

Agriculture: Enhancing Productivity, Resilience, and Sustainability in a Changing Climate



Marjory-Anne Bromhead, Advisor, ARD 14th May 2011

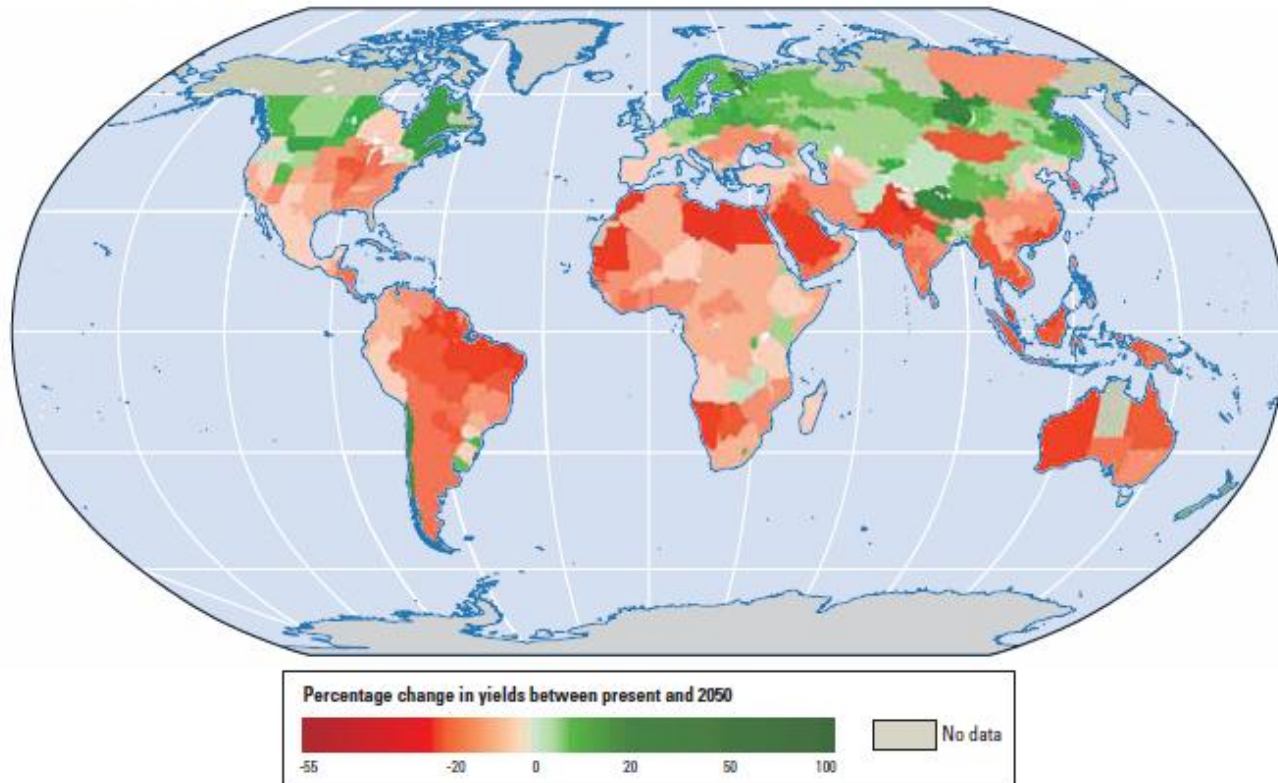




- Food production must increase by **70% by 2050** to feed our growing population, with rising demand for livestock and higher value products
- Climate change makes meeting this goal more challenging
- Societies depend on natural and managed ecosystem resiliency – *watersheds, soils, hydrology, forests, wetlands, coral reefs, agriculture and grazing land, fisheries* – for fuel, water, fiber, safety, recreation and many other things

Climate Change means declining yields in most of the world, especially the developing world

Map 3.3 Climate change will depress agricultural yields in most countries by 2050 given current agricultural practices and crop varieties



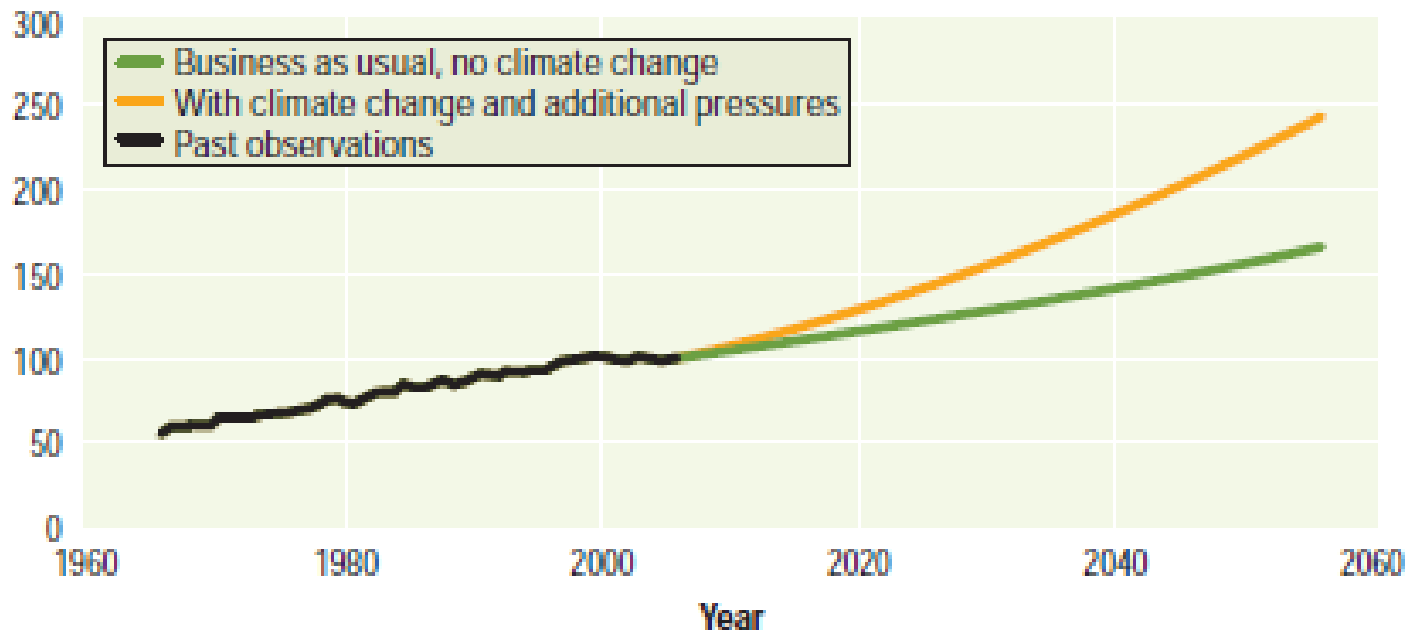
Source: Muller.

Note: The figure shows the projected percentage change in yields of 11 major crops from 2046 to 2055, compared with 1996–2005. The values are the mean of three emission scenarios across five global climate models, assuming no CO₂ fertilization.

Need massive increase in agricultural productivity to feed 9 billion people

Figure 3.5 Climate change means that increases in agricultural productivity must accelerate if the world is to meet the demands of a larger, richer, and more urban population

Agricultural productivity index (2005 = 100)



Source: Lotze-Campen and others 2009.

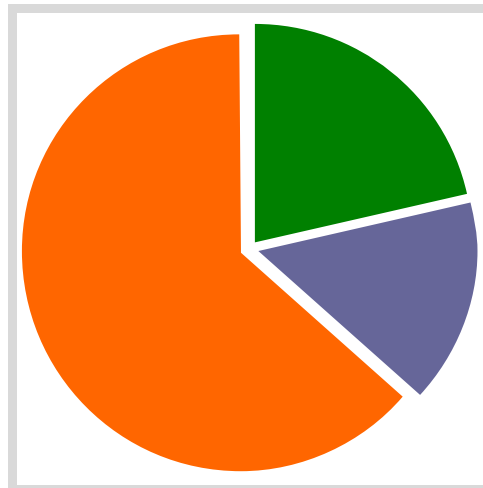
Agriculture: key user of natural resources

- 70% of fresh water resources
- 40% of land area
- 30% of GHG emissions



Contributions to greenhouse gas emissions

Industrialized
countries
64%



Developing country
agriculture &
deforestation 21%

Developing
country other
sources 15%



There Are Solutions For a “Triple Win” of:

1. Improved productivity and food security

2. Enhanced resilience to drought, flood, erosion, heat & water stress

3. Low carbon growth

(potential for carbon sequestration in the soil alone is 13% annually of 2010 GHG emissions)



How do we do it?



