

**Agricultural Climate Change Impact  
General Concerns and Findings from Mali, Kenya,  
Uganda, and Senegal**

Tanveer A Butt, Jay Angerer, Paul Dyke, Man-keun Kim,  
Robert Kaitho, and Jerry Stuth

Center for Natural Resource Information Technology

Texas A&M University

College Station, TX

**SANREM CRSP**

**Accomplishments and Lessons Learned Workshop  
June 16, 2004**

Contact Info: [tanveer@tamu.edu](mailto:tanveer@tamu.edu); Ph:  
979-845-3805

# **Presentation Outline**

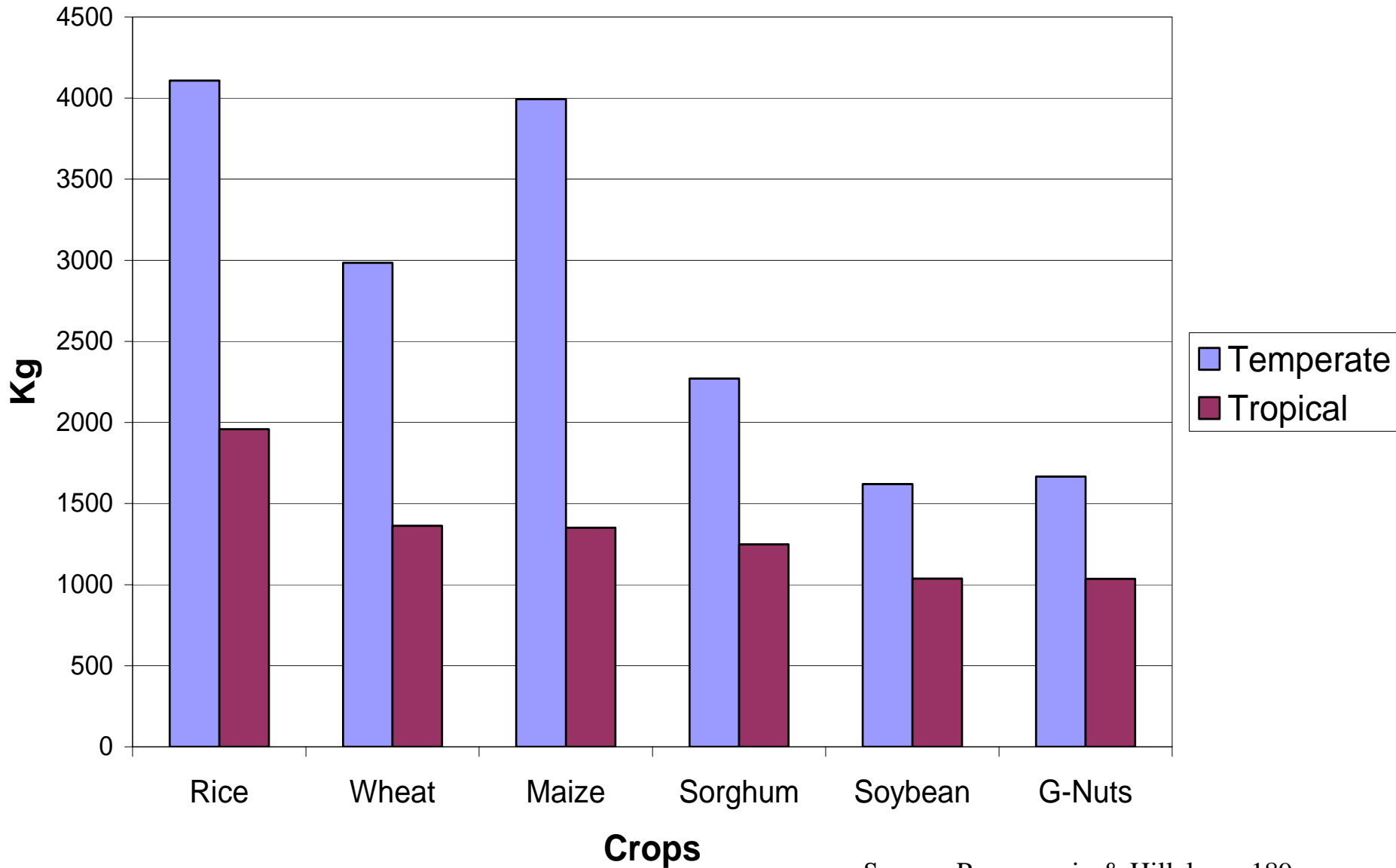
---

- Concern about climate change
- Climate Change Impact Assessment Methodology
- Climate Change Impact Assessment in Mali, Kenya, Uganda, and Senegal

# Specific Concerns In Regards to Agriculture

	Temp	Rainfall	CO2	Sea Level	Extreme Events
Plants					
Crop and forage growth	X	X	X		X
Crop /forage water need	X	X	X		X
Soils					
Soil moisture supply	X	X			X
Irrigation demand	X	X	X		X
Soil fertility	X	X	X		X
Animals					
Performance	X	X			X
Pasture/ Range Carrying capacity	X	X	X		X
Irrigation Water Supply					
Evaporation loss	X	X			
Run-off/general supply	X	X			X
Non-AG competition	X	X			
Other					
Water borne transport	X	X		X	X
Port facilities				X	
Pest and diseases	X	X			X
Crop insurance					X
Forest/Brush Fires					X
Losses owing to floods	X	X			X

# Average Yields in Temperate and Tropical Regions (Kg/Hect.)

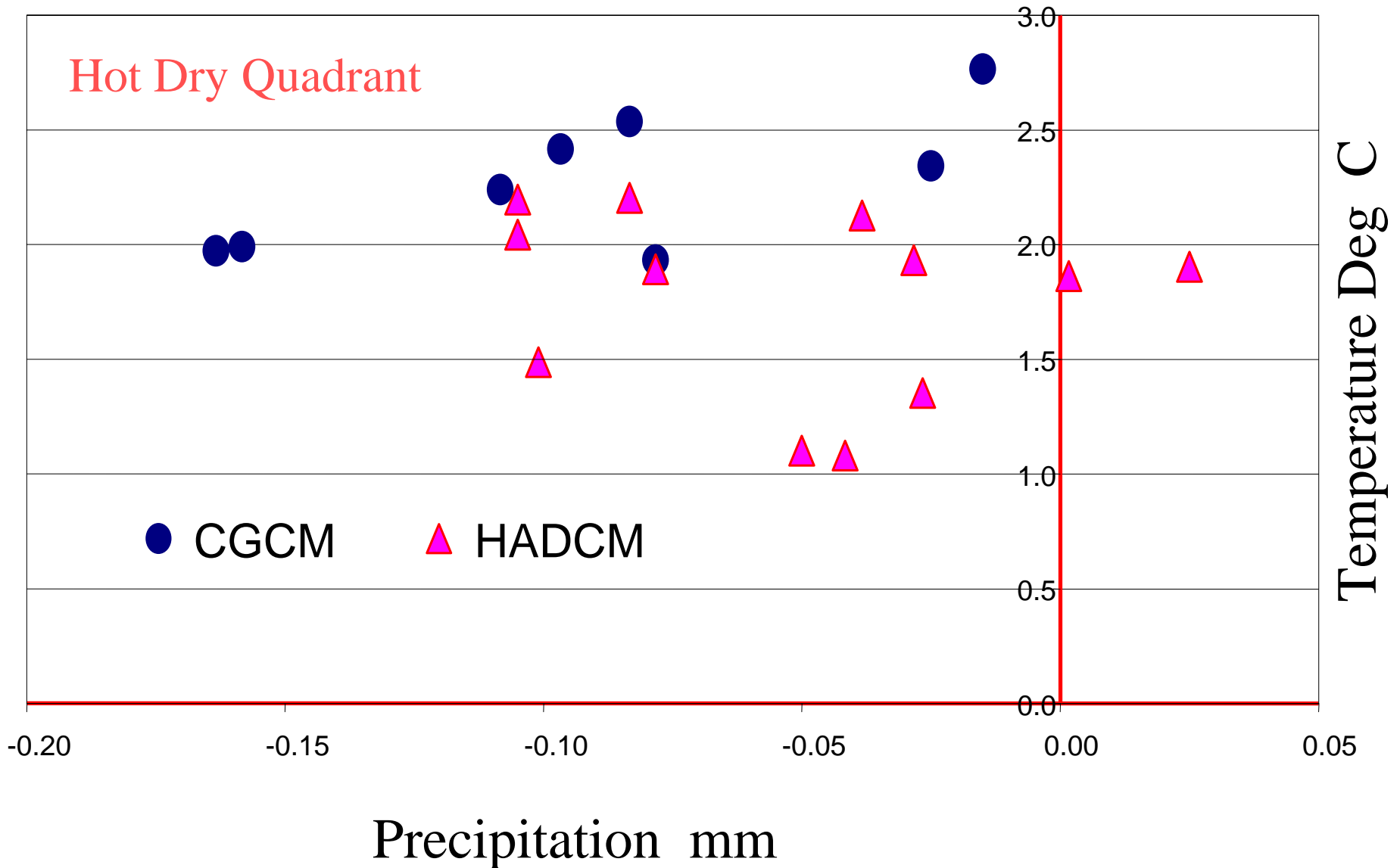


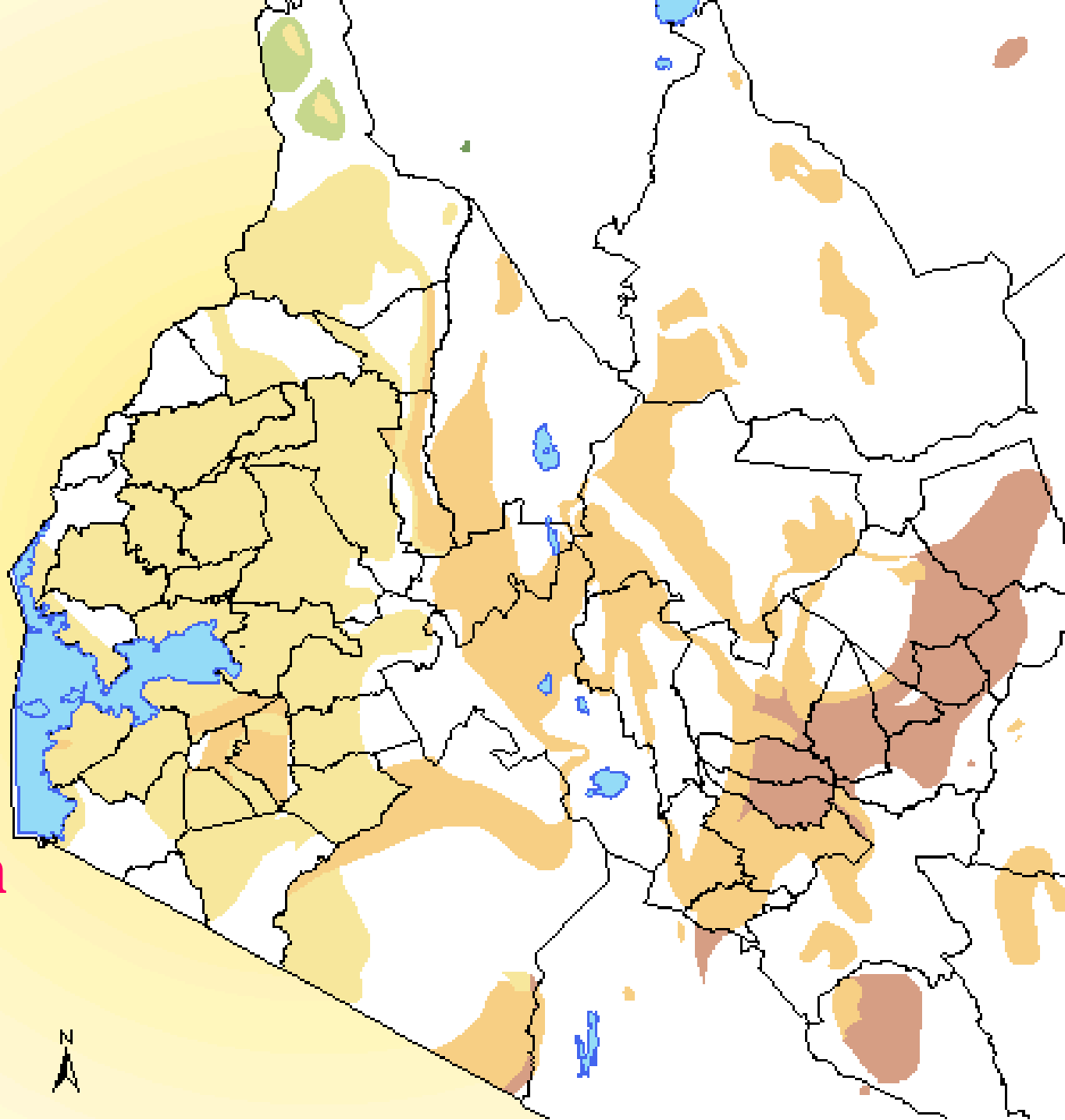
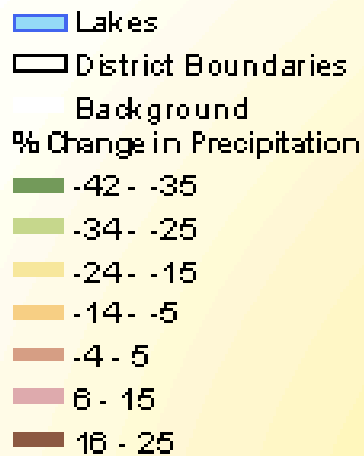
# Changes in Temperature and Precipitation During 1900-2000

