Institute and Faculty of Actuaries

GIRO40

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Index Insurance for Weather Risks

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1. Agriculture Risks

Types of risk and loss-

Highly covariate losses are critical

Covariance	Frequency	Example	Loss-Life	Loss-Asset	Loss-production/income
Low	High	Localised weather & pest problems	Relatively predictable deaths & illness	Relatively predictable damage or loss of assets	Low yields for some farmers due to variety of localised weather related problems
			Some local capacity to pool risks, relatively quick recovery		
Medium	Medium	Less-severe drought or excess rainfall in critical periods	Some loss of life & widespread health problems	Widespread loss of animals from drought or contagious diseases	Loss of income from poor market prices, shrinkage of rural non-farm economy
			Moderate capacity to cope, modest recovery		
High	Low	Catastrophes-tsunami, severe drought, flood, hurricance, earthquake	Widespread loss of life and/or injuries	Widespread loss of home and/or productive assets	Severe impact on local production
			Low or no capacity to cope locally, very slow recovery		

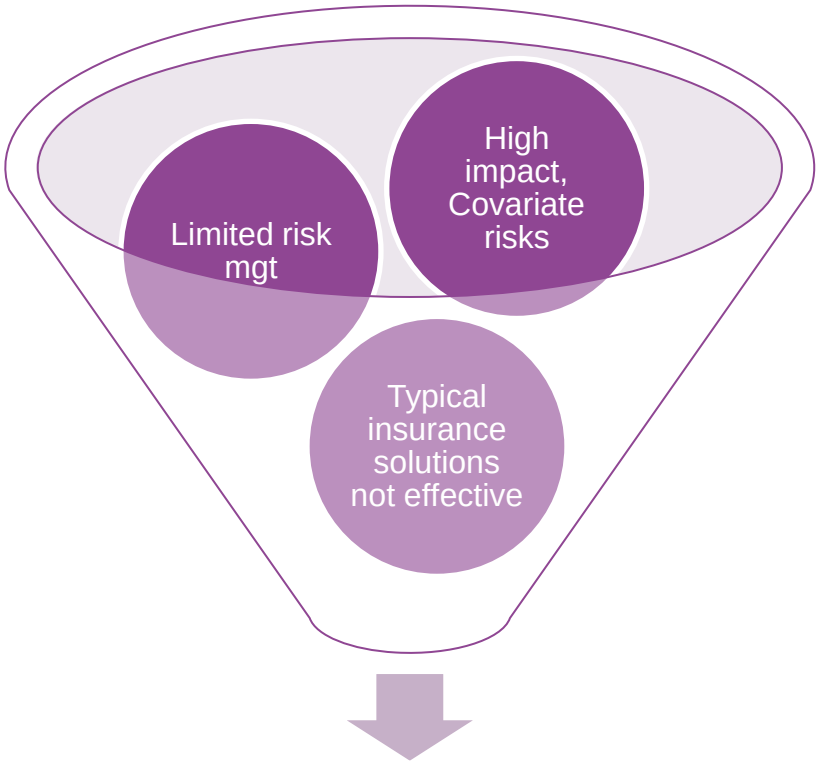
Risk Management-

Players with varying issues, incomplete risk mgt across levels

Player	Risk Management	Limits
Rural Households & Communities	•Crop diversification, farm fragmentation, share cropping (ex-ante) •Credit, work, savings (ex-post) •Informal sharing networks at community level	•High opportunity costs •Limited access to credit •Unable to handle high impact low frequency events
Financial Institutions	•Unable to take on covariate risks, some limited mgt of independent risks •Risk averse product design esp for rural populations	•Cant handle covariate risks •No financial services for high-risk areas/clients
Private Insurers	•Conservative pricing & limit to specific perils •Limit market to large commercial farmers with high-value crops	•Reluctant to insure crop & livestock yields •Moral Hazard & inadequate risk assessment information
Government	•Typically ex-post intervention after major catastrophe •Increasingly ex-ante through National Agri schemes for key crops and perils	•Ex-post – no or limited risk financing and inadequate response •Ex-ante- improving but still limited and many lessons being learned •Political and economic pressures often affect long term sustainability

Role of Insurance-

Ineffective risk management creates important role for insurance – but what type?



Index Insurance?

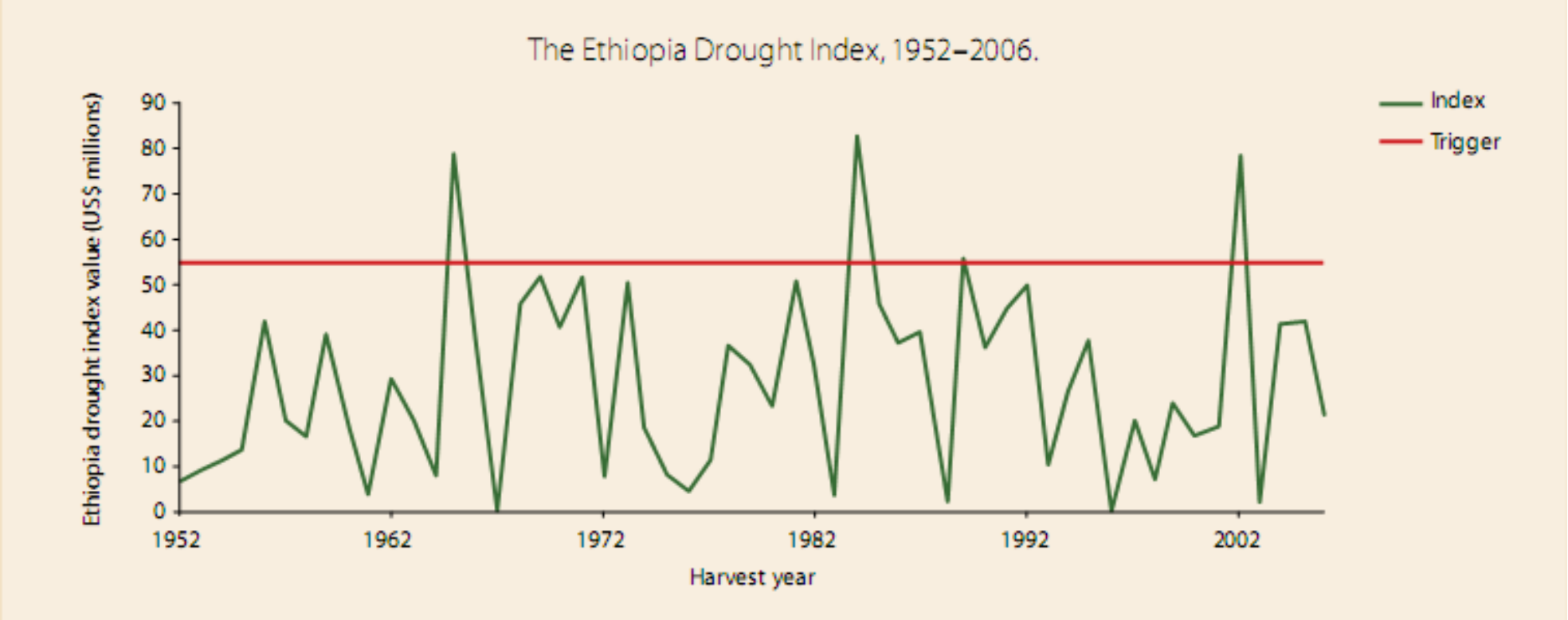
2. Basics of Index Insurance

What is Index Insurance?