United States: The White House Council on Environmental Quality - Climate Change Adaptation Task Force

Definitions for Key Terms in This Document¹

- **Adaptation:** Adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.
- **Resilience:** A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.
- **Vulnerability:** The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.
- **Mitigation:** An intervention to reduce the causes of changes in climate, such as through reducing emissions of greenhouse gases to the atmosphere.

¹ *Adapting to the Impacts of Climate Change, America's Climate Choices: Panel on Adapting to the Impacts of Climate Change, National Research Council, (2010).*

Guiding Principles for Adaptation

- Adopt Integrated Approaches
- Prioritize the Most Vulnerable
- Use Best-Available Science
- Building Strong Partnerships
- Apply Risk-Management Methods and Tools
- Apply Ecosystem-based Approaches
- Maximize Mutual Benefits
- Continuously Evaluate Performance



Summary of Policy Goals and Recommended Actions for the Federal Government

1. Encourage and Mainstream Adaptation Planning across the Federal Government

2. Improve Integration of Science into Decision Making

3. Address Key Cross-Cutting Issues - The Task Force focused on an initial set of cross-cutting issues and recommends the following actions:

- **Improve water resource management** in a changing climate
- Protect human health by addressing climate change in **public health** activities
- Build resilience to climate change in **communities**
- Facilitate the incorporation of climate change risks into **insurance** mechanisms

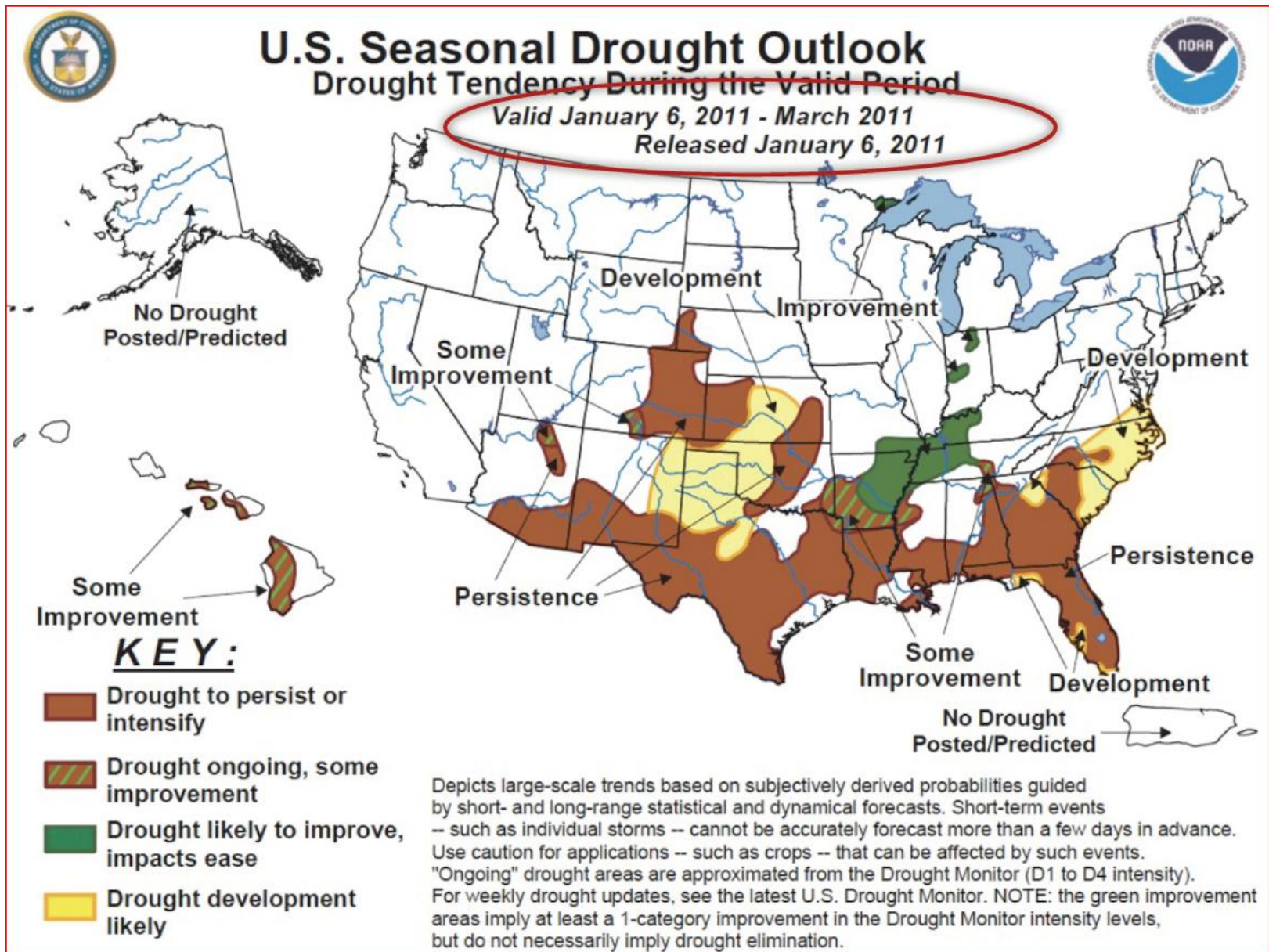
4. Enhance Efforts to Lead and Support International Adaptation

5. Coordinate Capabilities of the Federal Government to Support Adaptation

Next Steps: Building a More Resilient Nation

- Build on this initial set of priorities, the Federal Government should pursue to advance a national approach to adaptation.
- Agencies will initiate a formal adaptation planning process with the support of the Office of the Federal Environmental Executive (OFEE).
- USGCRP will continue efforts to build a robust body of science and critical tools to support decision making.
- Interagency workgroups will collaborate to address cross-cutting issues and support international adaptation objectives.
- Agencies will continue to develop and strengthen individual and interagency adaptation initiatives (e.g., National Climate Assessment and efforts to provide climate services (e.g., modeling, decision-support tools).
- The Task Force will prepare another progress report in October 2011 that summarizes the results of implementation efforts and refines or expands recommended policy goals and actions where necessary.

An example of US climate support programs



Disease Pressure

Disease Pressure
Botrytis - Plant City, FL



Botrytis - Pre-harvest



Botrytis - Post-harvest

Climate Phase	Low	Avg	High
Neutral	29%	34%	37%
El Niño	8%	23%	69%
La Niña	61%	32%	7%

Number of years with low, average, and high disease pressure. Farmers can reduce by more than half the number of applications during La Niña years. (Fraise et al. 2010)

Strawberry Advisory System (SAS)

[« Back to Tools](#)



Botrytis

Select station/county:

Balm/Hillsborough

Display County Boundary

Disease Risk Levels:



High Moderate Low

Fungicide List: [Click here](#)

Publications:

[Fruit Rot of Strawberry - Anthracnose](#) - fruit rot, caused by the fungus *Colletotrichum acutatum*...

[Botrytis Fruit Rot or Gray Mold of Strawberry](#) - Botrytis fruit rot, also known as gray mold, is caused by...

A [Web-based Decision Support Tool](#) - Plant disease decision support systems are management tools to help...

Balm Station

Recommendations
Disease Simulation
Weather
Contact
Disclaimer

Spray Recommendation

» **When was your last fungicide application?**

Last 7 days
 More than 7 days
 None

» **Select product(s) used*:**

Abound (Anthracnose) - Systemic

Cabrio (Anthracnose) - Systemic

Captan (Anthracnose, Botrytis) - Contact

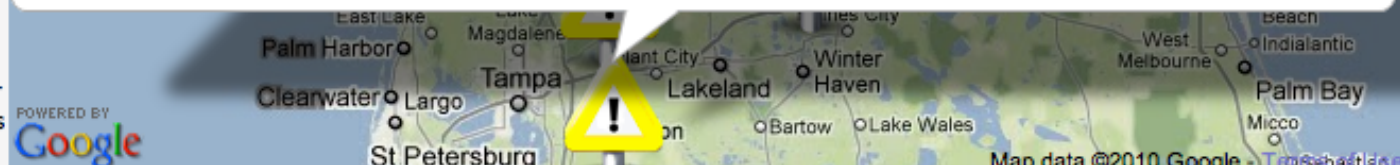
Captevate (Botrytis) - Systemic

* Use Ctrl or Shift to select more than one.

