Advanced Business Risk Management Programs Around the World

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Challenges with Loss-Based Crop Insurance

- Asymmetric information.
  - Moral hazard.
  - Adverse selection.
- High transaction costs.
- Spatially correlated risk.
- Typically requires large premium subsidies (U.S., Canada, Spain, etc.)

Index Insurance

- Insurance product that makes payments based on the realized value of specified underlying index rather than on losses experienced by the policyholder.
- Common indexes.
  - Aggregate yield measure.
  - Yield proxy (e.g., weather variable) – can be structured to protect against too little or too much of the underlying weather variable.

Index Insurance

- Example: policy protects against insufficient rainfall measured at specific weather station over a three month period.
  - Threshold = 100 mm
  - Limit = 50 mm
  - Sum insured = $10,000 so tick-size is $200 per mm
- If realized rainfall = 80 mm, indemnity = $4,000
- If realized rainfall = 50 mm, indemnity = $10,000
- If realized rainfall = 40 mm, indemnity = $10,000

Index Insurance

- Little potential for adverse selection or moral hazard.
- Effectively transfers spatially correlated risk exposure.
- Low transaction costs relative to loss-based insurance (no need for policyholder-specific risk assessment or loss adjustment).

Example from Canada

- Production Insurance (PI) forage rainfall plan (protects against insufficient rainfall).
  - Underlying index is weighted average rainfall measured at a given weather station from May through August.
  - Purchaser selects weather station and coverage option (that assigns weights to each month).
  - Payments are triggered if realized weighted average rainfall is less than 80 percent of the long-term average.
  - Realized daily rainfall is capped at 50 mm. Realized monthly rainfall is capped at 125 percent of the long-term average.
  - Sum insured varies from $25 to $300 per acre depending on type and value of the forage stand.

Examples from U.S.

- Rainfall Index Pilot Program (insufficient rainfall).
  - Underlying index is a 12 mile by 12 mile grid estimate of rainfall based on weather station, satellite, and radar data.
- Vegetation Index Pilot Program (insufficient rainfall).
  - Underlying index is a 4.8 mile by 4.8 mile grid measure of the Normalized Difference Vegetation Index (NDVI).
- Purchaser selects coverage level, period of coverage, and the sum insured per acre (within limits).
- Pasture, rangeland, and forage and apiculture.
- For 2010, $415 million sum insured (mostly in rainfall index).

Examples from U.S.

- Group Risk Plan (GRP) based on county yield and Group Risk Income Protection (GRIP) based on product of county yield and futures market price.
- Purchaser selects coverage level and sum insured per acre (within limits).
- GRIP is available for corn, cotton, grain sorghum, soybeans, and wheat. GRP is also available for barley, oysters, and sugarcane.
- For 2010, $4.2 billion sum insured (mostly in GRIP) out of almost $78 billion total sum insured in federal crop insurance program.

Weather Index Insurance Basis Risk

- For any given magnitude of the underlying index (e.g., rainfall measured at a weather station), there is a conditional probability distribution for the policyholder's exposure to the same variable (e.g., rainfall measured at the policyholder's location).

