Innovations in Adaptation to Climate Change in Dryland Agriculture

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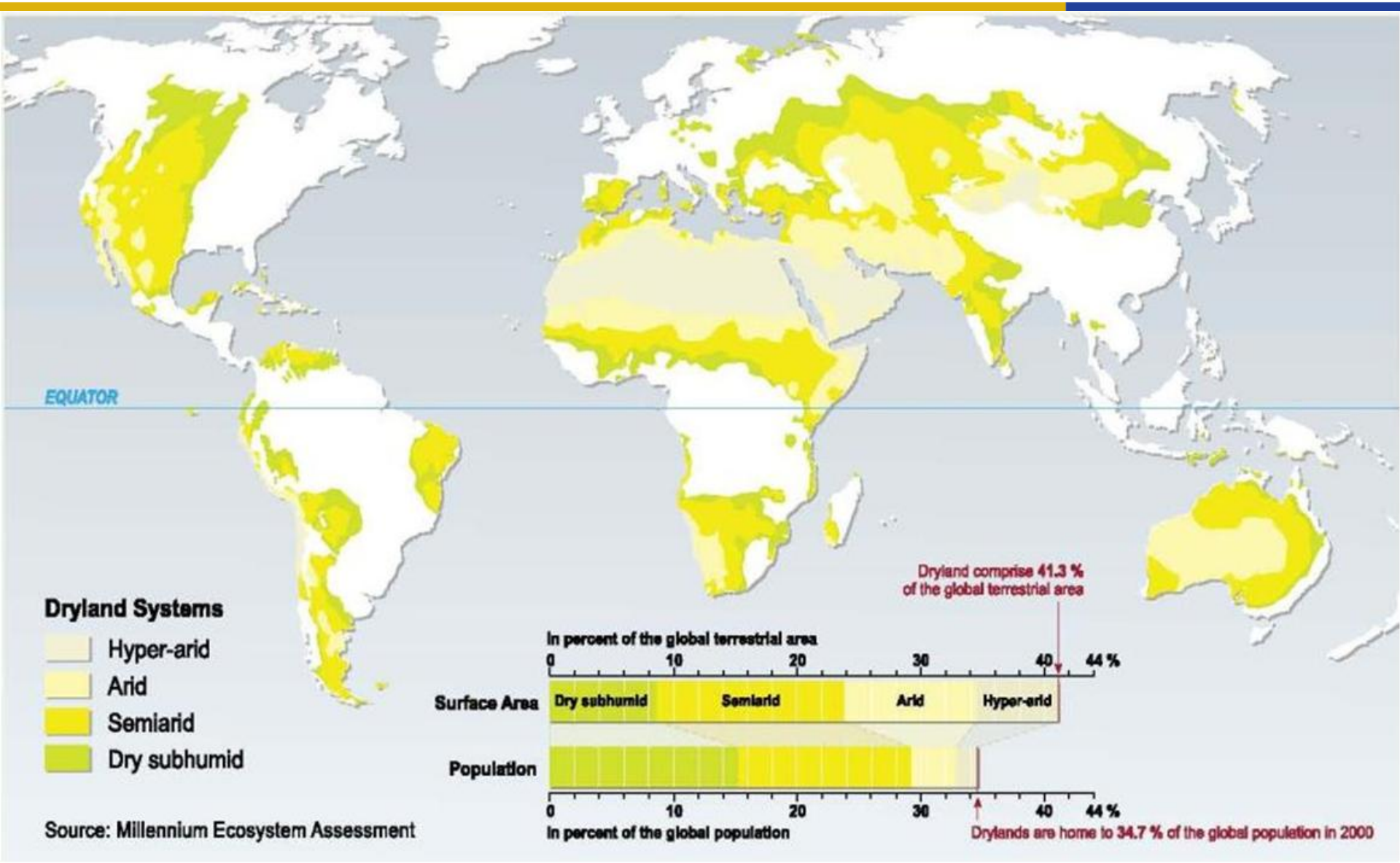
Outline

- World drylands;
- Big questions in climate change & agriculture;
- Adaptation technologies;
- Examples from Australia & China;
- Conclusions.