Region	Temp. (°C)	Precipit. (%)
Central Asia	+0.2 to +0.6	-10 to +40
South Asia	-0.2 to +0.2	+10 to +40
Sub Saharan Africa	+0.2 to +0.4	-20 to -50
North America	-0.2 to +0.4	-20 to +50

Source: IPCC

# Mali Projected Changes in Temp. and Precipit.

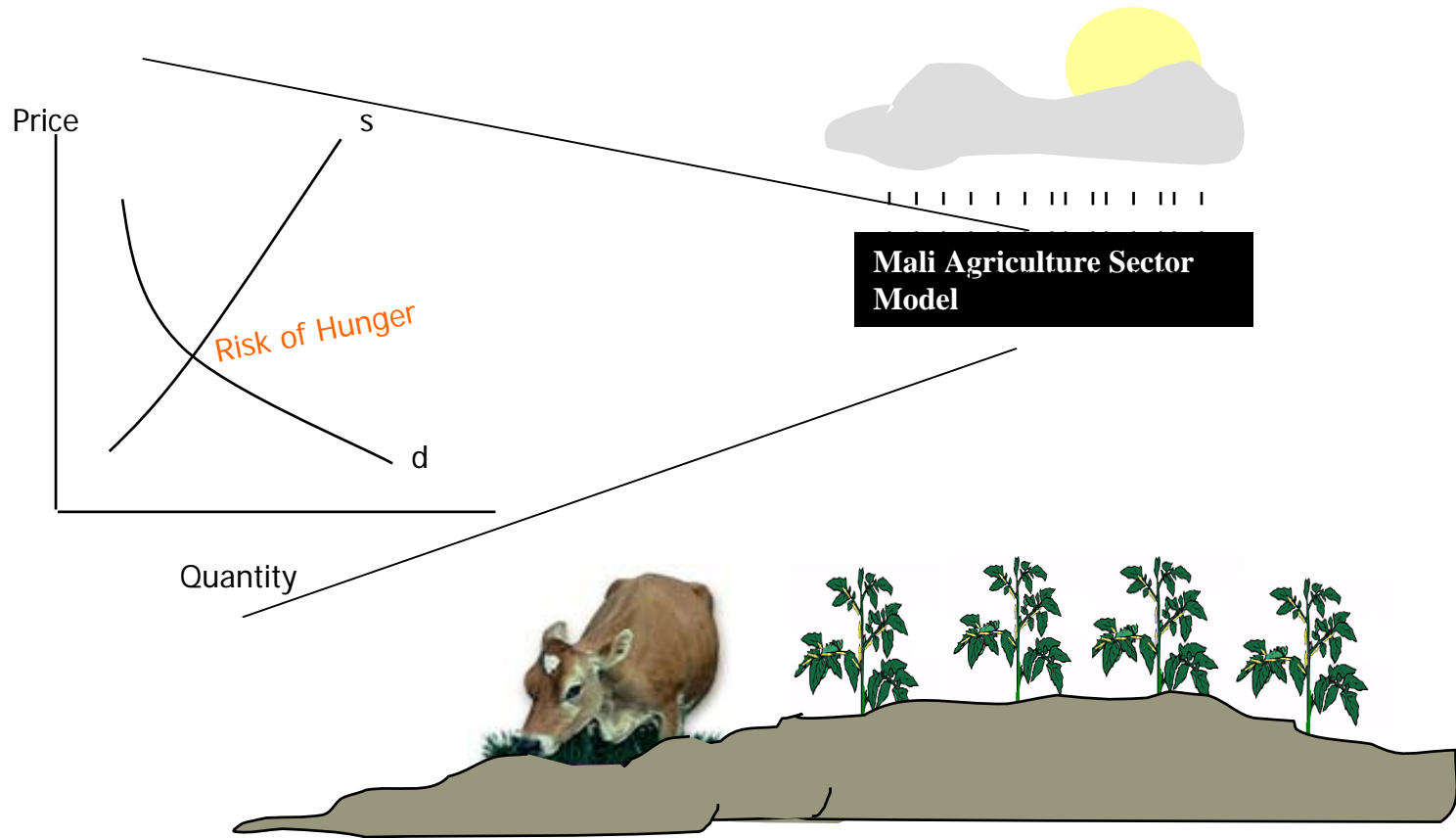




# Kenya – Changes in precipitation



# Climate Change Impact Assessment



## Physical Impacts

Changes in crop yield -- EPIC

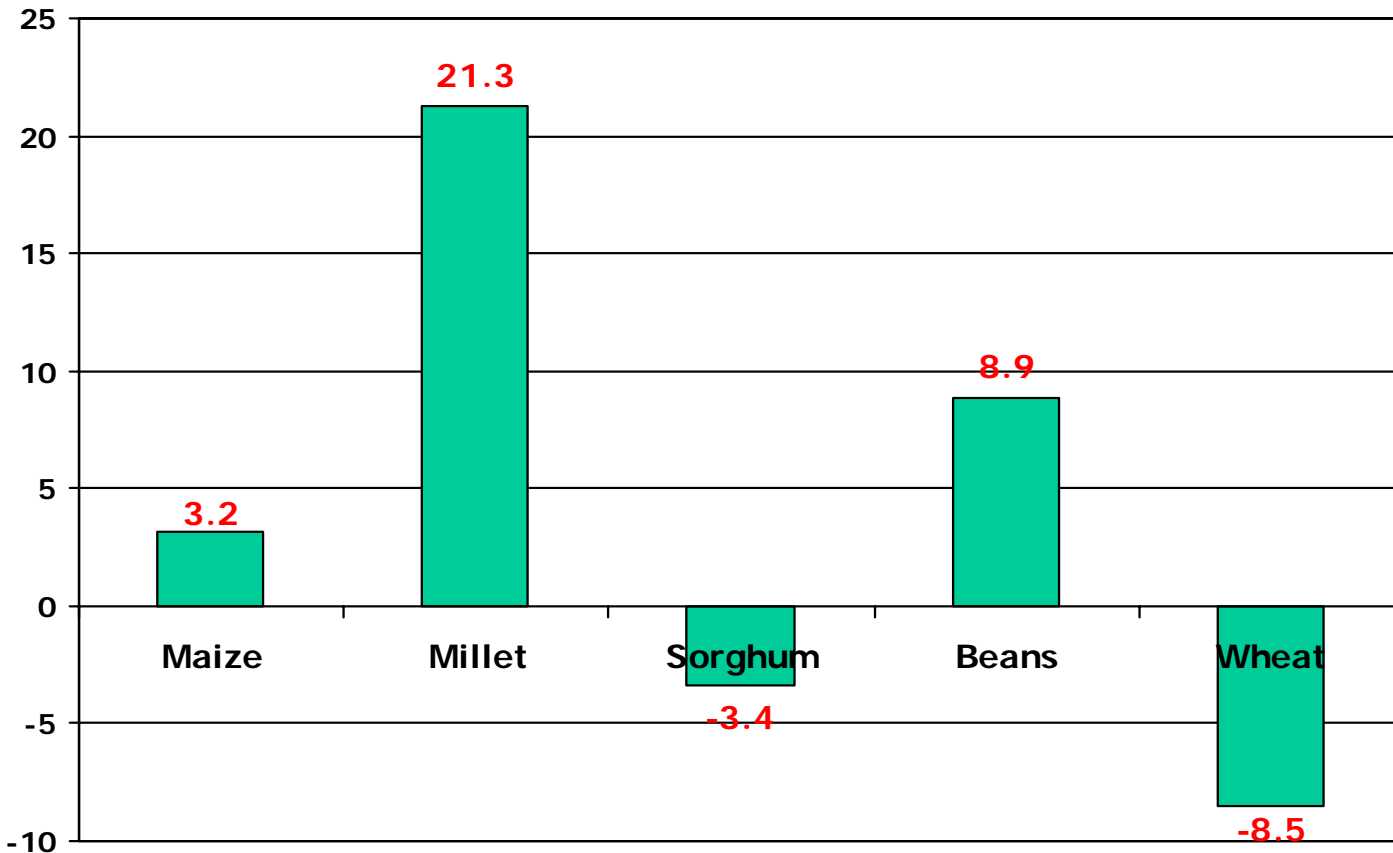
Changes in livestock forage yield on pasture land - Phygrow

Changes in animal appetite and weight loss - Nutbal



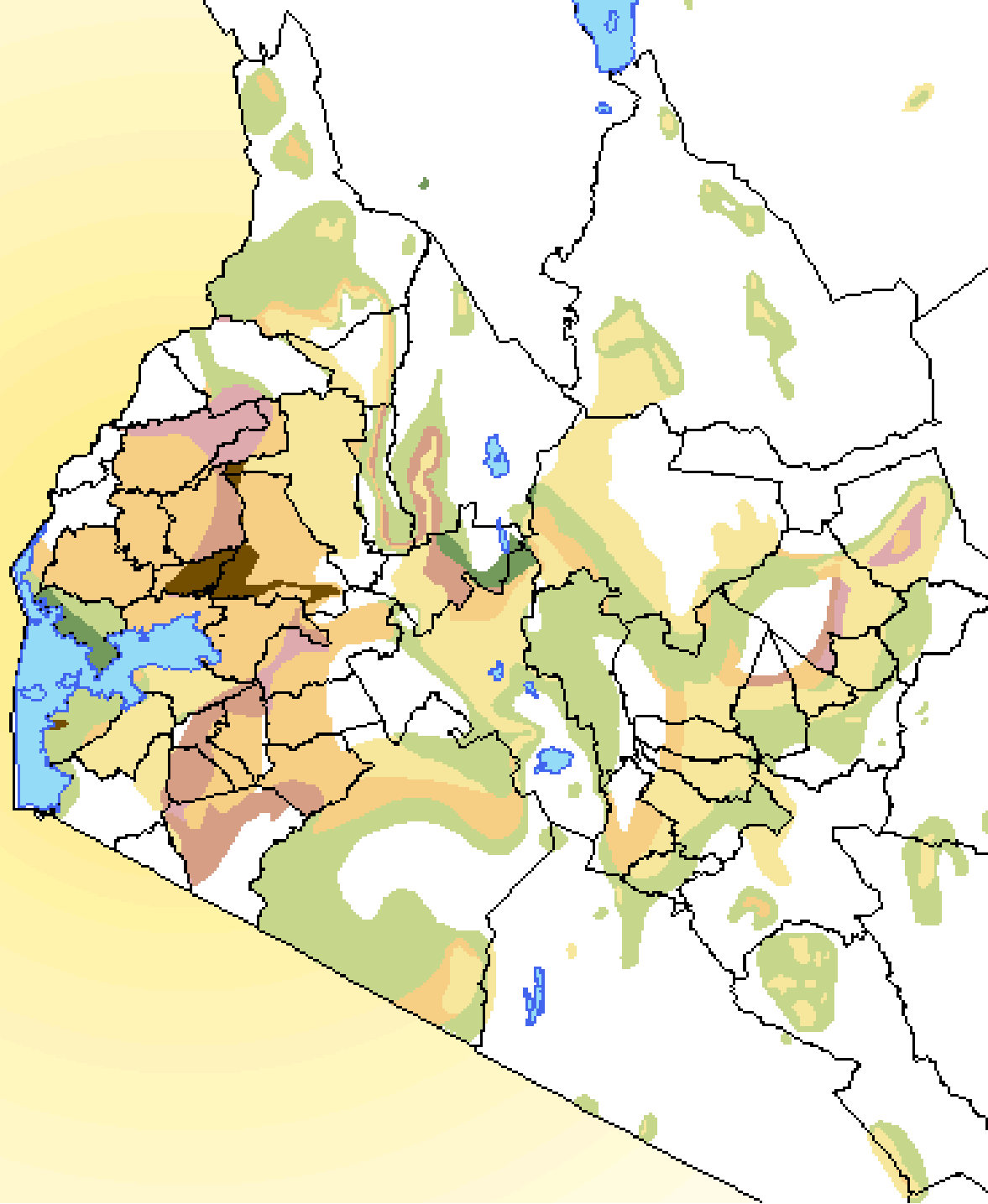
# Changes in Crop Yield (%)

## Kenya



- Lakes
- District Boundaries
- Background
- % Change in Crop Available Water
  - 10 - -5
  - 4 - 0
  - 1 - 5
  - 6 - 10
  - 11 - 15
  - 16 - 20
  - 21 - 25

