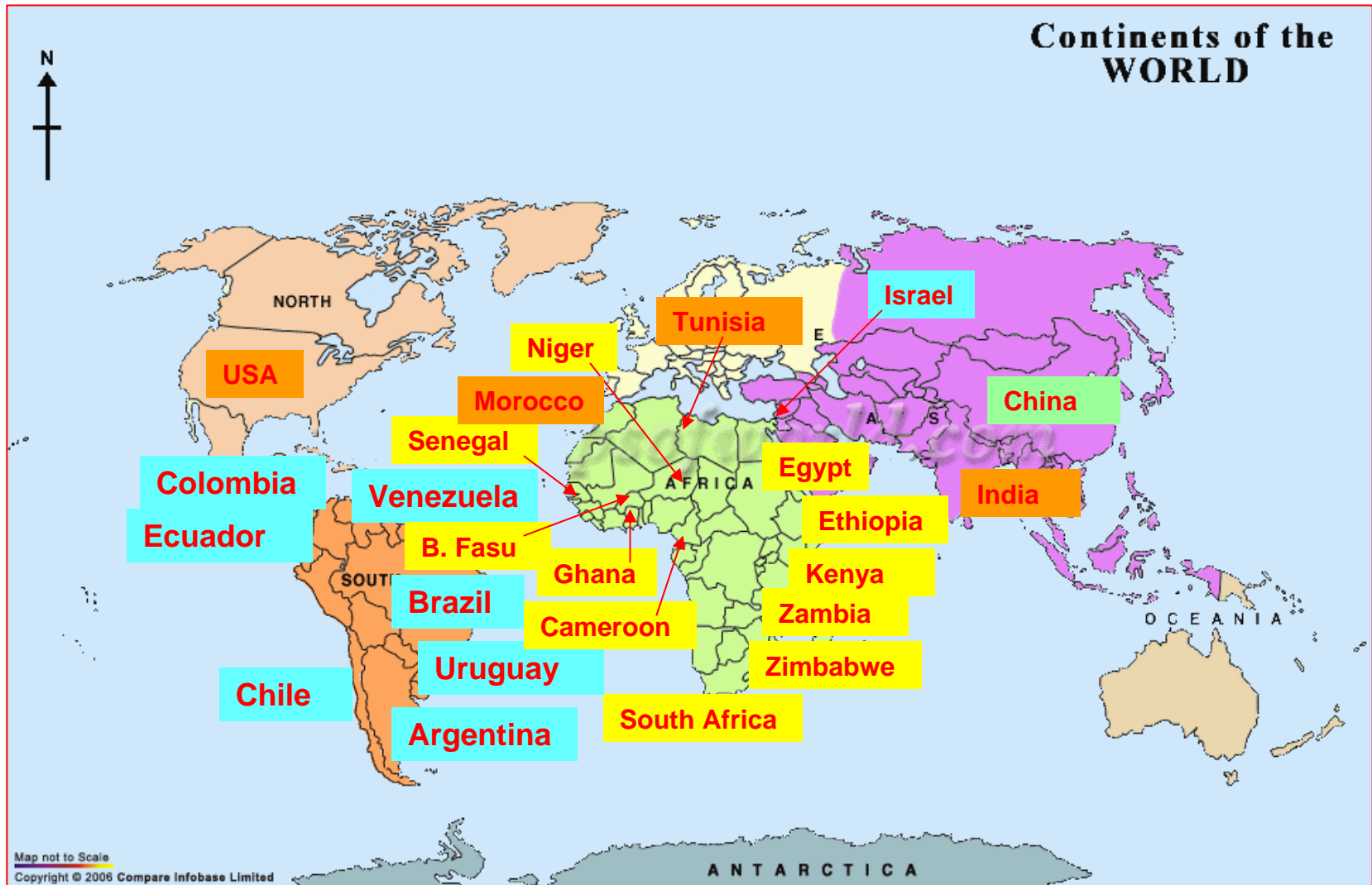


World Bank-funded research on impact of and adaptation to climate change in agriculture