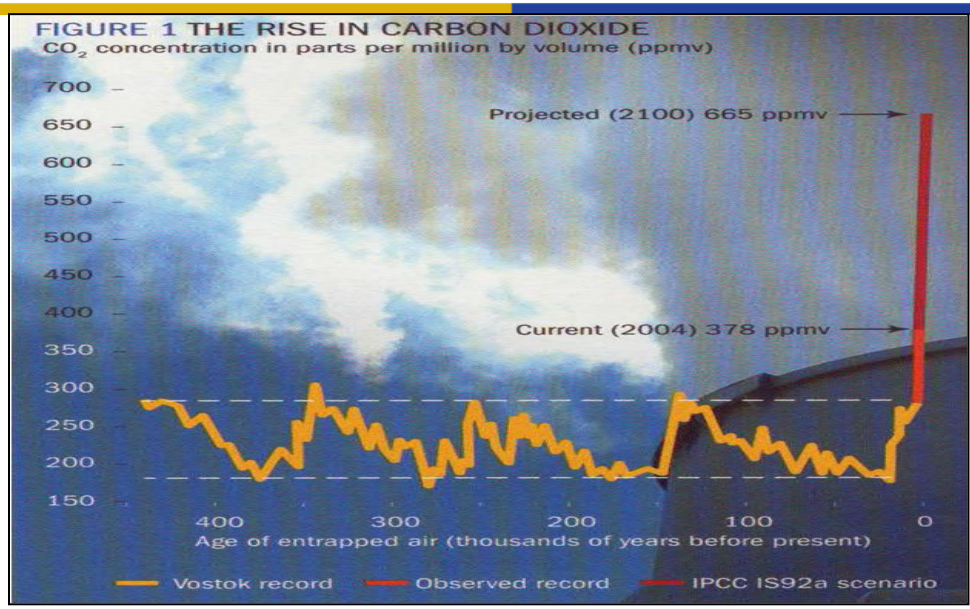
World drylands



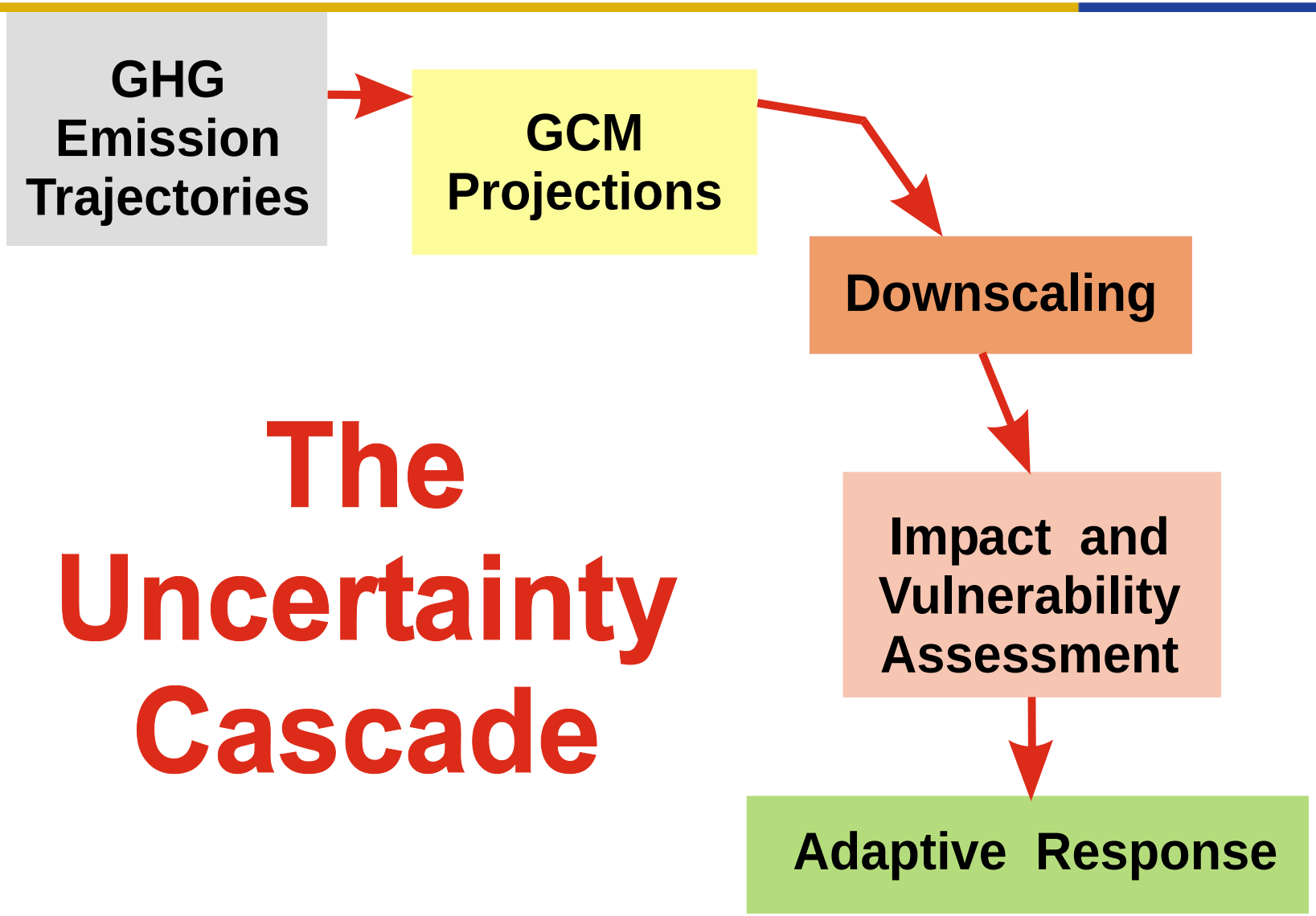
Adaptation

Adaptation is defined as:
"adjustments made in response to stress"