# % Change in Maize Yield in Kenya

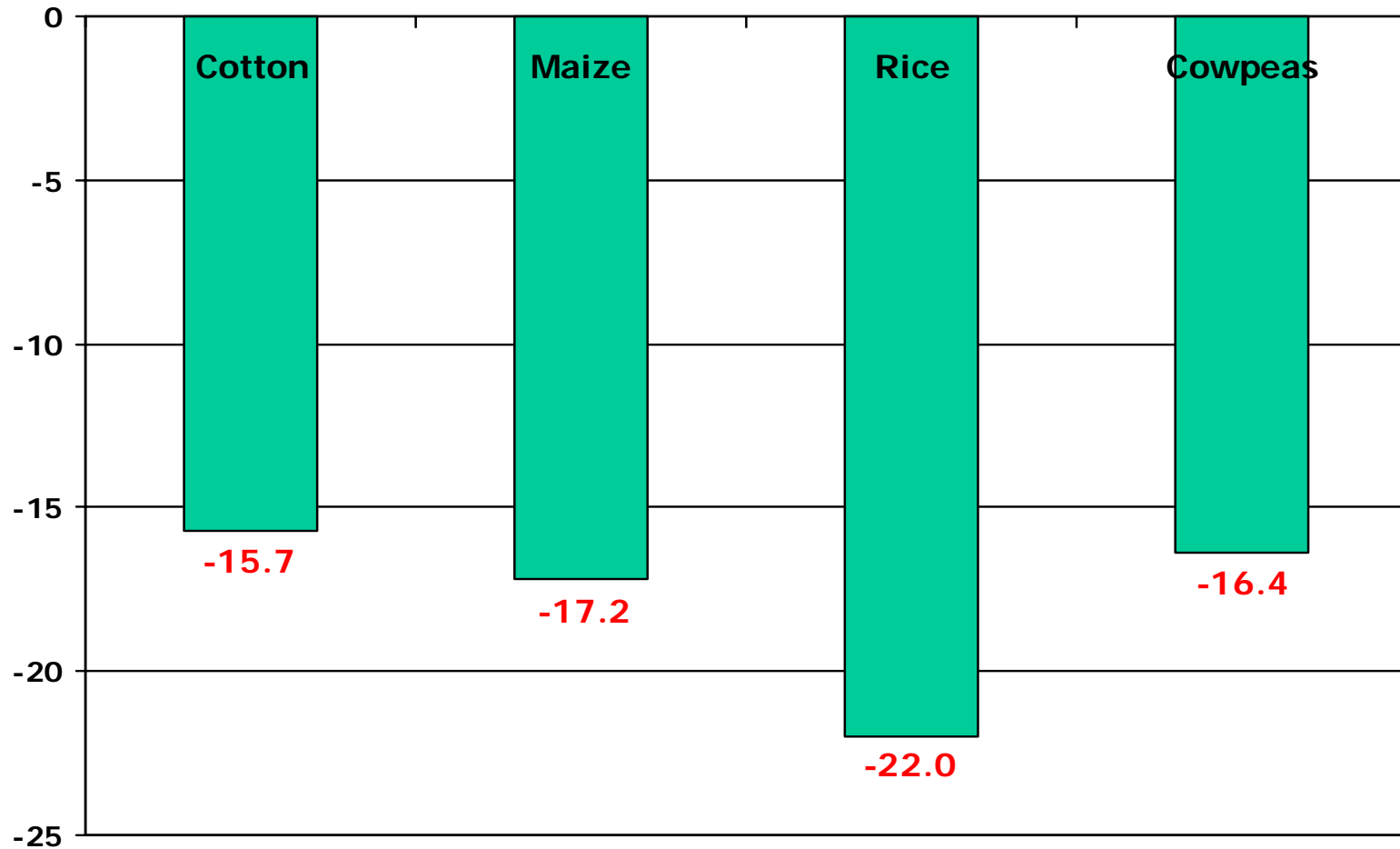


0 20 40 60 80 100 Kilometers

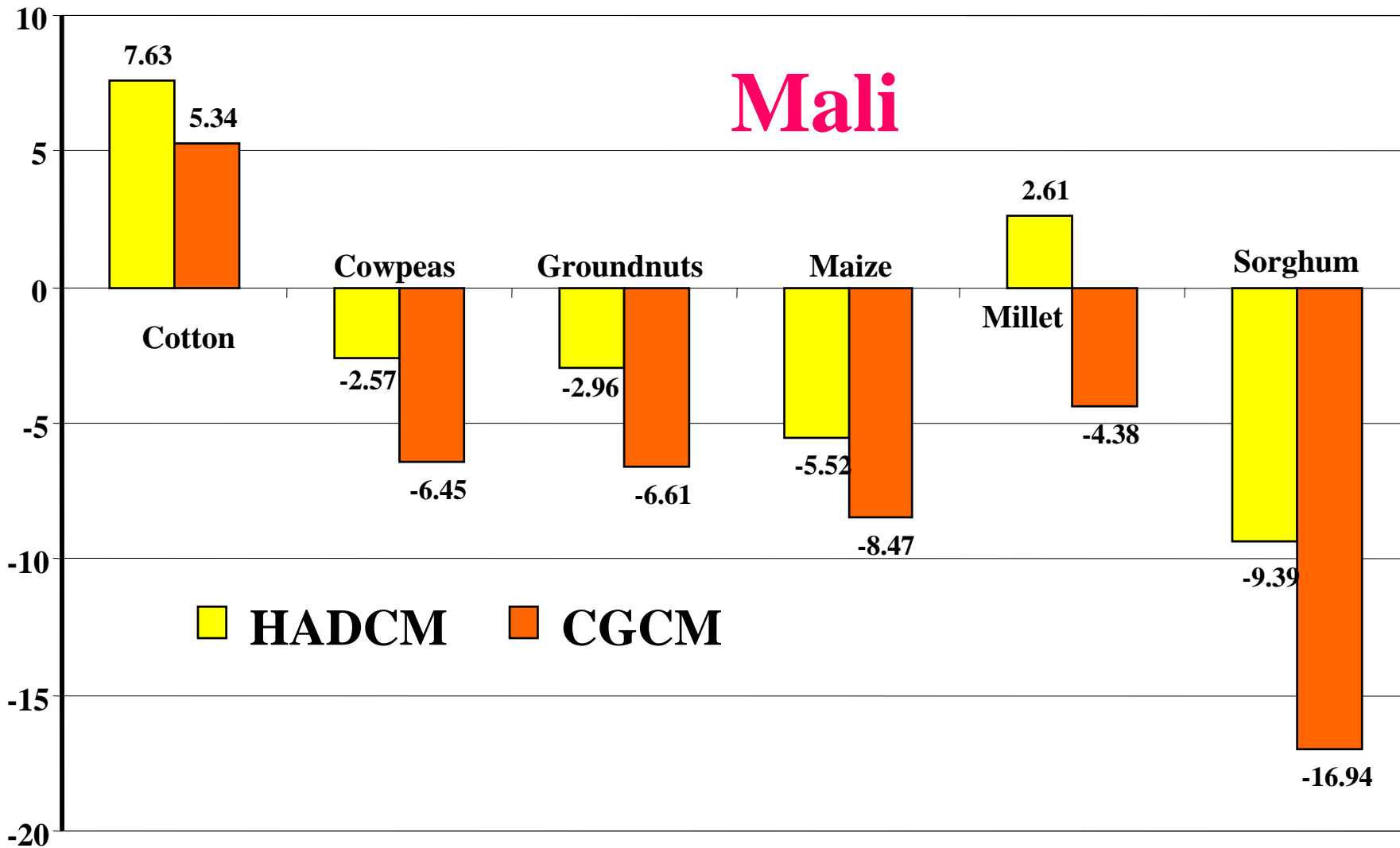


# Changes in Crop Yield (%)

## Senegal

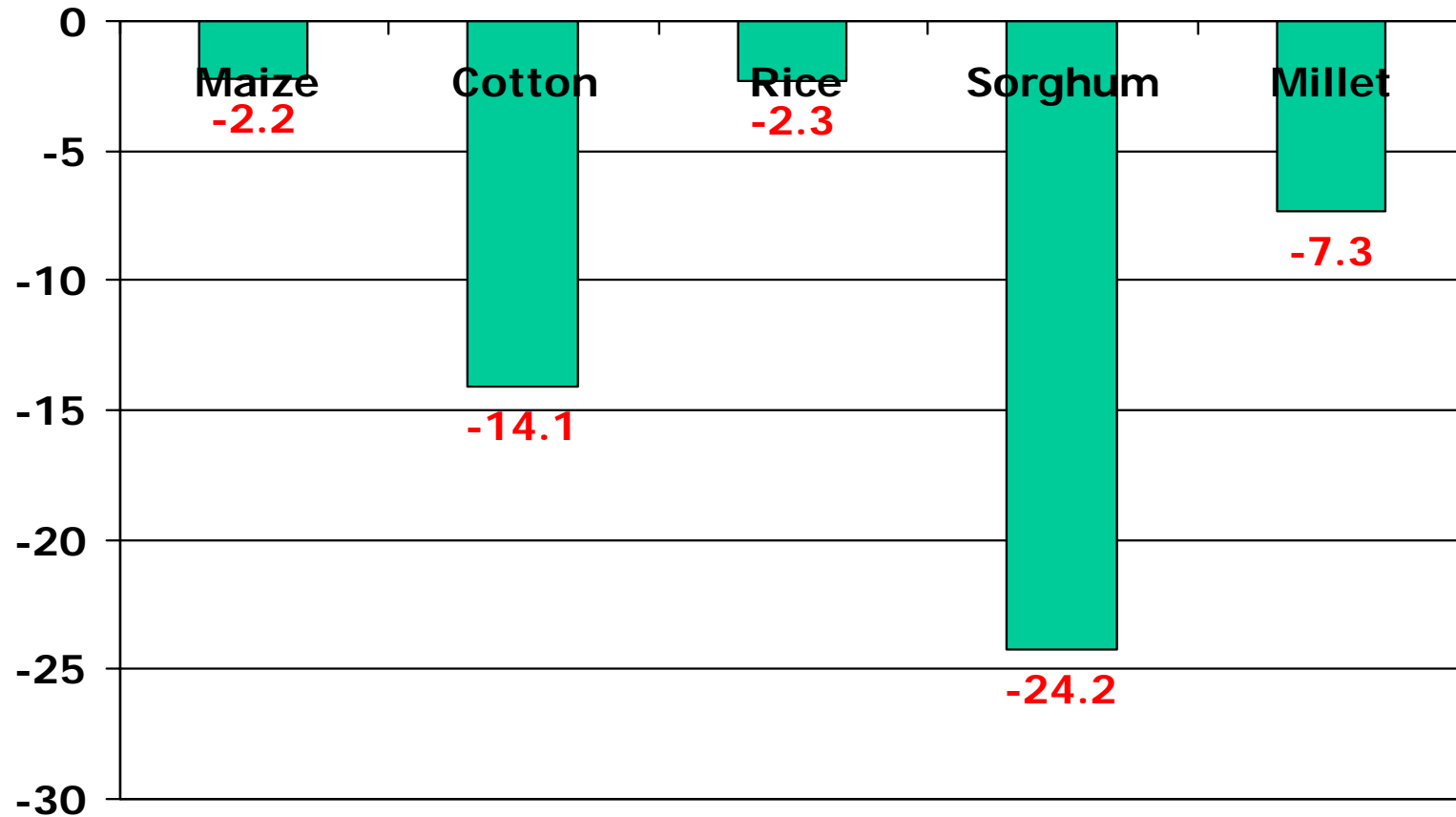


# Physical Impacts - Changes in Crop Yield (%)



# Changes in Crop Yield (%)

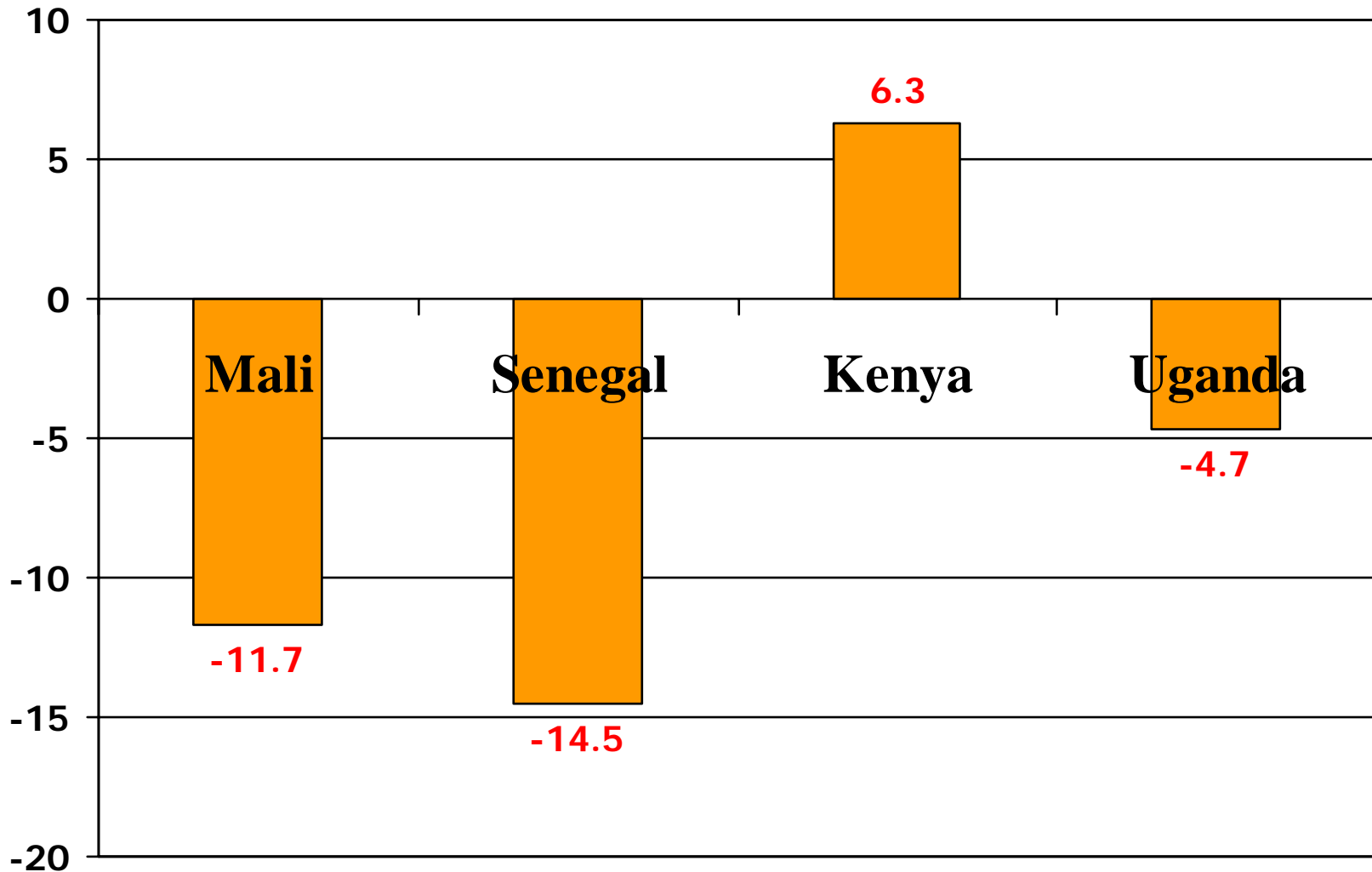
## Uganda



# **Impact on Production, Import, and Prices of Cereals**

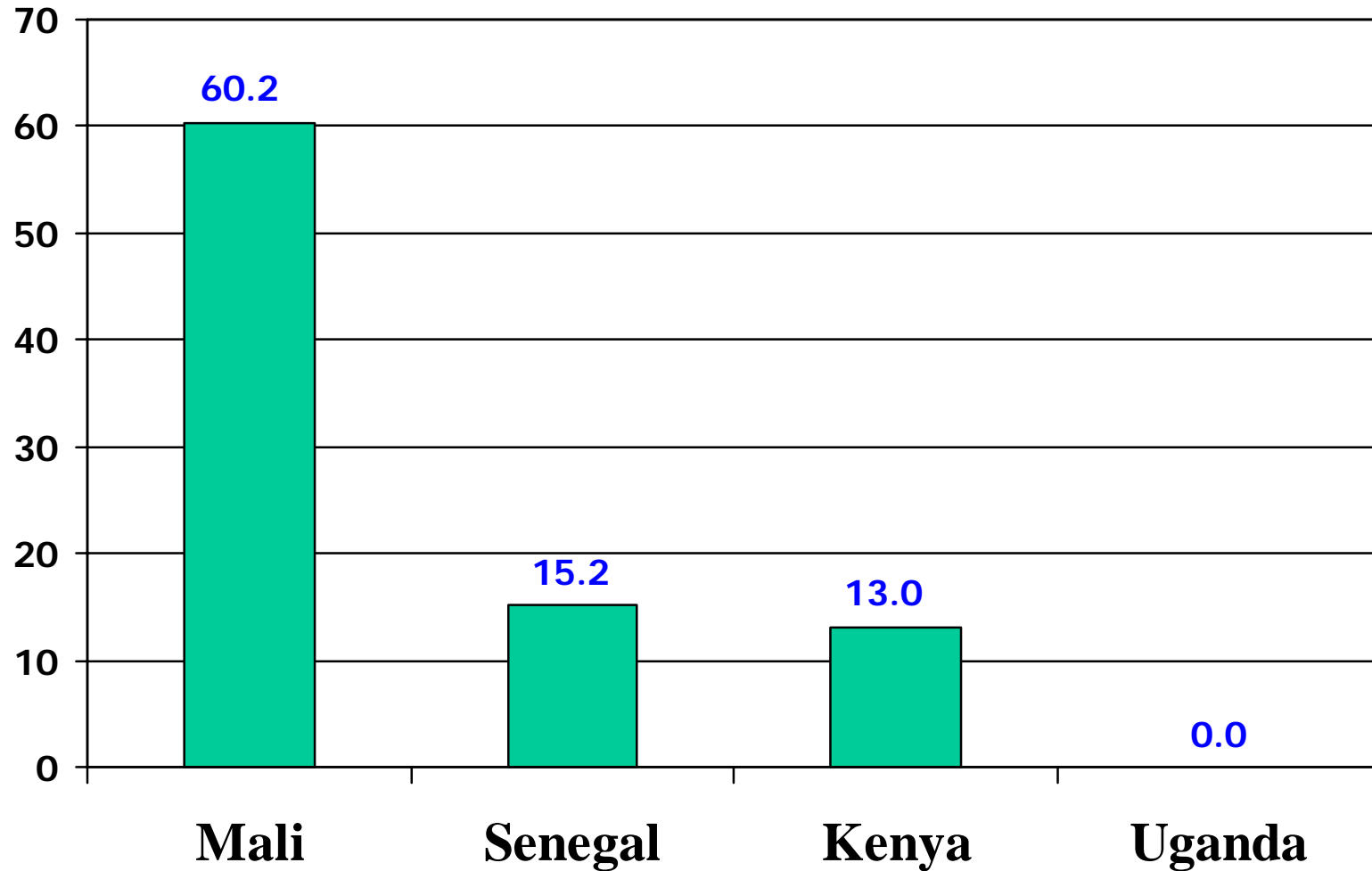
# Changes in Cereal Production (%)