**Ariel Dinar
World Bank, DECRG-RU**

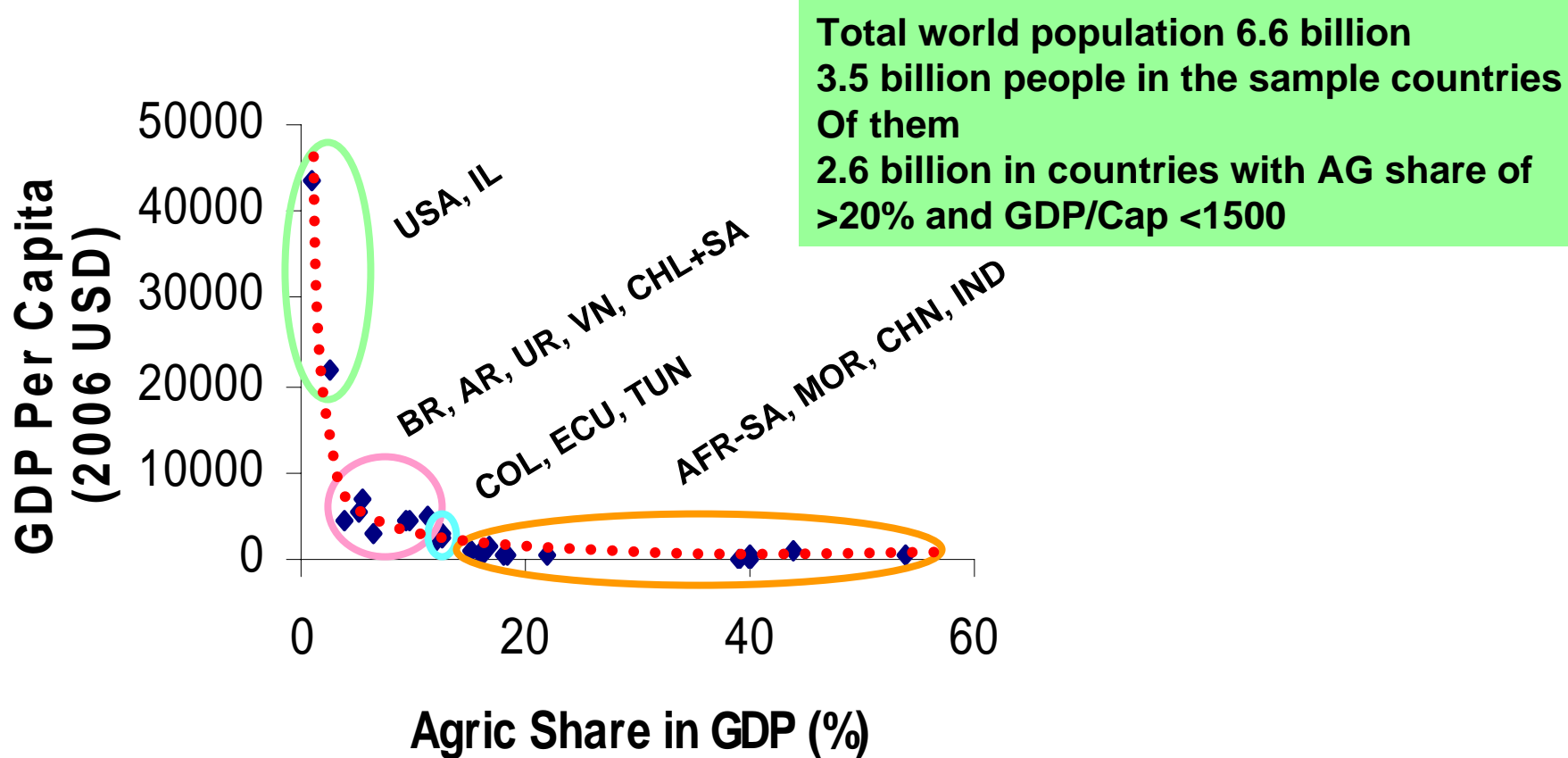
**TFESSD Annual Meeting
November 14, 2007**

World Bank Ricardian Studies (24 countries)



Why is it Important for the WB to Study Impact of Climate Change on Agriculture?

Ag and well being



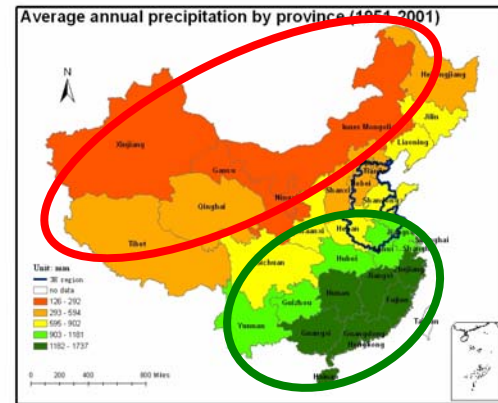
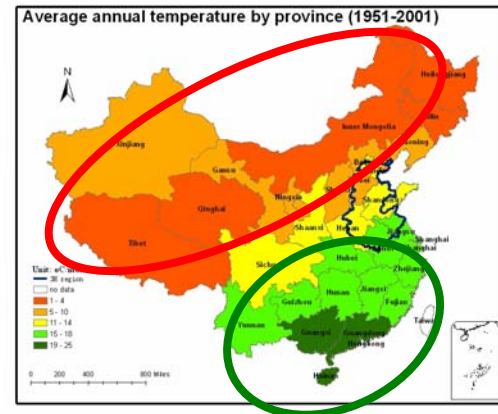
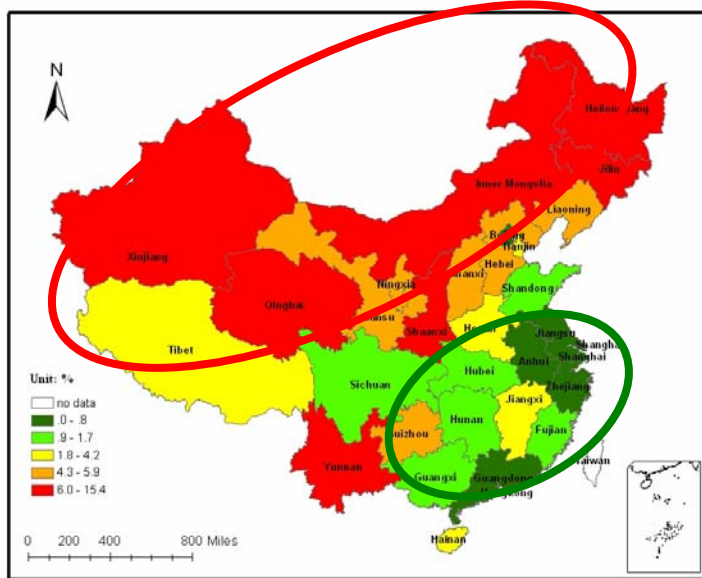
The Dark Continent



