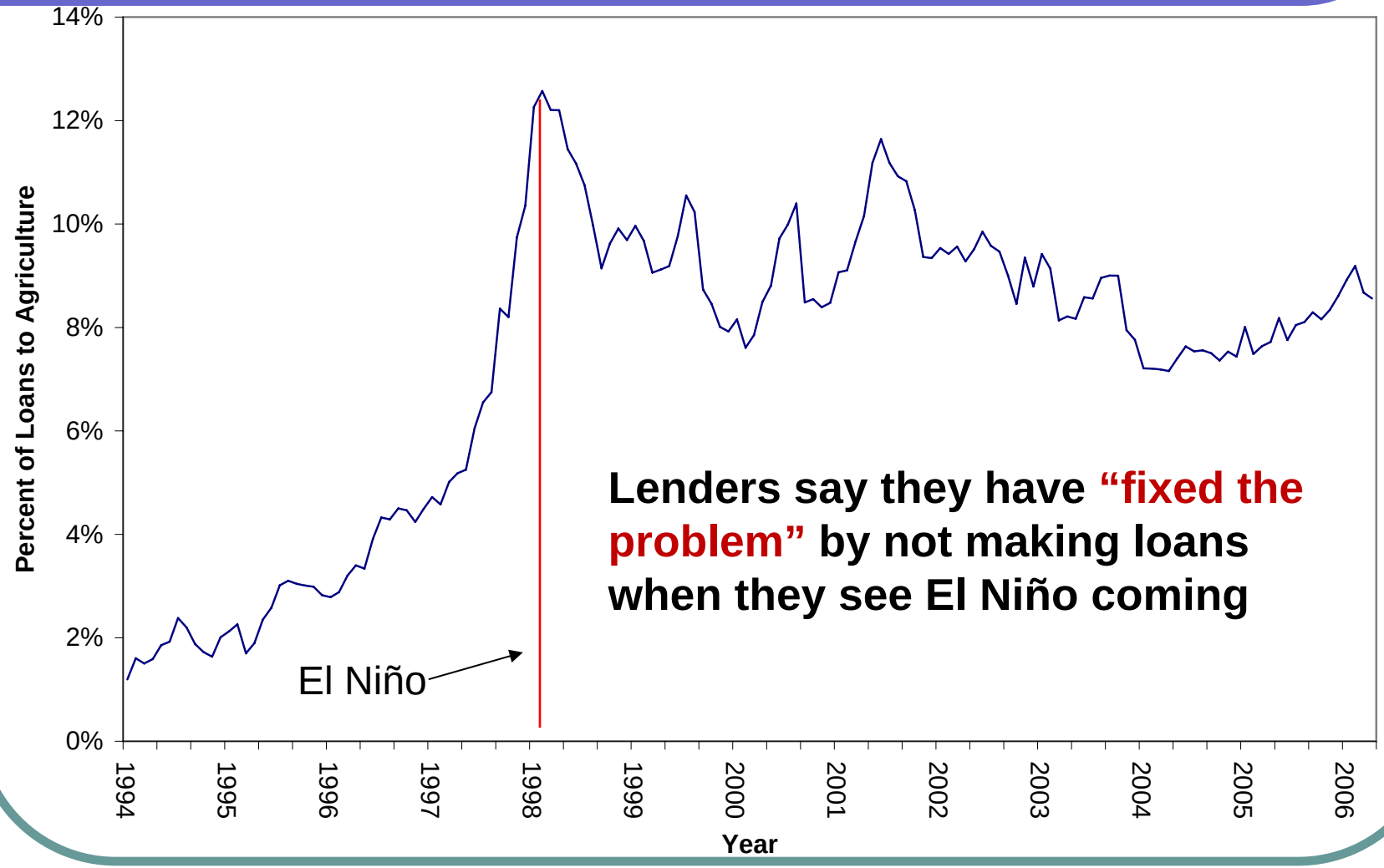
The Market Development Process *Longer Timeframe*
Insurance as a Percent of Maximum Probable Loss



