FEED THE FUTURE INNOVATION LAB
FOR MARKETS, RISK & RESILIENCE
basis.ucdavis.edu

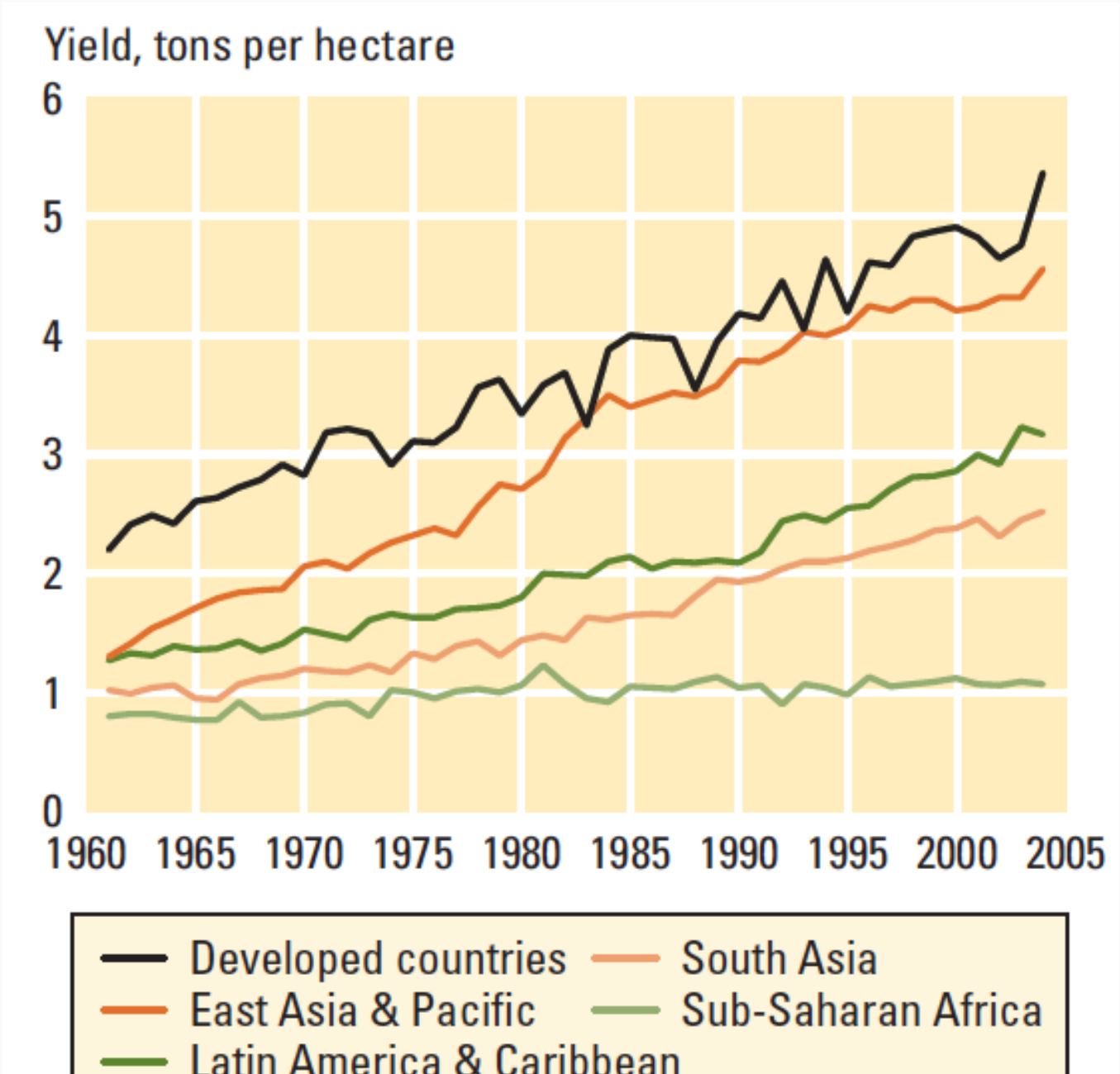
Expanding Impacts: Merging Seed & Financial Innovations for Resilient Agricultural Growth