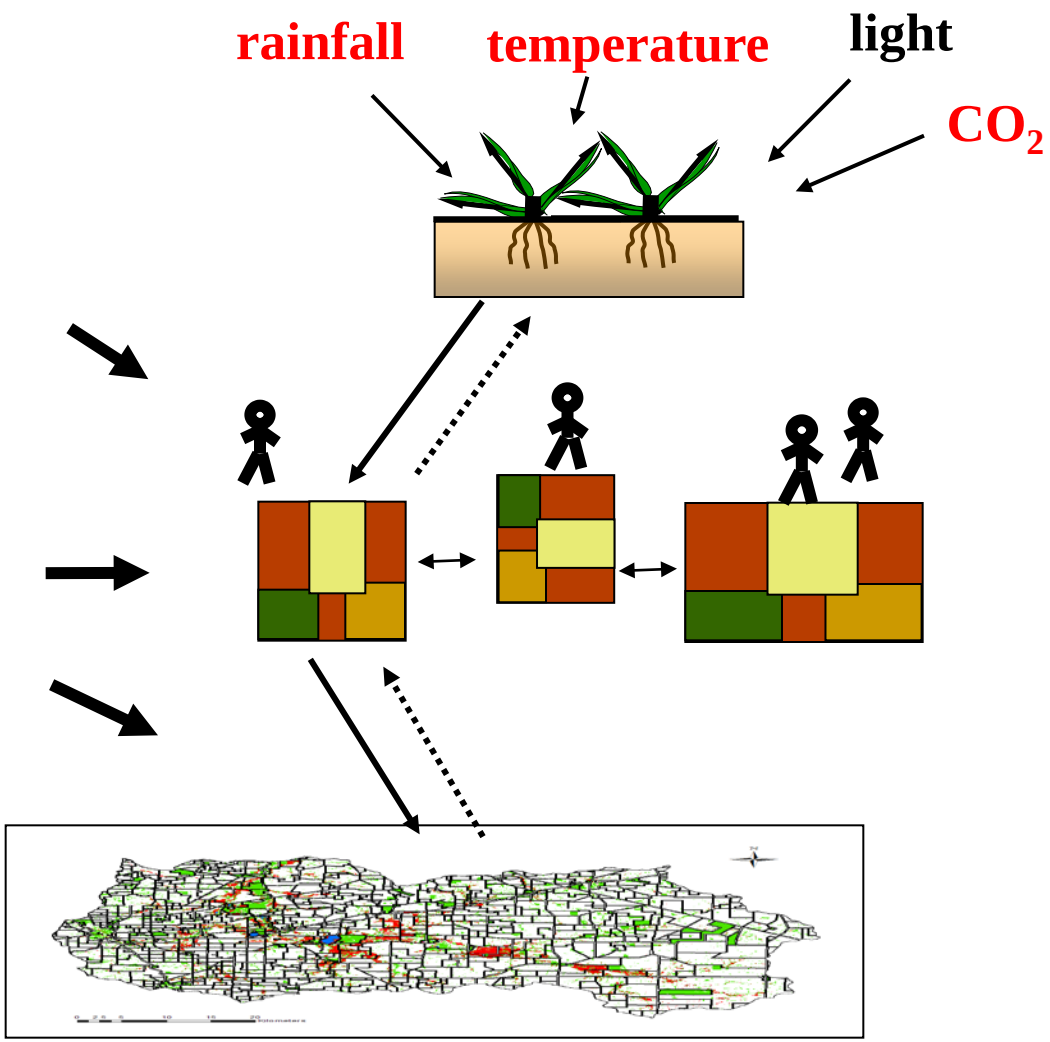
- Adaptation should be based on process to minimise the potential negative impacts of variable climate;
- Successful adaptation enhances a system's ability to deal with uncertain future change.



Climate change and adaptation



“Big” questions in climate change and agriculture



- What is the impact of climate change on agriculture?
- What are the risks & opportunities?
- Will farmers/industry be able to adapt?
- What is needed to adapt?
- What is the impact of adaptation?