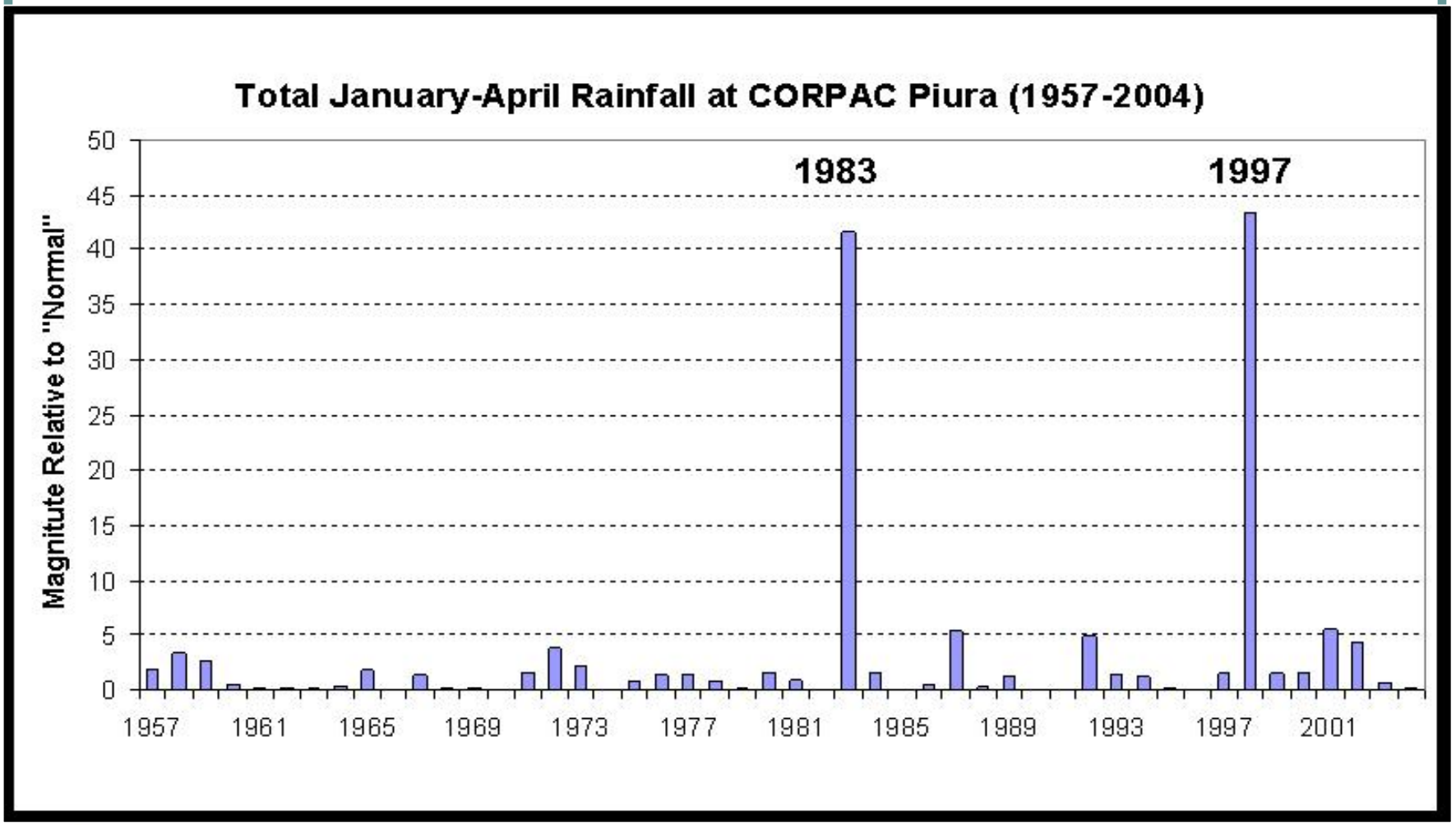
Extreme Flooding and El Niño

- Extreme flooding in Piura is directly tied to El Niño
  - Warm Pacific trade winds meet cold air coming down Andes Mountains
  - Results in extreme, prolonged rainfall
  - Severe El Niño occurs roughly 1 in 15 years
- Most recent severe El Niño events: 1982/83 and 1997/98
  - Rainfall was 40x normal from January to April
  - For 1997/98, volume of Piura River was 41x median value
  - For 1982/83, volume of Piura River was 36x median value
- El Niño is the biggest risk event for agriculture, also affects many other sectors due to infrastructure breakdowns