View Recommendation

Botrytis: No Spray!

Anthracnose: Spray Contact Fungicide (Products recommended: Captan)



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Map data ©2010 Google - [Tom Sebastian](#)

High Moderate Low

Country Examples: Mexico Building resilience: policies for climate smart agriculture

Agriculture: Only 4% of GDP but a key role in broader landscape management; 15% of employment; 77% of water consumption with forestry 21% of GHG emissions. Forests are 23% of area: pattern of deforestation

Will face rising temperatures, reduced rainfall and more frequent and severe droughts and storms,

More frequent forest fires; impact on productivity especially of maize and pastureland; impact and vulnerability vary widely between regions

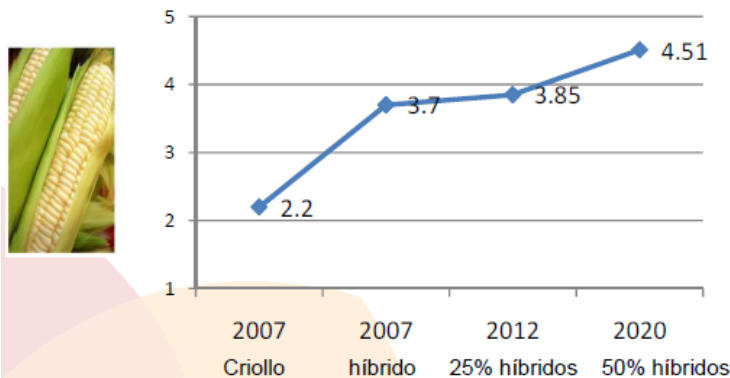


Mexico's adaptation strategy for agriculture and water management

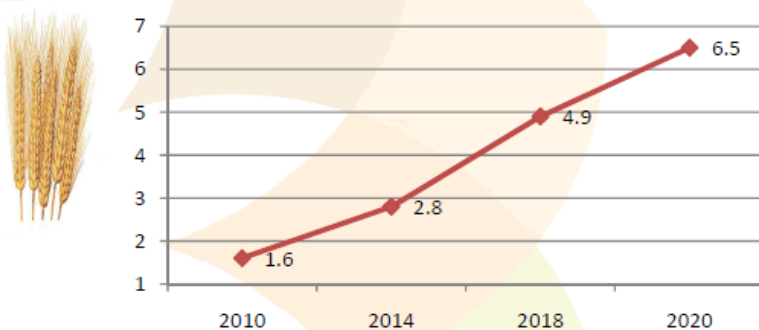


LINK WITH AGRICULTURE RESEARCH INCREASES PRODUCTIVITY

Rendimiento de Maíz ton/ha



Rendimiento de Trigo ton/ha



FOR AGRICULTURE: conservation tillage, crop rotation, fertilizer management, research, gene banks, productivity, conservation corridors, wild land conservation: conversion of agricultural land to perennial & mixed crops, control of cropland burning

FOR FORESTRY: reforestation and sustainable forest management, commercial plantations, scaled up support (US\$ 27 m budget allocation in 2001, US\$ 396 m in 2010)

FOR LIVESTOCK: rangeland restoration, manure management & improved breeding

FOR WATER: Irrigation modernization and water conservation (67% of irrigation is surface), flood and watershed management,

Improved Climate Information

Social protection and risk reduction measures including support for: crop diversification; non-farm income generation (e.g. public works, tourism), cash transfers, remittances and migration.

Insurance and disaster protection: programs including federal support to states for low income producers; mutual insurance cooperatives, index based insurance products and an ex-post disaster fund



World Bank Support



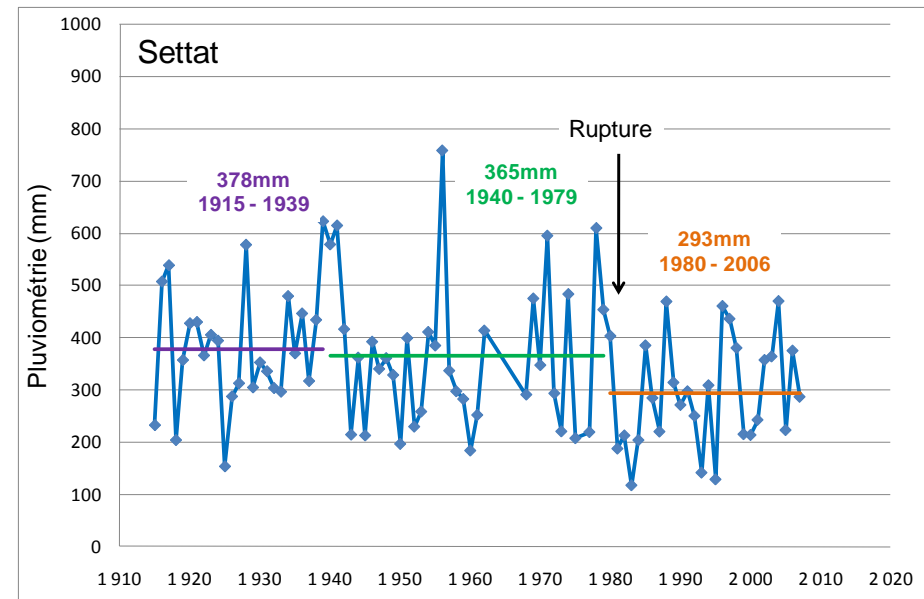
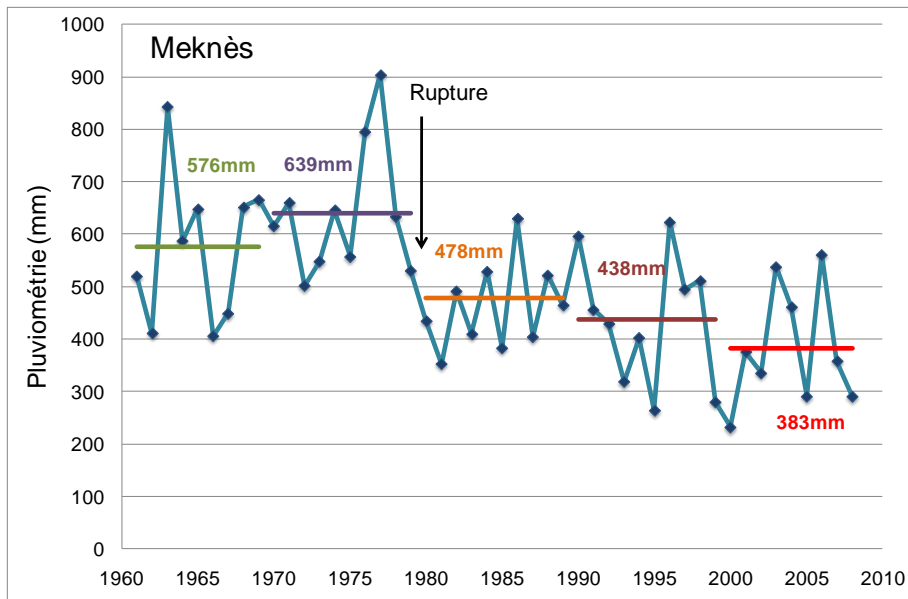
- **Water Sector** development policy loan (US\$ 450m) supports integrated water & watershed management and conservation and institutional strengthening;
- **Climate Change DPL** (US\$ 501m) for integration of climate change into sector programs including mitigation
- **Sustainable Rural Development** project (US\$ 168m) for environmentally sustainable agri-business
- Forests and climate change project (under preparation) focuses on community forestry and REDD
- Hydromet project (proposed)
- Ecosystems adaptation DPL (proposed)

Morocco Strategies and Policies for Climate-smart Agriculture

- Agriculture is 15% of GDP and 45% of employment
- Low productivity rainfed agriculture accounts for 85% of agricultural land: ageing farmers
- Irrigation: 15% of land area, 45% of value added, 83% of water use. 75% of agricultural exports
 - ❖ Irrigated lands (1.36 million hectares), which represents only 14.6% of the agricultural areas, contribute for 45% to the added value (up to 75% in dry years) and produce nearly 75% of agricultural exports
 - ❖ Irrigation uses now the major portion (83%) of all collected water resources ;
 - ❖ Moroccan agriculture is still strongly dependent on rainfall, as rainfed areas represent 85% of agricultural lands (7.9 millions hectares);
- Rising temperatures, increased aridity and water stress are major climate challenges
- Food self-sufficiency or increased value-added for food security?