Index Insurance is…"a financial product linked to an index highly correlated to changes in the 'value at risk'. Contracts are written against specific perils or events (eg area yield loss, drought..) that are defined and recorded at regional levels (eg weather station rainfall measure..)"

- Indemnifications are triggered by pre-specified levels of the index, as opposed to actual yields
- Based on an independently verifiable index - assists risk transfer to global markets
- Typically all buyers offered ***same*** contract terms and premium rate
- Payout occurs if index above pre-specified ***trigger*** level
- All buyers receive same ***payout rate***; Actual payout amount depends on Value Insured
- Payouts structured in variety of ways;
    - Simple zero/one contract or
    - Layered payment schedule or Proportional payment schedule

Example index-
Ethiopia Drought Index



Payout Example (1)

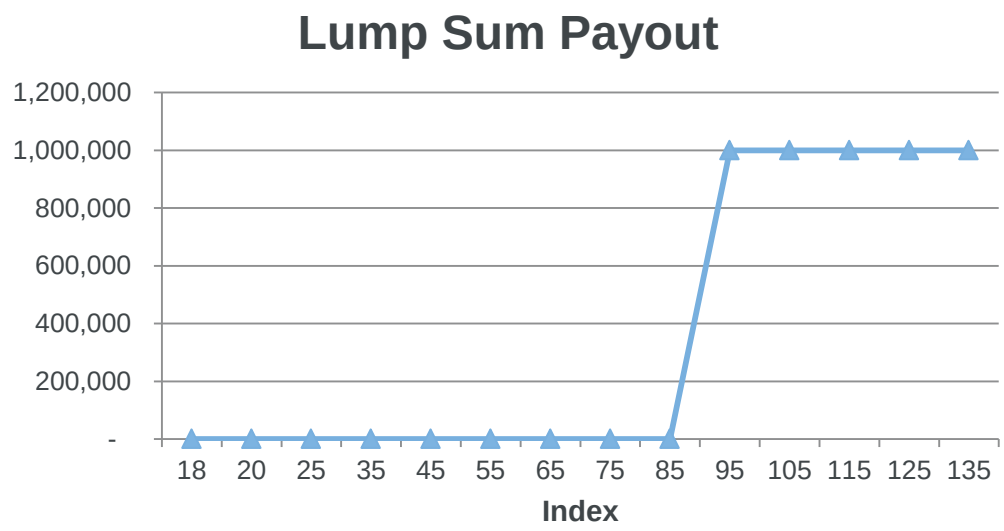
Zero/One Payout if index exceeds threshold

Payout options

Zero/One - Lump Sum

0 if Index < Threshold

Fixed Amount if Index > Threshold



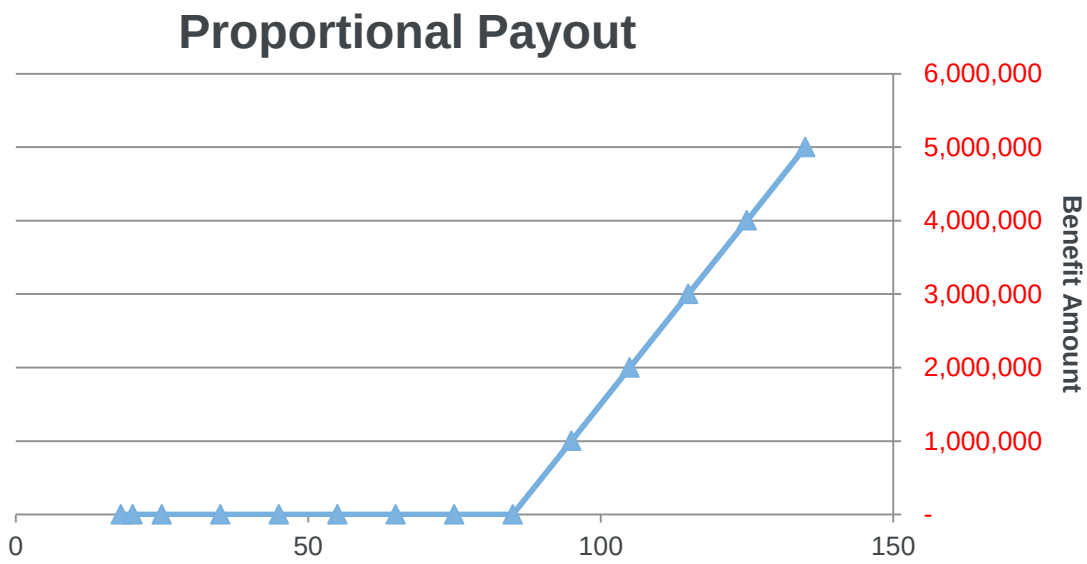
Payout Example (2)