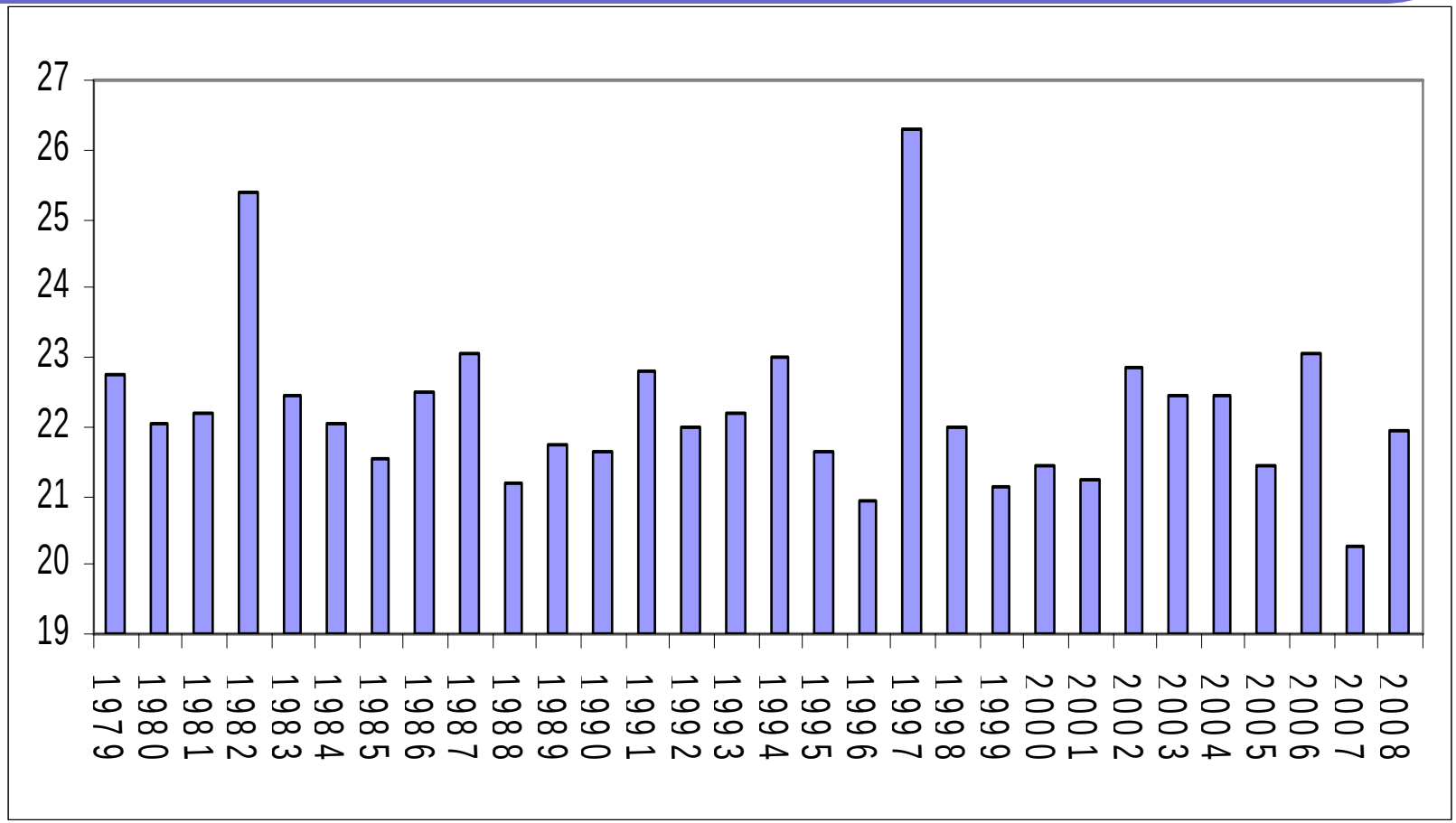
Historical Pattern of Agricultural Lending in Piura 1994–2006