  index $\longleftrightarrow$ variable measured at farm

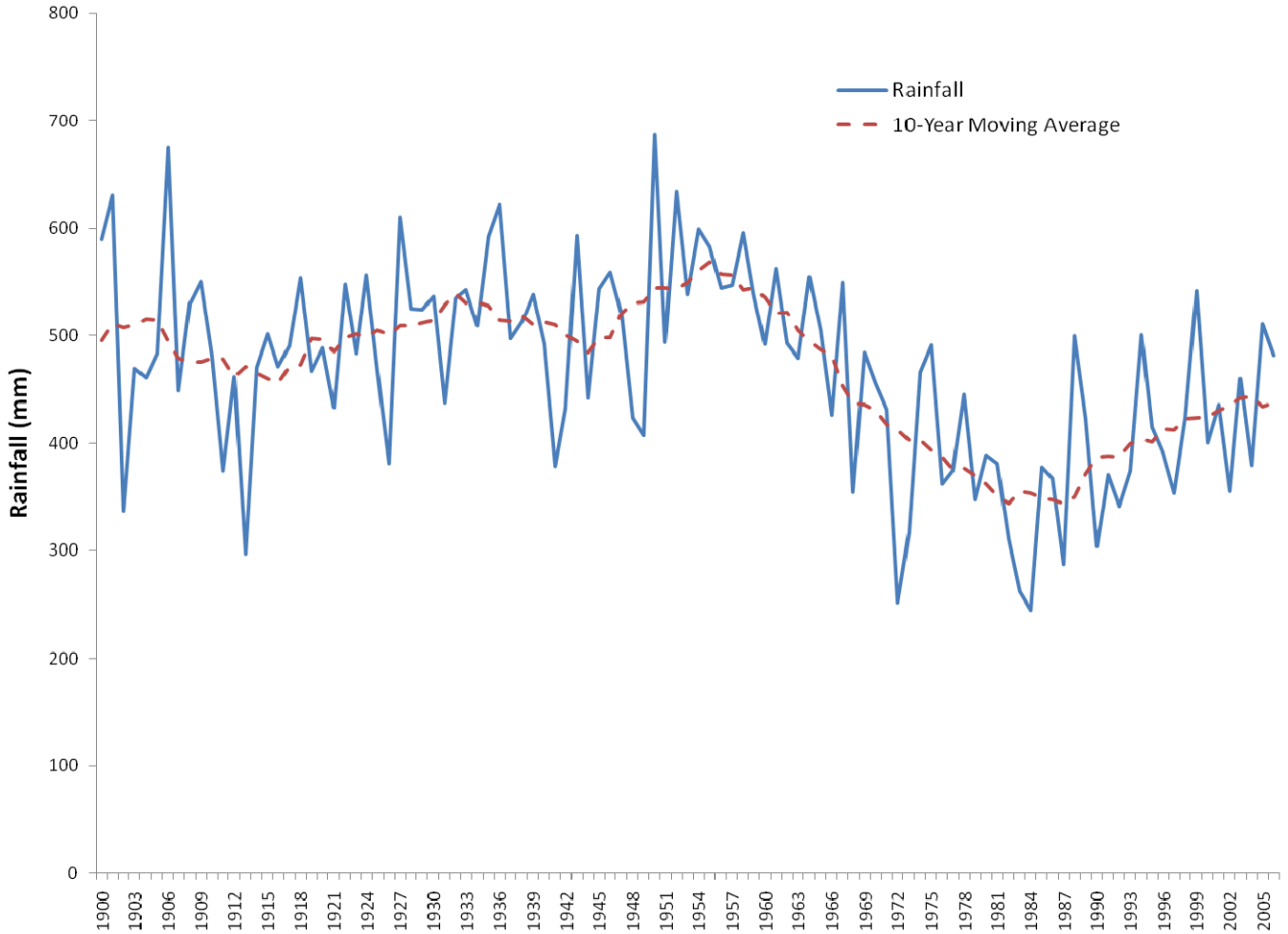
- For any given magnitude of the underlying weather variable measured at the farm, there is a conditional probability distribution of loss.

  variable measured at farm $\longleftrightarrow$ loss

Pricing and Triggering Indemnities

- Sufficient quantitative data of an appropriate spatial specificity are required to price the insurance.
- How much is sufficient? It depends on the temporal presentation of the risk.
  - Is the probability distribution of the index stationary?
  - Is the variance of the probability distribution constant over time?
  - Do either of the above exhibit multi-year cycles?
- Understanding the tail of the distribution is critical.