Proportional Payout if index exceeds threshold

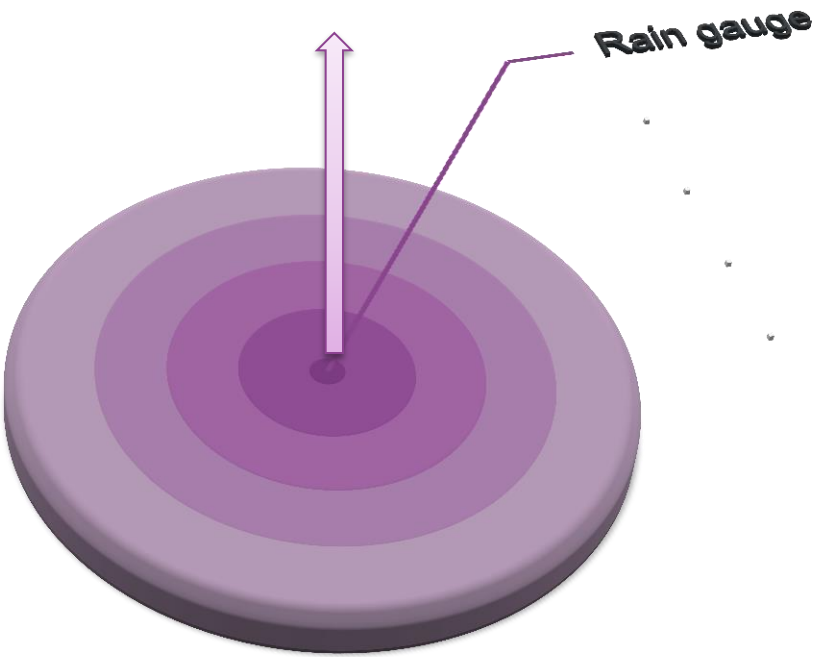
Payout options

Proportional to Index

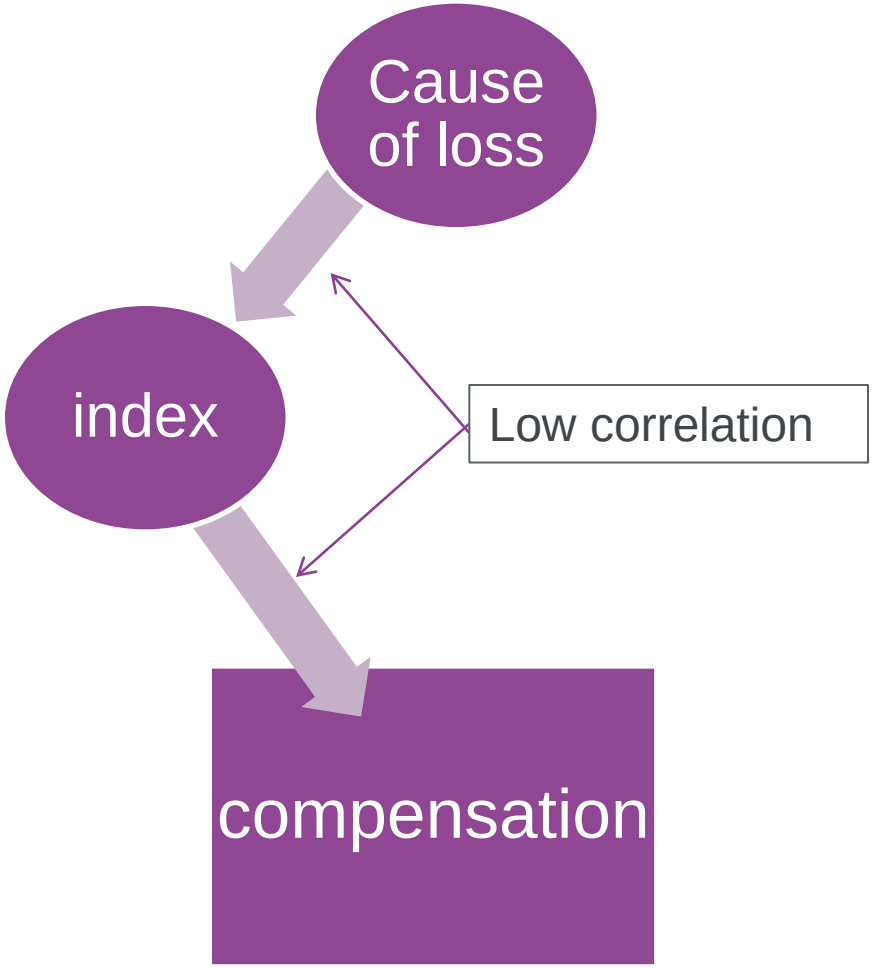
$$\begin{cases} 0 & \text{if} \quad \text{Index} < \text{Threshold} \\ A + \omega . \dfrac{(Index - Threshold)}{Threshold} & \text{where} \quad \text{A is Asset replacement value and } \omega \text{ the "wage" factor} \\ A + \Omega_{Max} & \text{where} \quad \Omega_{\text{Max}} \text{ is a maximum wage compensation if Index is} > \text{I}_{\text{max}} \end{cases}$$



Basis Risk-
An imperfect solution



Correlation between rainfall recorded & actual rainfall decreases as the distance increases from AWS



Basis Risk

Compensation <> Actual Loss

Pro’s and Con’s

Con’s

- Basis Risk
- Low Take up – scalability
- Renewals after claim
- High set up cost
- Often subsidised – sustainability issues

Pro’s

- “Observable event” – no dispute
- Address correlated weather risks
- Reduces Adverse Selection
- Reduces Moral Hazard
- Low (Claims) transaction cost
- Ability to layer multiple perils
- Access to Global RI markets

3. Index Insurance in Developed Markets

Brief History of Index Insurance in developed markets

History of index insurance….

1920, Indian scholar proposed area-yield insurance, rather than individual farmer yield

1949, US scholar wrote a Ph.D. on issues of moral hazard & adverse selection in farm level crop insurance

1950's, Sweden started area-yield insurance for a bundled package of crops

1980's, India started government area-yield insurance for cropping districts

US Crop Insurance…

Early 1990's US area yield (index) crop insurance program (GRP) started.

- GRP developed to cover seven major crops in over 1900 counties
- In 1999 GRIP (income protection) started, insures against decline in expected county revenue
- Acres insured grown from 2% to 16% (2007)
- GRP/GRIP premium US$650m (2007), plus ***subsidy*** approx 55%
- Average Loss ratio; GRP: 118%, GRIP 72% (1999 to 2007)

Index Insurance vs Traditional Insurance

Product		Key Features	Perils	Benefits	Challenges
Indemnity Based	Named Peril Crop Insurance	• Specific perils • Agreed SI • Damage Based (measured) • Unsubsidized	• Main: Hail, fire • Other: frost, freeze, wind • Suitable for local ind. perils	• Simple policy • Transparent loss assessment • Manageable adv selection & moral hazard	• Ind loss assessment – cost & time • Unsuited for complex perils & covariate risks
	Multiple Peril Crop Insurance (MPCI)	• All perils, few exclusions • Typically Yield based • Harvest Yield (measured) • Highly subsidized	• Wide scope • Sometimes includes price risk • Includes Mgt influences	• Adaptable to different crops • Protects farmer production & income • Indemnity basis suits many insureds	• Major loss adjustment costs • Adverse selection & Moral hazard • Set up for individual exposures • High premium & admin cost
Index Based	Area yield index Insurance	• Farmers grouped • MPCI but on area average yield • All farmers treated equally	• as for MPCI	• Limited adverse selection, reduced moral hazard • Low admin costs • Can address CAT	• Local perils (eg hail) will not lead to payout • Yield history challenge • Basis risk at local level
	Weather Index Insurance (WII)	• Payout based on “weather measurement” • Index trigger set at expected loss of yield •Complex to design & ltd experience to date	• Main: rainfall deficit/excess, High/Low temp • Other: wind, sun	• Ltd adverse selection, reduced moral hazard • Can address CAT • Transparent data • Easier to reinsure	• Basis Risk key issue • Set up cost/challenge • Need for good quality data

Insurance or a Derivative?