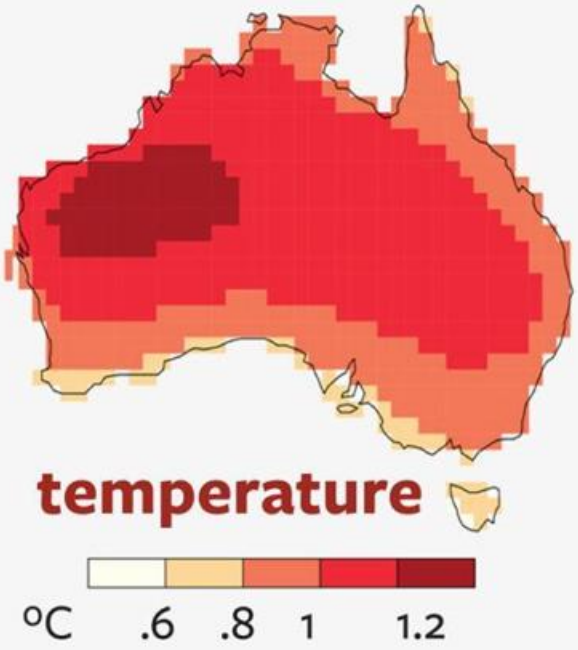
Projected changes in agricultural productivity from climate change at 2050

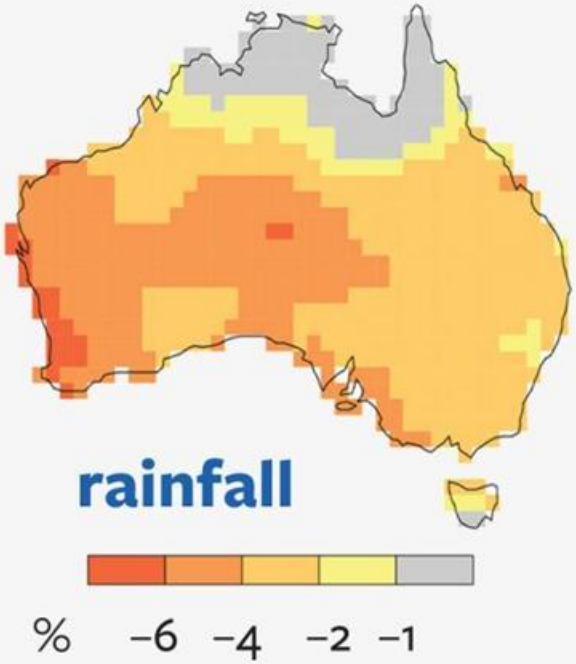
Country	% change
Australia	**-17**
Canada	-1
United States	-4
China	**-4**
Japan	-4
New Zealand	1
ASEAN	-12
India	-25
Argentina	-7
Brazil	-10
European Union	-4
Rest of Europe	-4
Least developed countries	-18
Rest of the world	-13