---



# Changes in Cereal Import (%)

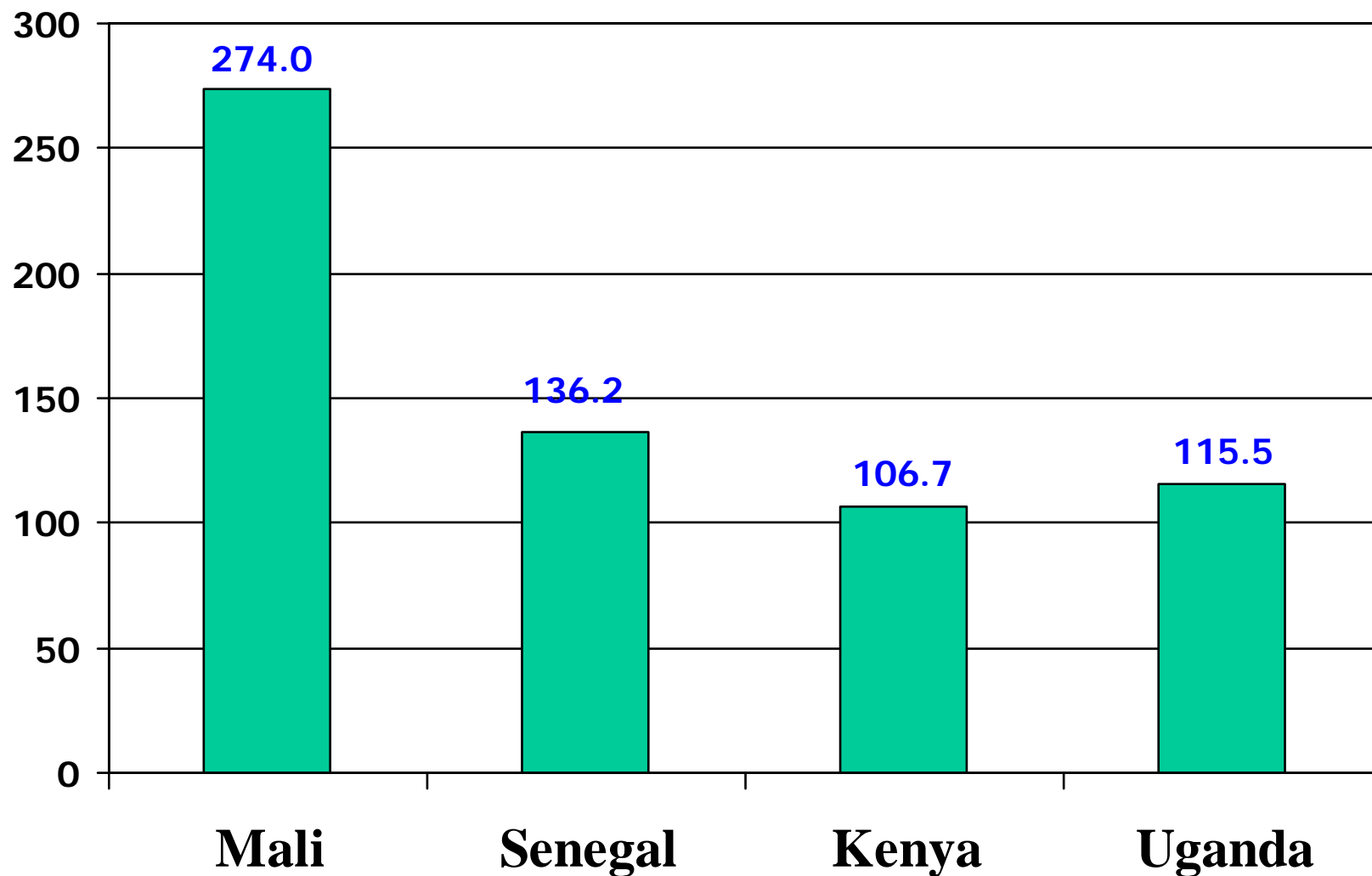
---





# Changes in Cereal Price Index (Base = 100)

---



# **Economic and Food Security Implications of Climate Change and the Mitigative Adaptations**

**Details for Mali**

# Adaptations to Climate Change

---

## ➤ Economic Adaptations

- Crop mix
- Market and Trade

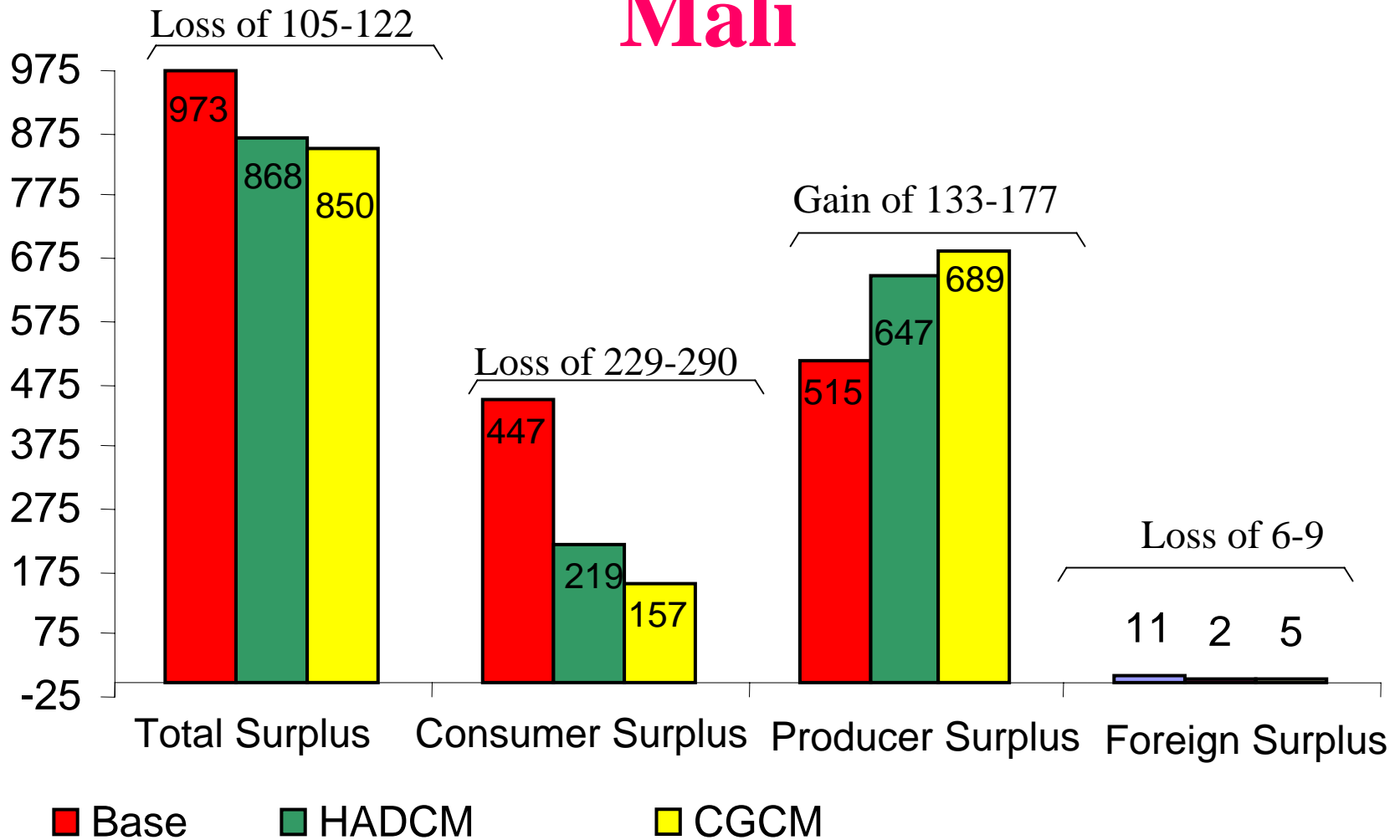
## ➤ Agronomic Adaptations

- Changing planting and harvesting dates
- Heat resistant varieties