Player	Insurance	Derivative
Legal	Subject to contract law and insurance principles; • insured pays premium to insurer • insurer accepts risk of uncertain event • insurer agrees to indemnify/compensate for loss arising from insured event • insurable interest • contract has a specified term etc	• Shared features: payment, transfer of risk and contract term **Key differences:** • insurable interest ***not*** required •principle of indemnification/ compensation for loss ***doesn't*** apply •Derivatives are ***tradable***
Regulatory	• Highly regulated industry though significant variation by country • ICP's do **not** consider Index Insurance • Depends on local regulator(s) perspective	• Often limited/underdeveloped regulation for capital markets in developing countries • Exchange traded vs OTC • Non-standard terms & conditions
Summary	•Weather Index usually classified as Insurance if all typical insurance parties involved and insurance principles apply • Regulation often not complete for Index Insurance esp re Capital, Reserving and Pricing	• Test for insurance principles and if traded •Could be interaction between the 2 types of contracts

4. Case Study-Mongolia

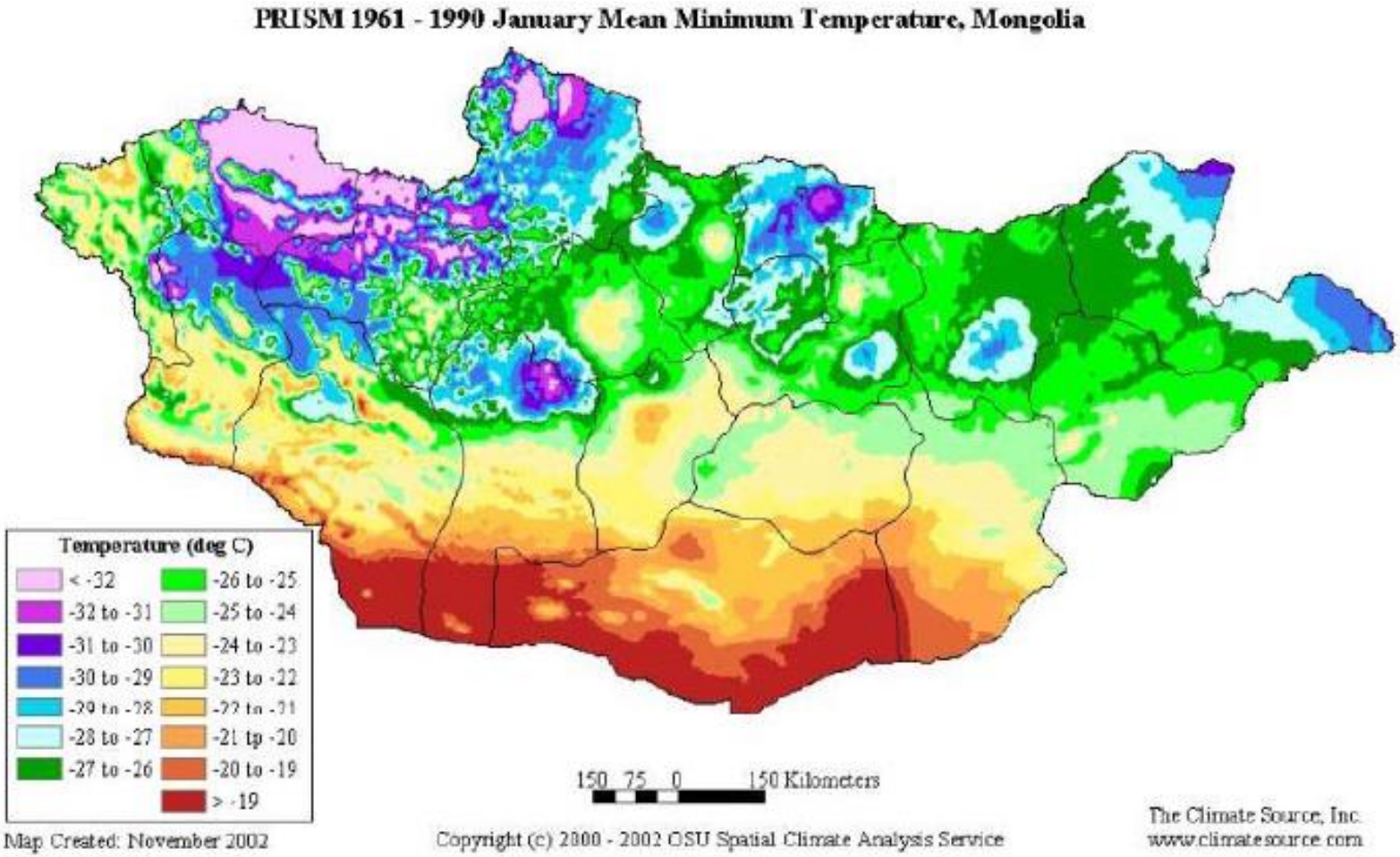
Context of Mongolia-

Young growing population, urban vs nomadic split. Undergoing major demographic and economic changes