Sahelian Rainfall



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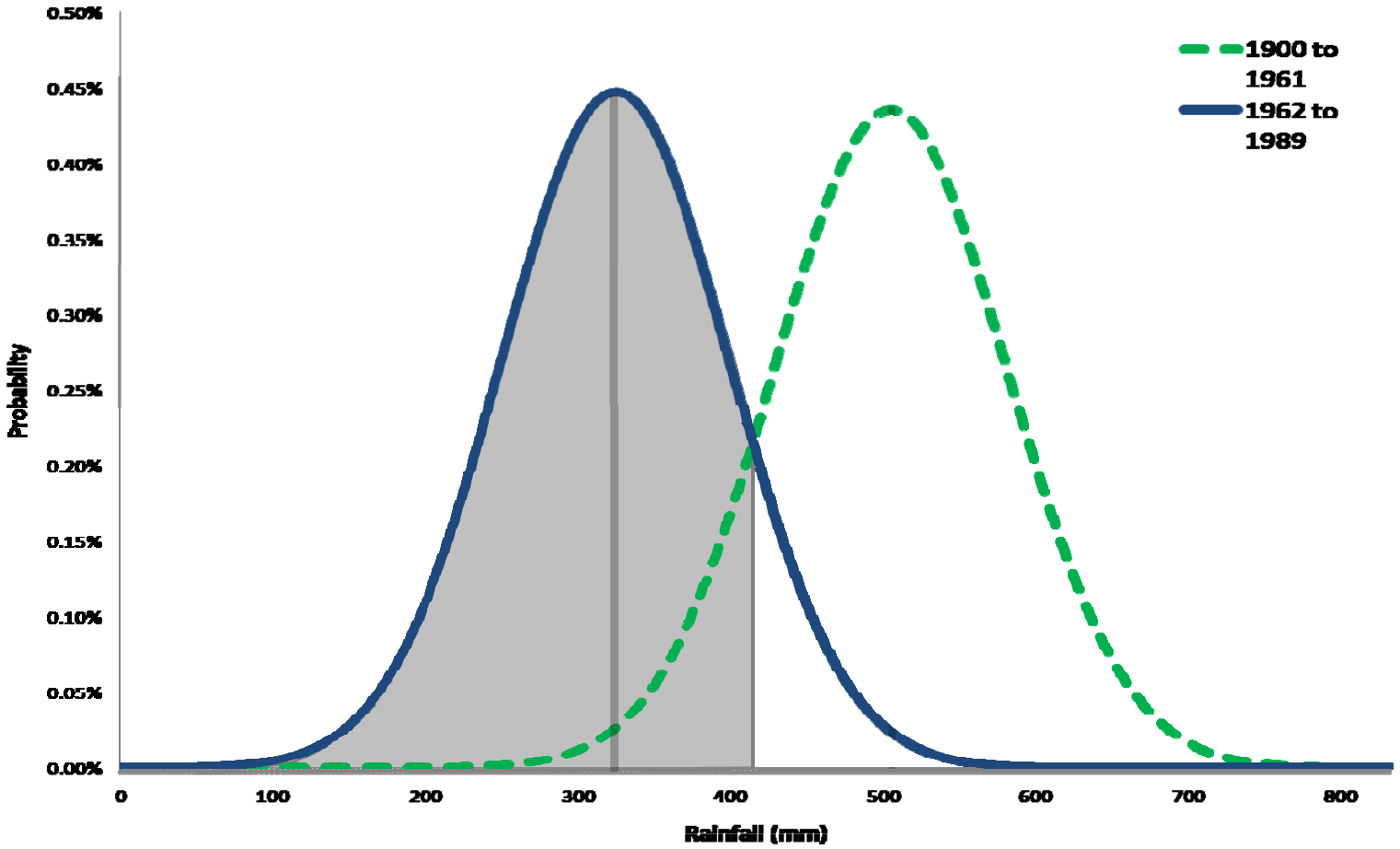
Sahelian Rainfall



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Extreme Weather and Rural Poverty

- More than 1 billion people currently live on less than one US dollar per day.
- Approximately 75 percent of those live in rural areas.
- While rural households engage in various income generating activities, these activities are often tied directly or indirectly to weather-sensitive industries such as agriculture.
- In many rural areas the risk of extreme weather events contributes to poverty and low rates of economic growth.