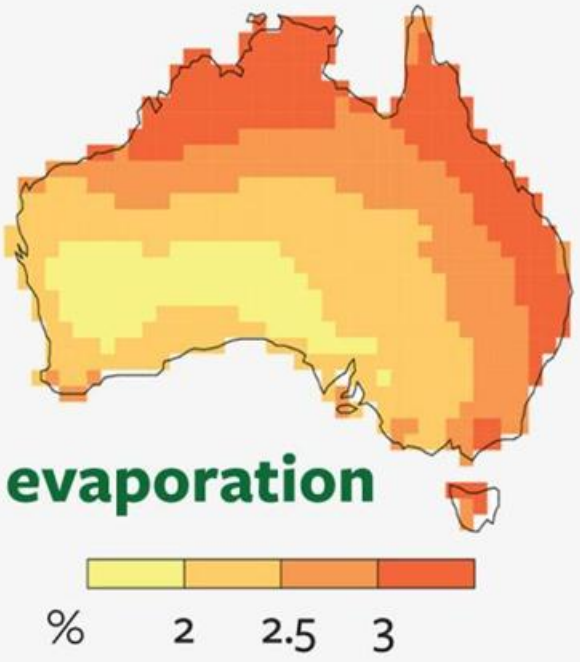
Source: RIRDC 2013

Projected changes in key climate variables

by 2030 relative to 1990

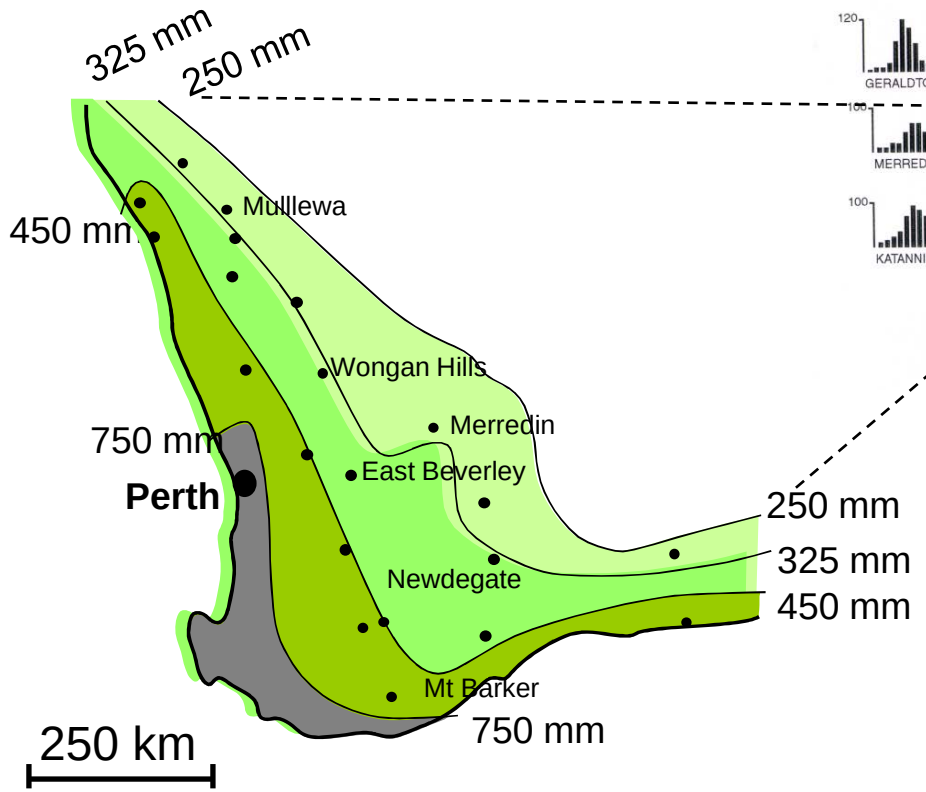


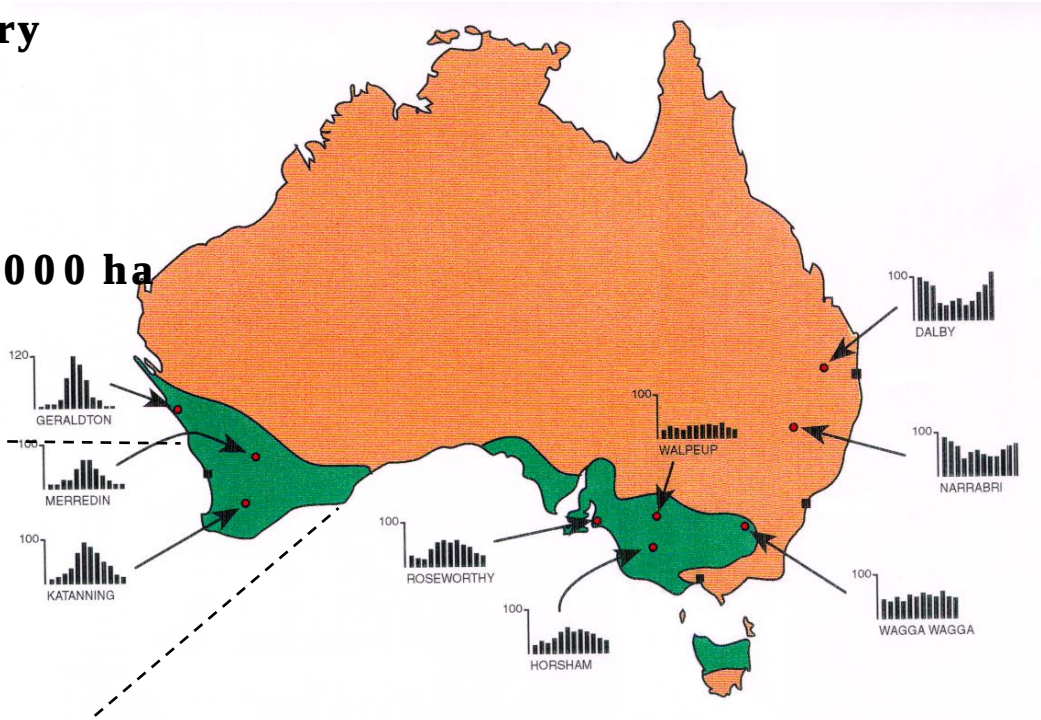




Mediterranean zone of Australia

- **Climate: cold wet winters and hot dry summers;**
- **12 million ha of arable land in WA;**
- **4,000 farmers, average farm size 3,000 ha**