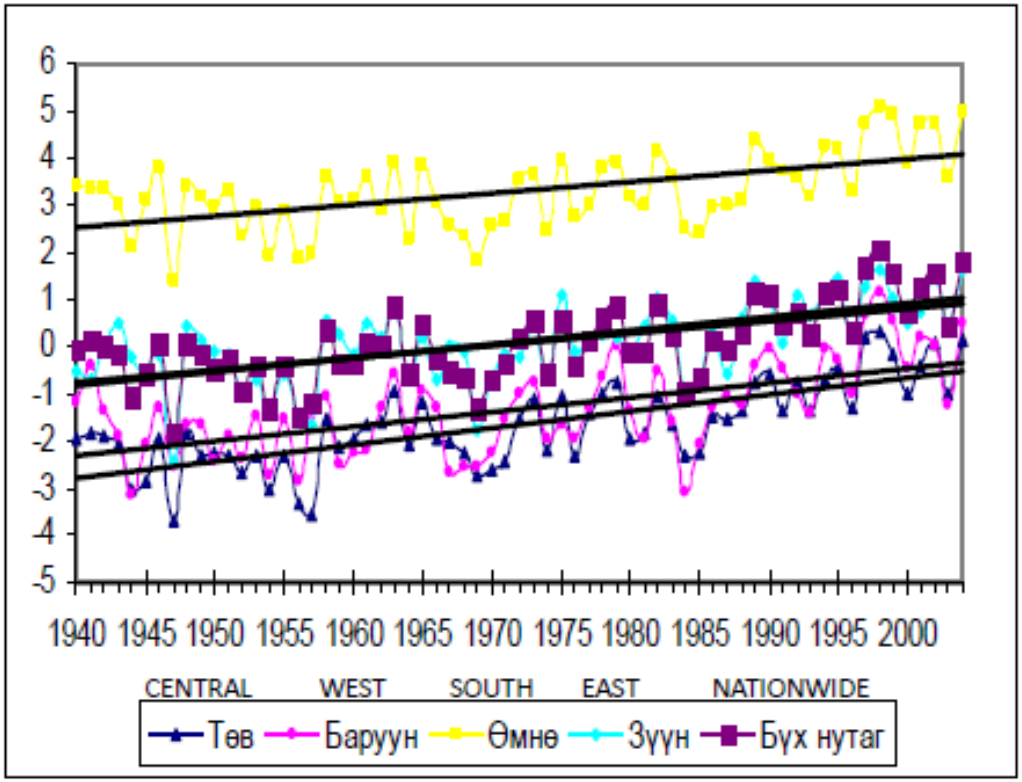
National Statistical Office (2,612,900, end of June 2007). Mongolia's population growth rate is estimated at 1.2% (2007 est.).
About 59% of the total population is under age 30, 27% of whom are under 14. This relatively young and growing population has placed strains on Mongolia's economy.

During the state socialist period, education was one of the areas of significant achievement in Mongolia. Illiteracy was virtually eliminated, in part through the use of seasonal boarding schools for children of nomadic families. Funding to these boarding schools was cut in the 1990s, contributing to slightly increased illiteracy.

Mean temperature (in January) -
Extreme levels & variations in temp



Mean temperature trends-
Increasing temp, varying by season and region



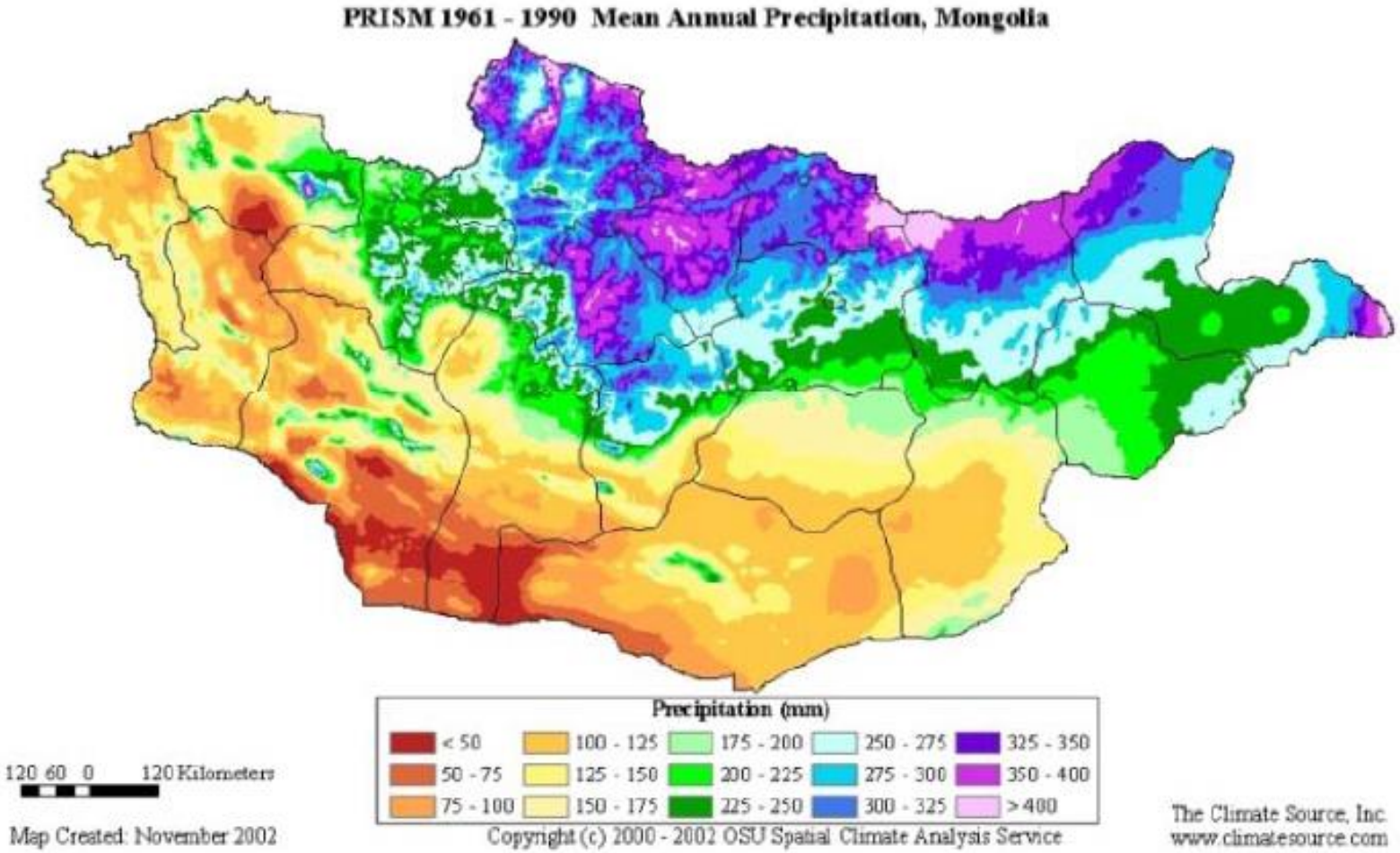
Source: SDC Green Gold Project, Mongolia 2010

Mean temperature has increased by 1.9 Degrees of Celsius during 1940-2004 period.