Extreme El Niño Events of 1982/83 : 1997/98

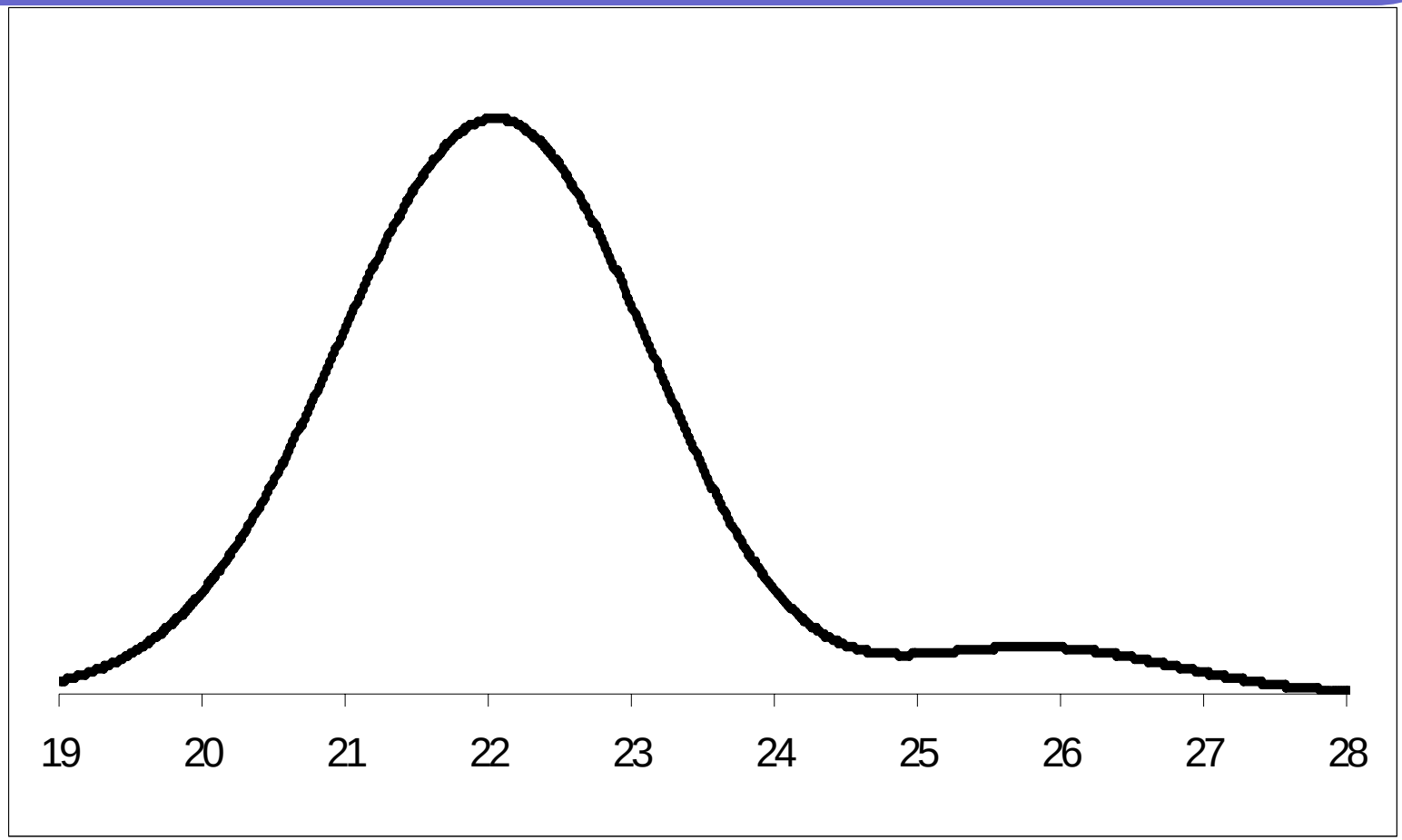


ENSO Index from 1979 to 2008



1982 Payment Rate = 34 Percent; 