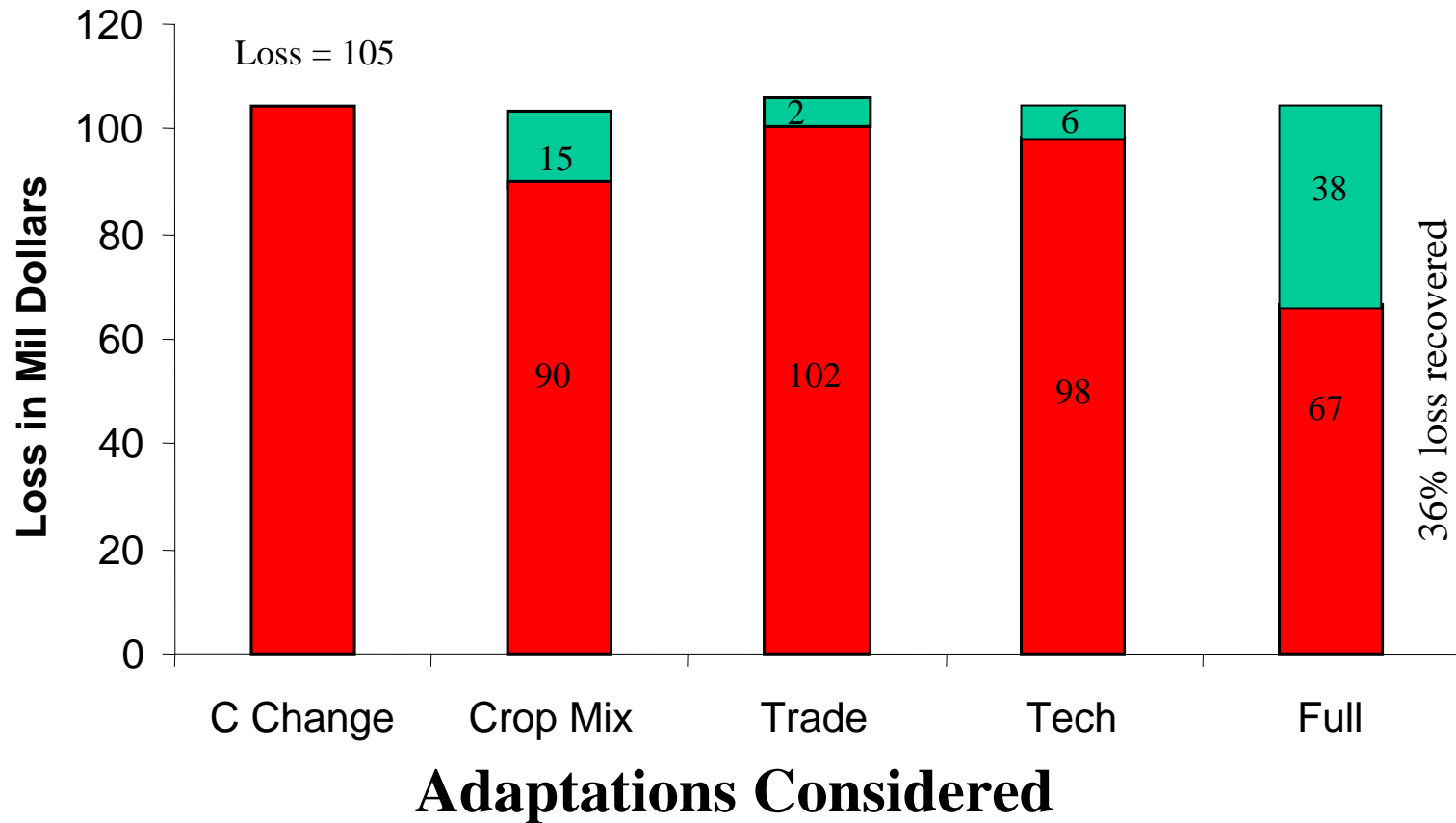
## ➤ Policy Adaptations (later)

# Economic Implications - Surplus Measures (Mil. Dollars)

## Mali



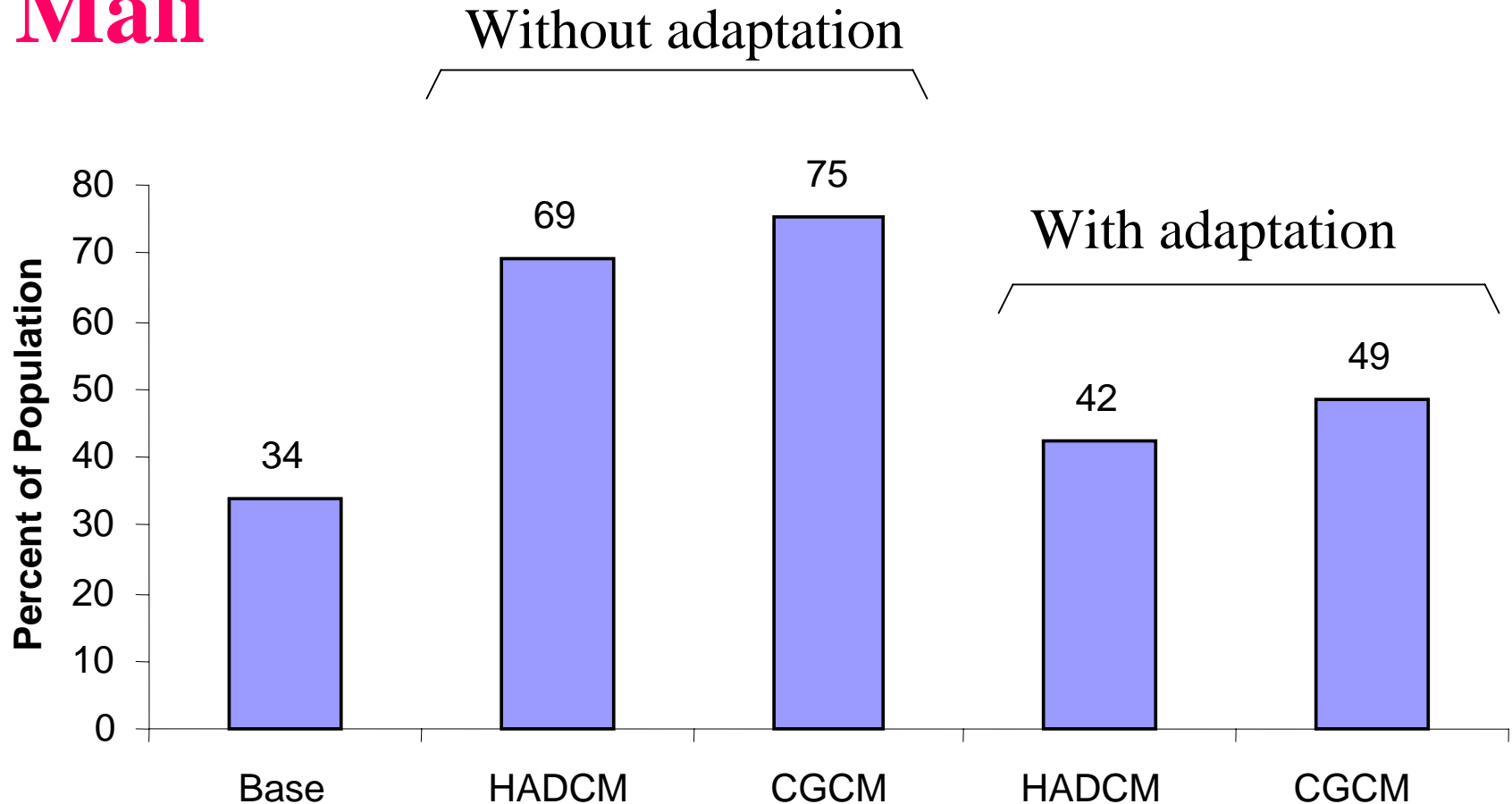
# Value of Adaptation (\$ Million) - Mali



HADCM Model Projections

# Risk of Hunger - With and Without Adaptation

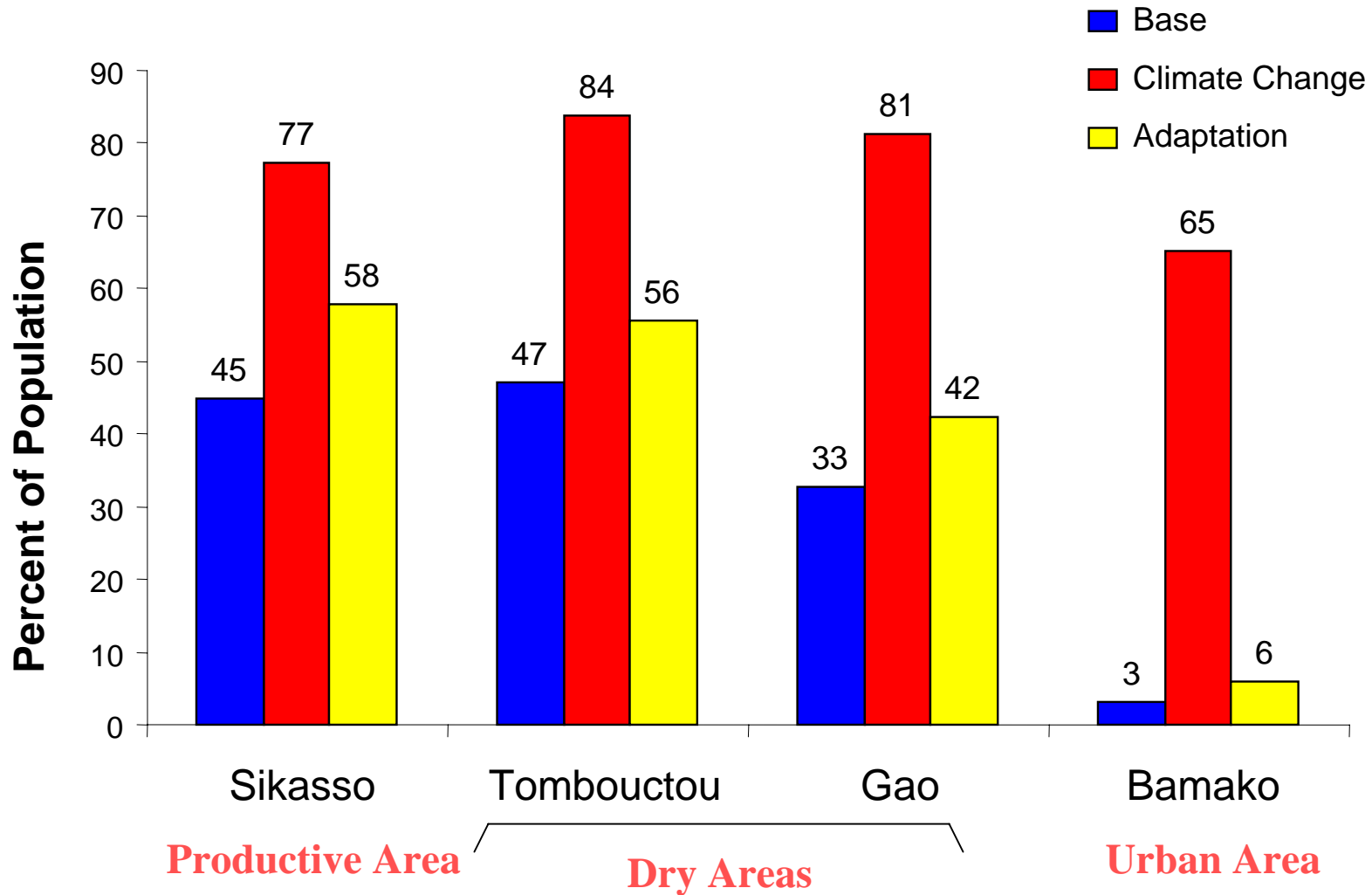
## Mali



HADCM: Hadley Coupled Model

CGCM: Canadian Global Coupled Model

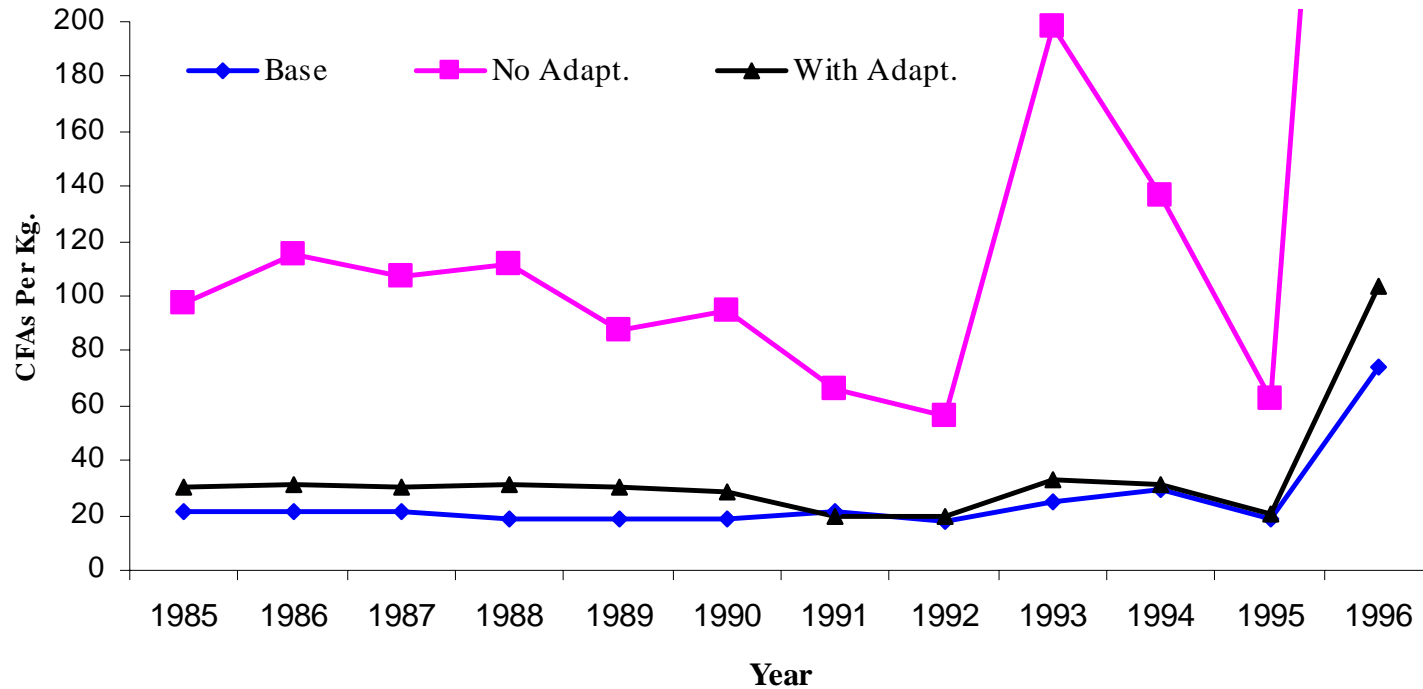
# Risk of Hunger in Mali - Regional Implications