- Winter ↑3.6 ^{0}C
- Spring & Fall ↑1.4-1.9 ^{0}C
- Summer ↑0.6^{0}C

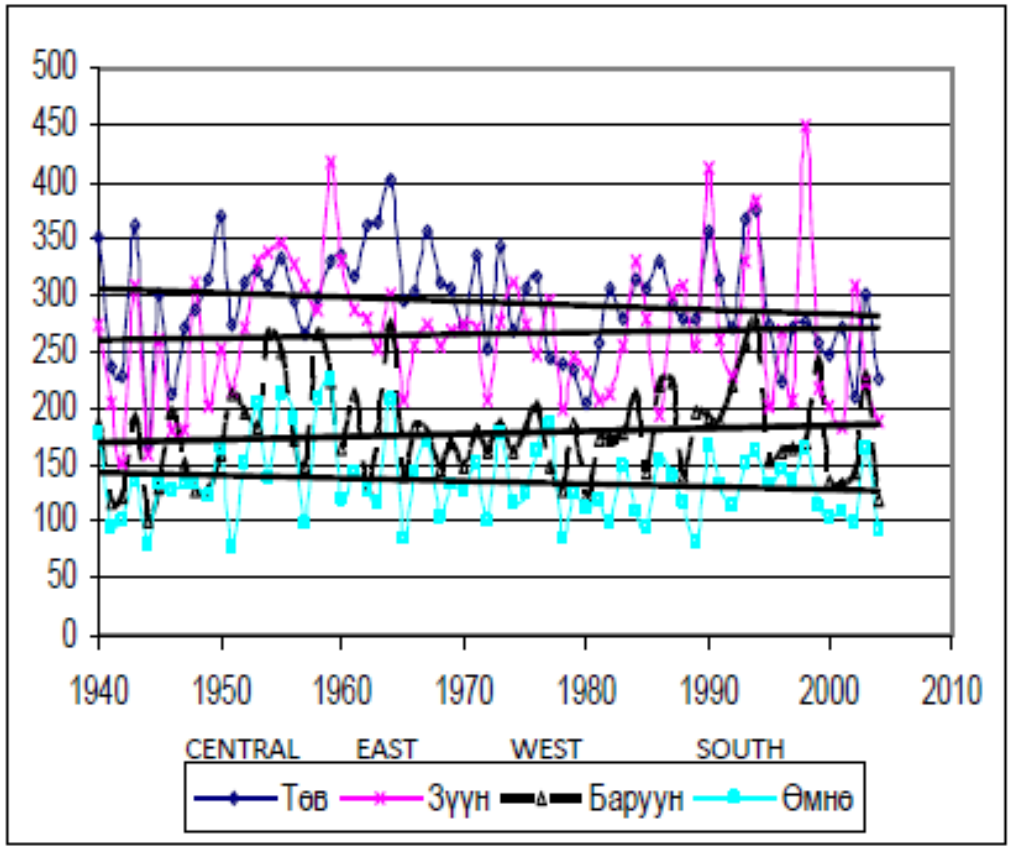
Mean Annual Precipitation

Desert/Arid areas vs heavy rainfall areas



Precipitation Trends by region-

Varied changes in precipitation by region

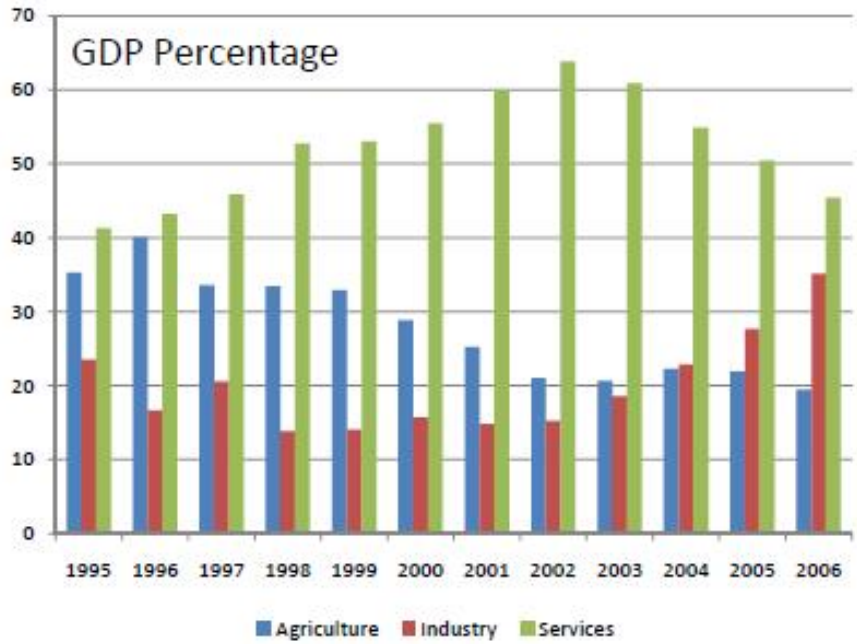


Source: SDC Green Gold Project, Mongolia 2010

- South and Central Mean Precipitation ↓8.7-12.5%
- East and West Mean Precipitation ↑3.5-9.3%
- Fall and Winter Mean Precipitation ↑ 5.2-10.7%
- Spring and Summer Mean Precipitation ↓9.1-3.0%