1997 Payment Rate = 71 Percent
Start Threshold = 24.5; Exit Threshold = 27

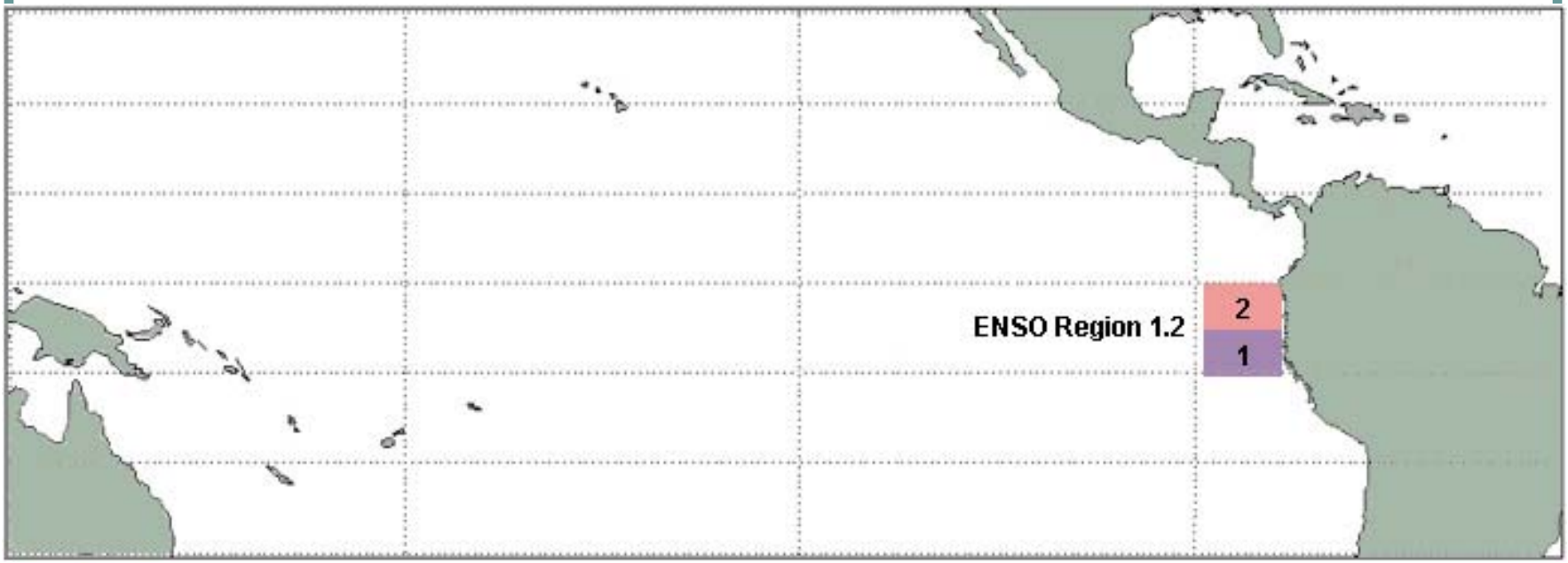
Estimated Probability Density Function