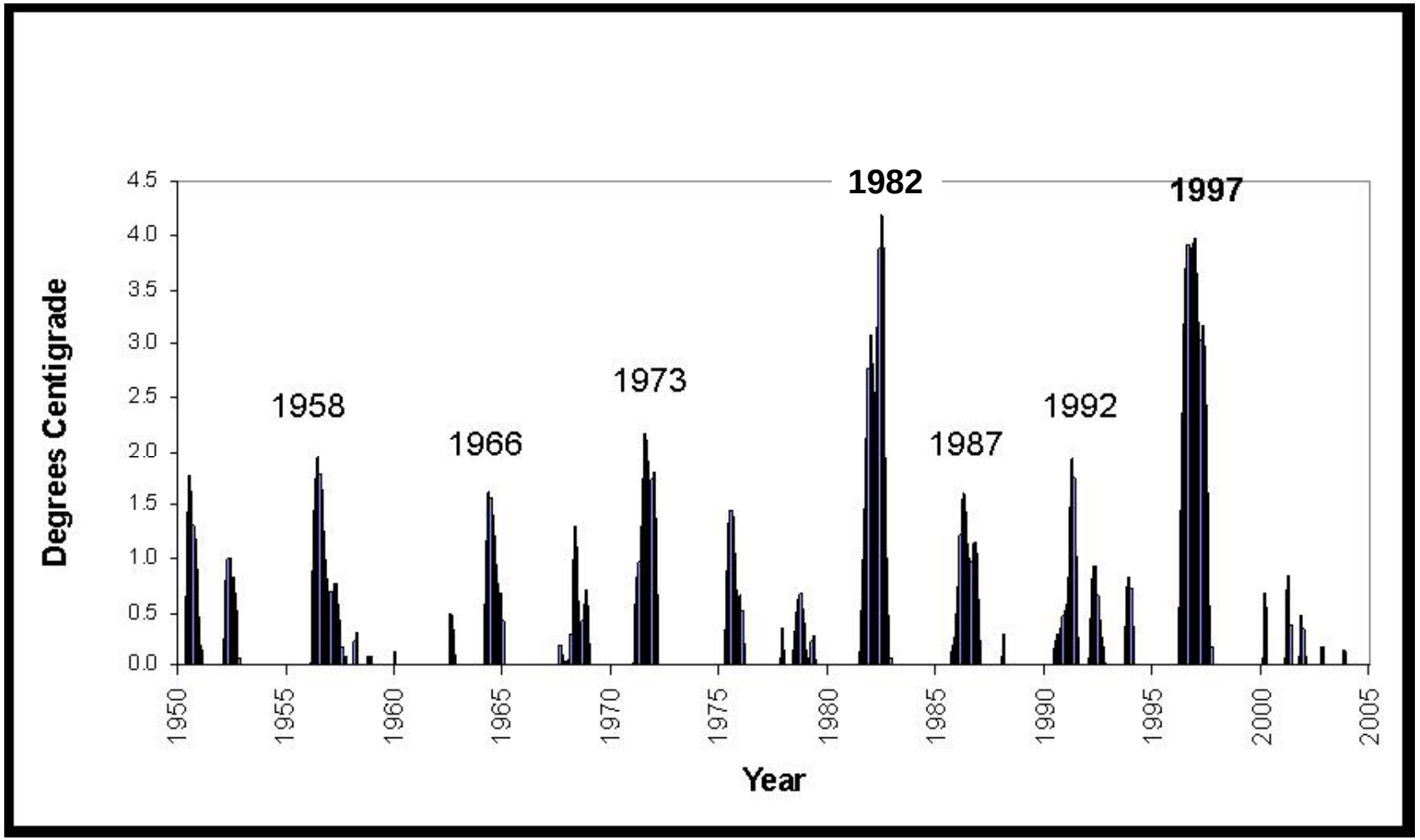
Weather Index Insurance in Lower Income Countries

- Over the past few years, weather index insurance has received a lot of attention from international development researchers and practitioners.
- Currently, there are between 30 and 40 projects on weather index insurance being conducted in countries around the world.
  - Funding has come from the ADB, IADB, UNDP, USAID, the Ford Foundation, the Gates Foundation, GTZ, DFID, etc.
- Conferences on index insurance are held frequently around the world.

ENSO Index Insurance

- El Niño (years with high Pacific sea surface temperature) are associated with extreme flooding in northern Peru.
- Index insurance based on sea surface temperature.