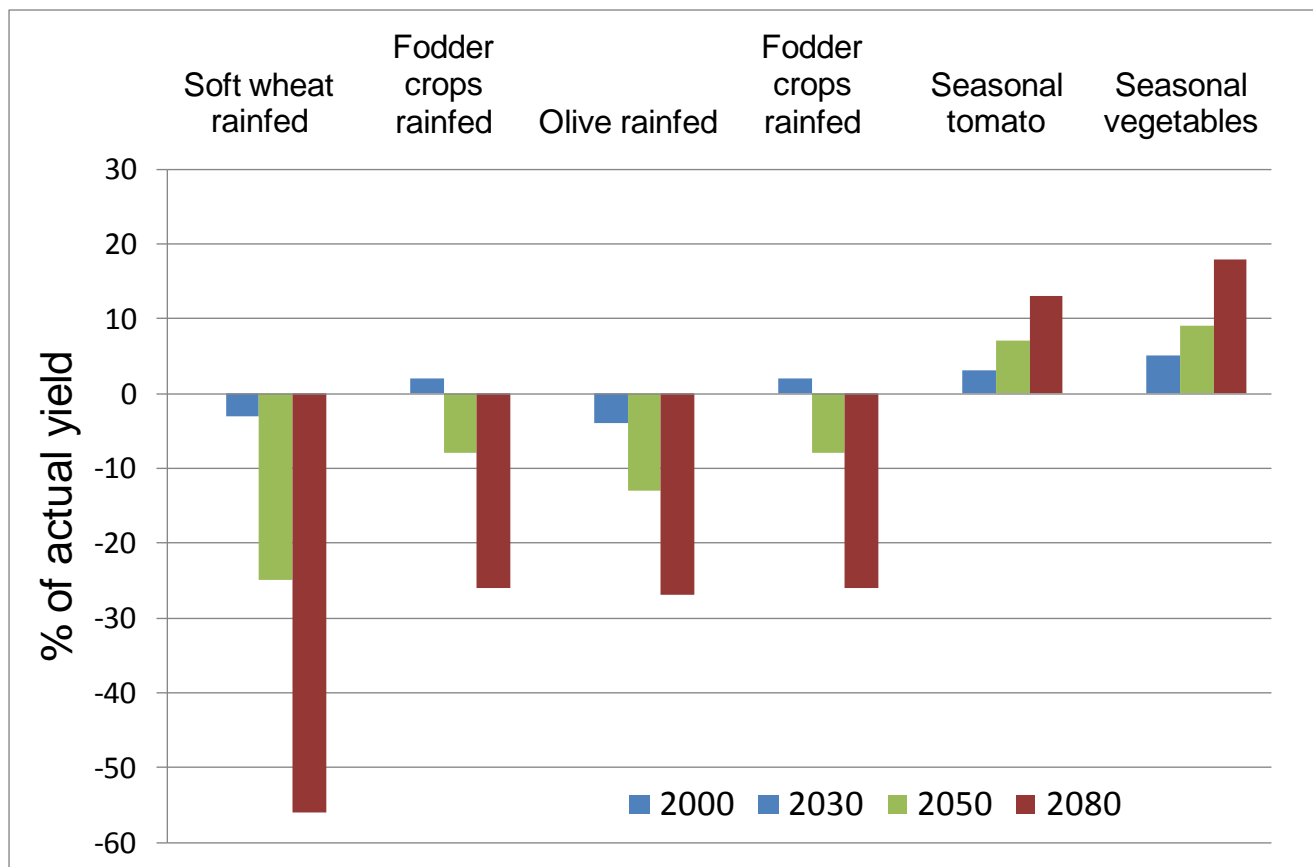
Climate Change in Morocco

Morocco is facing climate change since the beginning of the eighties



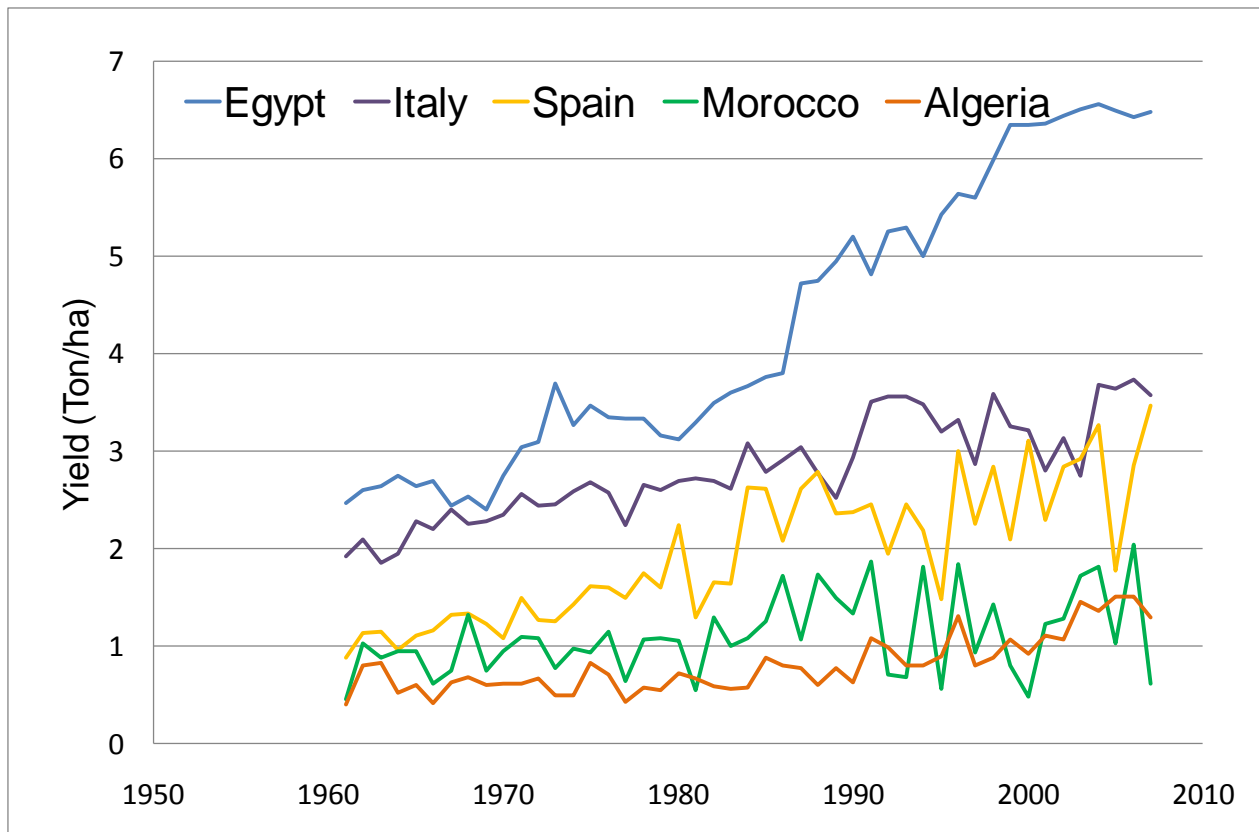
Impact of Climate Change in Morocco

Higher impacts of climate change on rainfed crops



Food Security in Morocco

Morocco needs 30% increase in cereal needs in the present to achieve self sufficiency



Source : FAOSTAT

Morocco's Green Plan (2010-2020)

“A triple bottom line answer to food insecurity, adaptation of agriculture to climate change and sustainable growth of small farmers”