Michael R. Carter

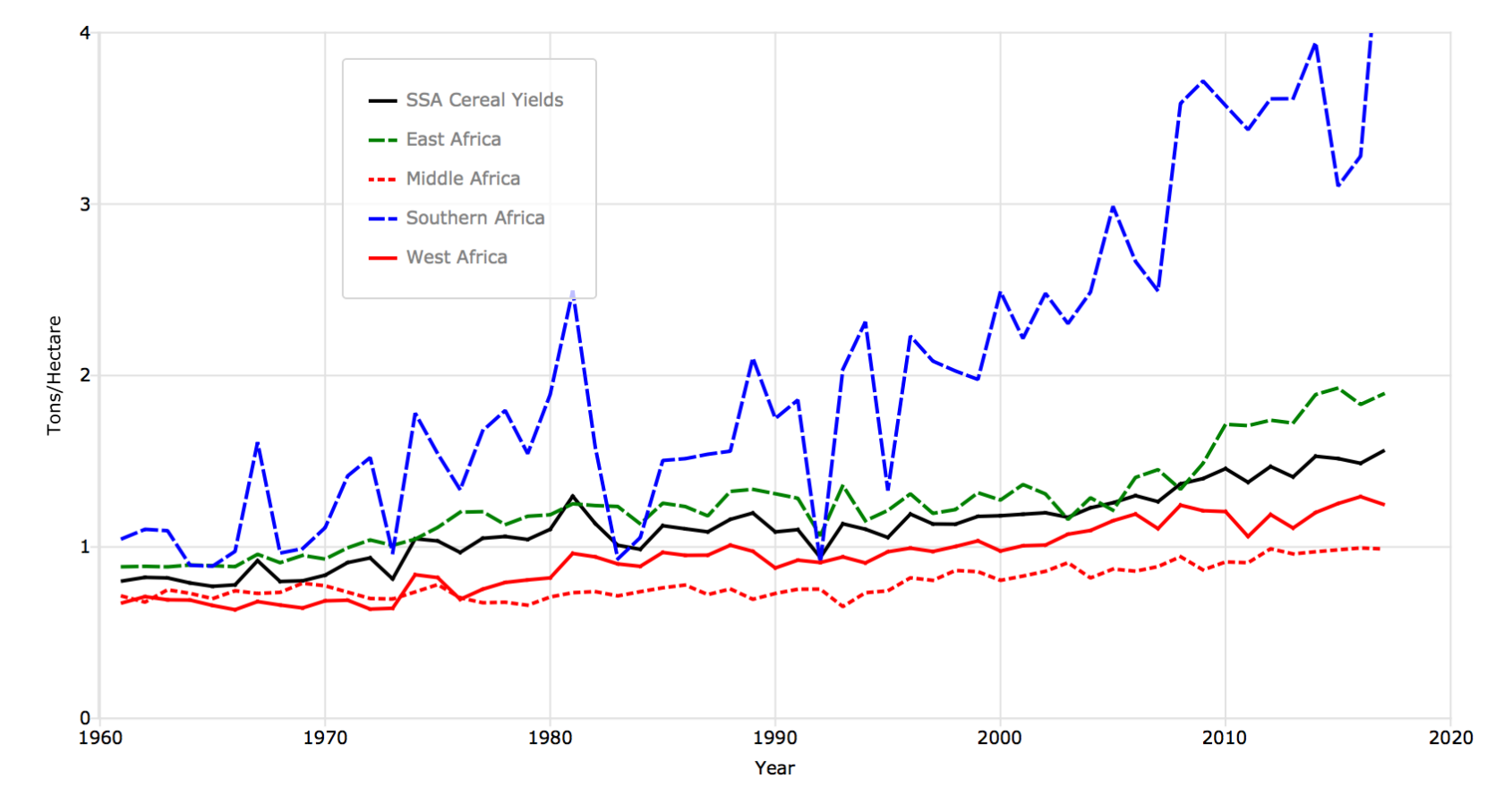
University of California, Davis, University of Cape Town & NBER

Workshop on the Drought Tolerant Maize-Index Insurance Pilot Project
31 October 2019

