Adaptation and food security

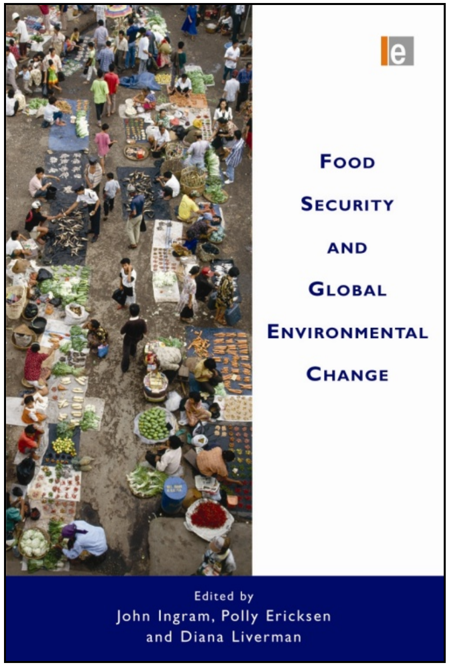
Diana Liverman
Institute of the Environment
School of Geography and Development
liverman@email.arizona.edu
AGCI Aug 2012

Key messages

- Need to focus on food systems not just agricultural production
- Production responds to price as much as (or more than) biophysical conditions
- Prices set within a global market (and thus a global climate)
- Price driven by speculation, energy, demand, and climate

GECAFS
Global Environmental Change
and Food Systems

www.gecafs.org



Food security…

… exists when all people, at all times, have **physical and economic access** to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life *(World Food Summit 1996)*

Modeling climate change and food security (in 1983)

FORECASTING THE IMPACT OF CLIMATE ON FOOD SYSTEMS: MODEL TESTING AND MODEL LINKAGE

DIANA M. LIVERMAN

Department of Geography, University of Wisconsin, Madison, WI 53706.

Abstract. This paper discusses the importance of testing models which may be used to forecast the impact of climate on society. Model testing using sensitivity analysis and validation techniques is illustrated with two models: (1) the YIELD model which simulates the impact of climate on crop yields of several major crops, and (2) the International Futures Simulation model which can be used to simulate the impact of crop yield changes on the world food system. The problems of linking such models to each other are also discussed.

1. Forecasting the impact of climate on food systems

Changes in climate can have dramatic effects on food systems. Climatic variation triggers starvation, migration, economic disruption, and land use change, for the climate-food link is one of the most ancient, critical, and persistent problems of the physical environment. Hence, the anticipation of climatic change and the associated impacts on human activity are important forecasting issues which link the natural and social sciences.

For example, the possibility that increased carbon dioxide (CO_2), produced by fossil fuel burning will lead to an increase in average global temperatures is an important forecasting and policy issue. In order to decide what we should do about carbon dioxide emissions, we need to make a series of forecasts. First of all, we need to predict the consumption of fossil fuels for the forseeable future and to decide what contribution this will make to the concentration of carbon dioxide in the atmosphere. This assessment requires both a socioeconomic forecast of energy use, and a technical calculation of the carbon content of different fuels. Secondly, climate modelers can estimate the effect of increased atmospheric CO_2 on global and regional temperature, precipitation, and other variables. Crop yield modelers can use temperature and precipitation data to assess the impact of a CO_2 climate change on crop production. The crop yield and production results can then be used to make a forecast of the associated changes in food distribution and consumption, economic conditions, and other social factors. If the forecast changes are serious enough, either globally or nationally, policy makers may decide to control fossil fuel burning or prepare other responses to the impacts that

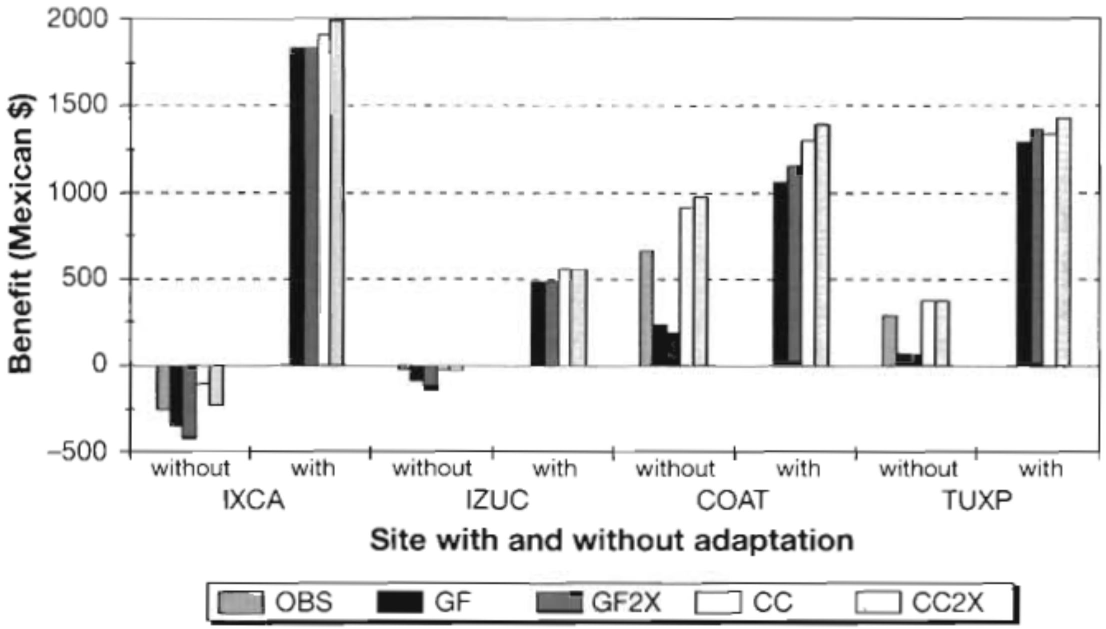
Climatic Change **11** (1987) 267–285.

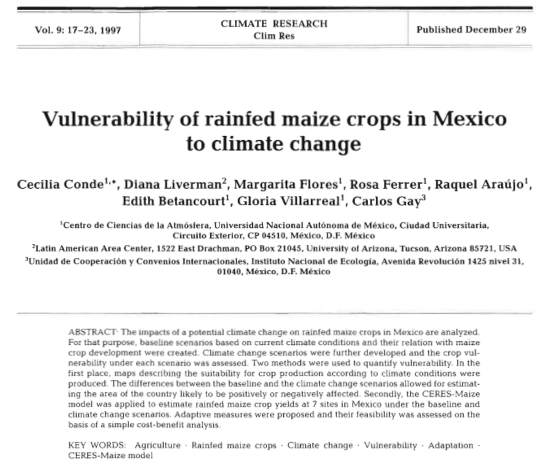
Table 2: Summary of Sensitivity Analysis

Type of change		Region of change	Starvation as % of base run
Base run			100.0
Pulse	YLF 0.8 in 1985	US	115.5
	YLF 1.2 in 1985	US	109.5
	YLF 0.5 in 1985	US	124.2
	YLF 1.5 in 1985	US	115.8
	YLF 0.8 in 1985	All	124.3
	YLF 1.2 in 1985	All	103.4
Step	YLF 0.8 1985–2000	US	102.2
	YLF 1.2 1985–2000	US	92.0
	YLF 1.2 1985–2000	All	21.5
	YLF 0.8 1985–2000	All	304.1
Trend	YLF 0.8 by 2000	US	107.1
	YLF 1.2 by 2000	US	94.7
	YLF 0.8 by 2000	All	207.4
	YLF 1.2 by 2000	All	50.7
Region of pulse	YLF 0.8 in 1985	WEUR	102.7
		RDEV	105.1
		EEUR	102.8
		USSR	102.0
		LAM	101.9
		AFR	100.1
		OPEC	99.1
		SASIA	103.3
		CHINA	102.1

Changes in crop yields change food security in very complex ways – shocks > oscillations, 20% decline doubles starvation

Modeling climate impacts and adaptation: maize in Mexico (Conde, Liverman et al)





Vol. 9: 17–23, 1997 | CLIMATE RESEARCH Clim Res | Published December 29

Vulnerability of rainfed maize crops in Mexico to climate change

Cecilia Conde[1,*], Diana Liverman[2], Margarita Flores[1], Rosa Ferrer[1], Raquel Araújo[1], Edith Betancourt[1], Gloria Villarreal[1], Carlos Gay[3]