for ENSO Index Using Data 1979 to 2007



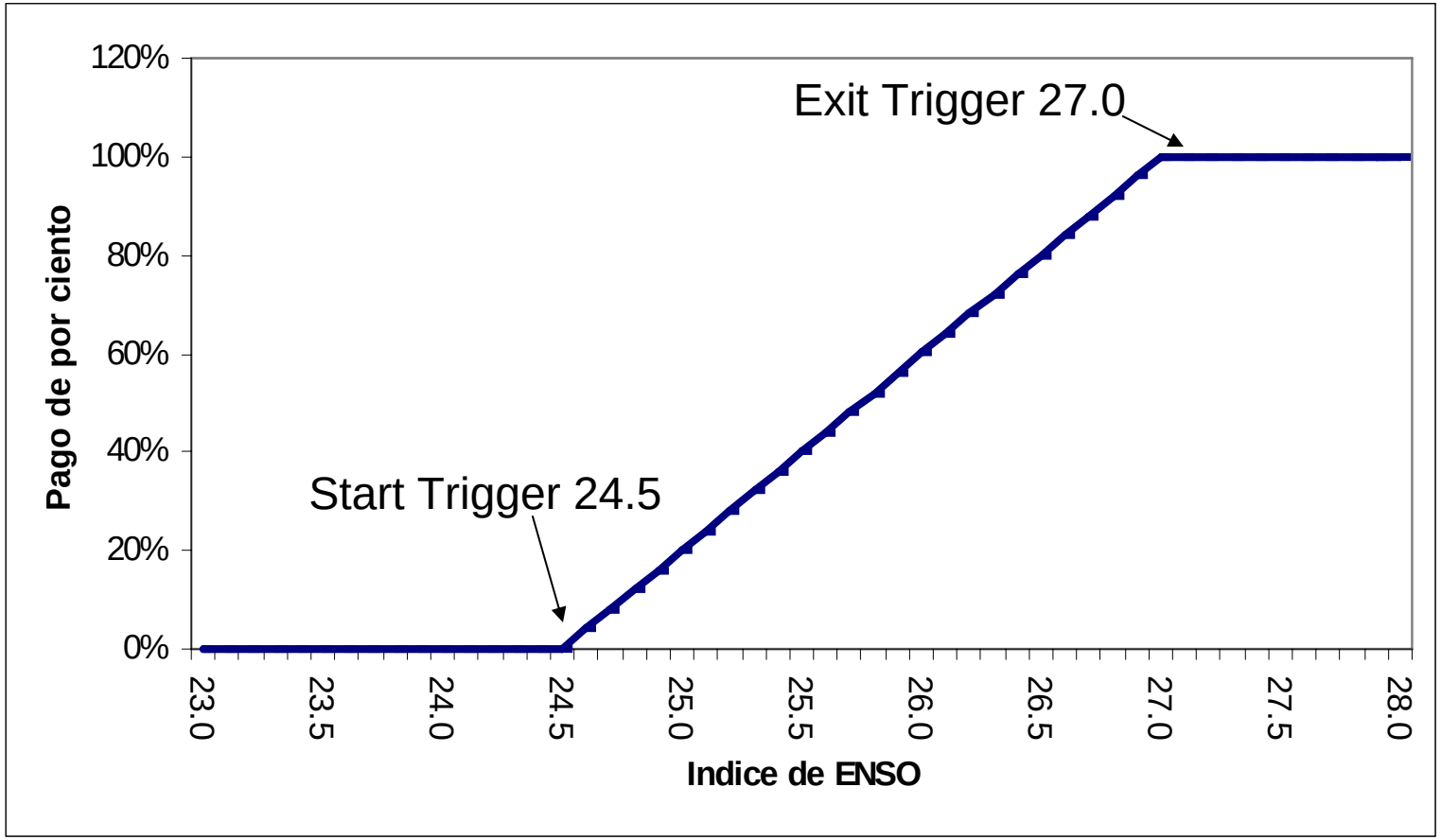
Events in excess of 24 may occur as frequently as 1 in 11 years