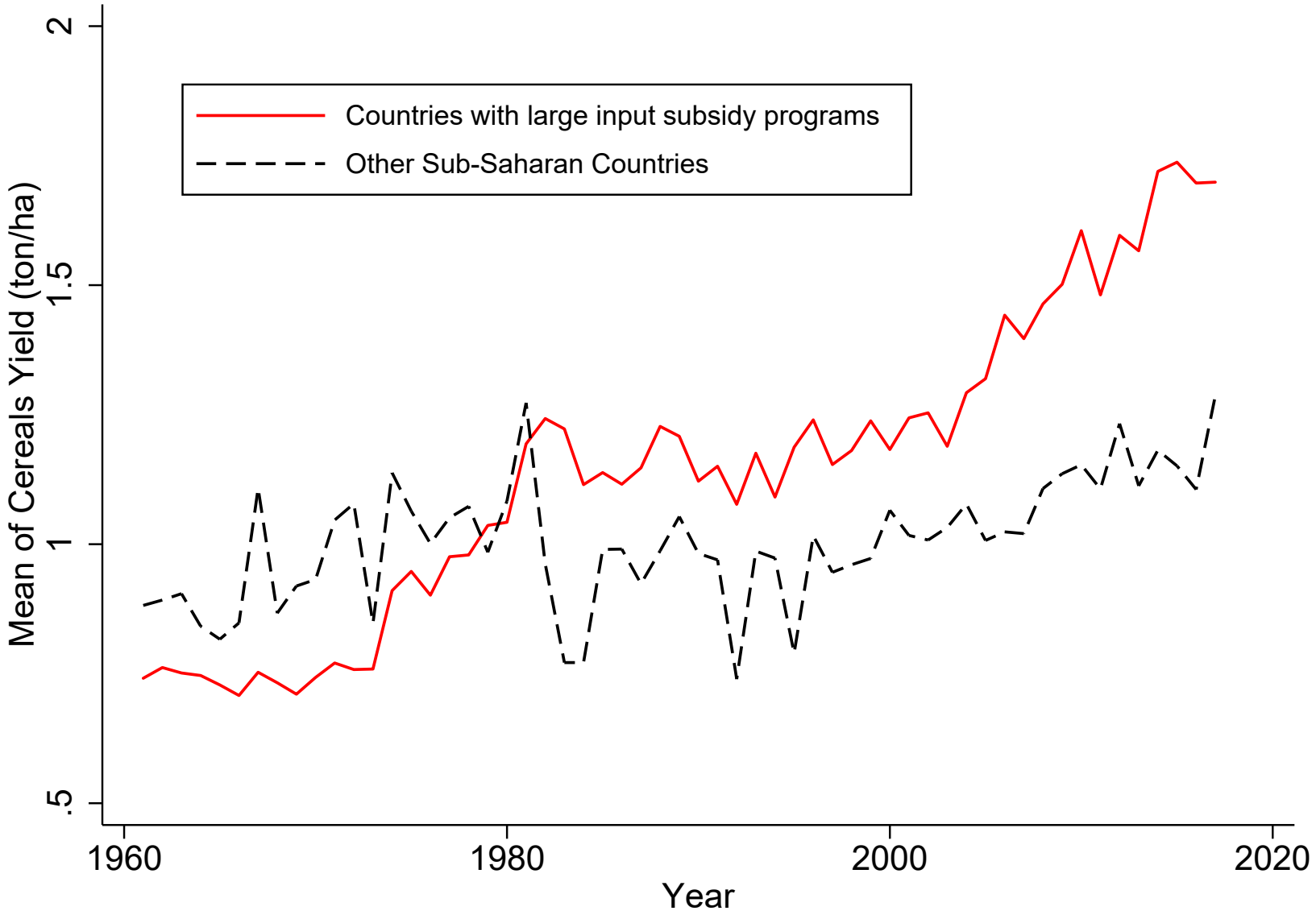
The Green Revolution that Wasn't, 1960-2005



The Green Revolution that Maybe is Starting, 2005-2017



Where Is the (Maybe) Incipient Green Revolution Located?



What's Risk Got to Do with It?

- So why did the green (seed-fertilizer) revolution largely bypass the continent?
  - Seed-fertilizer technologies not profitable because of nature of soils and agro-ecological conditions across large parts of the continent
  - Technologies are profitable, but farmers 'misbehave,' *e.g.* are time inconsistent
  - Technologies are profitable, but farmers constrained by:
    - Lack of information & experience
    - Lack of finance
    - Discouraged by risk
- This latter explanation, risk, has always loomed large as an explanation for this sub-Saharan African exceptionalism
  - Less than 5% of the cultivated area is irrigated
  - Substantial areas exposed to high risk of total crop failure

What's Risk Got to Do with It?