Canadian Model Projections

# Price Instability - Millet Prices under Canadian Model

## Mali



Coefficient of Variation:

Base: 61

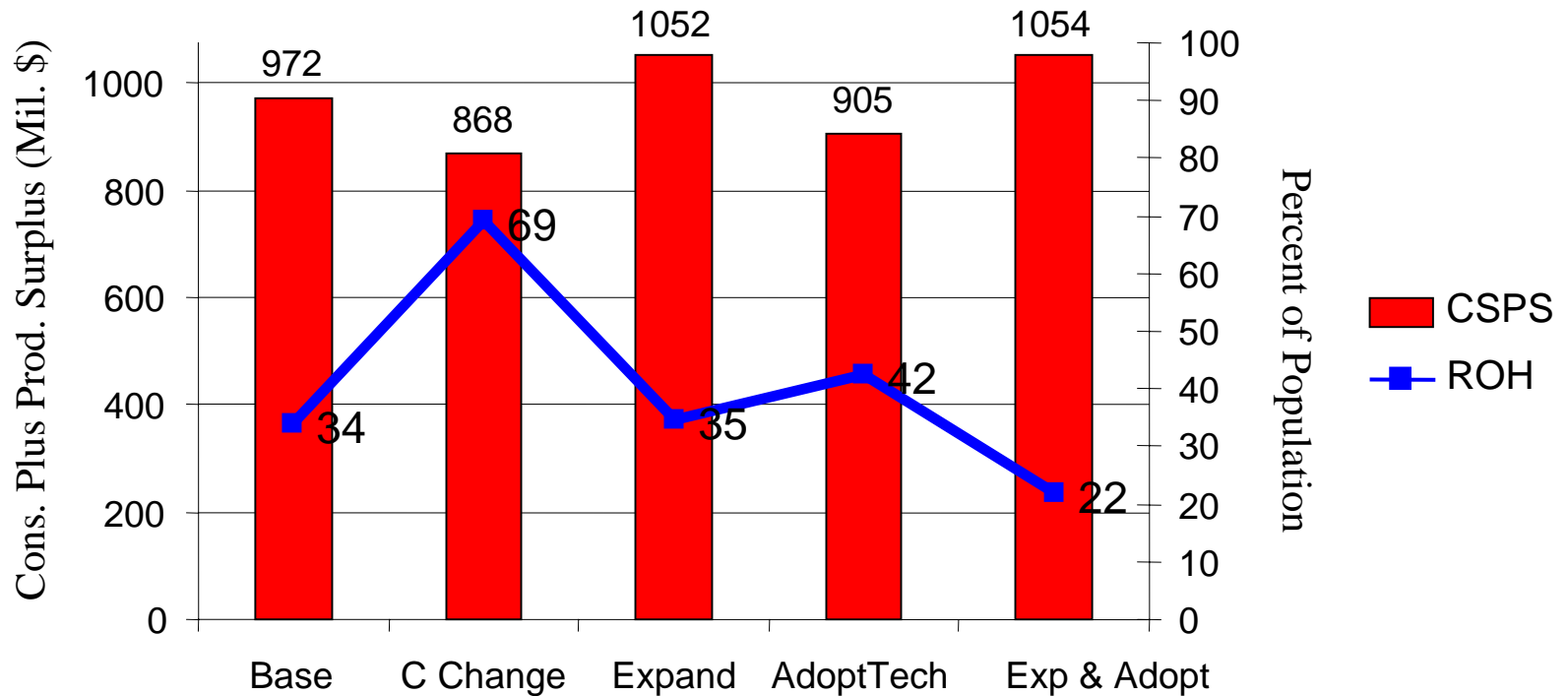
Without Adaptation: 100

With Adpatation: 65



# Policy Adaptation - Land Expansion and Technology Adoption

## Mali



Policy adaptations are super-imposed on economic and technological adaptations considered earlier. The results shown in this graph are under Hadley projections.

# General Findings For the Four Countries

---

Generally, unfavorable environmental conditions for agriculture are expected (worsening food security conditions)

Increased risk of hunger

Increased dependence on food import

Weather induced price instability is likely to increase

Adaptations to climate change can effectively mitigate the climate change impact (In Mali, the risk of hunger reduced to 22% - even lower than the base level of 34%)

Economic adaptations through trade may be realized if markets work well.

Investing in heat resistant varieties may have high pay-off.

# Recommendations for Future Research

---

Extreme climatic events

Cost of adaptation

Implications for regional trade

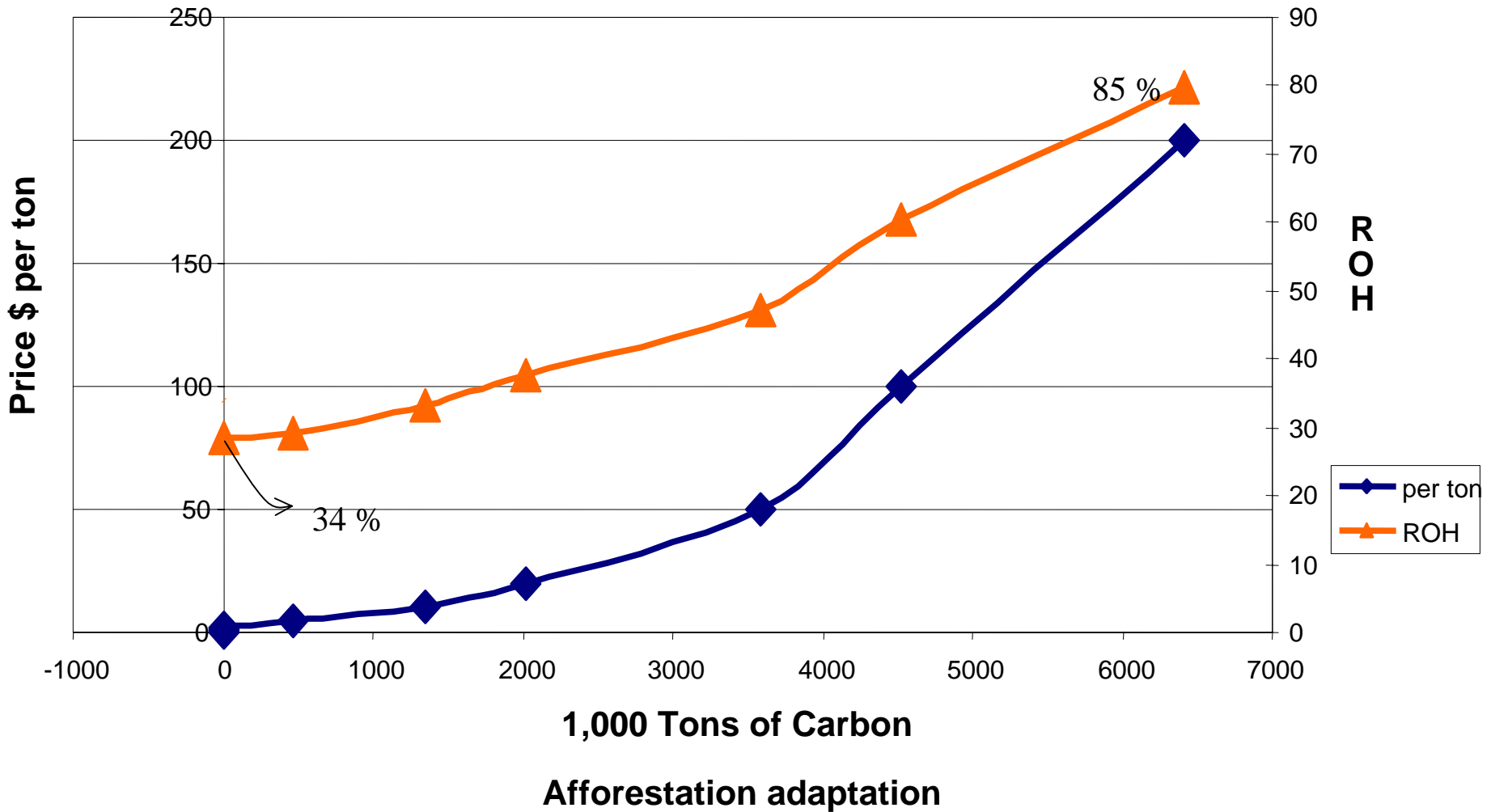
# References

---

- Following references were consulted for this presentation
- Butt, T.A., McCarl, B. A., Dyke, P., Angerer, J. P., and Stuth J.W.: 2003, Economic and Food Security Implications of Climate Change - A Case Study for Mali. *Climatic Change* (Under submission) <http://agecon.tamu.edu/faculty/mccarl/climchg.html>
- Butt, T.A., and McCarl, B. A.: 2003, An Analytical Framework For Making Long -Term Interlinked Economic And Food Security Projections: A Case Study For Mali. (Under submission) <http://agecon.tamu.edu/faculty/mccarl/roh.htm>
- Downing, T. E., Olsthoorn, A. J., and Tol, R.S.J.: 1999, *Climate Change and Risk*. Routledge Pub., London, U.K.
- Rosenzweig, C., and Hillel, D.: 1998, *Climate Change and the Global Harvest: Potential Impacts of the Greenhouse Effect on Agriculture*, Oxford University Press, New York.
- Swaminathan, M.S. and S. K. Sinha (eds.). 1986. *Global Aspects of Food Production*. Tycooly International. Oxford. Pp. 417-449.

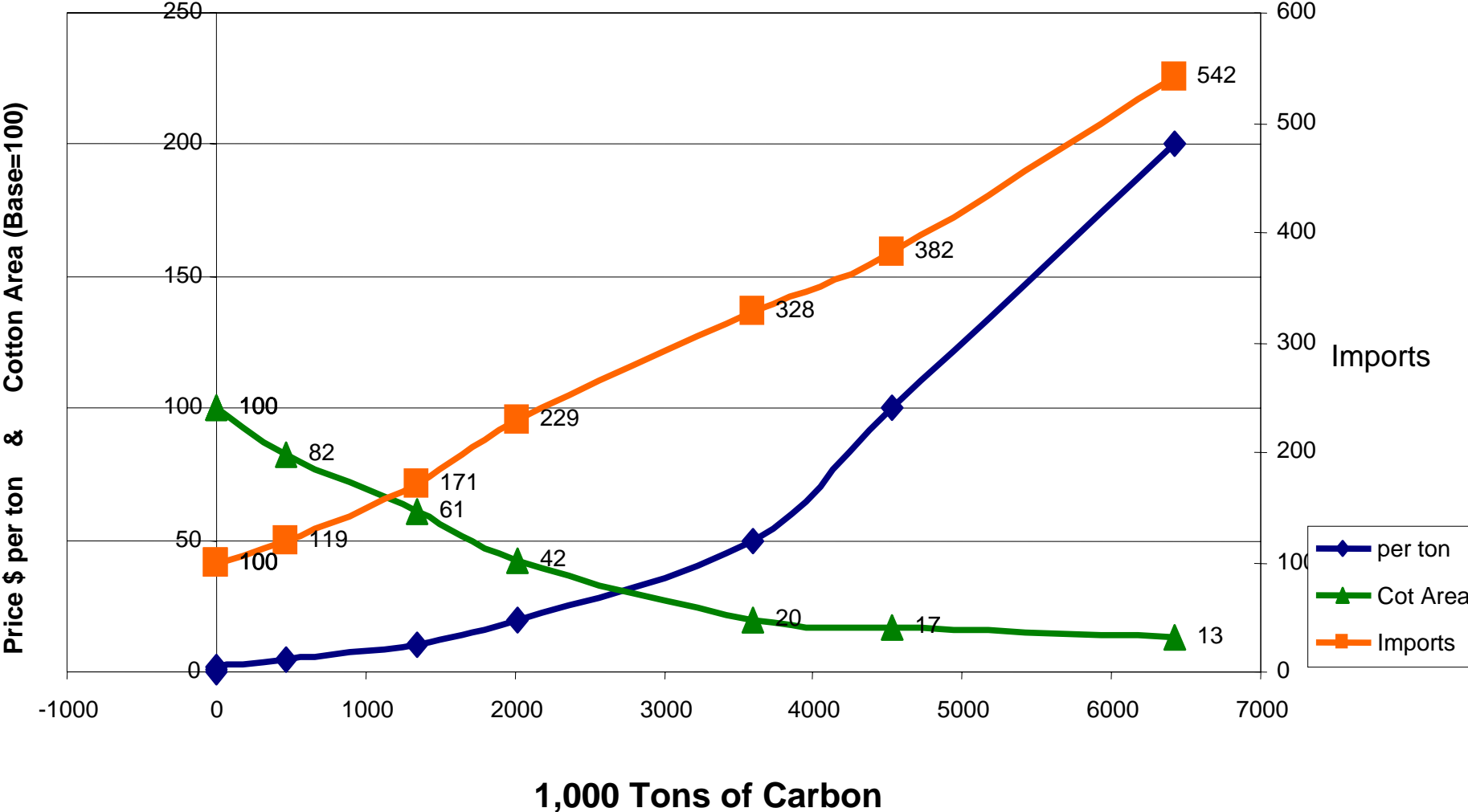
# Carbon Sequestered For Different Payments and the Associated Risk of Hunger