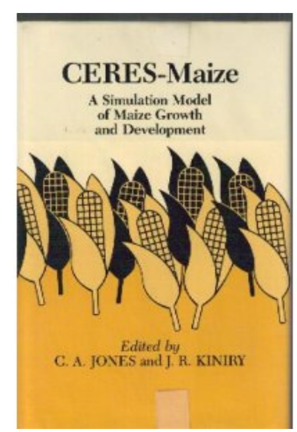
[1]Centro de Ciencias de la Atmósfera, Universidad Nacional Autónoma de México, Ciudad Universitaria, Circuito Exterior, CP 04510, México, D.F. México

[2]Latin American Area Center, 1522 East Drachman, PO Box 21045, University of Arizona, Tucson, Arizona 85721, USA

[3]Unidad de Cooperación y Convenios Internacionales, Instituto Nacional de Ecología, Avenida Revolución 1425 nivel 31, 01040, México, D.F. México

ABSTRACT· The impacts of a potential climate change on rainfed maize crops in Mexico are analyzed. For that purpose, baseline scenarios based on current climate conditions and their relation with maize crop development were created. Climate change scenarios were further developed and the crop vulnerability under each scenario was assessed. Two methods were used to quantify vulnerability. In the first place, maps describing the suitability for crop production according to climate conditions were produced. The differences between the baseline and the climate change scenarios allowed for estimating the area of the country likely to be positively or negatively affected. Secondly, the CERES-Maize model was applied to estimate rainfed maize crop yields at 7 sites in Mexico under the baseline and climate change scenarios. Adaptive measures were proposed and their feasibility was assessed on the basis of a simple cost-benefit analysis.

KEY WORDS: Agriculture · Rainfed maize crops · Climate change · Vulnerability · Adaptation · CERES-Maize model



Adaptation (irrigation, fertilizer, crop variety and mix, planting dates can prevent declines in production – but most farmers do not have access to these options and consumers cannot afford food if adaptation increases costs

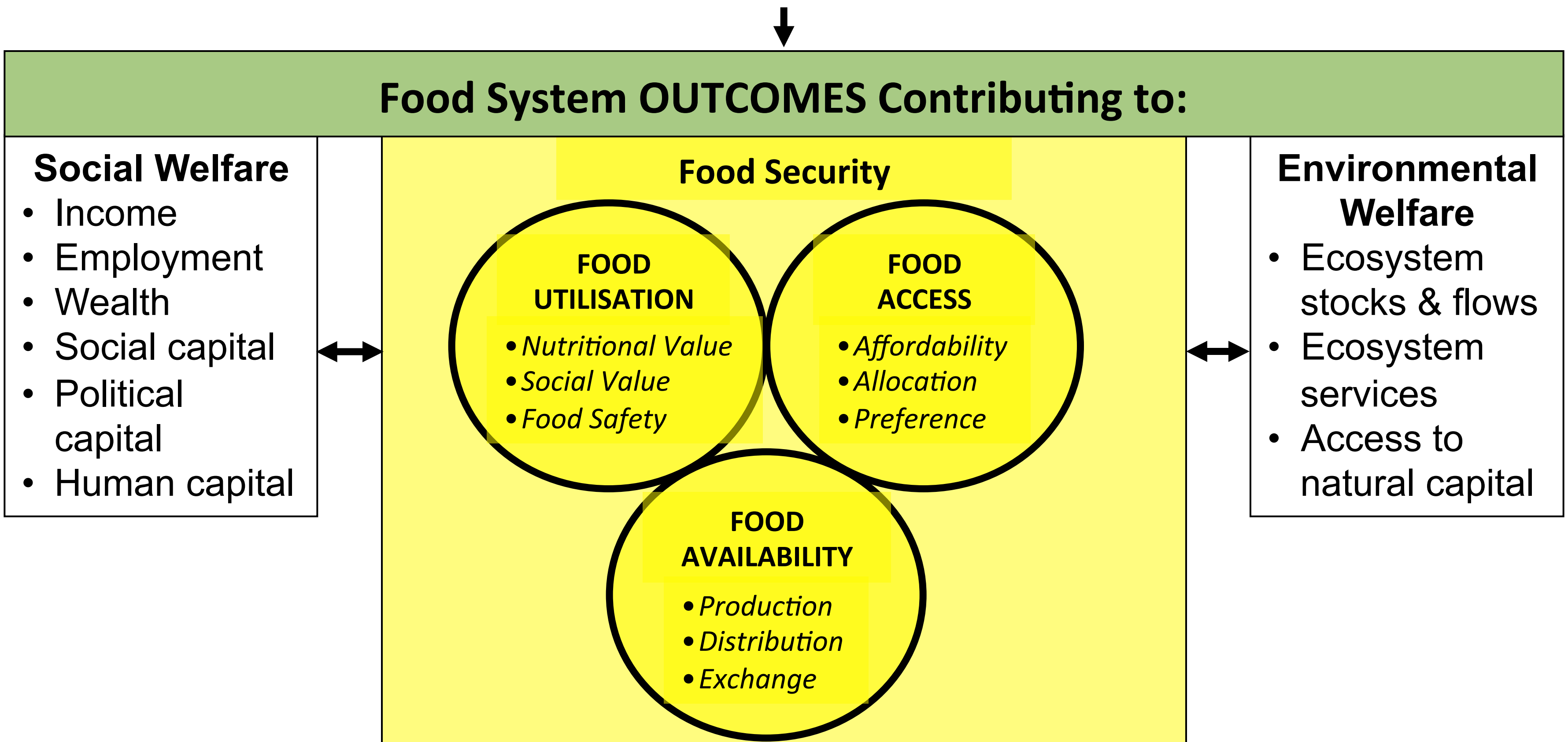
Understanding climate adaptation in the field (Eakin)

Climate adaptation

- Replant
- Apply more or less inputs
- Switch crops
- Sell livestock or equipment
- Government programs
- Marketing strategies
- Migration and remittances