- The veracity of this risk-based explanation is supported by multiple insurance studies that demonstrate that de-risking agricultural systems results in increased investment:
  - Ghanian maize farmers increased investment in improved inputs by 20% when covered by an index insurance (Karlan, Osei, Osei-Akato & Udry)
  - Malian cotton farmers increased investment by over 30% when covered by index insurance (Elabed & Carter)
- Note that if we define *resilience* as the ability to manage adversity and change without compromising current and future well-being, then we see that de-risking can create "*resilience plus*," meaning that households increase investment & improve their level of well-being over what it would have been absent improved risk management

Drought Tolerant Maize for Africa

- As reviewed earlier by Olaf, substantial resources from Gates, USAID & others were dedicated to the development of drought tolerant maize varieties (DT)
- Can DT maize replicate the success of flood tolerant rice varieties seen in India where:
  - Flood tolerant seeds protected yields against a flood event, promoting resilience
  - Farmers with flood tolerant seed increased investment, creating resilience-plus (see Emerick *et al.*)

Drought Tolerant Maize for Africa

- One reason DT may not replicate the success of the flood tolerant rice is because the DT trait only protects against a sub-set of droughts, namely those that occur during the midseason flowering period of maize growth
  - Similarly, flood-tolerant rice varieties can only survive floods that last less than 15 days
  - The flood event studied in India was only 14 days–one more day and its impact on resilience would have evaporated!
- The partial protection afforded by seed genetics suggest a role for combining stress tolerant seed varieties with a complementary insurance contract

Seed & Insurance Technologies

- Simulation analysis shows that a stylized DT-insurance combo package works (Lybbert & Carter)

Table 22.2 Consumption and Certainty Equivalent Performance of DT, II, and Bundled DT–II

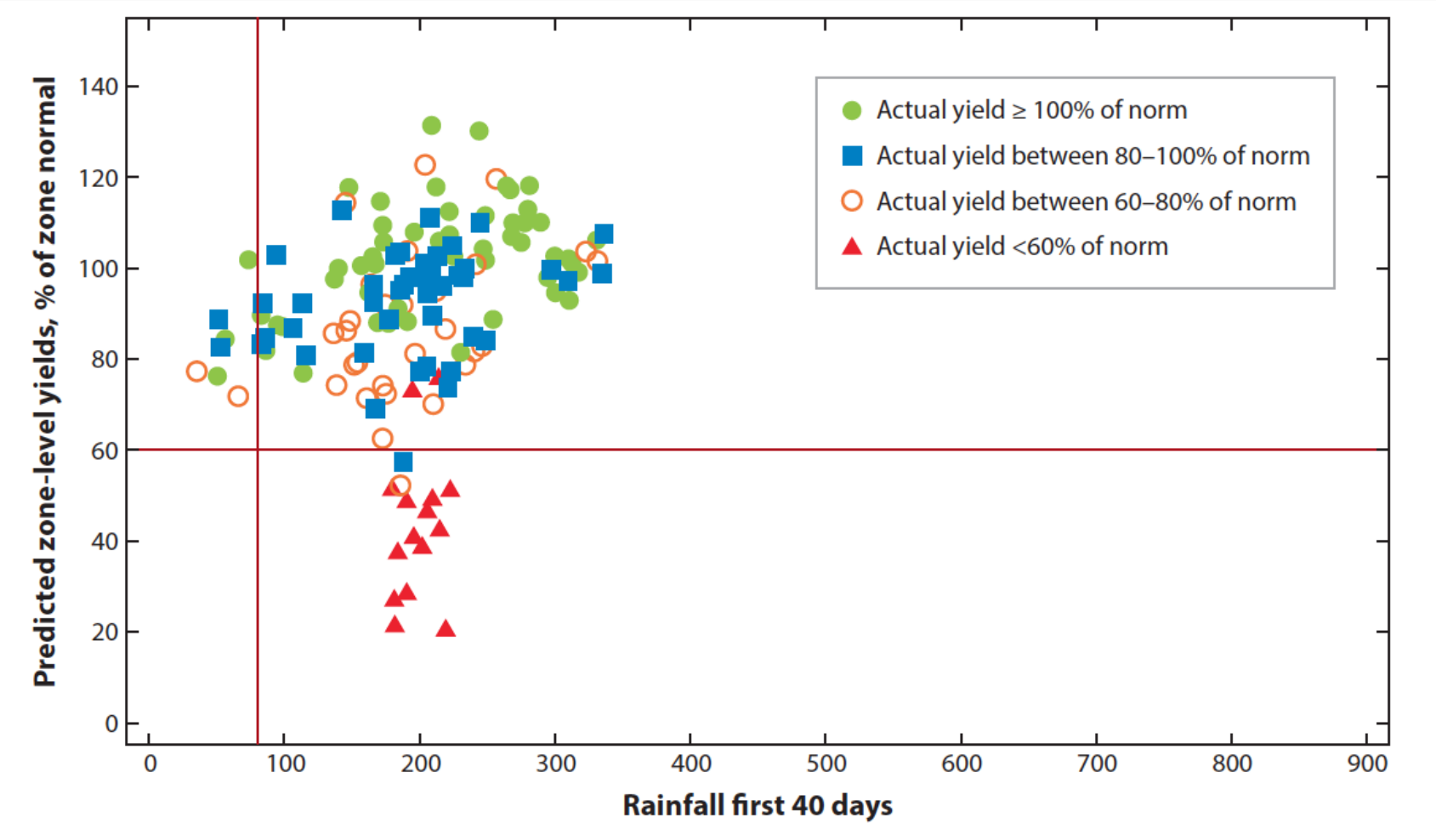
	Additional Cost Above Traditional Technology (USD/acre)	Mean Gross Income, USD (Net of Insurance Costs)	Certainty Equivalent, USD/acre	% Change Certainty Equivalent
Traditional maize	–	716	675	
DT maize	–	750	715	6.1
II-high coverage (15% yield shortfall strike)	66	710	692	2.6
II-low coverage (35% yield shortfall strike)	20	718	688	1.9
Bundled DT–II with low coverage II "optimized" for DT yield distribution	13	748	723	7.2