ENSO 1.2

- Measured and reported by the NOAA Climate Prediction Center for over 50 years
- ENSO Region 1.2
  - (0°-5°S, 90°W-80°W and 5°S-10°S, 90°W-80°W)

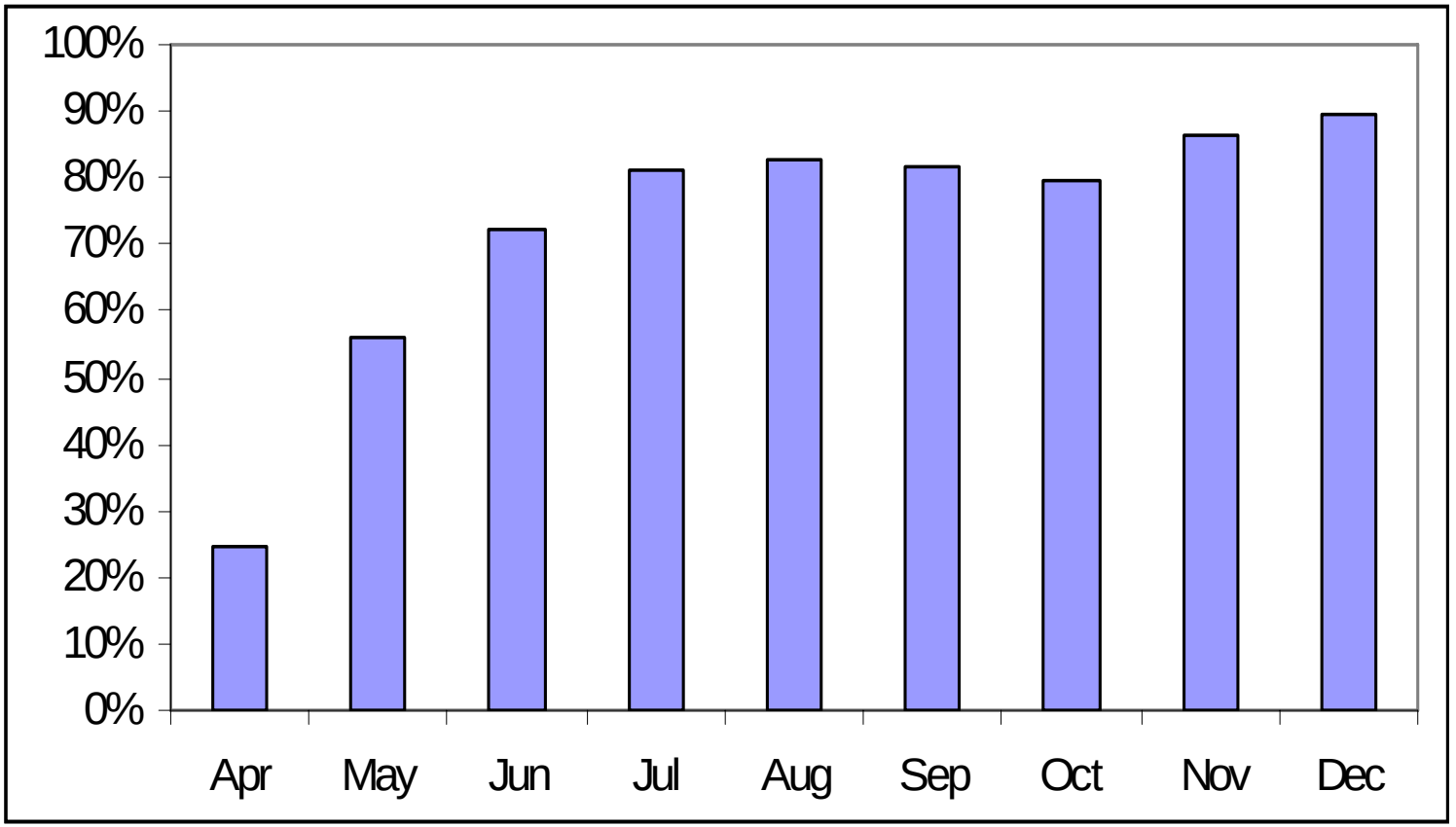


Payout Structure



Linear payout so that if temperature is ½ the way between 24.5 and 27 or 25.75, the payout rate is 50 percent

ENSO Forecast Can Be Made as Early as April



Simple correlation between Jan–March ENSO 1.2 and previous year by month, using only Jan–March ENSO 1.2 average values above the median

Timing of the Contract

Year 1			Year 2	
February–April	**May–October**	**Nov–Dec**	**Early January**	**February–April**
Marketing period with a sales closing date of April 30	The EBIII is in force for possible upcoming severe event	SST data from ENSO 1.2 is used to calculate payments	Payments can be made ***before*** flooding as lenders begin to incur costs	Catastrophic flooding in the region

- Sales closing date must occur before buyers can predict an El Niño — Target April 30
- Insurance contract covers ENSO 1.2 (Nov–Dec)
- Payments will be made in early January as business interruptions are occurring

ENSO Business Interruption Index Insurance (EBIII)

- Rainfall insurance not viable due to limited data
  - Short time period, sparse, difficult to interpret
  - Weather stations destroyed during previous catastrophic events
- ENSO 1.2 Index of sea surface temperatures (SSTs)
  - Monthly average SST from two areas off the coast of Peru
  - Published by the U.S. National Oceanic and Atmospheric Administration (NOAA) using a consistent and reliable methodology
  - ENSO 1.2 can be used to predict extreme flooding associated with El Niño

ENSO Business Interruption Index Insurance (EBIII)

Covers lost profits or extra costs due to extreme flooding as indicated by high average sea surface temperatures in November–December

- Liquidity risk
- Savings are being withdrawn
- Decrease in certificates of deposits
- Loans are being refinanced
- Cost of capital will increase
- Defaults will follow
- Increased need for more capital for provisioning

Accomplishments to Date

- Regulator has approved the product
- LaPositiva Insurance Company of Peru is offering the ENSO Insurance
- PartnerRE will provide reinsurance
- Strong and growing interest among many stakeholders in Peru
- GlobalAgRisk has support from the Bill and Melinda Gates Foundation to advance this work with risk aggregators over the next 3 years

ENSO Insurance for Risk Aggregators

- GlobalAgRisk will work with
  - 4 Financial institutions
  - 1 Business in the value chain (Bananas)
  - 3–4 Farmer associations
- Next steps
  - Perform risk assessment to inform risk aggregators about the potential value of the ESNO Insurance
  - Continue working with Peruvian banking and insurance regulator to understand more about how this fits as a warranty-like instrument
  - Begin working with credit risk agencies in Peru to assess how this insurance can change the credit risk rating of financial institutions