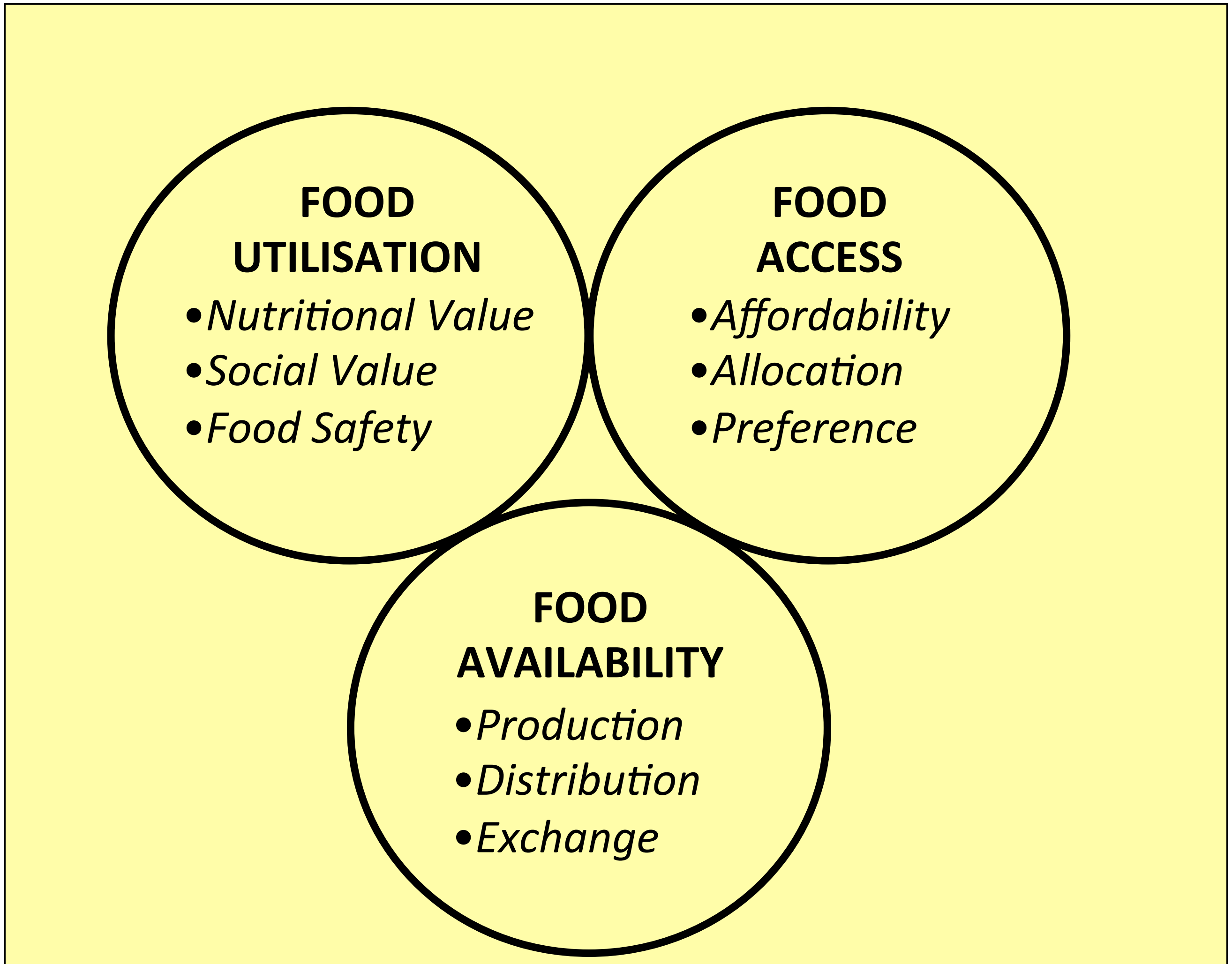
Food System ACTIVITIES

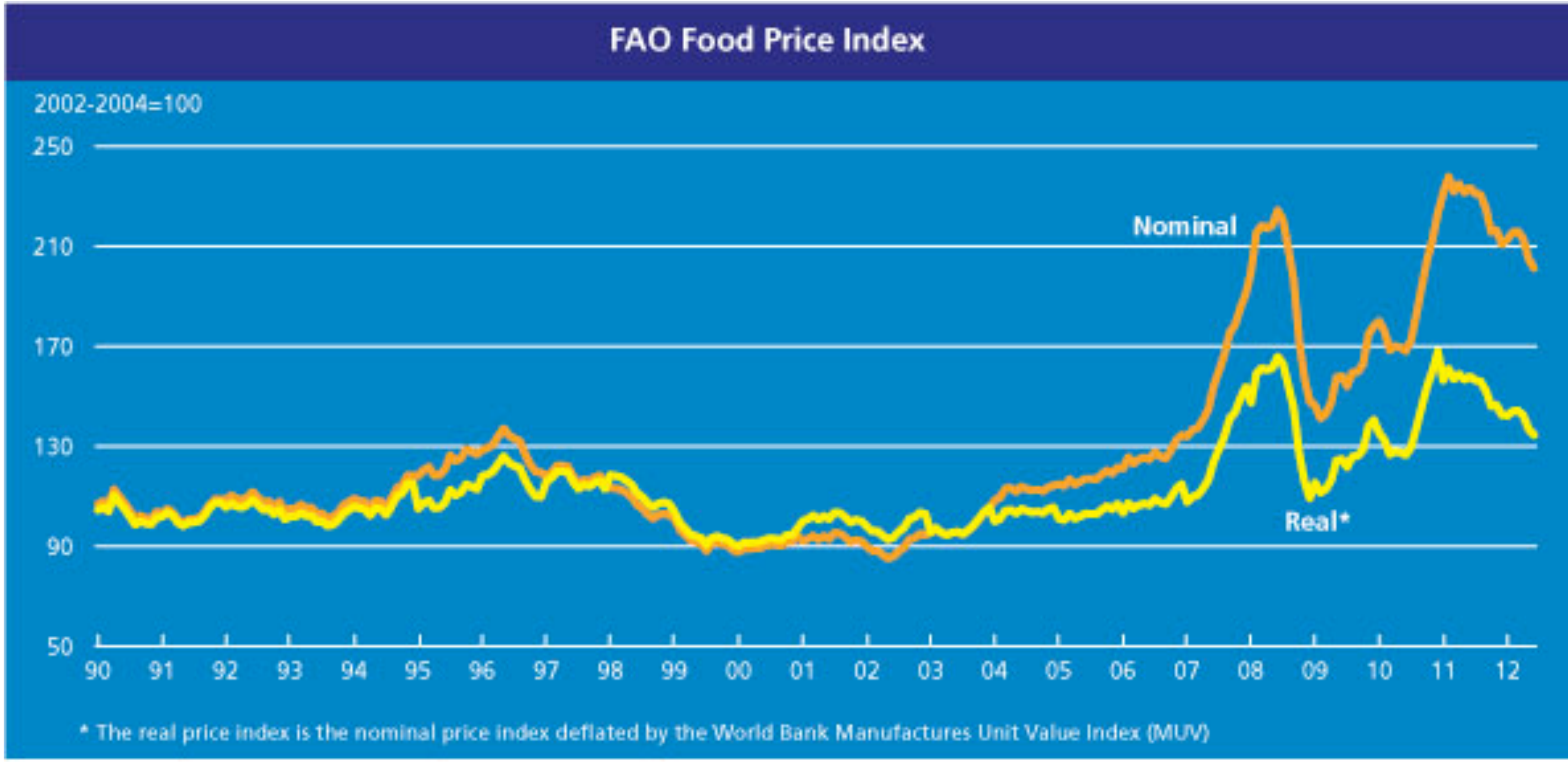
Producing food: *natural resources, inputs, technology, …*
Processing & packaging food: *raw materials, standards, storage requirement, …*
Distributing & retailing food: *transport, marketing, advertising, …*
Consuming food: *acquisition, preparation, customs, …*



Ericksen, P. Conceptualizing Food Systems for GEC Research (GEC: 2007)

Elements of food security



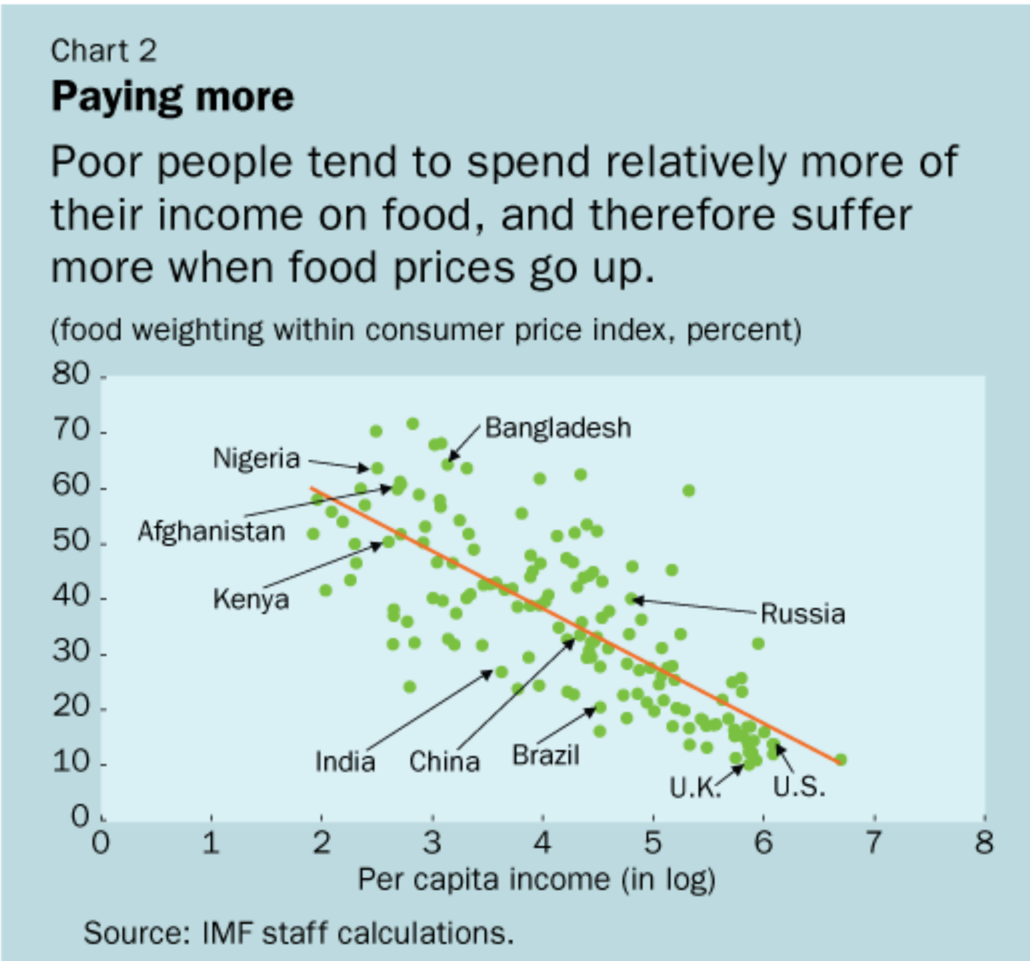

FAO Food Price Index
2002-2004=100
250
210
170
130
90
50
Nominal
Real*
90
91
92
93
94
95
96
97
98
99
00
01
02
03
04
05
06
07
08
09
10
11
12
* The real price index is the nominal price index deflated by the World Bank Manufactures Unit Value Index (MUV)