- **Wheat, barley, canola, grain and pasture legumes and sheep**

Australia-change in rainfall 1900-2009

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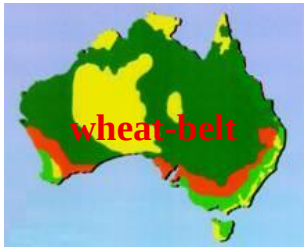
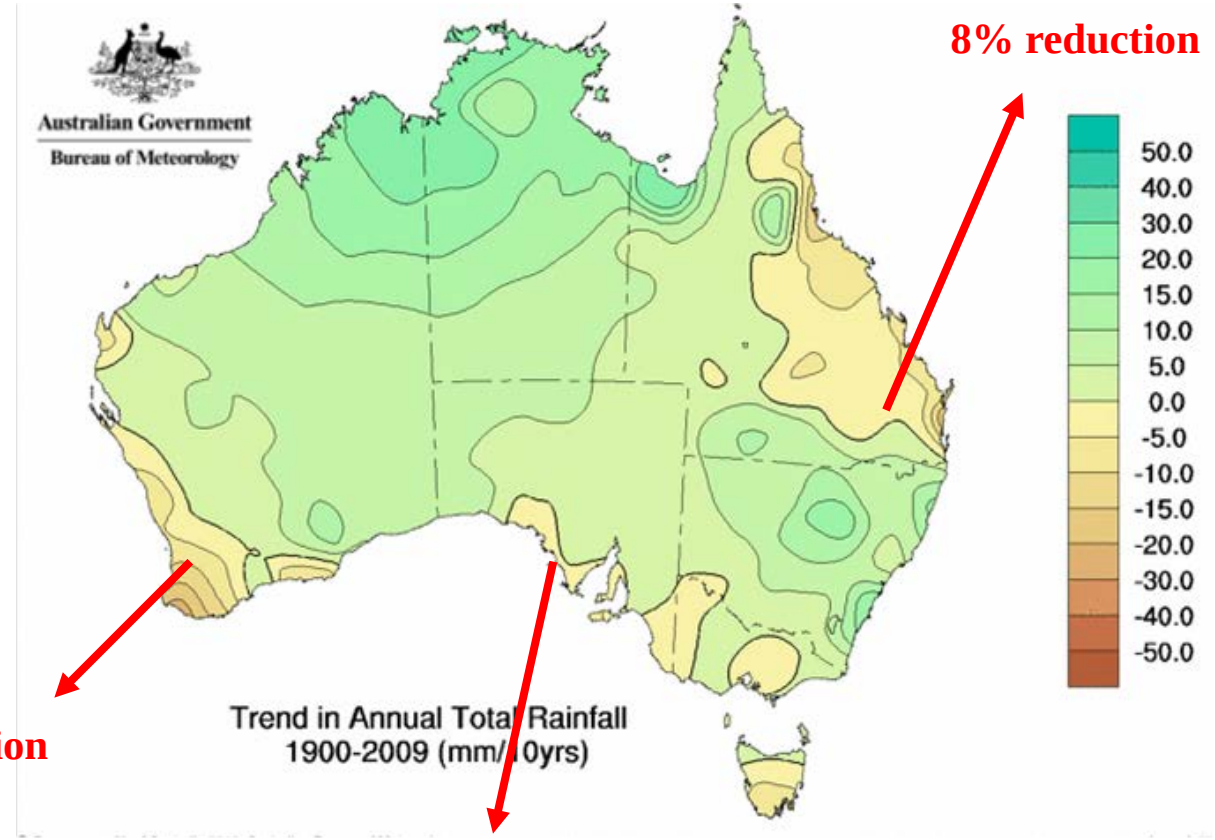