The Economist August 18th 2007

Climate and Poverty in China

Poverty Incidence by Province in 2001



The dynamics of developing research methods

1996-2000
India, Brazil,
Morocco,
Tunisia, USA

2000-2005
Africa

2003-2006
Latin America,
Israel

2007-2008
China

1. Census data at district level (Net Revenue and Land Value)
2. Meteorological station data
3. Implicit adaptation
4. Cropping Agriculture

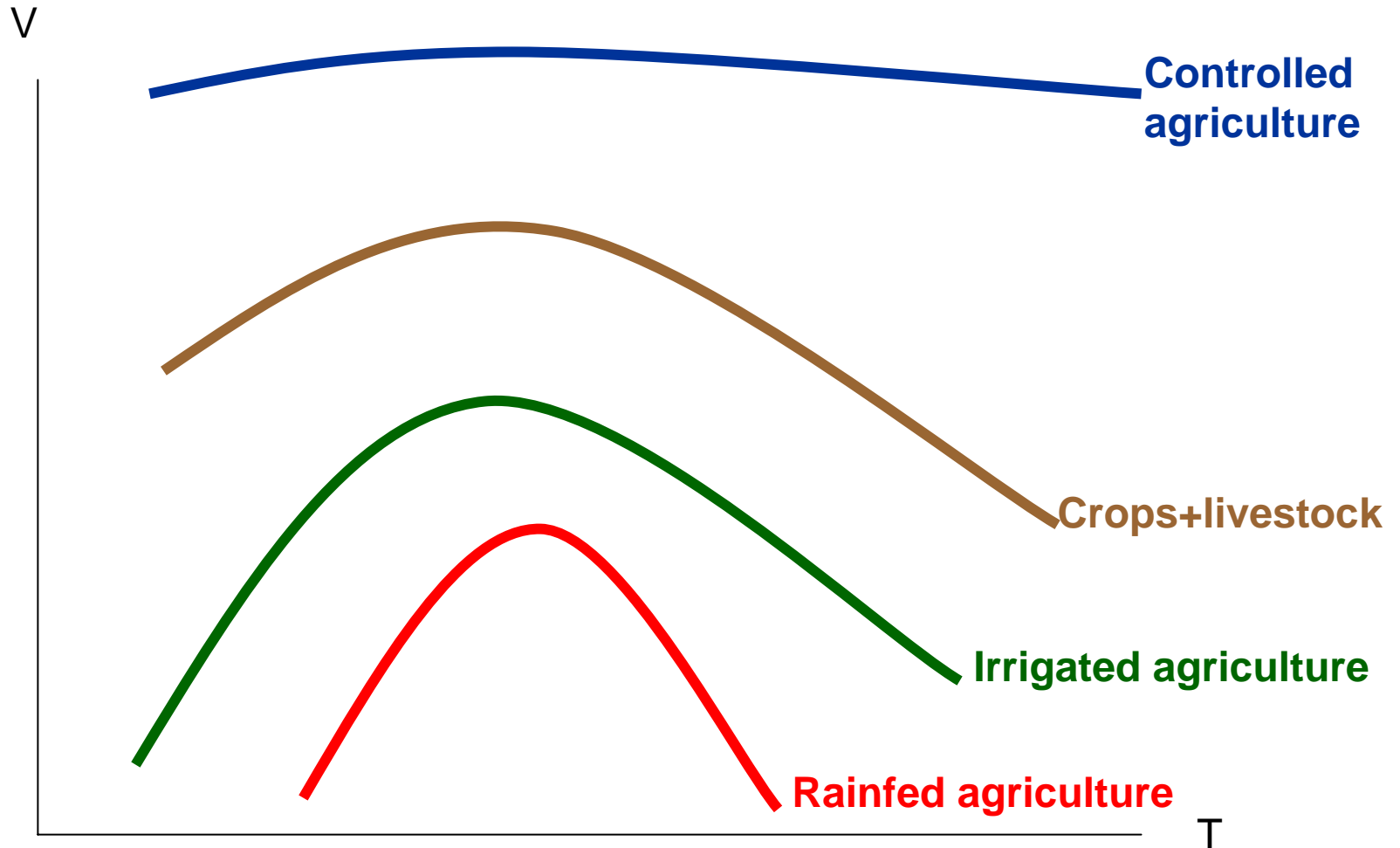
1. Household data sampled across districts (Net Revenue)
2. Satellite rainfall and wetness data
3. Flow & runoff data
4. Explicit household adaptation data (11,000 obs)
5. Crops+Livestock
6. Crop modeling
7. Soil data