Causes of price rises in 2008-09

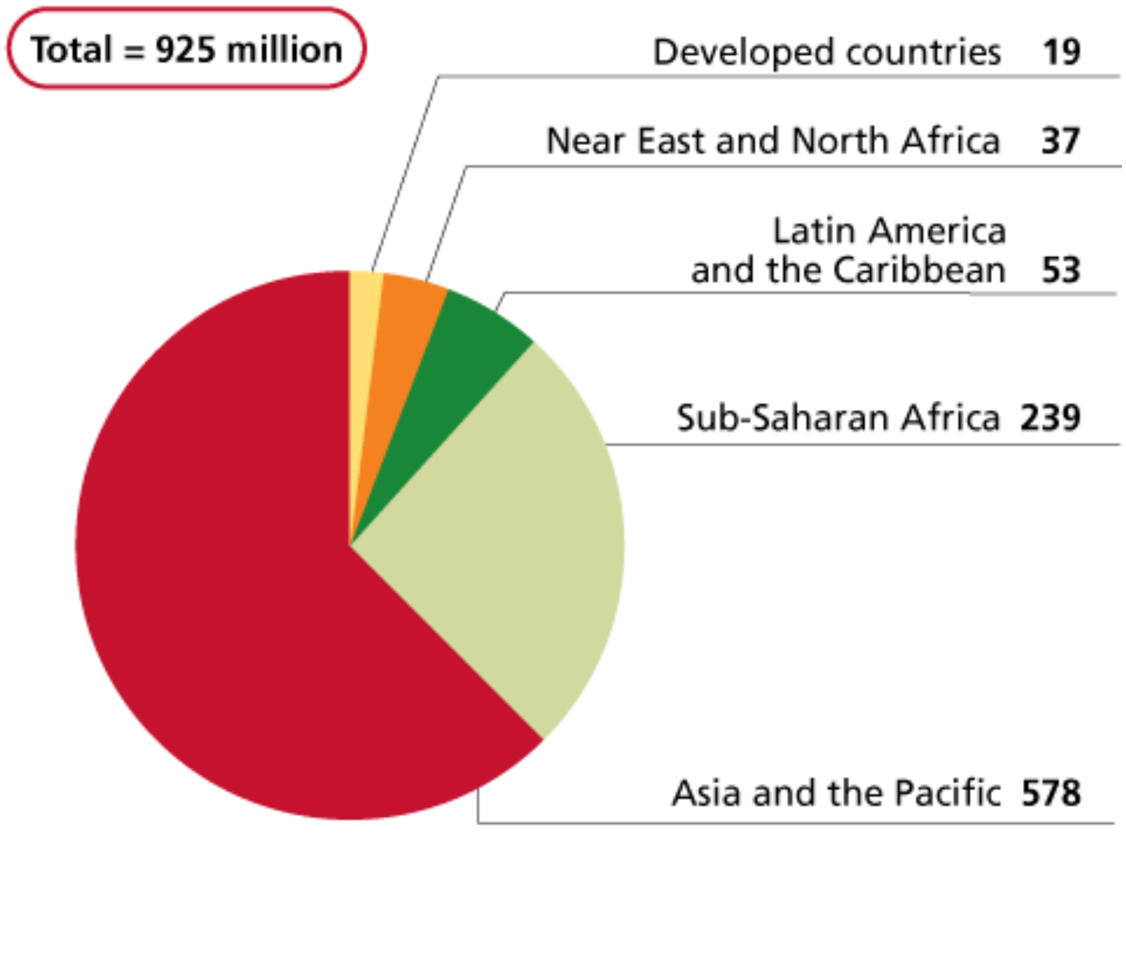
- Climate variability (drought in Australia, extreme weather in Europe) 10%?
- Biofuels (corn > ethanol, land > biofuels) 30%?
- Increased demand for dairy and meat, especially in Asia (grain fed to animals)
- Increased energy prices (gasoline, fertilizer) 20%?
- Lack of grain reserves
- Export bans
- Speculation in commodities

Chicago Board of Trade

Poverty and food insecurity



Where are the hungry?

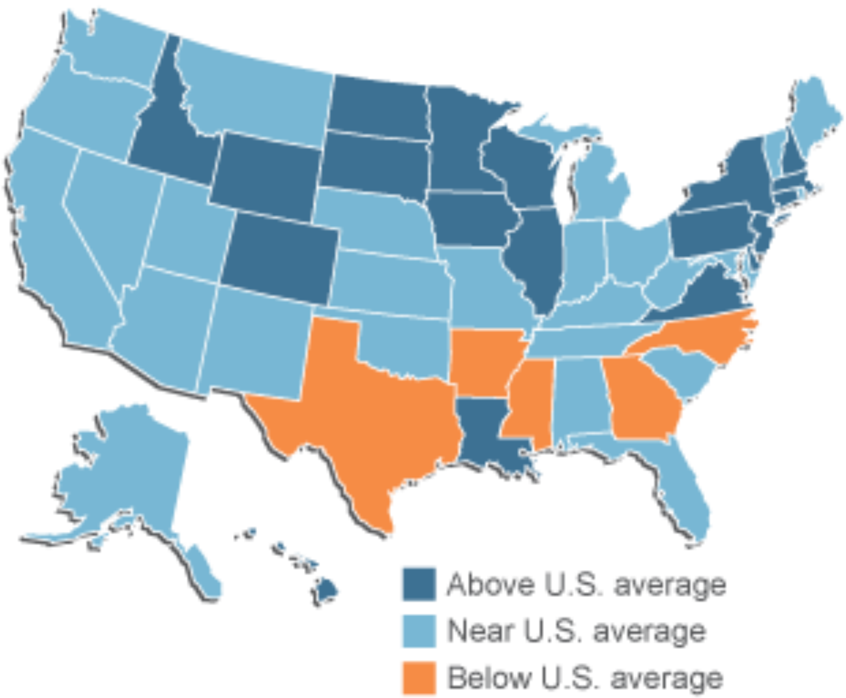


Source: FAO.

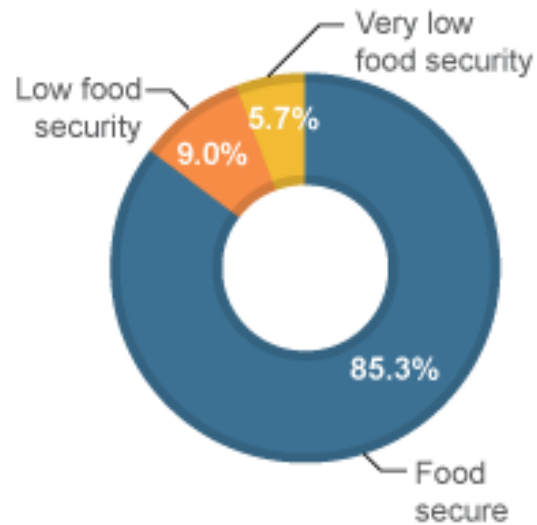
Hunger in the U.S.

One in seven U.S. households hit by hunger issues in 2009.

Food security* by state



Food security by household



15/11/10

* "Food security" means that at a minimum, the ready availability of nutritionally adequate and safe foods and the assured ability to acquire acceptable foods in socially acceptable ways.