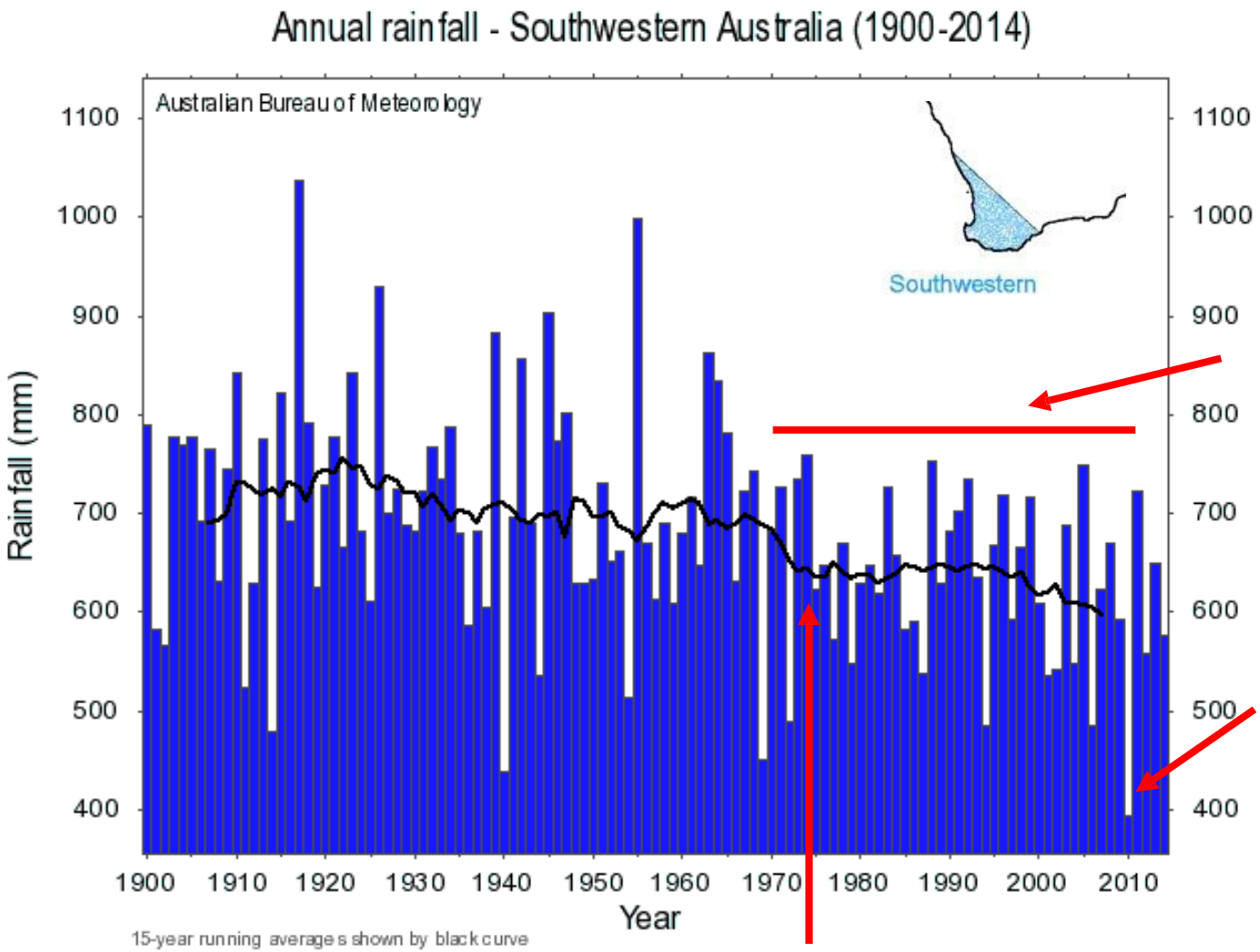
8% reduction

20% reduction

10% reduction

Source: BoM

southwest Western Australia



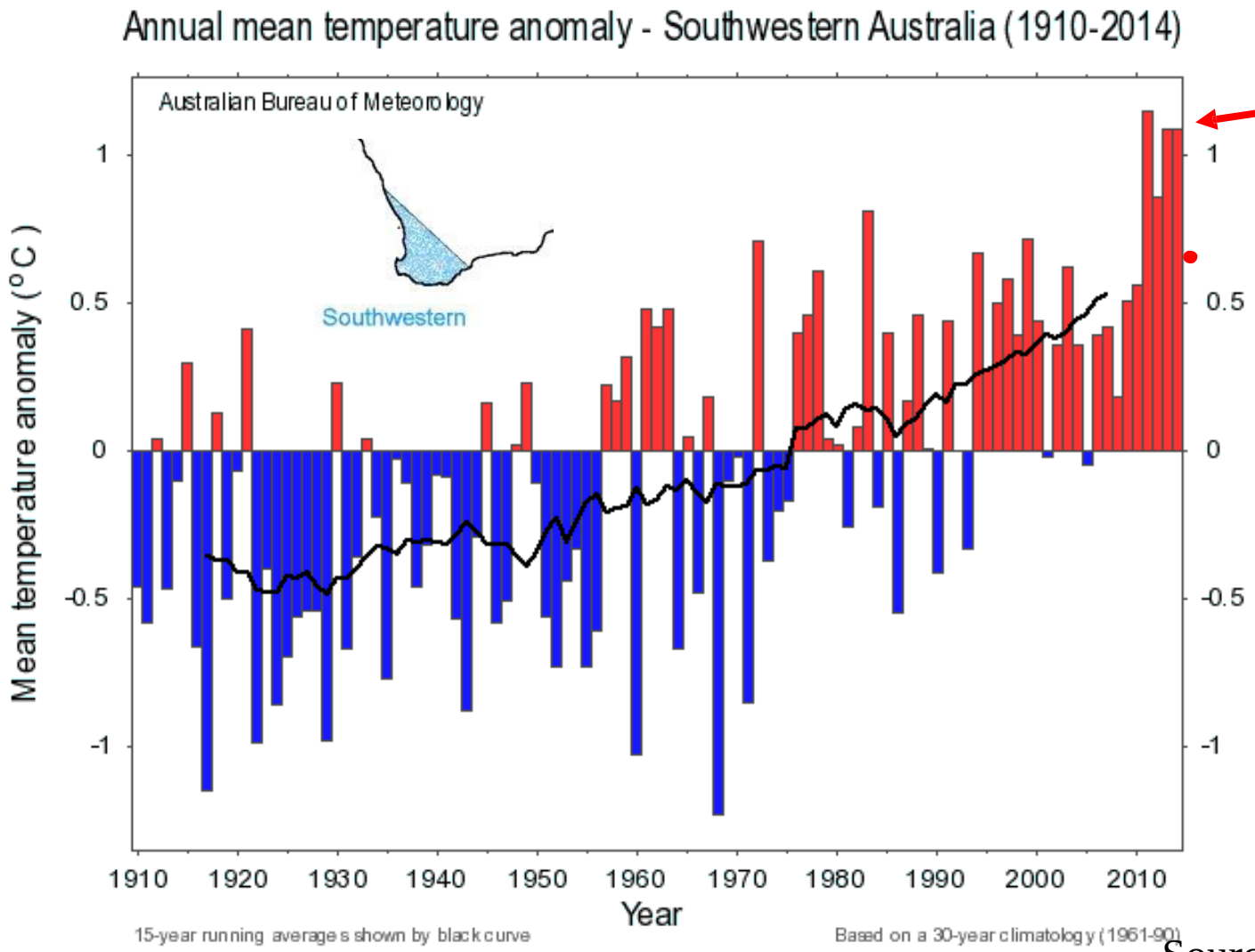
Lack of very wet years & decrease in variability