- But can such a complementary package really work in practice?
  - Can we devise a reliable insurance contract to complement DT seeds?
  - Do DT seeds work in farmers' fields, outside of the carefully controlled experiment conditions where they were bred?

Designing a Complementary Financial Technology

- Goal was to design an index insurance contract that offered protection against risks not well-covered by DT seed technology:
  - Early season rainfall deficit; and,
  - Large, end of season yield deficit likely caused by forces beyond mid-season drought
- Collected retrospective maize yield data that allowed us to design a quality contract based on two satellite indices:
  - Estimated rainfall data to detect early season drought
  - NDVI (a bio-mass or "greenness" index) to measure yield deficit
- Measure each of these at the level of "contract zones, which comprise roughly 3 villages
- Included a back-up, fail-safe audit option

Overall Contract Performance



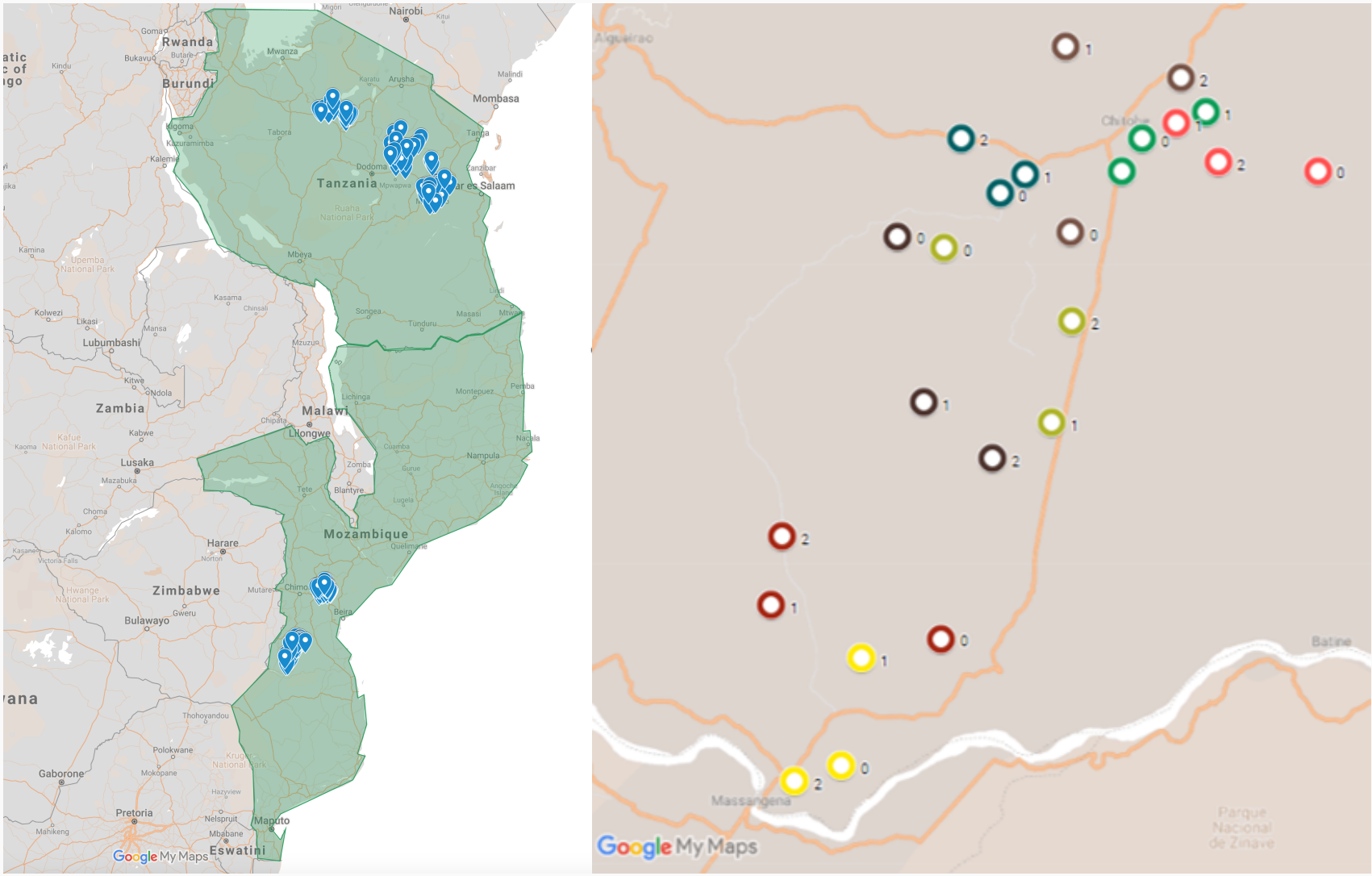
The Primary Research Questions

- With these technologies prepared, set out to explore key questions:
  - Do DT seeds protect against mid-season drought in *farmers' fields?* (In farmers' fields seeds are simultaneously subject to a variety of stresses (poor soils, no fertilizer, poor weather beyond mid-season drought) that were not part of the experimental breeding design)
    - We will examine this question in stages, stepping down from experiment station results, to farmer field trials (with selected high productivity farmers), down to randomly selected farmers in remote areas
  - What happens to DT farmers when confronted by more severe stresses?
  - What additional benefits do we see when insurance is incorporated into the package?
  - Are the impacts of the technology strong enough to improve food security?