Source: USDA

REUTERS

Reuters graphic/Stephen Culp

Changes in growing season

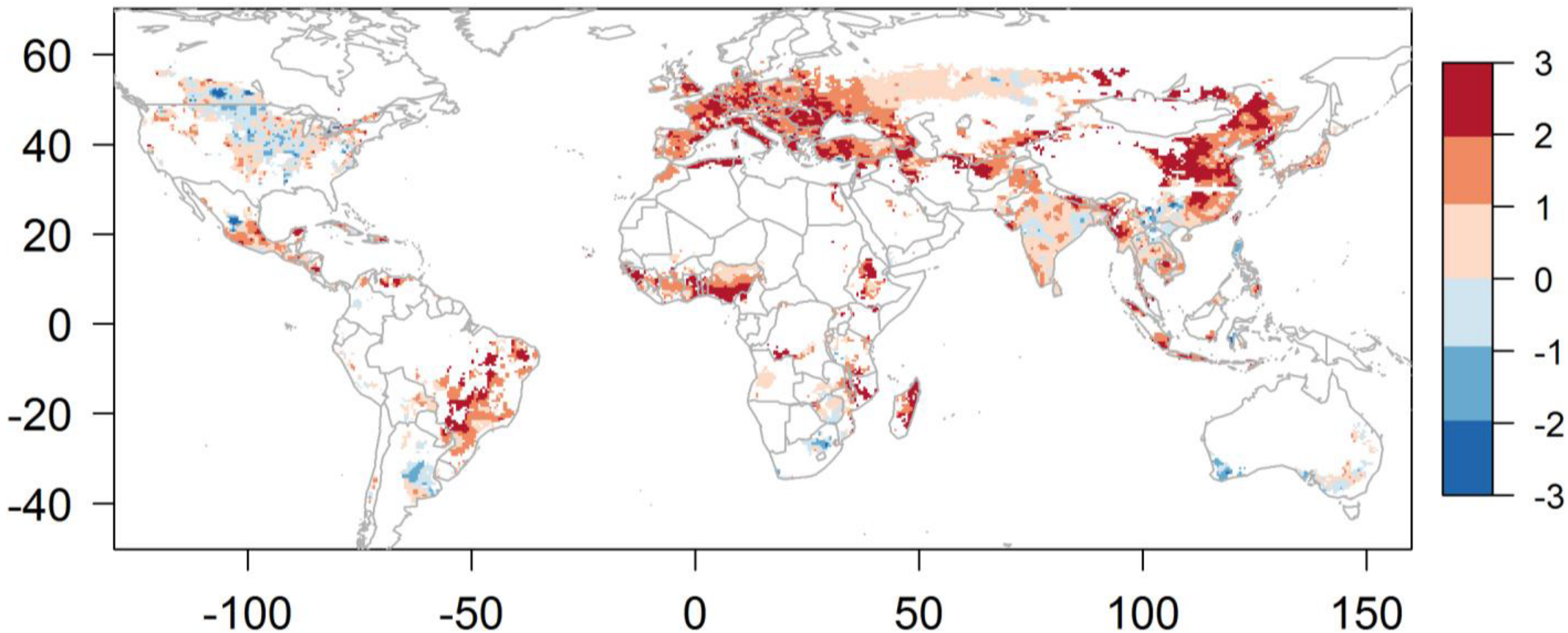
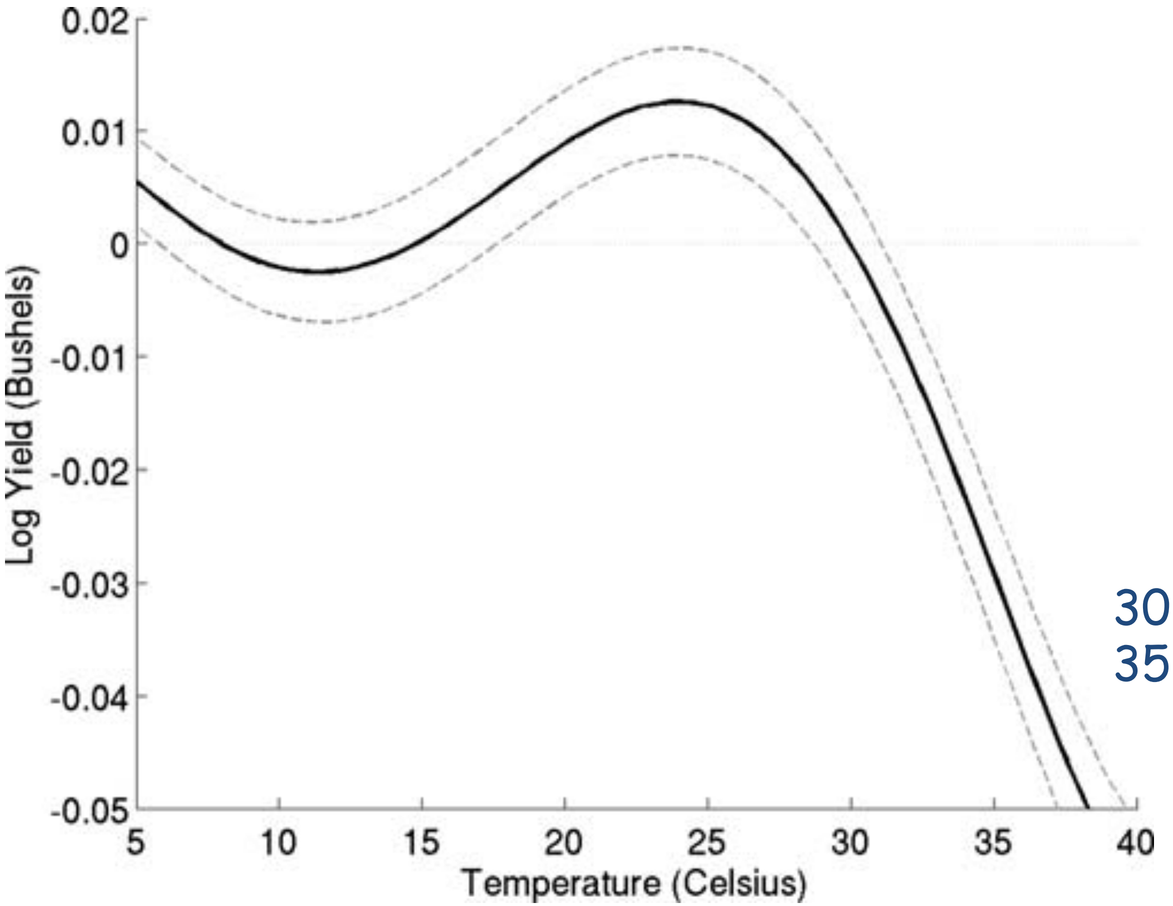


Figure 1. Observed changes in growing season temperature for crop growing regions for 1980-2008. Values show the linear trend in temperature for the main crop grown in that grid cell, and for the months in which that crop is grown. Values indicate the trend in terms of multiples of the standard deviation of historical year-to-year variation. A value of two, for example, indicates that the expected growing season temperature in 2008 was two standard deviations above the expected value in 1980. Grid cells with less than 1% of land area covered by maize, wheat, rice, or soybean, are omitted for clarity.

Lobell et al 2011 Climate Trends and Global Crop Production since 1980. Stanford Program on Food Security and the Environment Policy Brief

Crops prefer cooler temperatures

Effect of Temperature on U.S. Corn Yields
(Schlenker and Roberts, 2006)



30°C = 86 °F
35°C = 95 °F

Some positive changes

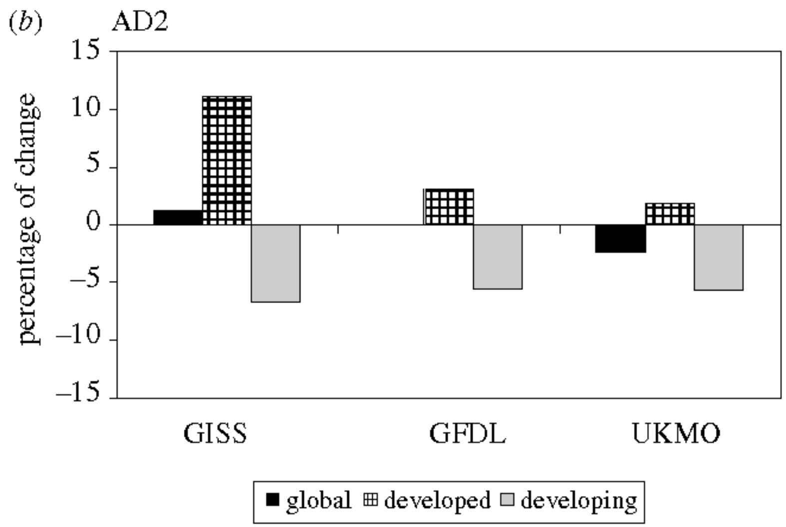
- Crops like higher levels of CO_2 all else being equal
- Some cold regions will become suitable for agriculture
- Farmers will adapt to new climates, by switching to new crop varieties, new locations etc.