With Partial Support from TFESD

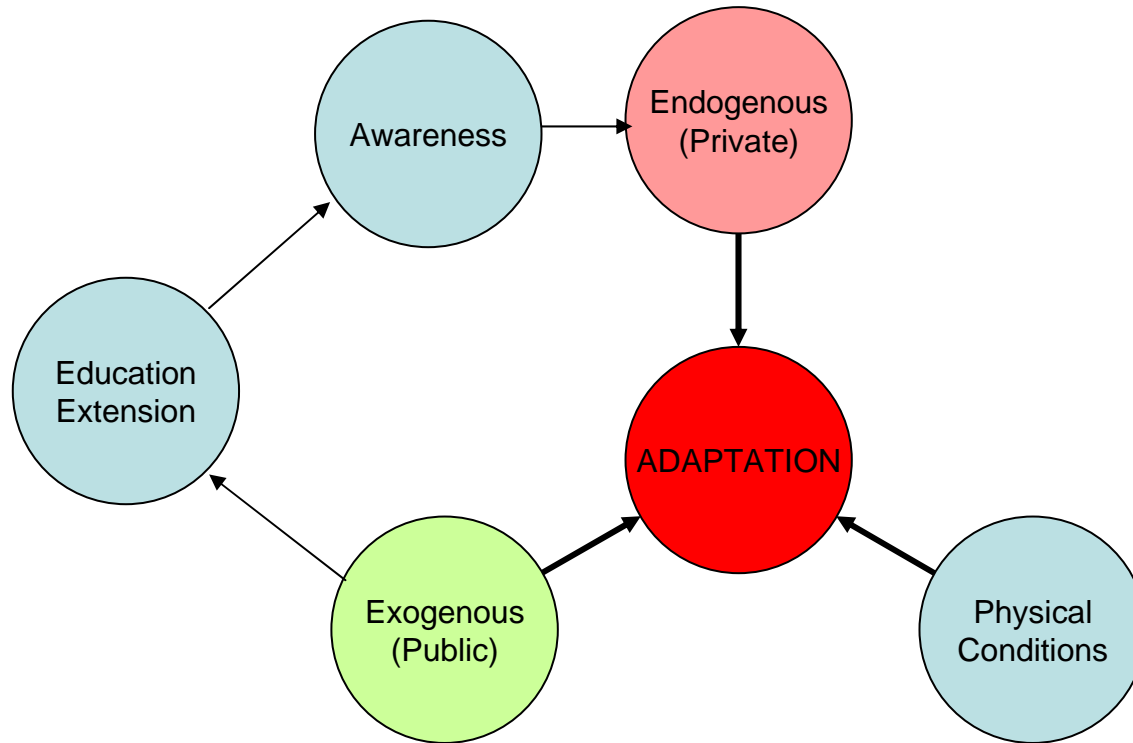
1. Household data sampled across districts (Land Value)
2. Satellite rainfall and wetness data
3. Explicit household adaptation data (3,500 obs)
4. Crops+livestock
5. Technology focus

1. Household data sampled across counties (Net Revenue)
2. Meteorological station data (750 stations)
3. Farm production / adaptation data (38,500 obs)
4. Flow and runoff data / model
5. Crops+livestock
6. Crop modeling
7. Soil data

Overall relationships



Adaptation = Reform



Adaptation (1)



Adaptation (2)

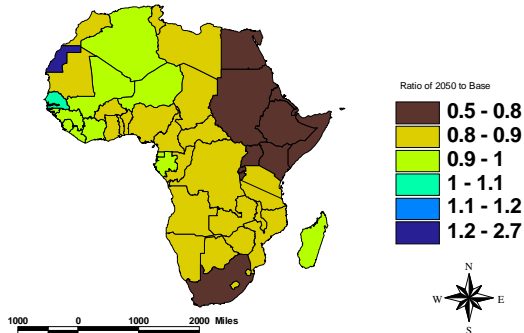


Focus on Endogenous Adaptation

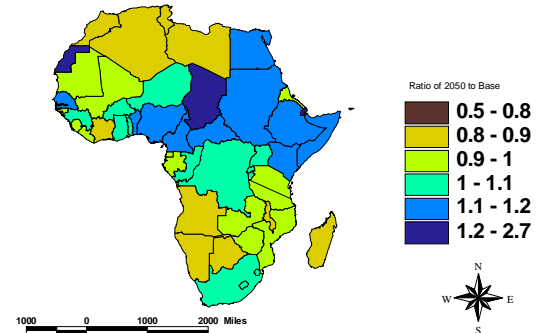
- Farmers adapt if they perceive CC
- Farmers adaptation range is limited to what they know and what is available to them
- In our studies adaptation observations include
 - Water availability/irrigation
 - Farm type/Livestock—Crop—Out-of-production
 - Crop choice/management practices
 - Livestock choice

Africa-Wide 2050 and 2100 Hydrology Predictions

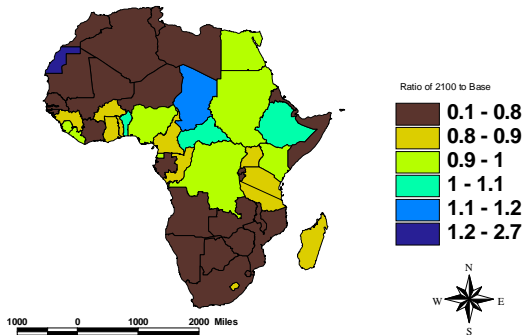
LOW STREAMFLOW 2050
AFRICA-WIDE 85% of BASE



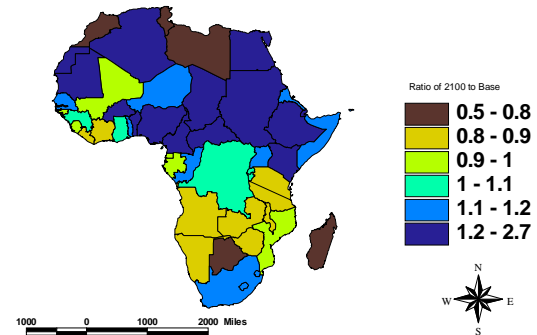
HIGH STREAMFLOW 2050
AFRICA-WIDE 105% of BASE