- A comprehensive plan to double value added, includes structural reforms in cropping patterns, land tenure, agricultural taxation
- Pillar 1 promotes growth in high value crops, trade and irrigation
- Pillar 2 aims to reduce rural poverty in low productivity rainfed sector
- Adaptation measures focus on more efficient land and water use and intensification:
- Irrigation water efficiency: conversion to drip irrigation, "more crop per drop" (700,000 ha, 50% of irrigated area by 2020)

Improved seeds, drought and disease resistance are priorities

Certified seeds and plants are the first vectors of the technological progress, from research to farmers

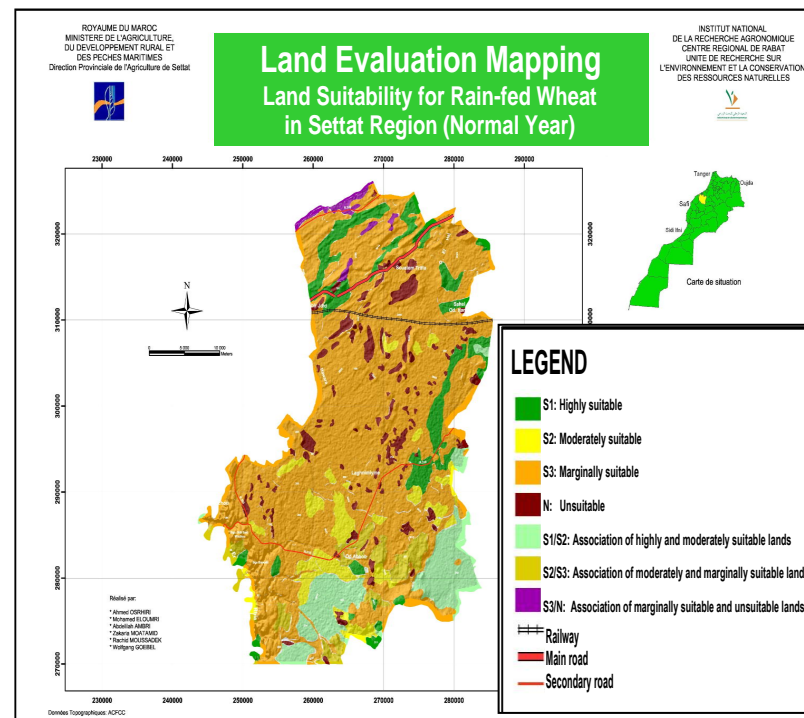
- Up to 50% yield increase for cereals
- Better quality of the harvests due to low infestation by diseases



Land Suitability mapping for landscape based approaches

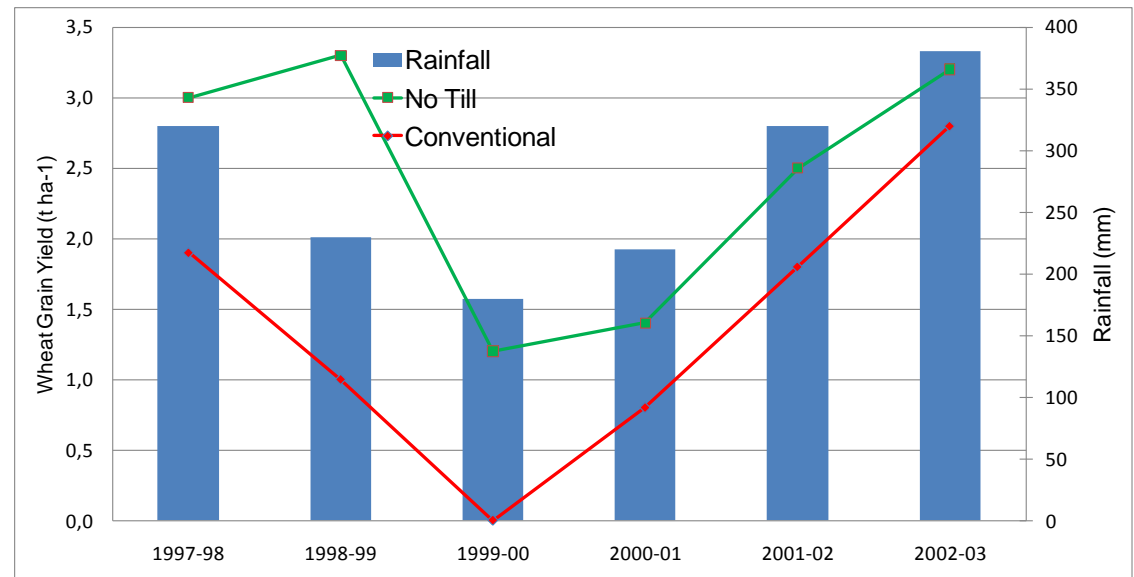
To provide to farmers and decision makers a support planning tool for technically feasible and profitable options for improved and sustainable land-use.

Almost 6 Millions hectares ($\approx 100\%$)
maps for rainfed areas



No tillage for sustainable rainfed agriculture

Experiments at farm level show the superiority of no-till system compared to conventional system.



+ 30 to 40 % in grain yield

+ 3 to 14% of organic matter

+ 60% in WUE

- 70% in energy consumption

Supplemental irrigation

Technology for low rainfall areas (200 to 400mm/year) or not well distributed rainfall

- 20 to 90 % yield increase for cereals (soft and durum wheat)
- 50 % yield increase for fruit trees (olive, almonds)
- SI improves also the quality of the production.



Water harvesting

Used for fruit trees and pastures species in low rainfall areas (100 to 300mm/year)

- Very high yield increase especially when rainfall is very low
- Specific machinery is needed



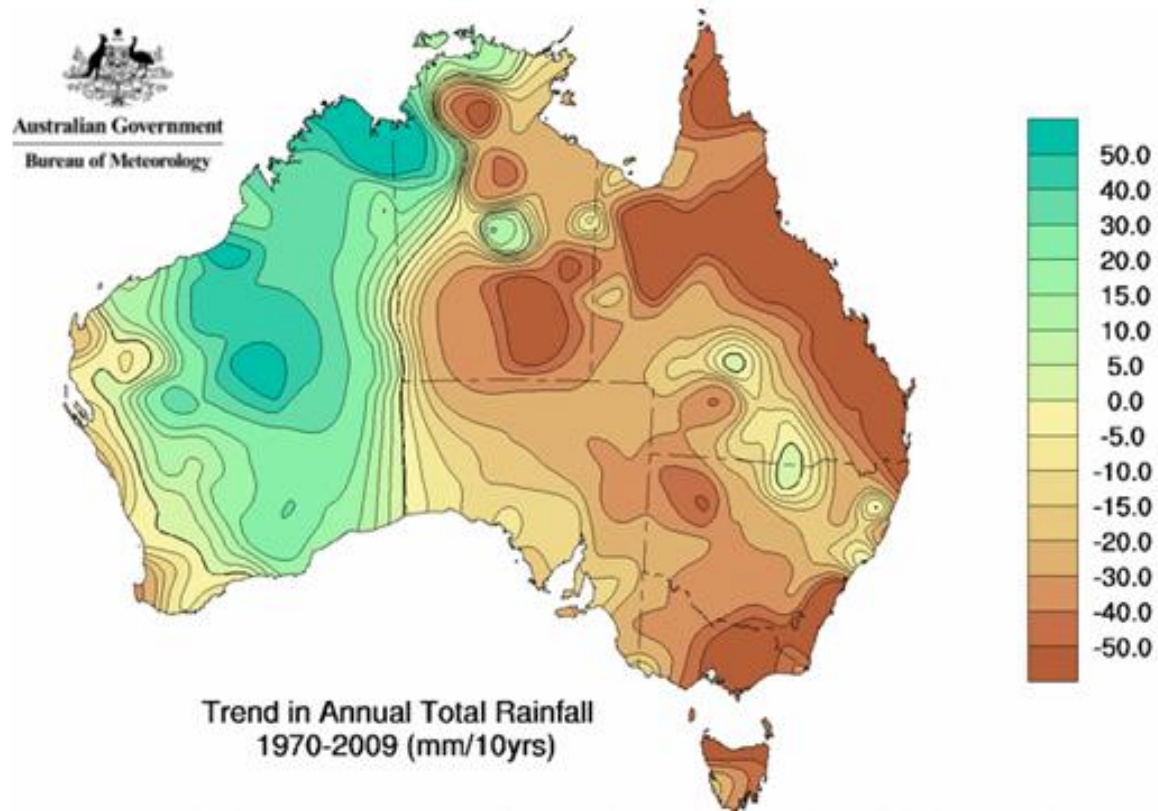
The plan includes many other measures to promote farmer organization, commercialization, resource conservation.....