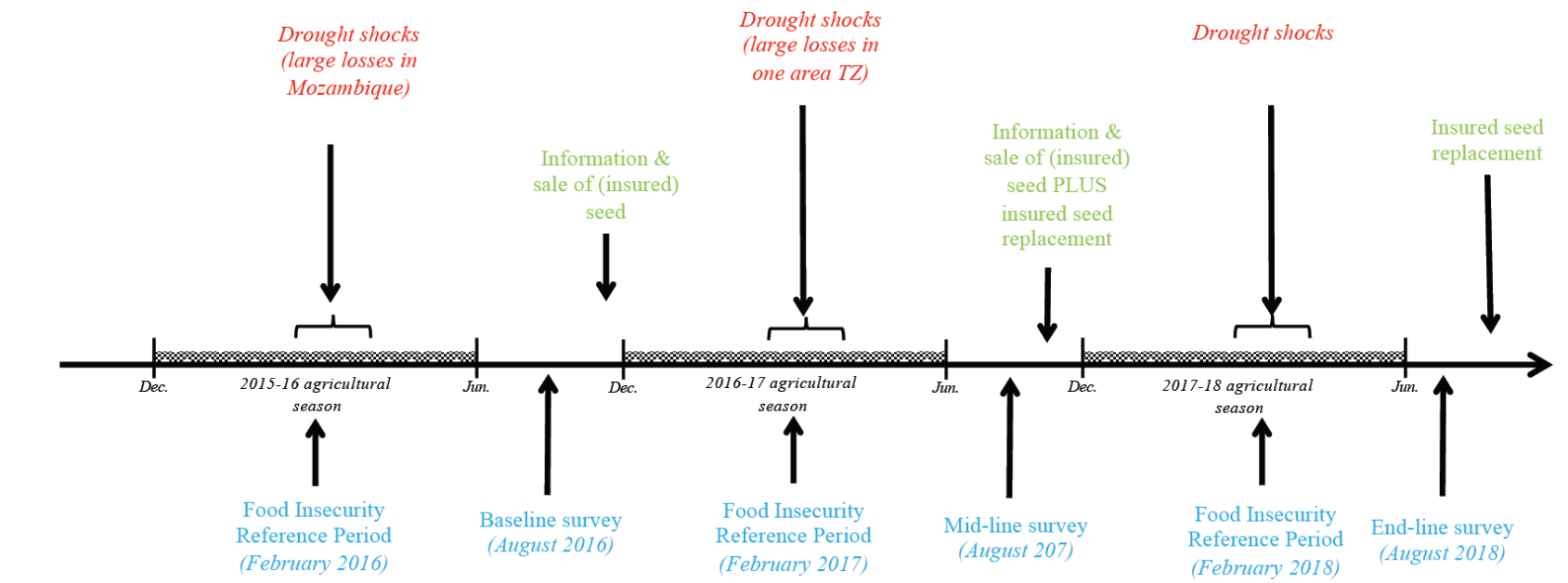
The Diversified DT-II Randomized Controlled Trial in Mozambique & Tanzania

- As Travis will discuss later, farmers face real challenges to learning about technologies with stochastic benefits
- The same problem confronts researchers wanting to study impacts of those same kind of technologies
- Diversified RCT design
  - 2 countries, 3 years
  - Further within country diversification
  - "Matched triplet" randomization

An Diversified RCT Approach to Studying Technologies with Stochastic Benefits

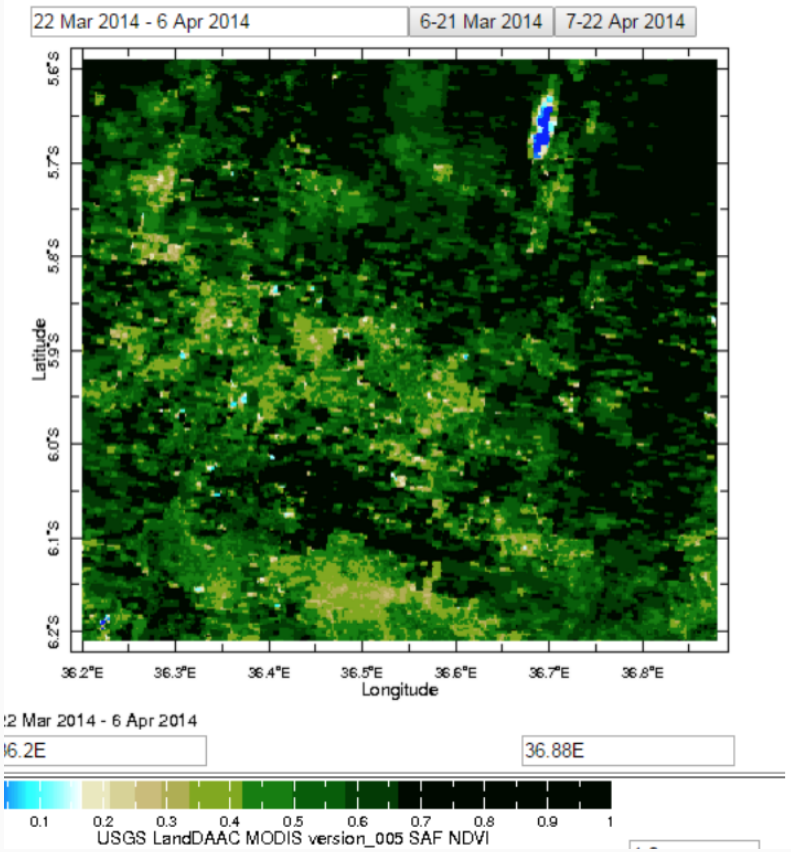


An RCT Portfolio Approach to Studying Technologies with Stochastic Benefits



Thank you, and on to the Results

2014 (Planting 11 Jan, 2013)



2015 (Planting 1 Dec, 2014)