LOW STREAMFLOW 2100
AFRICA-WIDE 81% of BASE



HIGH STREAMFLOW 2100
AFRICA-WIDE 114% of BASE



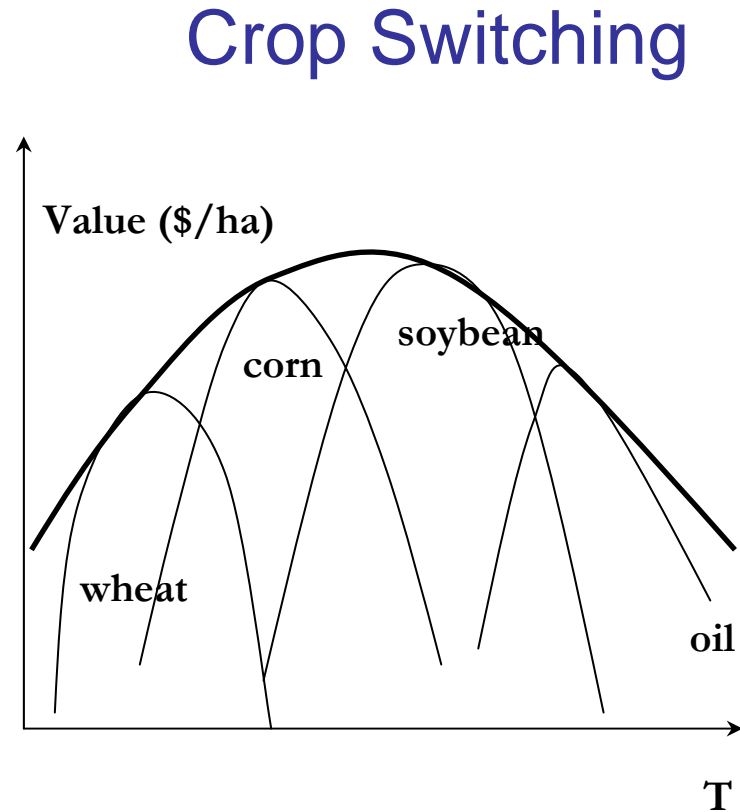
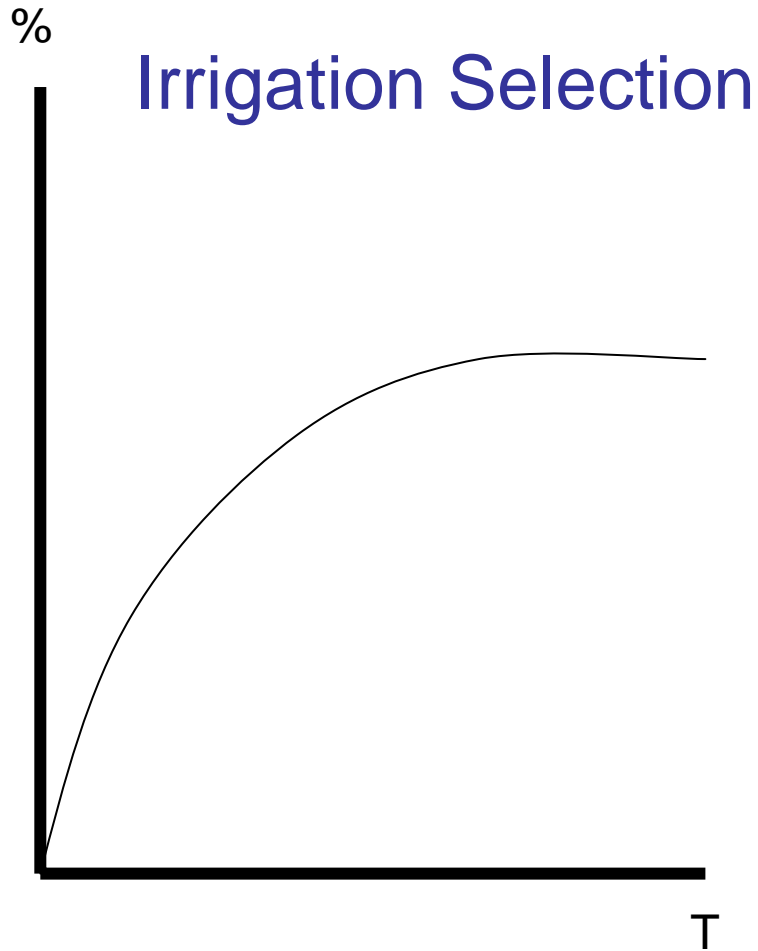
Adaptations to Climate Change

1. Different varieties
2. Crop diversification
3. Different planting dates
4. Moving to a different site
5. Changing quantity of land under cultivation
6. Change from crops to livestock
7. Change from livestock to crops
8. Adjustments to livestock management
9. Changed use of irrigation / groundwater / watering
10. Changed use of capital and labour
11. Changed use of chemicals and fertilisers
12. Changed use of water conservation techniques
13. Shading and sheltering / tree planting
14. Use of insurance or weather derivatives
15. No adaptation