Livelihoods Index Insurance for Weather Risk

- Rural areas are vulnerable to catastrophic risk in many ways
  - Both on- and off-farm labor can be affected
  - Infrastructure damage can disrupt access to jobs, markets
  - Rural incomes often come from a variety of sources
- Insuring the overall "livelihood" rather than a single crop yield could have more value to more HHs
- Similar to business interruption insurance (Our experience is that regulators are open to presenting index insurance as a form of business interruption insurance)

Livelihoods Insurance

- E.g., HH purchases insurance for a level of liability that pays whenever the insured CAT weather risk occurs
- Over-insuring is unlikely to be a problem — Experience has shown that HHs are more likely to under-insure
- Benefits over index insurance for a specific crop
  - Inclusive of HHs with diverse income sources
  - More inclusive of the landless poor
  - Straightforward, simple contract structure
  - Gives HHs more flexibility to adjust production strategies to changing conditions

Improving Delivery of Microinsurance

NGOs could play a significant role in advancing "Livelihoods Insurance" and addressing constraints

- Many NGOs are involved in supporting rural livelihoods
- Lots of interest among donors and NGOs about helping HHs manage their risk and adapt to climate change
- Linking weather insurance to mitigation and adaptation strategies can help HHs manage climate risk more effectively
  - Insurance is not a solution to climate change
  - Insurance can protect against weather extremes, but producers must adapt production strategies to changing climate trends

Advantages of NGO Linkages

Combining insurance with adaptation strategies can reduce risk exposure and protect livelihoods against severe events

- Complements NGO activities in risk mitigation and rural livelihoods
- Provide mutual insurance for community groups
- Can link to other services/benefits
- Encourage risk management *and* appropriate adaptation
- Smooth HH income following a disaster
- Targeted, timely payments
- Build on existing network for education and access to reduce cognitive failure and reduce transaction costs

Delivery Structures

Existing models of NGO linkages

- NGO as an intermediary delivery system
- NGO as the beneficiary for contingent financing for disaster relief

New model could provide direct, targeted benefit to HHs

- NGO co-finances or purchases an insurance contract on behalf of clients or a community group creating an informal mutual insurance association
  - Semi-formal risk sharing among clients could allocate indemnities to neediest households — Mitigating basis risk problems
  - If individual losses are low, indemnities could also be used to invest in risk mitigation

GlobalAgRisk Outreach

- Primer on Index Insurance: “Index Insurance for Weather Risk in Low Income Countries.” Prepared for USAID Microenterprise Development (MD) Office, December, 2006
- Online Courses: Market-based Risk Transfer prepared by GlobalAgRisk, Inc., in consultation with World Bank Institute
  - "Market-Based Risk Management for Development: Comprehensive Introductory Course." June, 2007
  - “Course II: Market-based Risk Management Framework.” May, 2008

Thank you!

Barnett, B. J., C. B. Barrett, and J. R. Skees. "Poverty Traps and Index-based Risk Transfer Products." *World Development* 36, no. 10(2008): 1766–1785.

Leiva, A. J., and J. R. Skees. "Using Irrigation Insurance to Improve Water Usage in the Rio Mayo System of Northwest Mexico." *World Development*. 36, no.12(2009): 2663–2678.

Murphy, A. G. "Using NGOs to Advance Microinsurance for Weather Risks Among the Rural Poor." Presentation to the 4th International Microinsurance Conference, Cartagena, Colombia. November 7, 2008.

Skees, J. R. "Innovations in Index Insurance for the Poor in Lower Income Countries." *Agricultural and Resource Economics Review* 37(2008): 1–15.

Skees, J. R. "Challenges for Use of Index-based Weather Insurance in Lower Income Countries." *Agricultural Finance Review* 68(Spring, 2008): 197–217.

Skees, J. R., J. Hartell, and A. Murphy. "Using Index-based Risk Transfer Products to Facilitate Micro Lending in Peru and Vietnam." *American Journal of Agricultural Economics* 89(2007): 1255–1261.

Skees, J. R., and B. J. Barnett. "Enhancing Micro Finance Using Index-Based Risk Transfer Products." *Agricultural Finance Review* 66(2006): 235–250.

Skees, J. R., and B. J. Barnett. "Conceptual and Practical Considerations for Sharing Catastrophic/Systemic Risks." *Review of Agricultural Economics* 21(1999): 424–441.

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