## Preliminary Estimates from CDM Study in Mali



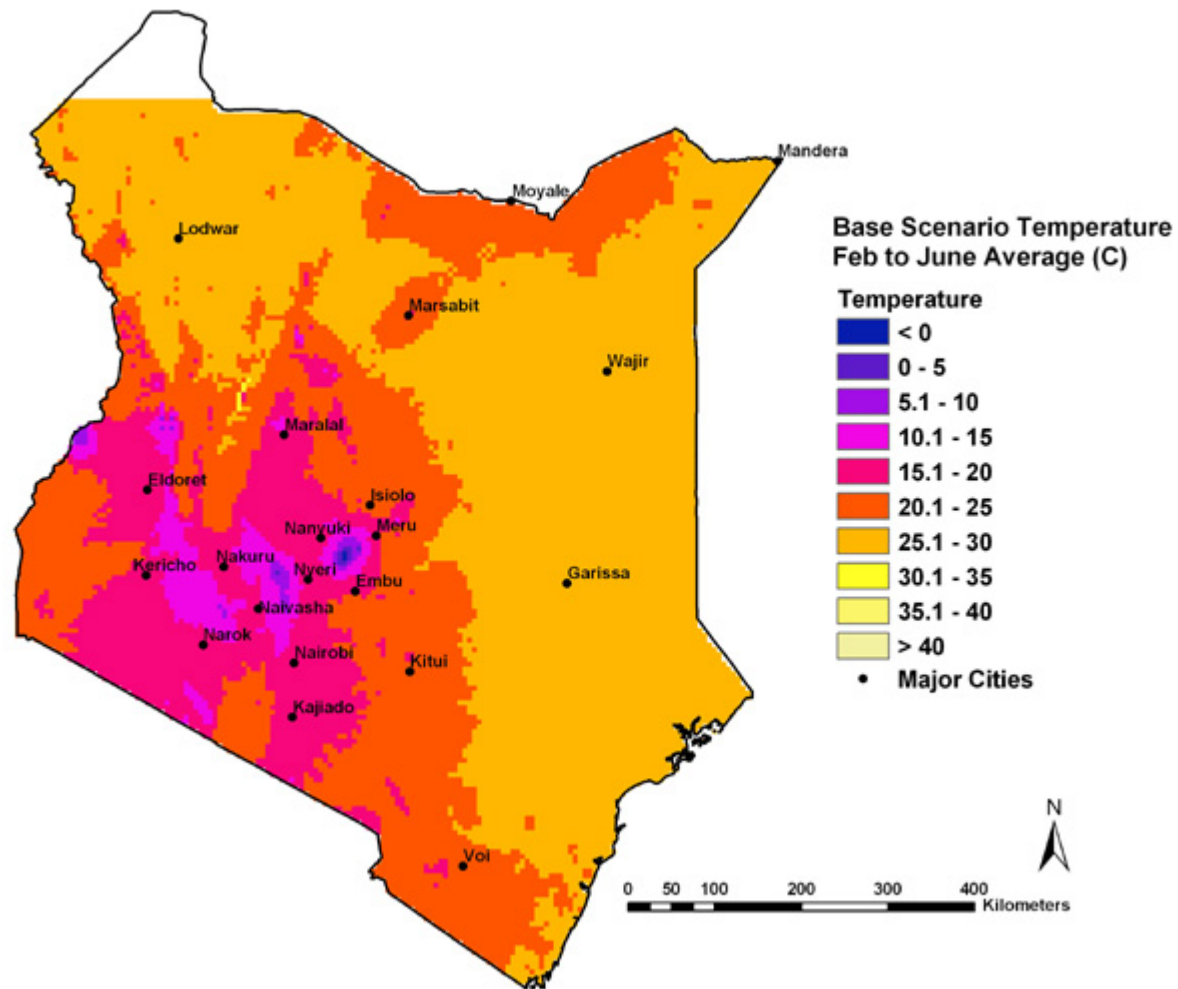
# Carbon Sequestered For Different Payments, Cereal Imports, and Cotton Area

## Preliminary Estimates from CDM Study in Mali



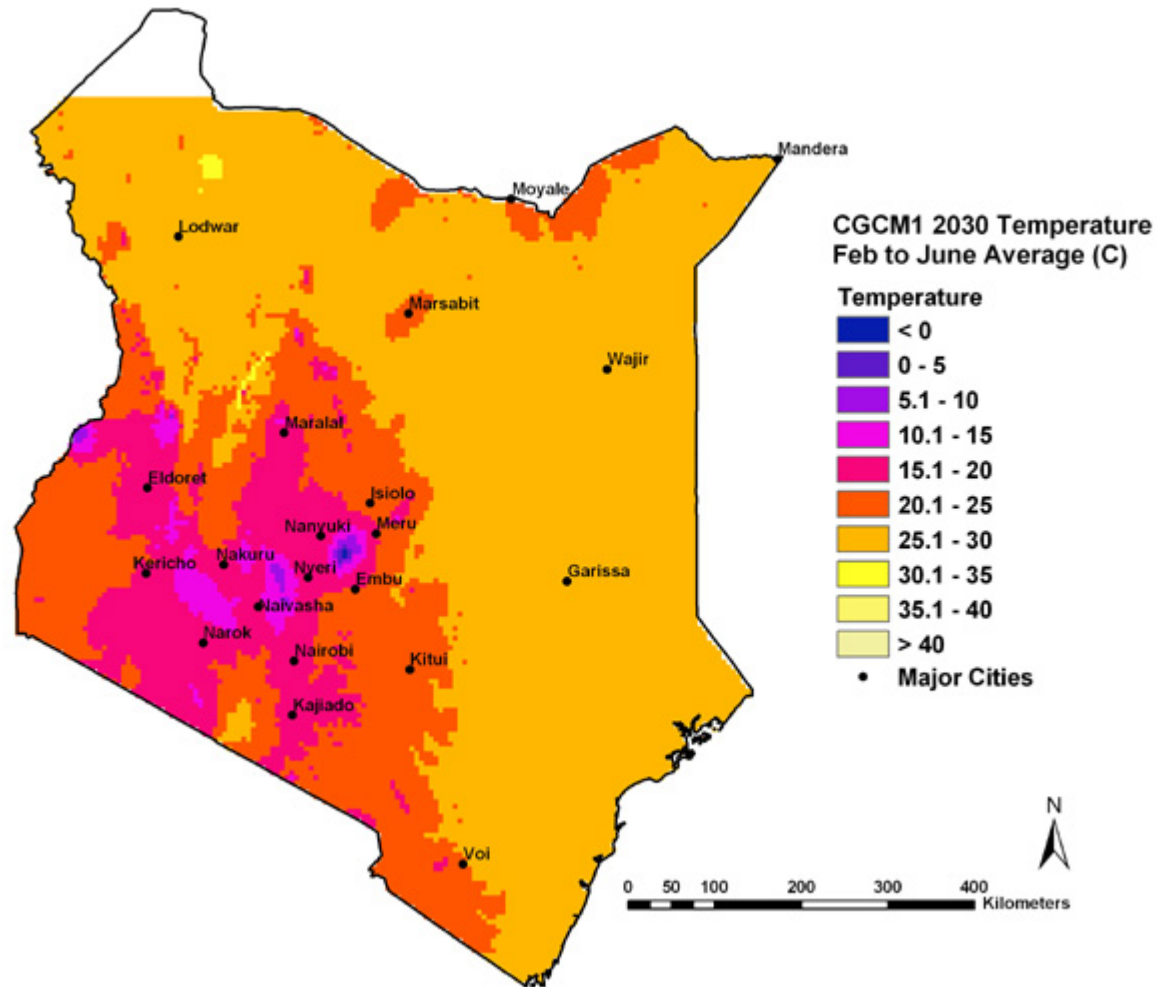
# Kenyan Current Temperature

## Feb to June Average (Deg. Cent.)



# Kenyan 2030 Temperature

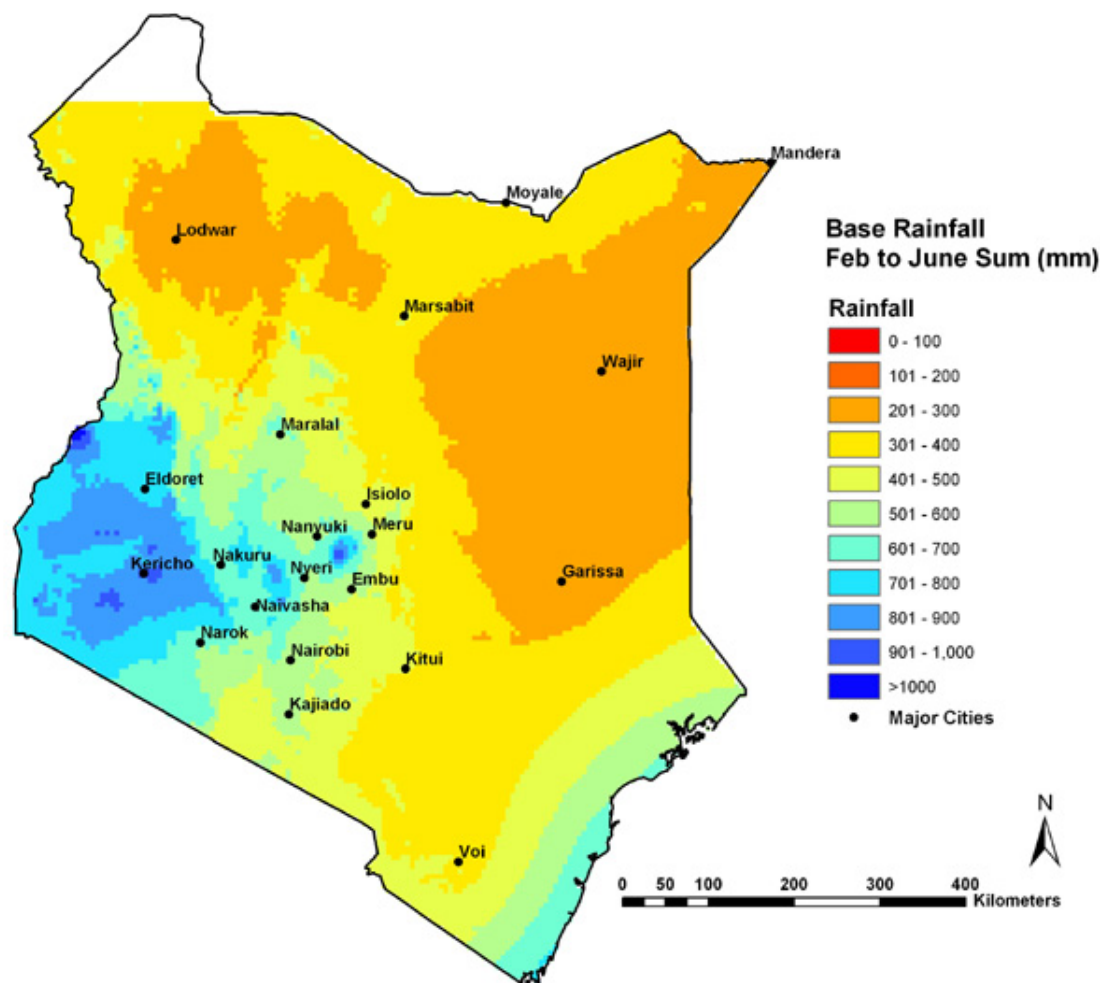
## Feb to June Average (Deg. Cent.)