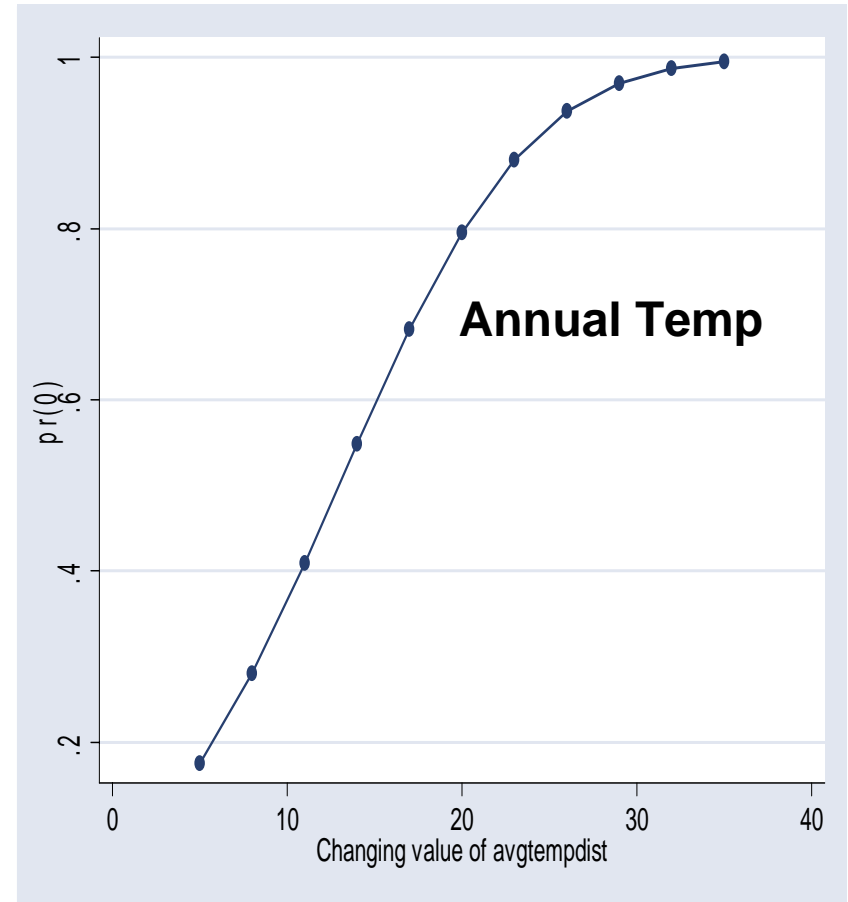
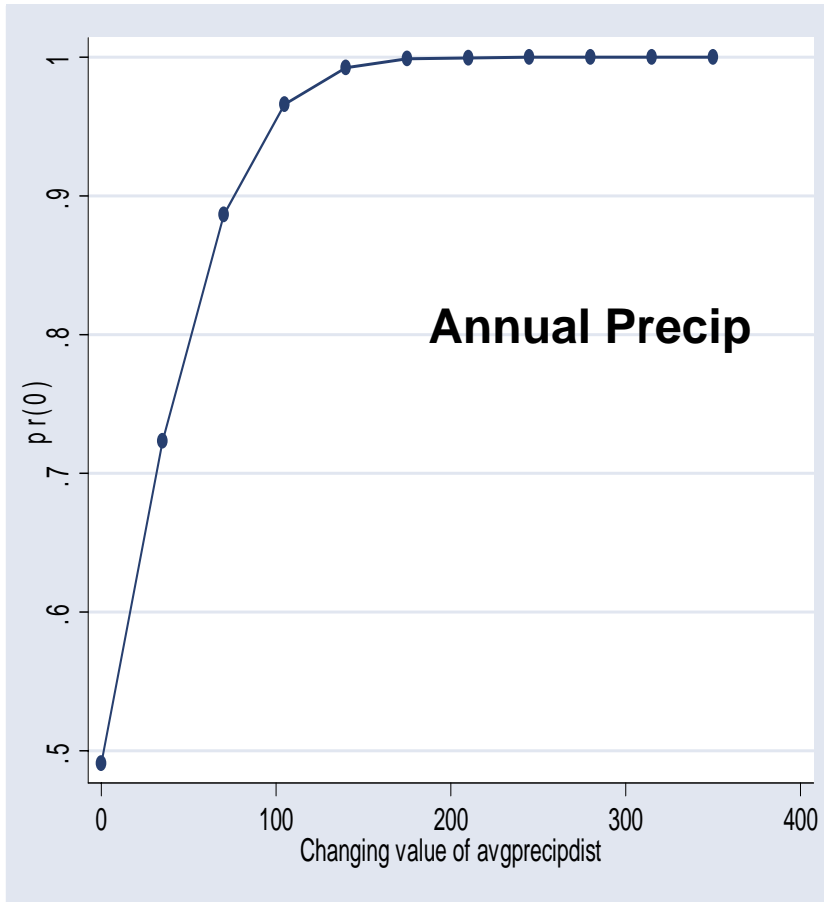
Crop and Livestock Choice

- Which crops will farmers choose?
- Which livestock will farmers choose?
- Which ratio of crop to livestock will farmers choose?
- Which additional adaptation measures farmers will consider?