- But beyond 2050 there are limits to adaptation

Impacts may be greater in tropics

-they are mostly warmer to begin with
-they are poorer and have less "capacity to adapt"

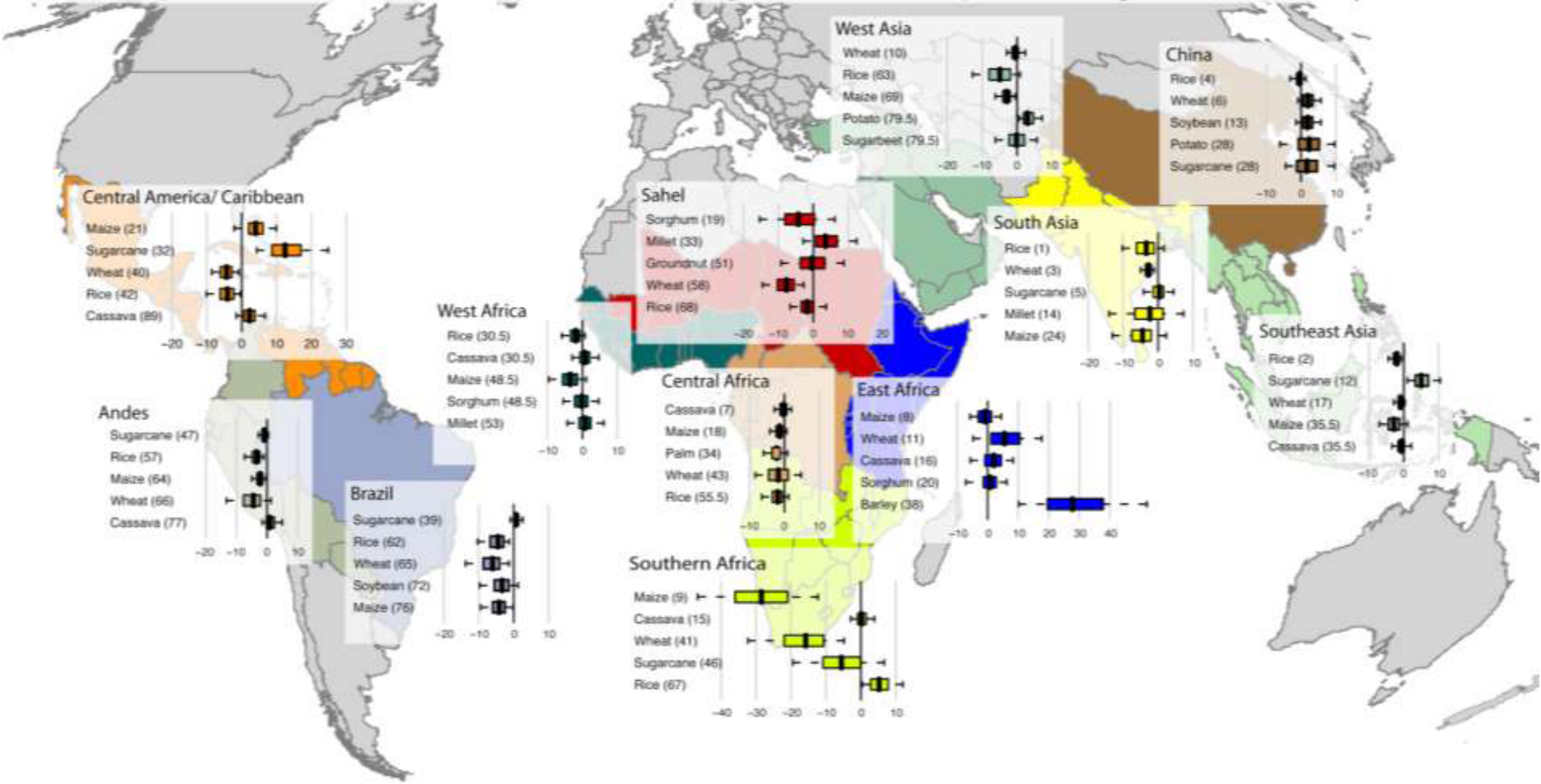
Global change in cereal production
resulting from climate change



3 different climate models (Rosenzweig and Parry, 1994)

Projected impacts of climate change by 2030, for top 5 most important crops in each region

Boxes represent 25th-75th percentile of model projections, whiskers 5th-95th, and dark line the median projection.
Number in parentheses is the overall rank of the crop/region in terms of importance to global food security.

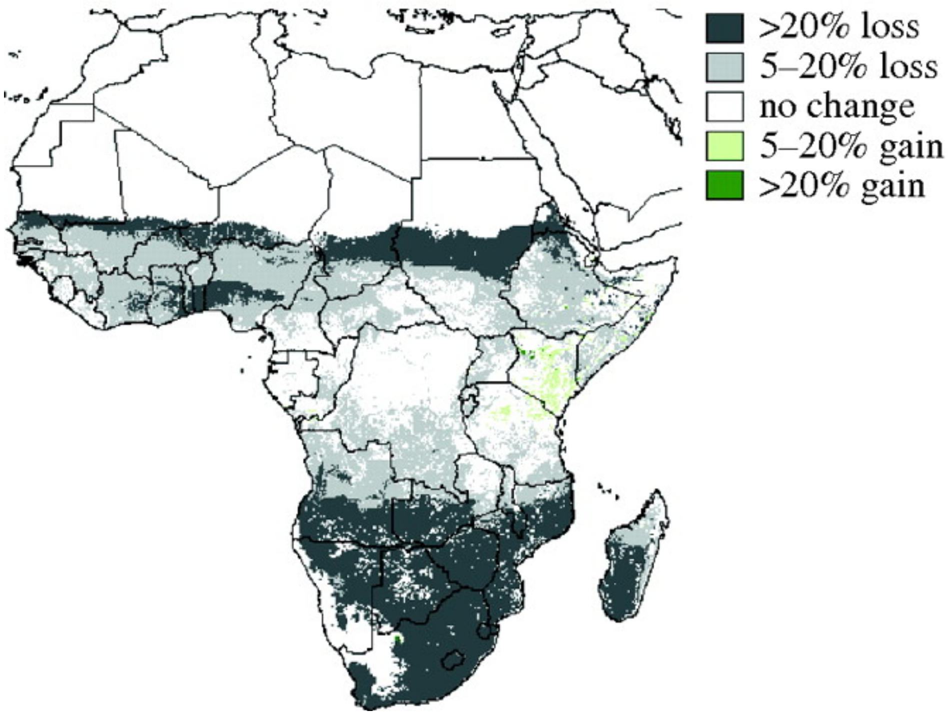


Global impacts of a 4C increase

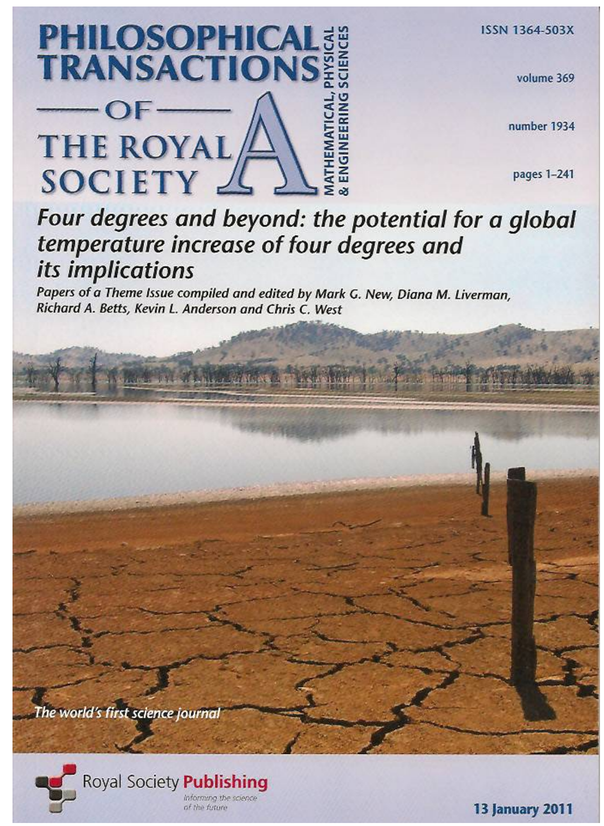
4degrees &beyond

International Climate Conference
28-30 September 2009, Oxford, UK

Implications of a global climate change of 4+ degrees
for people, ecosystems and the earth-system