El Niño – ENSO 1.2 SST Anomalies



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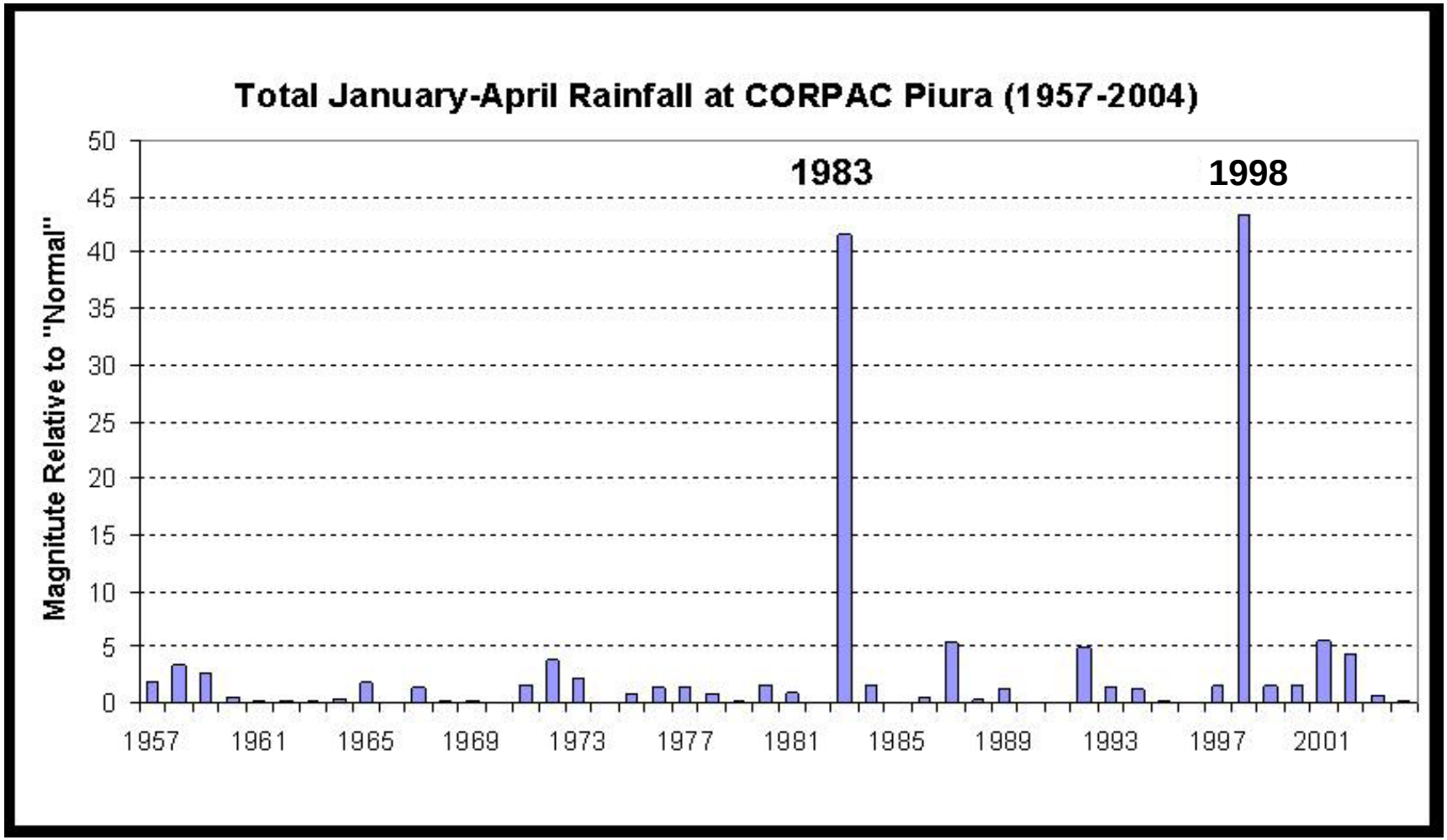
Rainfall in Northern Peru Relative to Normal



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El Niño Flooding in Northern Peru

Weather Index Insurance in Lower Income Countries

- Data limitations are perhaps the greatest challenge.
- Density of weather stations is very sparse in many lower income countries – especially in Africa.
  - Outside of South Africa, the only publicly available *daily* weather station data for many African countries is from major airports.
  - More stations exist that report less frequently but density is still sparse – especially in rural areas.

Alternative Data Sources

- Spatial interpolation of available weather station data.
- Satellite-based Normalized Difference Vegetation Index (NDVI).
- Satellite-based measures of rainfall.
- Satellite-based synthetic aperture radar (SAR) maps contours of geospatial environments (e.g., flooding).
- Reanalysis data.
  - A class of data products that combines and calibrates observations from many sources — weather stations, satellites, weather balloons, etc.

Assessment of Alternative Data Sources

- Satellite-based measures of weather variables still have significant errors when compared to ground-based measures.
- Many alternative sources tend to understate outliers.
- Insufficient spatial and/or temporal specificity (possible exception is NDVI).
- Limited time series of data and challenges with calibrating observations across evolving technologies.
- Will potential buyers purchase an insurance product based on satellite data?

Conclusion

- Index insurance has potential to provide insurance coverage for crops/regions that are not well suited to traditional loss-based crop insurance.
- Index insurance addresses many of the problems with loss-based insurance (moral hazard, adverse selection, high transaction costs).
- Challenges:
  - Basis risk.
  - Data limitations.