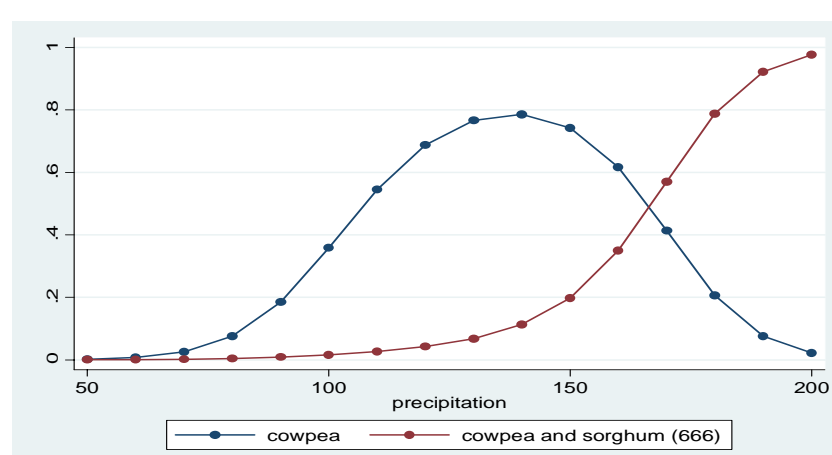
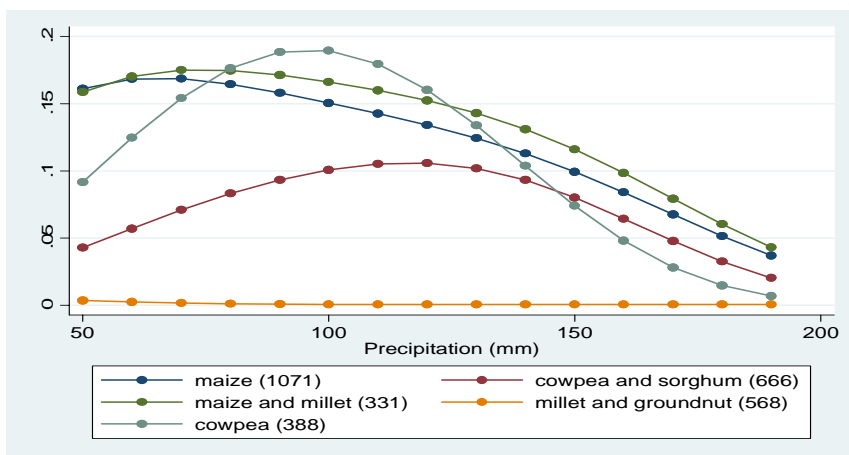
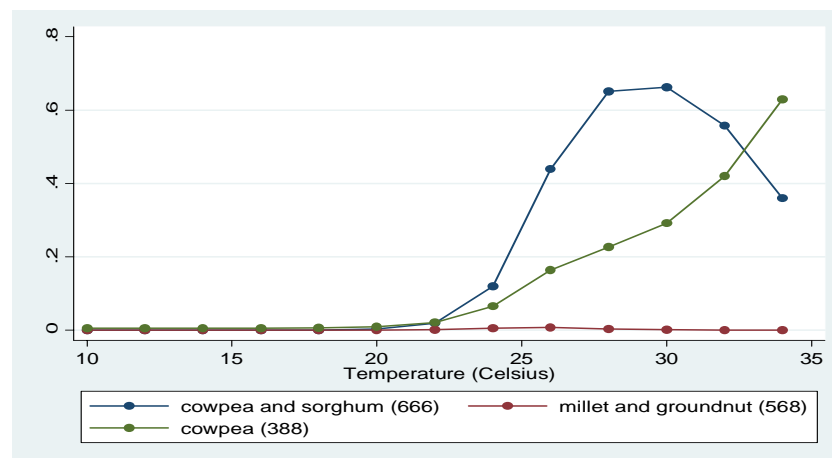
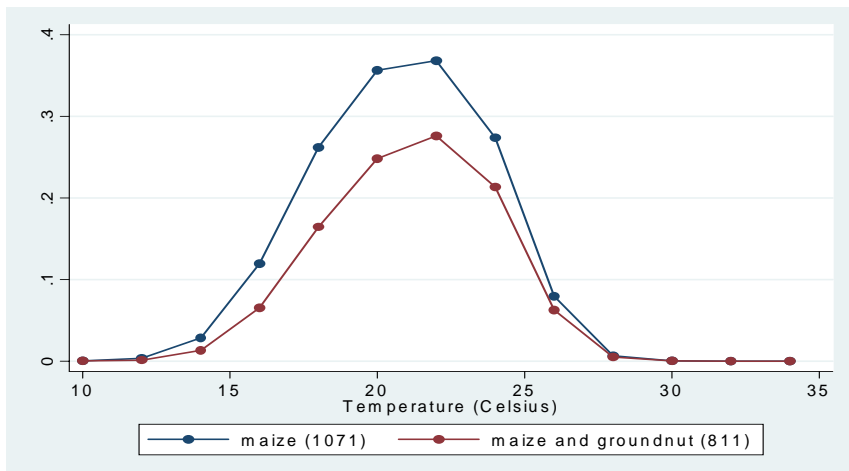
Theoretical relationships of adaptation to irrigation and crop selection