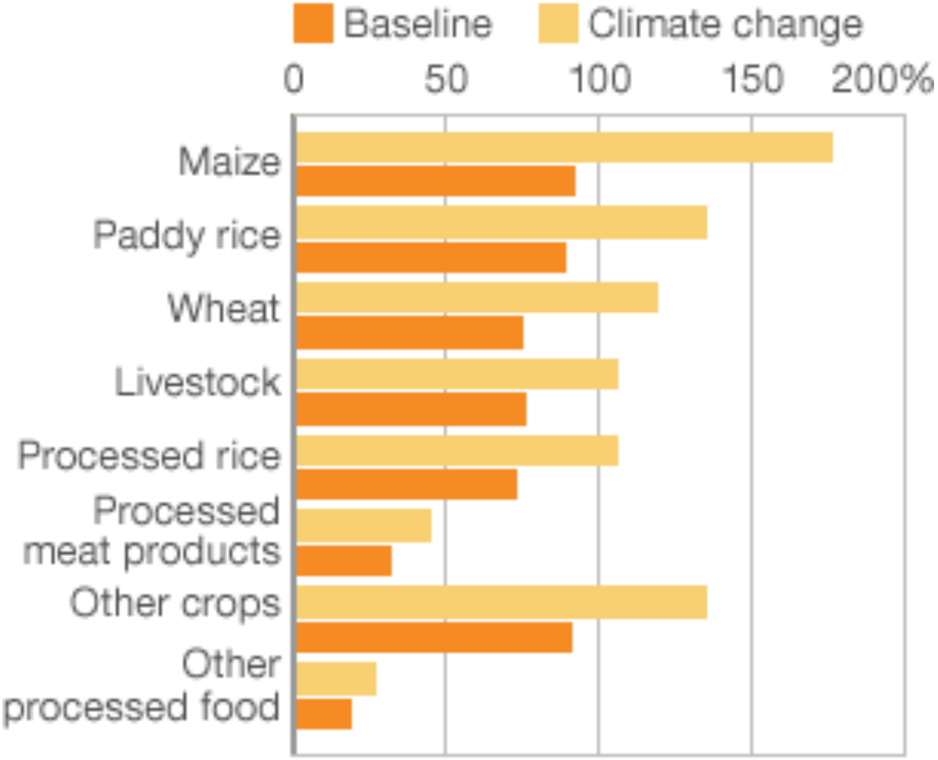


Change in length of growing period in 2090s
(Thornton et al 2010)



Real food price changes predicted over the next 20 years

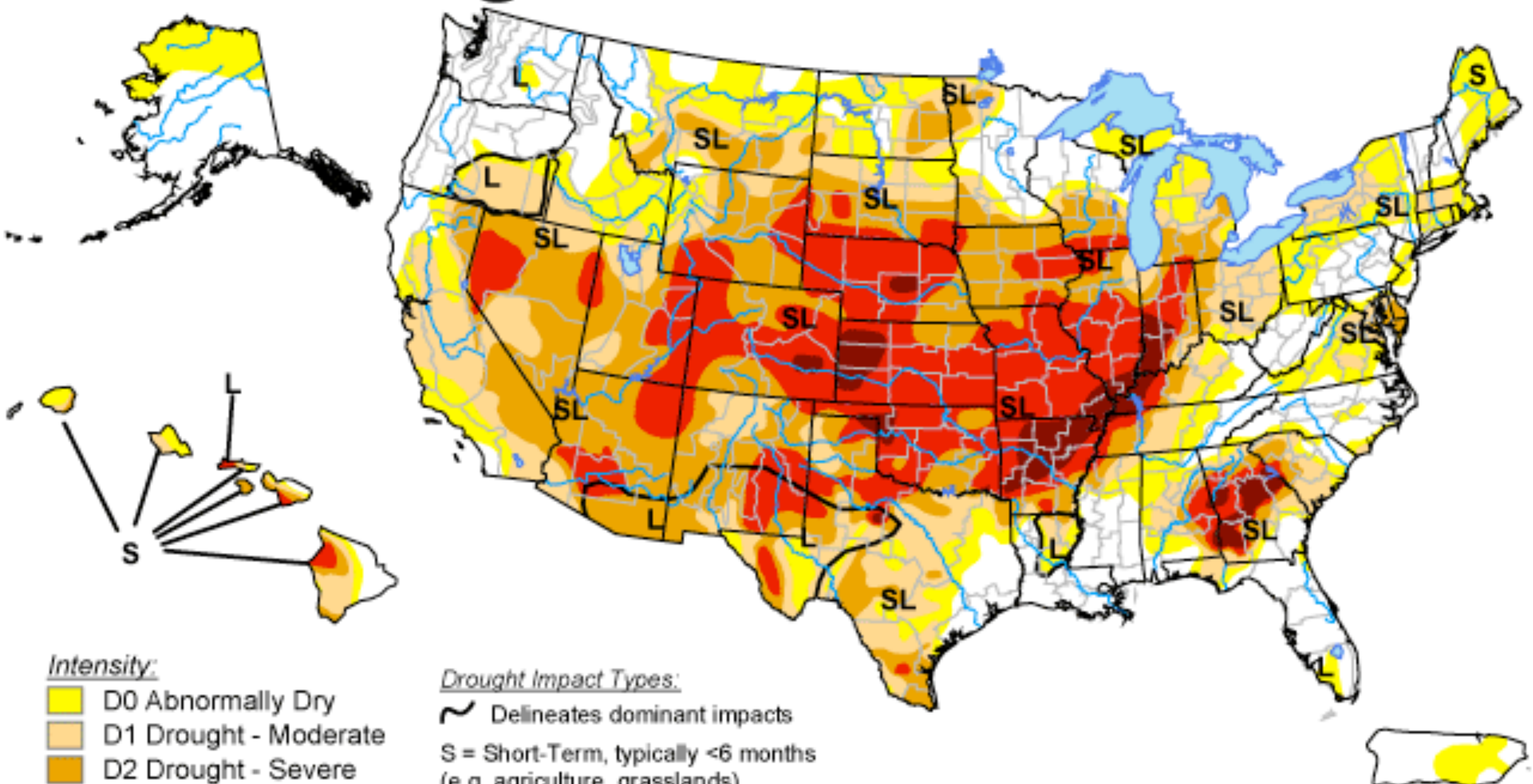
Increase in world market export prices in 2030 relative to 2010



Source: D. Willenbockel (2011) 'Exploring Food Price Scenarios Towards 2030', Oxfam and IDS

U.S. Drought Monitor

July 31, 2012
Valid 7 a.m. EDT



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

~ Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

USDA National Drought Mitigation Center

Released Thursday, August 2, 2012

Author: Mark Svoboda, National Drought Mitigation Center

http://droughtmonitor.unl.edu/

GLOBAL FOOD PRICES

Following a severe drought in the US, a spike in agricultural commodity prices to record highs is threatening the world with the prospect of a repetition of the food crisis of 2007-2008

From **MARKETS** Aug 2, 2012

Mexican buyer strikes big US corn deal

Severe Midwest drought raises doubts over supply

From **MARKETS** Aug 1, 2012

Cocoa at nine-month high in weather fear

Concerns over shortage of rain and stock in west Africa

From **MARKETS** Aug 1, 2012

Hedge funds bet on corn prices to soar

Figure tipped to rise to $9 a bushel as drought ravages crop

From **GLOBAL ECONOMY** Jul 31, 2012

Fears grow for rise in food prices

Developing economies likely to face biggest risk

From **MARKETS** Jul 30, 2012

Rain shortfall in US Midwest lifts grains

Hot forecasts for corn and soyabean-growing regions

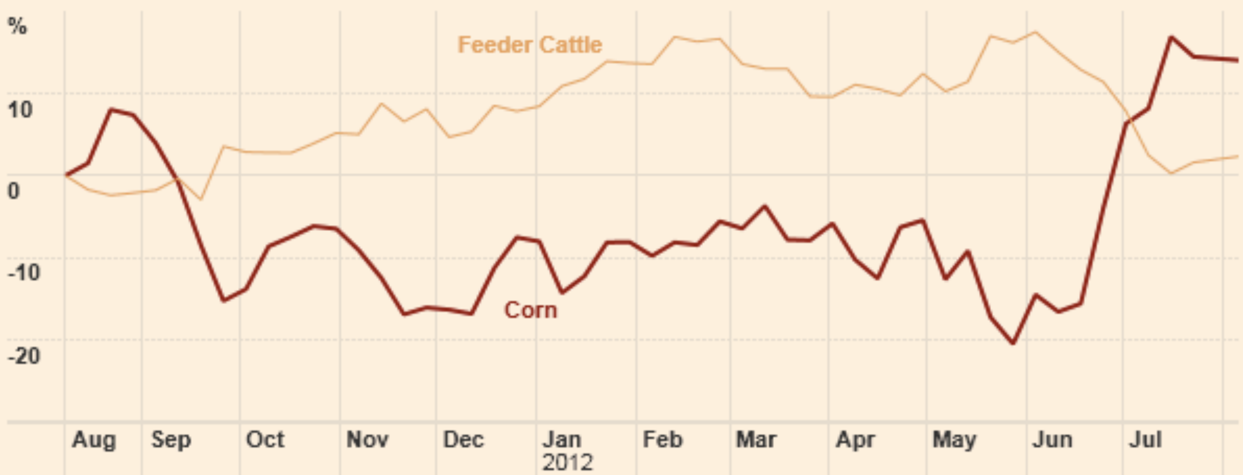
Commodities

Data archive   Data definitions

Get the latest prices and news with interactive charting options for key commodities. Click through to historic pricing and charting for individual commodity contracts.