Role of Agriculture-

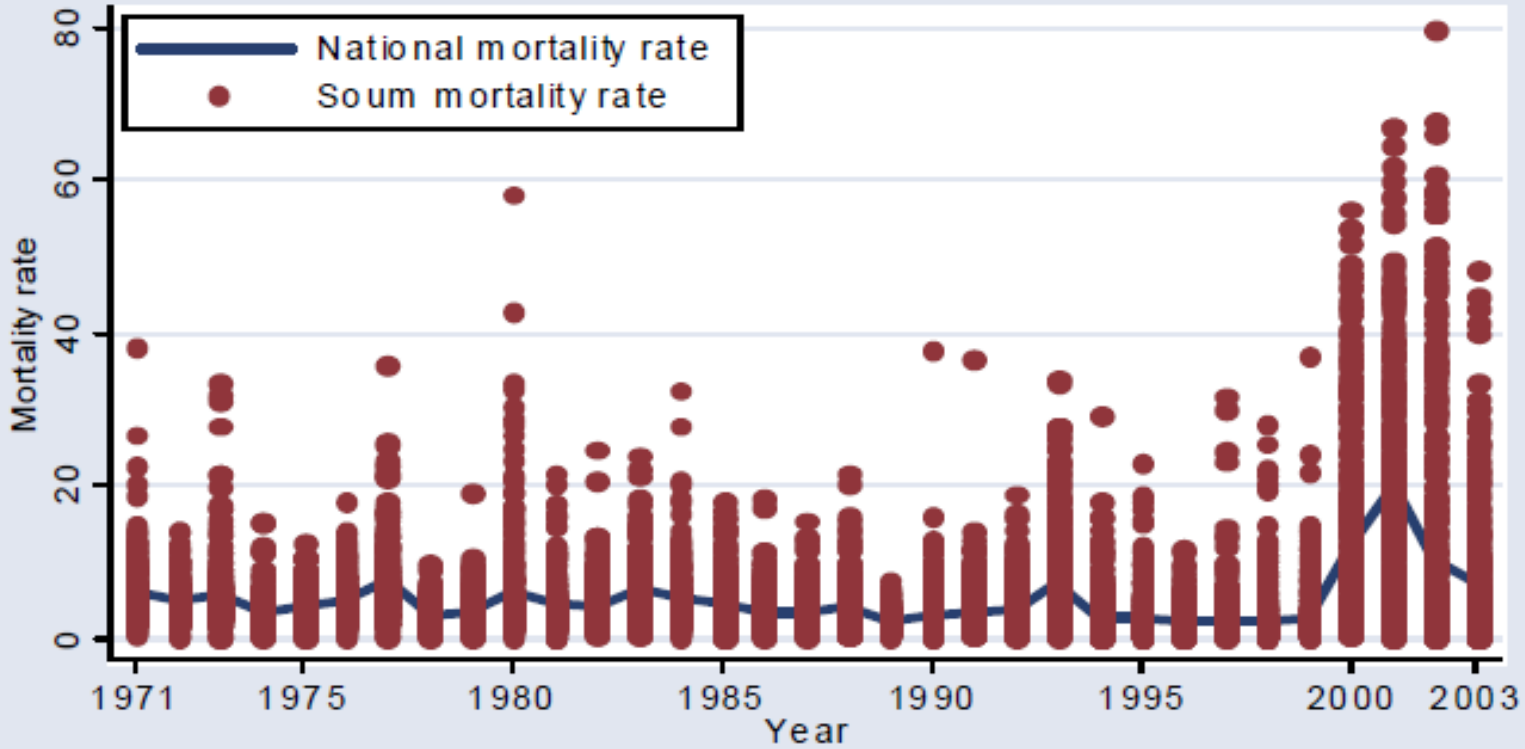
Critically important to economy and cultural life



- The agricultural sector plays a central role in the Mongolian economy, contributing around one-fifth of GDP.
- The most important agricultural activity is livestock husbandry, which has an 80 percent share of agricultural GDP and supports nearly half the population.
- Livestock provides an important source of income, jobs, food security, fuel and a means for households to invest and store their wealth.

Livestock Mortality-

Significant variation by Soum, increasing trend?



Note: Losses and livestock figures for all five main species of livestock were first transformed into bods. Mortality rate is defined as the percentage of bod losses at the end of the year with respect to the stock of bods at the end of the previous year.

Source: 1971-2003 Livestock Census.

Livestock Mortality Risk

Severe Mortality risk during Dzud

- During the 2009-10 Mongolians suffered a severe DZUD – a dry summer followed by a harsh winter that causes the starvation and death of livestock.
- Total of livestock loss reached around 9.7 million head, total amount of around 477 million USD.

IBLI-Index Based Livestock Insurance

Key Features

- Herder selects what livestock to insure; sheep, goats, cattle, horse, camel (approx 39million livestock at Dec 2012)
- Herder selects proportion of value to insure
- Premium = Insured Value times premium rate & admin loading
- Payout if Soum Mortality above 6%
- Primary Layer - Losses between 6% and 30%, covered by local insurance pool & global reinsurer
- Catastrophe Layer – losses above 30% mortality, covered by Mongolian Govt (with World Bank support)
- Sales Season: April to June Year XXXX
- Exposure Period: Dec to April Yr XXXX/XXXX+1
- Claims payment: August Yr XXXX+1

5. Scalability, Other Issues & Lessons Learned

Scalability Issues..

Demand

- Micro-Farmer buys insurance as part of package. Issues of affordability & understanding & basis risk
- Meso-FSP, Farmer Association, Input Supplier buy portfolio/group insurance. Issues of insurable interest.
- Macro-Governments & Relief Agencies. Issues of planning & LT commitment