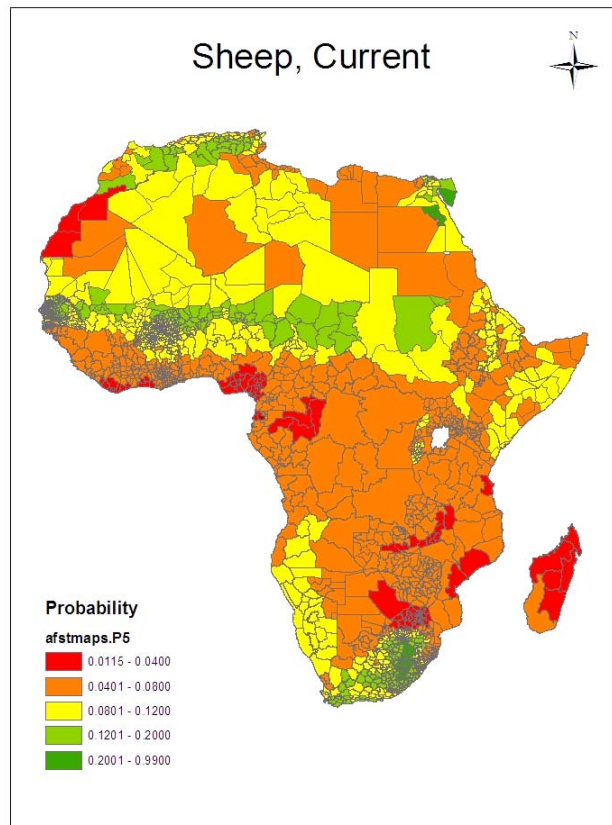
Likelihood of Adoption of Irrigation in Africa (Probit estimates)



Probability of selecting medium and high temperature (1st row) and low-medium and high precipitation (second row) tolerant crops

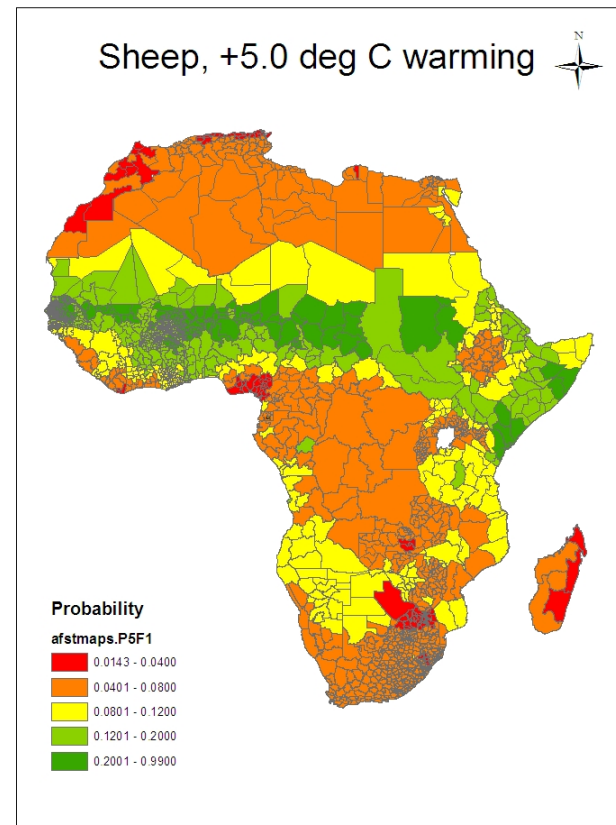


Change in Probability of choosing sheep in Africa with a uniform temperature increase of 5 C



0 2.5 5 10 15 20
Decimal Degrees

NIGGOL SEO, YALE UNIV.



0 2.5 5 10 15 20
Decimal Degrees

NIGGOL SEO, YALE UNIV.

Technological options

(Pictures: Aliza Flicher)

Growing roses in heated greenhouses and lettuce in an open field



Cooling syst (outside view)



Ventilation syst



Heating system



Growing on artificial soil and using drip irrigation



Shading net



Fertilized drainage from greenhouse recycled



Recycled water in a pond



Sprinkler irrigation using the recycled water



Annual net crop revenue per ha under present climate condition (\$/ha, in 2006)

	Botou	Huaiyuan	Cangxian	Yanggu	Gaomi	Nanyang	Shangqiu	Suqian	Xinyi	Mingguan
Rainfed farms	-399	404	332	275	-94	1185	1286	202	253	2326
Irrigated farms	1450	1119	1361	2182	1227	1239	2545	1730	1979	2328

Adaptation: Crop selection in China

Interim results

- Farmers plant different crops depending on the climate zone that they are in
- Farmers will respond to future change in temp and precipitation in their climate zone, given the set of options they have
- Warmer temperatures are therefore likely to get farmers to switch to wheat, maize, cotton, and oil
- Increases (decreases) in precipitation are likely to get farmers to switch to potato, oil, and sugar (wheat, rice, maize soybeans, and cotton).

Conclusion (1)

- **South America and Africa studies provides evidence that farmers adapt to climate in many ways**
 - **Change type of farm**
 - **Irrigation choice**
 - **Crop choice**
 - **Livestock choice**
- **The same holds for China**
 - **Crop choice**
 - **Irrigation choice**

Conclusion (2)

- **Adaptations reduce magnitude of net damages from climate change**
- **Still large agricultural damages from warming, depending on present climate**
- **Damages are larger in more severe climate scenarios**
- **Adaptations most important for more severe climate scenarios**