Commodity performance

View: Corn   Compare to: Feeder Cattle   Time period: 1 Year



Data delayed by at least 20 minutes.

Commodities news

Aug 07 2012 11:56 BST

Cash out of gold and send kids to college

Aug 07 2012 08:52 BST

Xstrata to cut costs and capital spending

Aug 07 2012 00:01 BST

BP to invest £60m in energy research hub

Commodity indices

S&P GSCI

1.13%

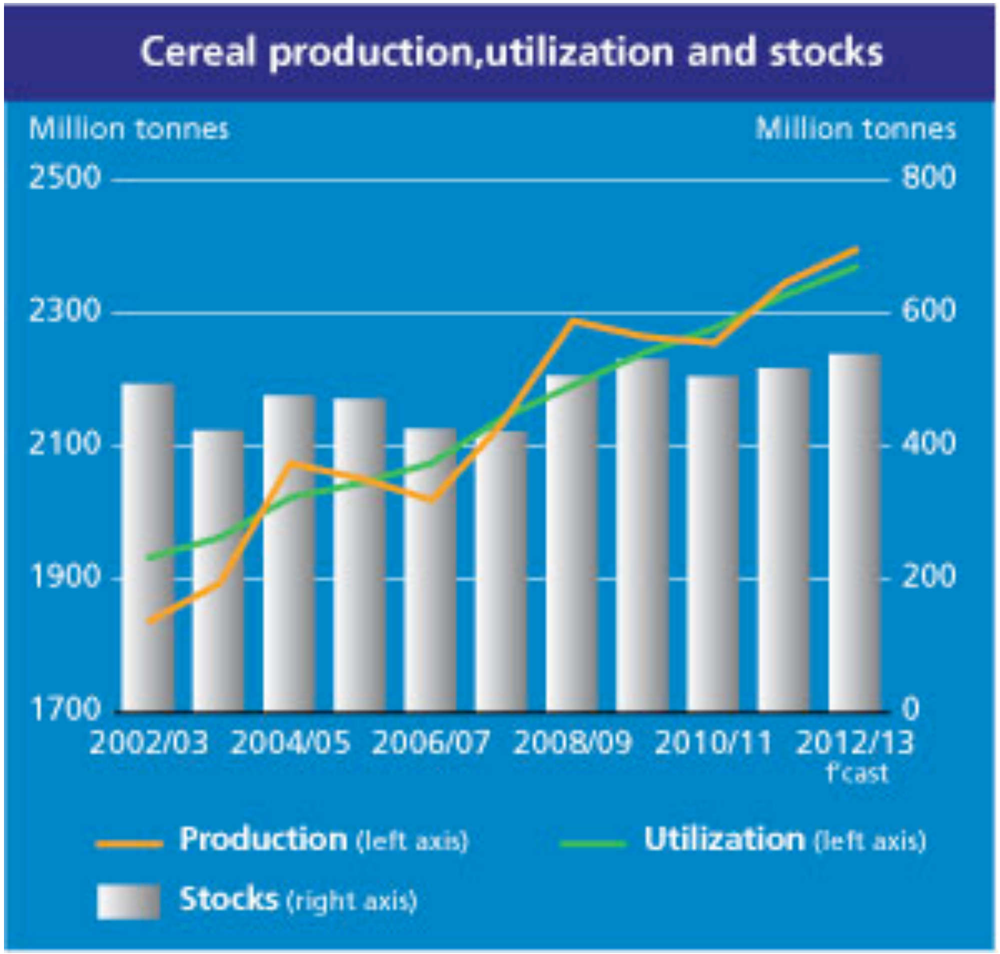
Today's change

657.67

Last

IFPRI recommendations re 2012 US drought

- Collaborative monitoring and prediction
- US and EU should halt biofuel from maize
- Avoid export bans and panic purchases
- Use national grain reserves and safety nets
- Protect World Food Program
- Invest in food security



Cereal production,utilization and stocks
Million tonnes
Million tonnes
2500
2300
2100
1900
1700
800
600
400
200
0
2002/03
2004/05
2006/07
2008/09
2010/11
2012/13
f'cast
Production (left axis)
Utilization (left axis)
Stocks (right axis)

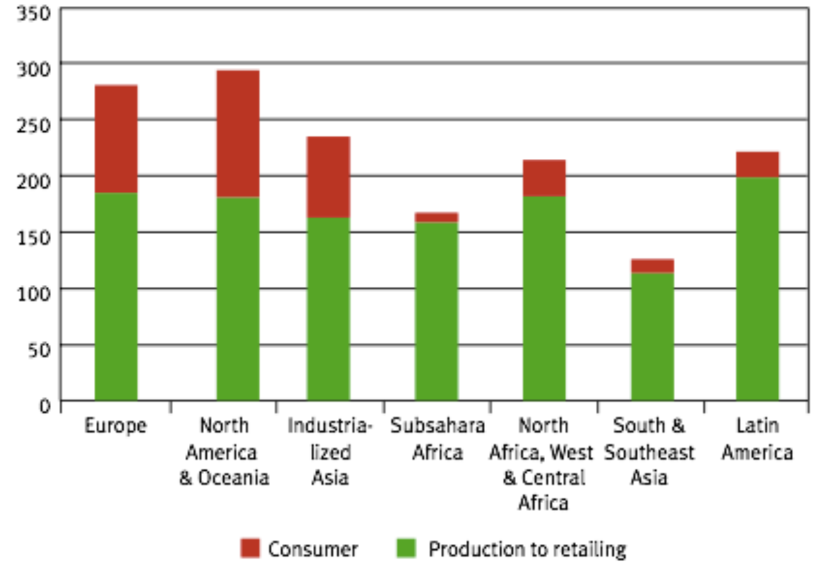
Adapting food systems to a warmer climate

- Reduce waste and inefficiency (in food, water systems)
- Water infrastructure and advanced technology (dams, desalination)
- Plant breeding and GM for warmer climates
- Alternative foods and vegetarianism
- Insurance and disaster risk reduction
- Food and development aid
- Relocation
- Traditional agriculture
- Geoengineering

Where should limited funds be allocated?

CLIMATE CHANGE AGRICULTURE AND FOOD SECURITY

(a) Per capita food losses and waste (kg/year)



(b) Food losses – Cereals

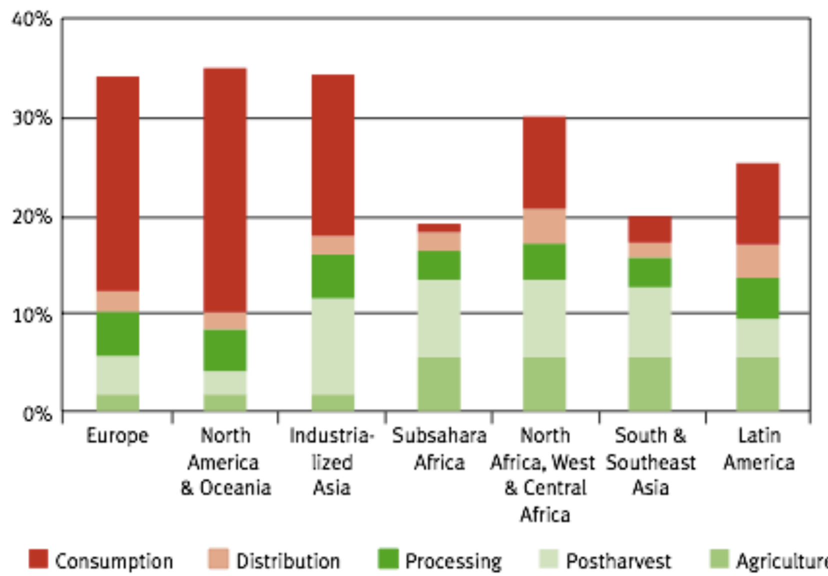


Figure 8. Food loss and waste within the food system