World Bank support

- World Bank support focuses on improved irrigation and river basin management
- DPL Plan Vert support loan (includes policy measures on domestic market liberalization, food and livestock safety, improved transparency, vertical integration and socio-economic impact monitoring of support to small farmers, improvements in agricultural services and research, and enhanced water management including installation of meters, relief on interest rates for irrigation water debt, enhanced irrigation water delivery)
- Adaptation and mitigation strategy
- Piloting and demonstration of adaptation measures to integrate climate resilience into the Plan Vert

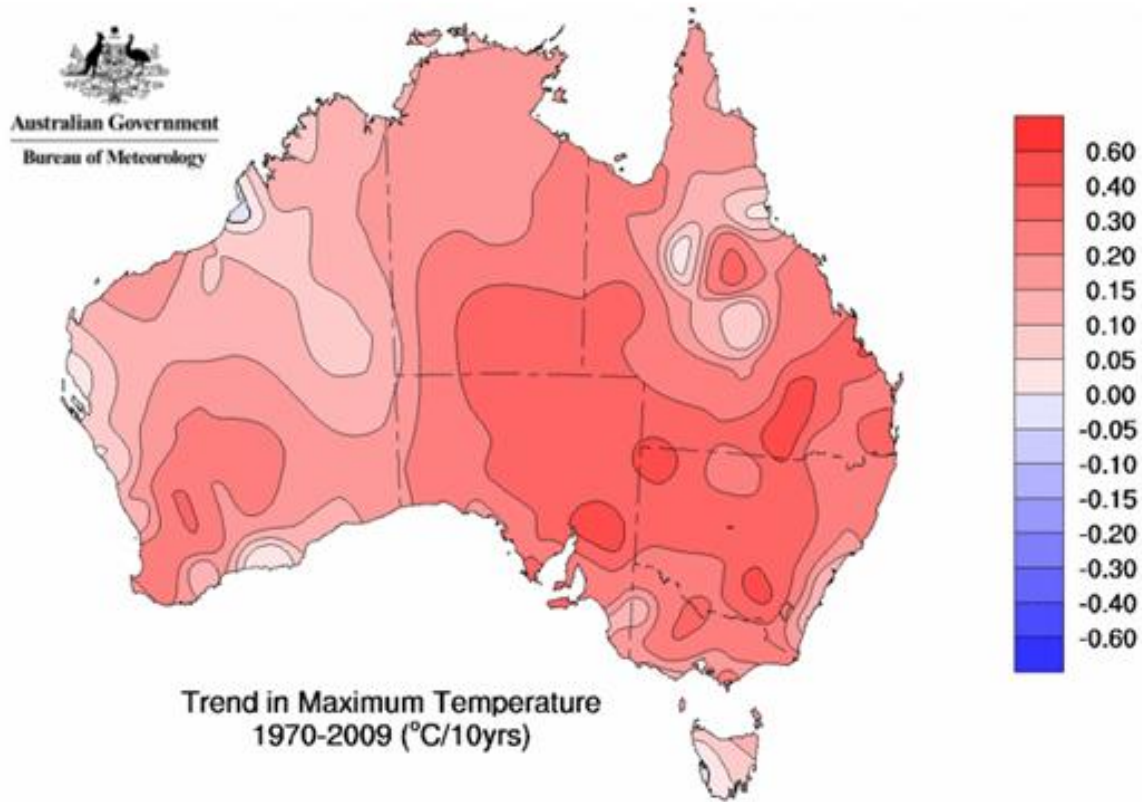
Australia

Challenges facing the rural sector



Australia

Challenges facing the rural sector



Australia: The Murray Darling Basin

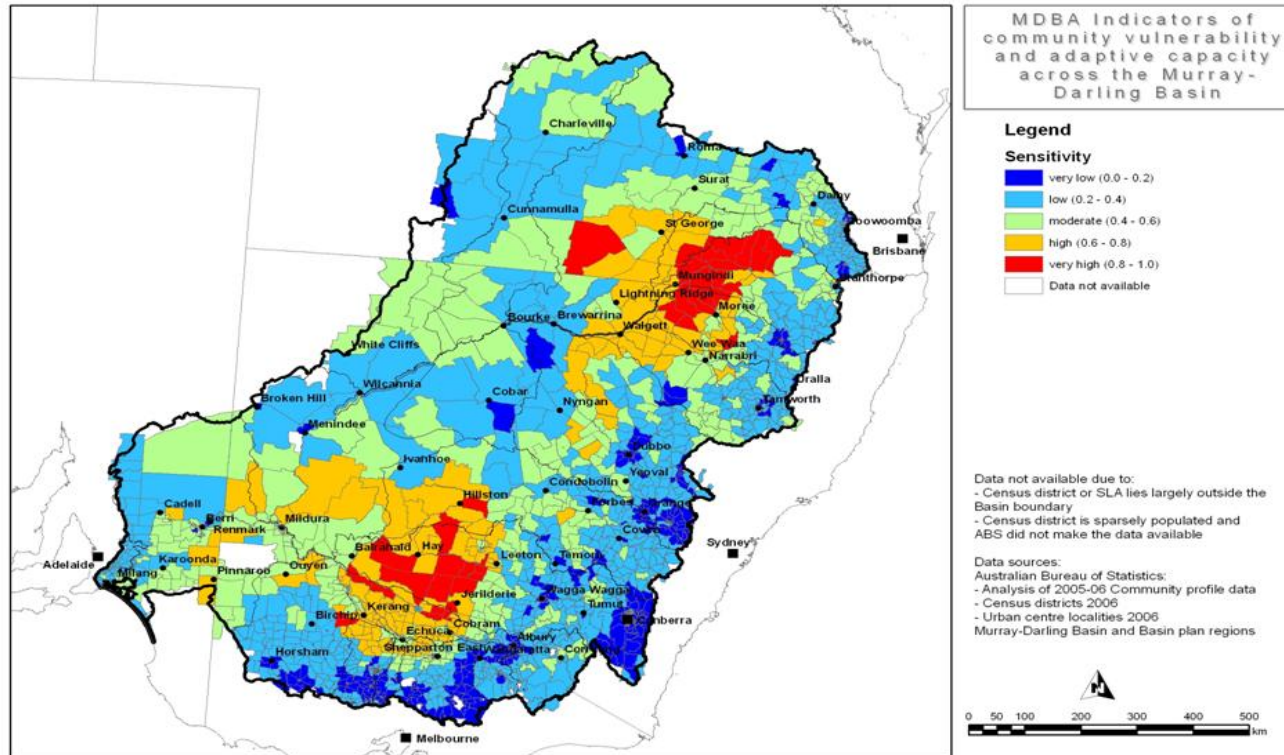
- Murray Darling Basin is a perfect example of Australia's challenge with managing water and preparing for climate change into the future.
- The Murray-Darling Basin comprises 23 rivers and 14% of the total area of Australia
- It is an most important agricultural area with over 70% of irrigated agriculture dependent on the Basin.
- By the end of this century, in a scenario where there is no mitigation of greenhouse emissions the combination of:
 - reduced median rainfall,
 - near complete absence of runoff in the Basin and
 - the increased frequency of drought

WILL RESULT IN A 92% DECREASE IN IRRIGATED AGRICULTURAL PRODUCTION IN THE MURRAY-DARLING BASIN

Australia: The Murray Darling Basin

Water access and availability

Sensitivity is a measure of reliance on irrigation water use and agricultural and processing employment.



This map highlights the areas most sensitive or how susceptible a community is to pressures and disturbances such as climate change.

Sensitivity here is a measure of the reliance of Basin communities on irrigation water and their dependence on agricultural for employment and income.