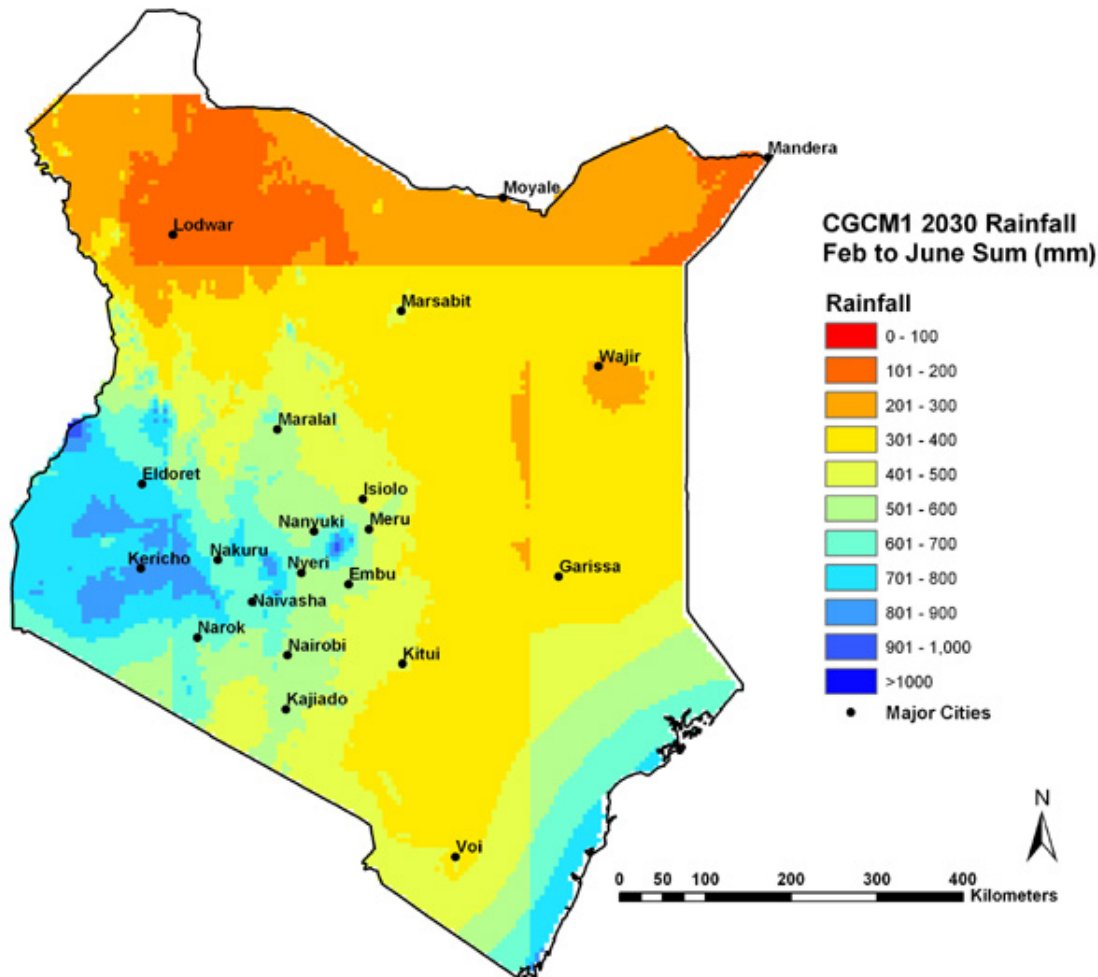
# Kenyan Current Rainfall

## Feb to June Total (mm)

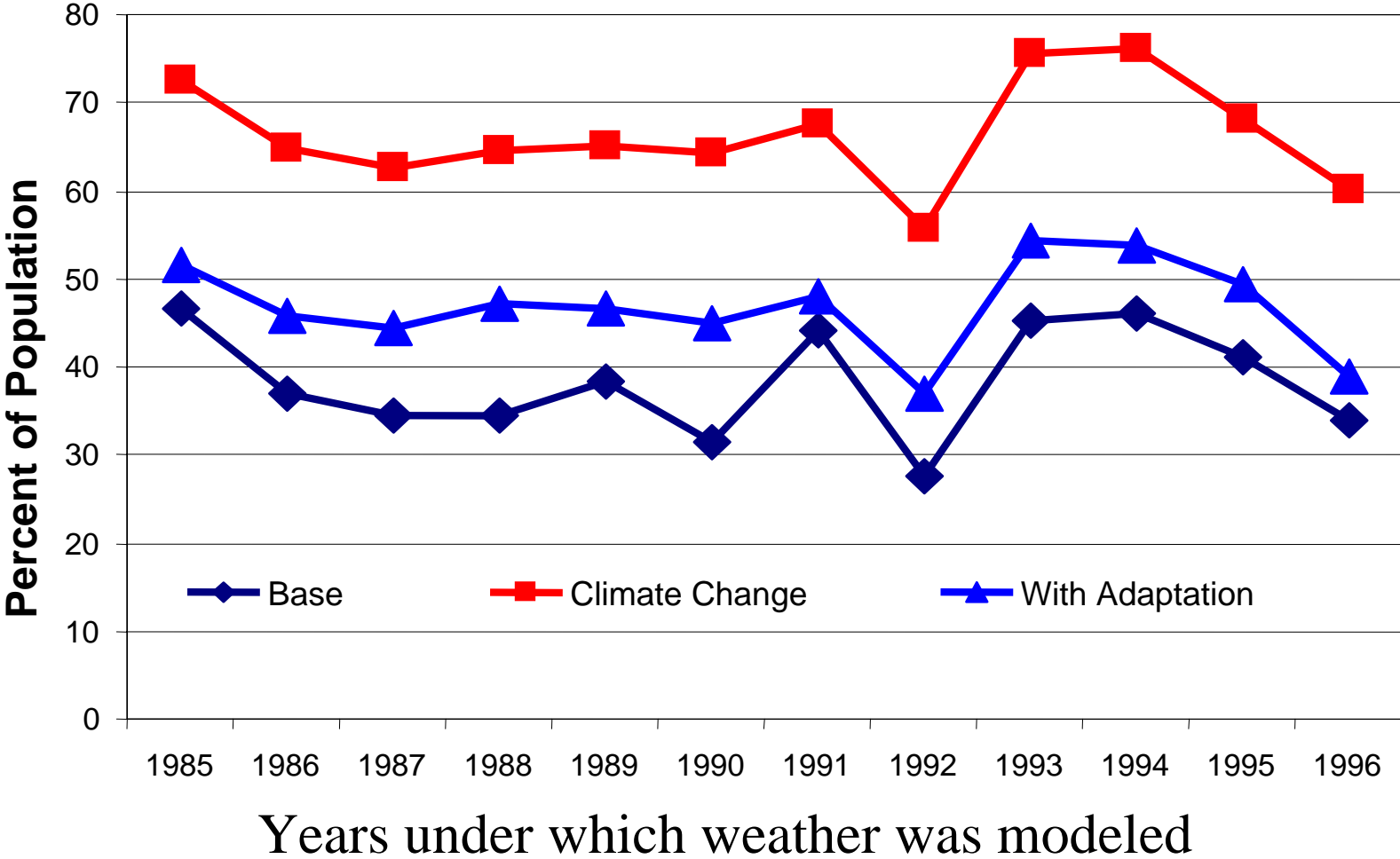


# Kenyan 2030 Rainfall

## Feb to June Total (mm)



# Risk of Hunger By Weather Across 1985-1996 (Canadian Model)



# **Implications for Agriculture for the Countries we Studied**

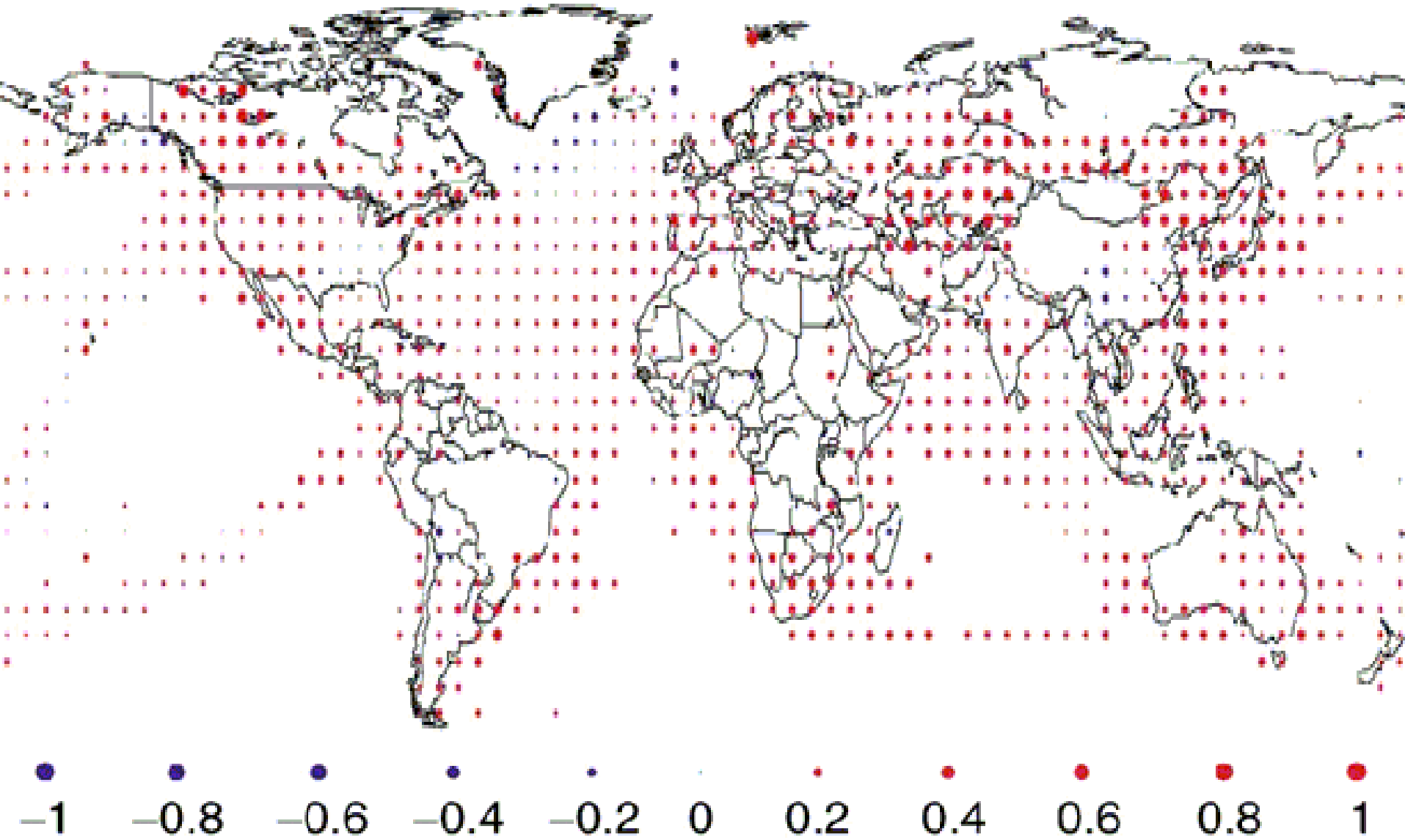
---

**Climate is expected to be hotter and drier**

**CO<sub>2</sub> fertilization effect**

**Adaptations can be made to mitigate climate change impact**

# Historical Temperature Changes (1900-1999)



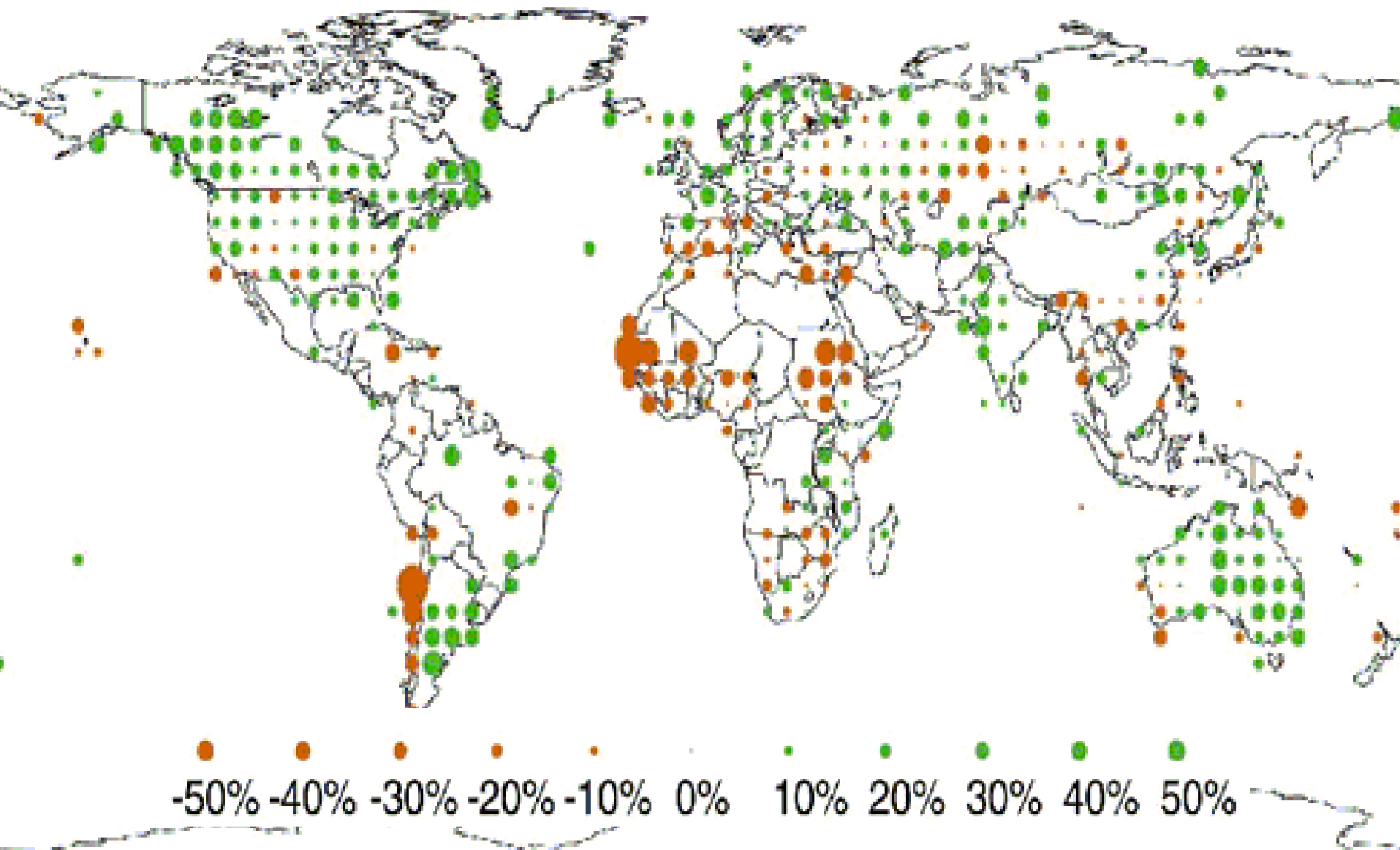
Source: IPCC

# Crop Diseases in Temperate and Tropical Regions (Swminathan and Sinha, 1986)

---

Crop	No. of diseases reported	
	Temperate	Tropical
Rice	54	500-600
Maize	85	125
Citrus	50	248
Tomato	32	278
Beans	52	250-280

# Historical Precipitation Changes (1900-1999)



Source: IPCC