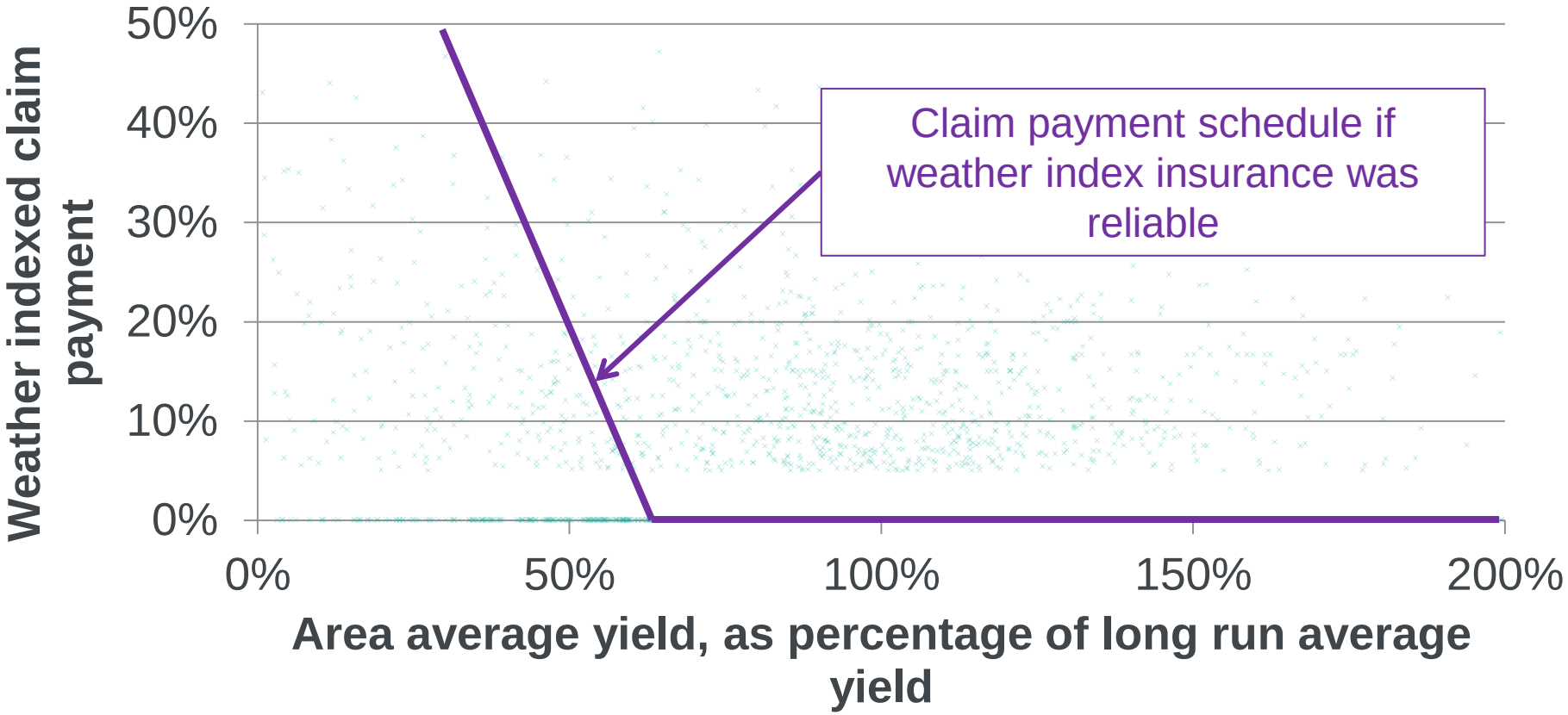
Supply

- Limited technical capacity of local insurers
- Some Global reinsurers more actively taking a role in this market
- Need for Government involvement at some stage

Contract Design

- Basis Risk
- Communication of terms & conditions
- Payment aspects

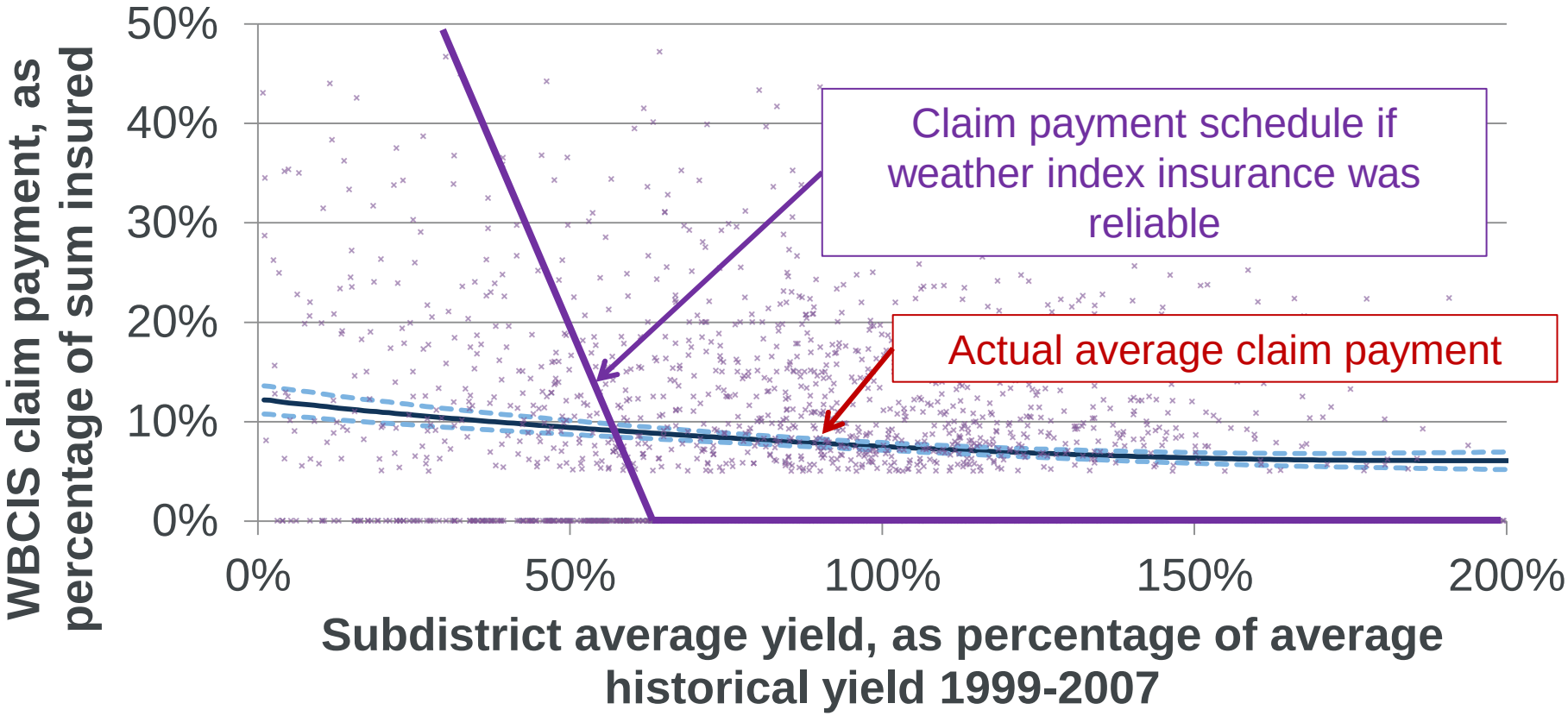
Does weather index insurance offer reliable protection for farmers?



Doesn't seem to offer reliable protection…

For example, across an Indian state:

- Correlation between yield and claim payment only -13%



9 years of data, 318 products sold across one state in India. Source: Clarke et al (2012)

Lessons Learned…

Technical Challenges

- Complexity – requires specialised knowledge & application at varying stages
- Costs – significant set up and ongoing costs
- Duality of Basis risk – built in basis risk
- Accuracy – applying mathematical process to a natural process

Practical Challenges

- Scale – many schemes have not scaled up
- Need for PPP and/or significant public sector support
- Ability/Willingness to pay and product value/affordability
- Farmers usually want full indemnity
- Outreach & training challenges

Where Index Ins shows promise

- Financial tool for social protection
- Large scale commercial farmers
- Portfolio risk management at Meso level (eg Financial providers)
- Sovereign risk transfer at macro level

Problems to Solve

- Lack of clarity over roles of public & private sector in promoting Agri Ins
- Lack of Coordinated investment in public goods & related insurance infrastructure
- Limited public capacity & institutions to meet core objectives eg mis-directed subsidies
- Lack of local technical capacity, in particular actuarial input into product design, pricing and risk financing
- Implementing informative Monitoring & Evaluation, esp for low frequency covariate risks

6. References

Key References

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Global Index Insurance Facility

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Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.