Australia

Water Policy in the Murray Darling Basin includes:

- \$3.1 billion over 10 years to purchase water for the Murray-Darling Basin – this is designed to improve the health of the river system
- \$5.8 billion to put farming on a more sustainable pathway including expenditure on modernising irrigation infrastructure
- Extensive consultation with the sector to set water allocation levels throughout the Basin

Australia

Climate Change Research Program

50 projects across Australia

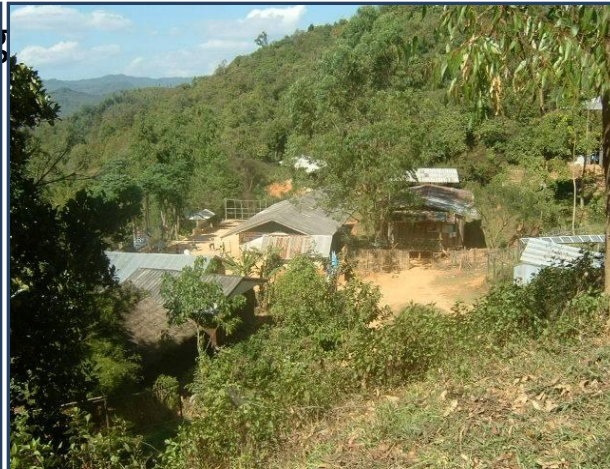
Over \$130 million invested

- ❖ **Soil Carbon Research Program - \$20 million**
- ❖ **Mitigation (emissions reduction) - \$39.5 million**
- ❖ **Biochar - \$3 million**
- ❖ **Adaptation - \$38 million**
- ❖ **Onfarm demonstrations - \$27 million**



Policies & Strategies for Climate-smart Agriculture

- ***Bringing together*** food security, agricultural productivity and climate change.
- ***Enabling policies*** for
 - investment in sustainable agriculture and rural development by both small holder and large scale farms;
 - Access to weather and climate information
 - inclusive access to finance;
 - secure access to land by smallholders;
 - efficient and sustainable use of land, water, energy and other inputs



Sustainable intensification of agricultural production.

This helps reserve lands for other uses and can use water more efficiently

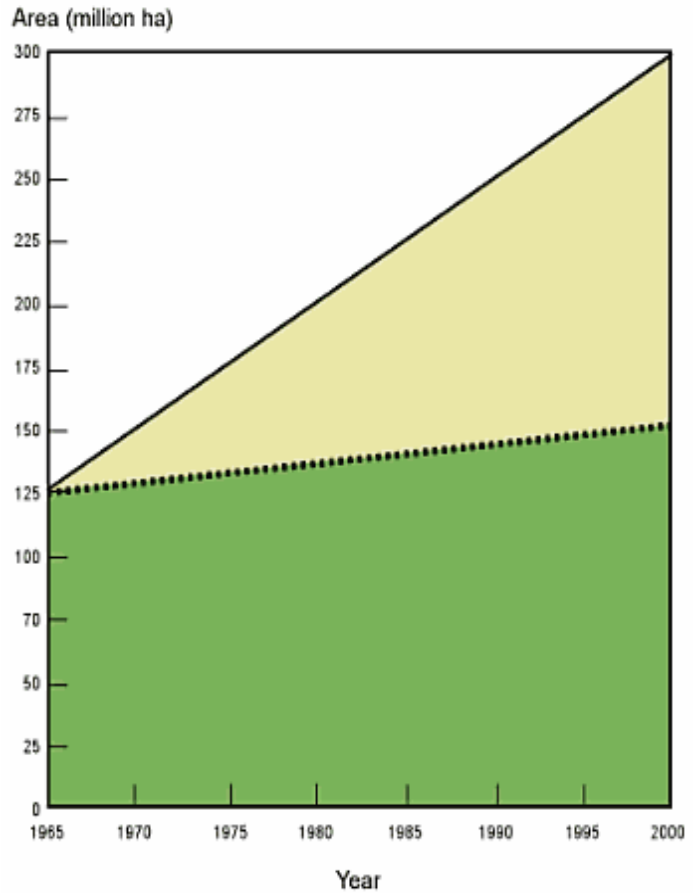
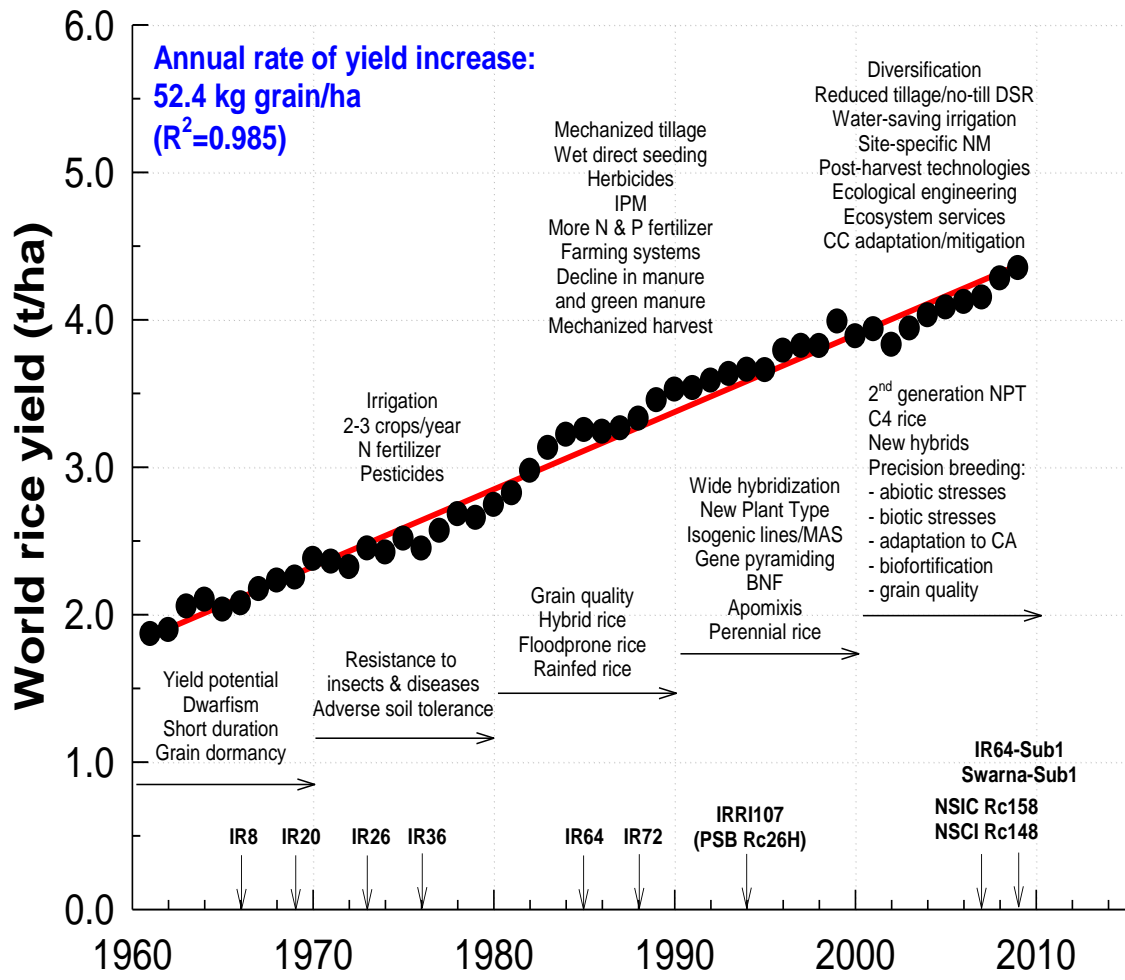
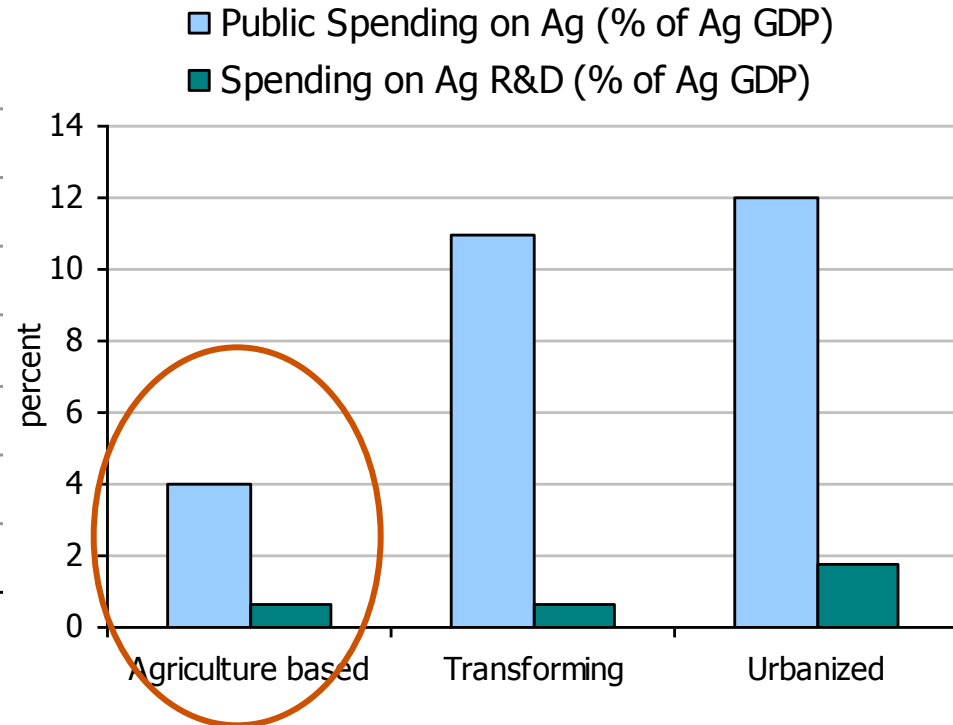
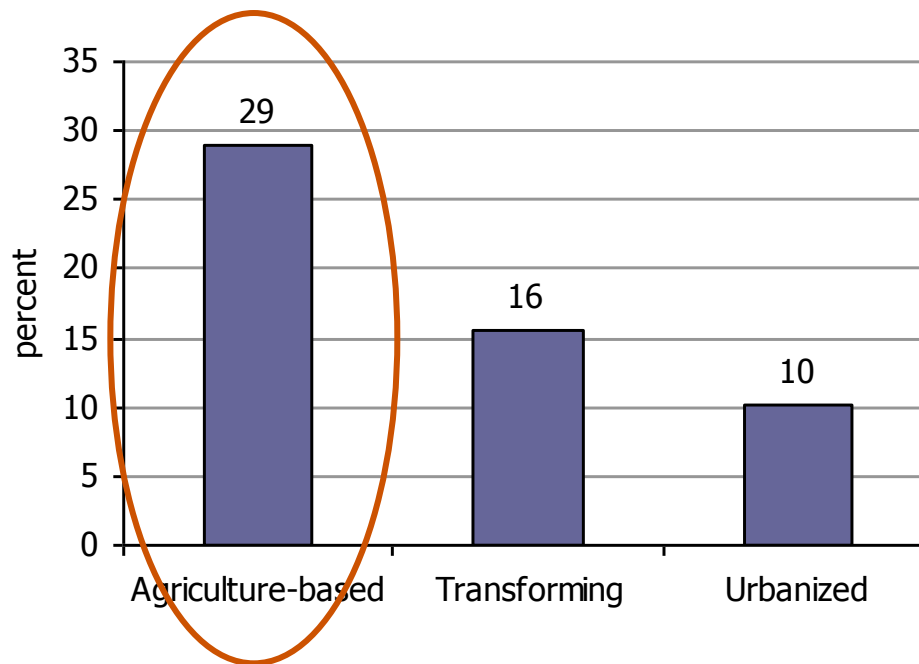


Fig. 3. Actual area planted to rice (■) and the additional area that would have been required to produce the 2000 level of production at the yield level of 1965 (■).

Challenges

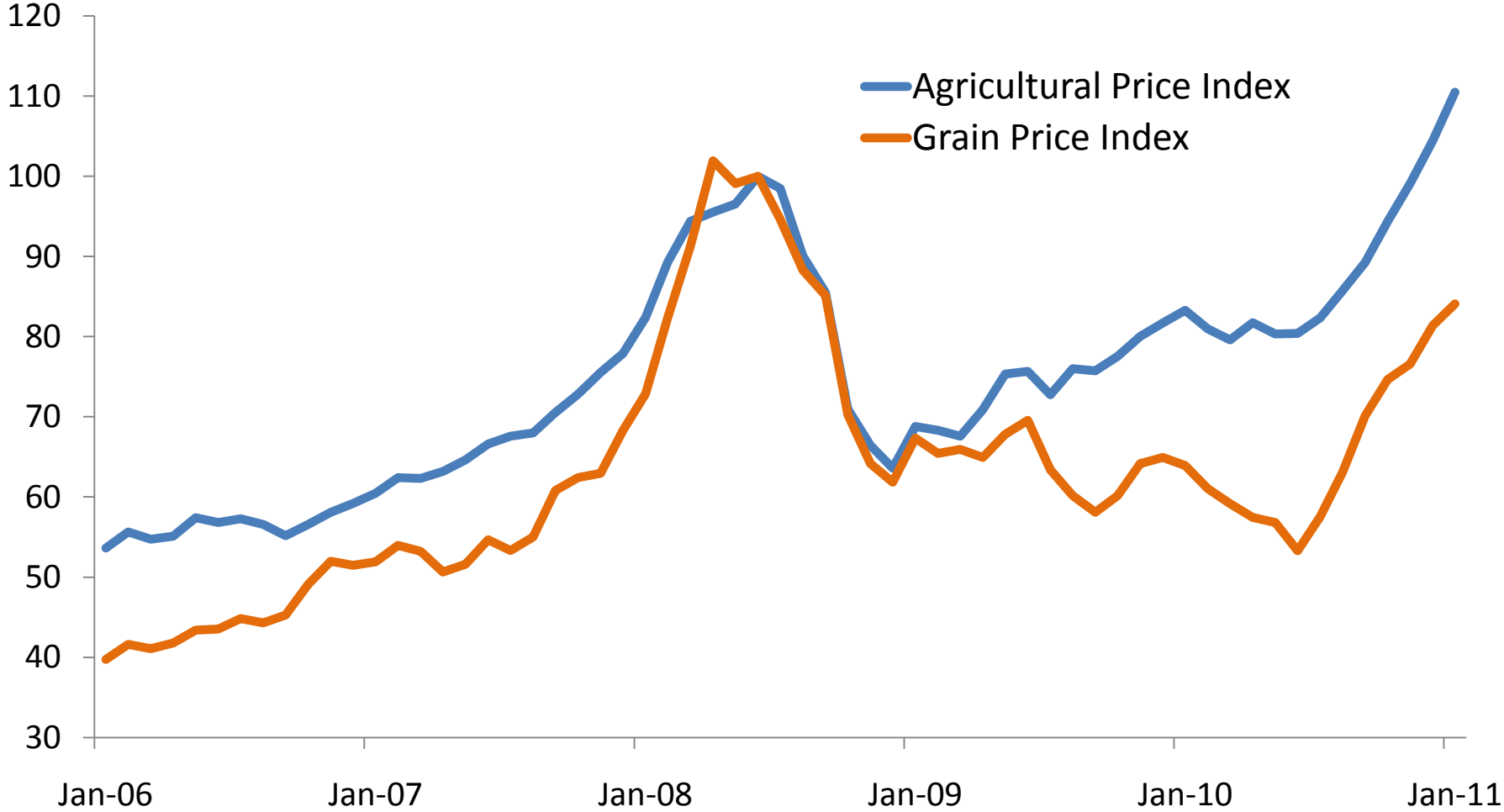
Agricultural-based countries spend too little on agriculture (and R&D)

Ag GDP/GDP



CONSECUTIVE AND PRONOUNCED PRICE SPIKES

Price Index, July 2008 = 100 (Prices through to end January 2011)



Source: World Bank

Some key areas for policy, supporting measures and research

- **Agriculture water management;** sustainable rice intensification systems
- **“Greening” the green revolution** integrated soil fertility management and minimum tillage
- **Managing intensive livestock systems;** in US in 2007 1 billion kg of milk required 21% of animals, 23% of feed, 35% of water and 10% of land compared to 1944
- **Forest landscape restoration;** India to increase forested area from 25% to 34%
- **Reversing degradation in less favored areas;** greening the Sahel
- **Scaling up agroforestry and integrated watershed management;** (Loess plateau) and
- **Payments for environmental services.** Costa Rica, REDD
- **Providing relevant weather & climate services to farmers**
- **Policies and regulations matter: but technology helps and political economy, food security, food safety and low prices are key**