2010 - driest year on record

Significant drop in rainfall in southwest WA in the mid 1970's

Source: Glenn Cook

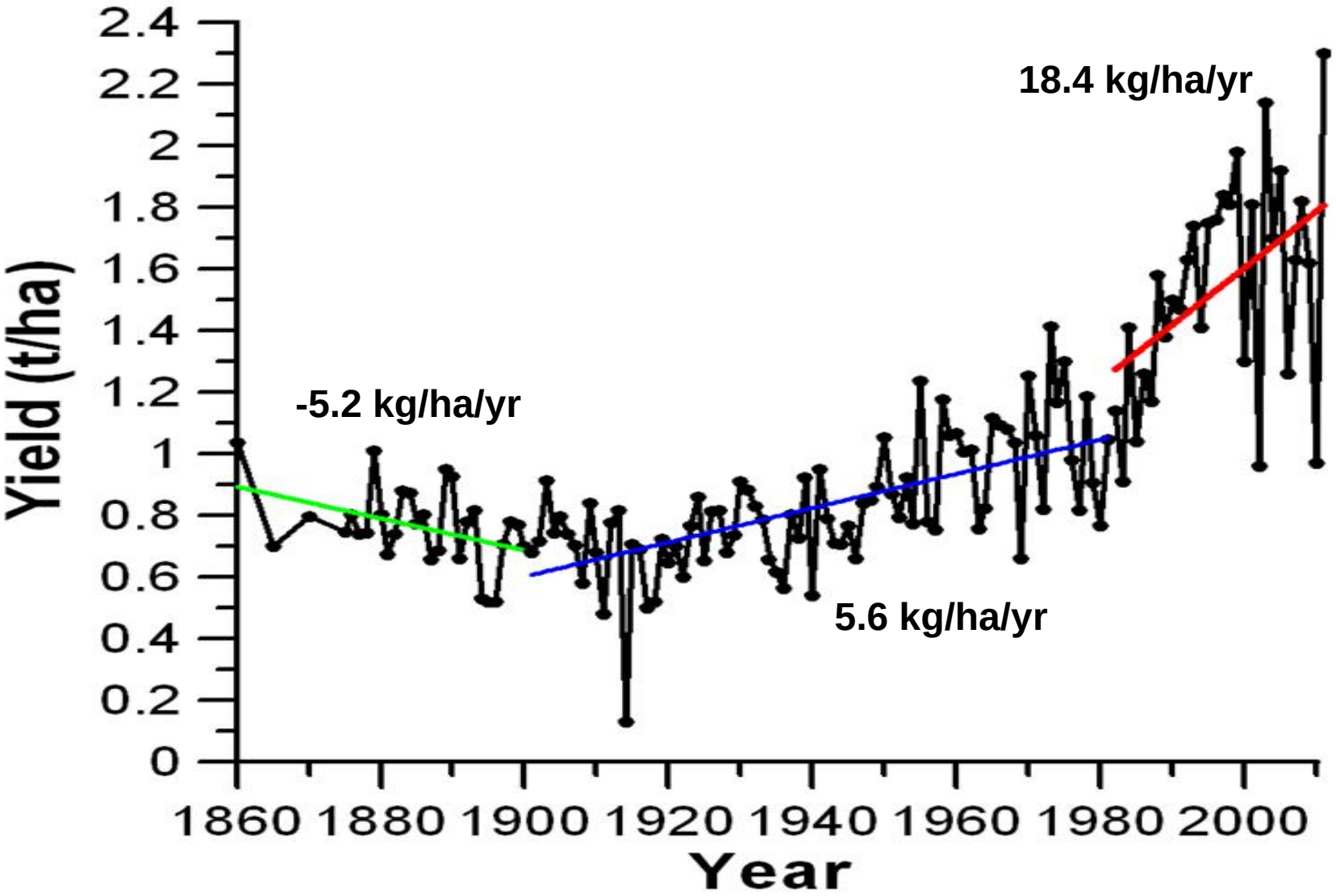
SW WA is getting hotter



Four hottest years on record

Source: Glenn Cook

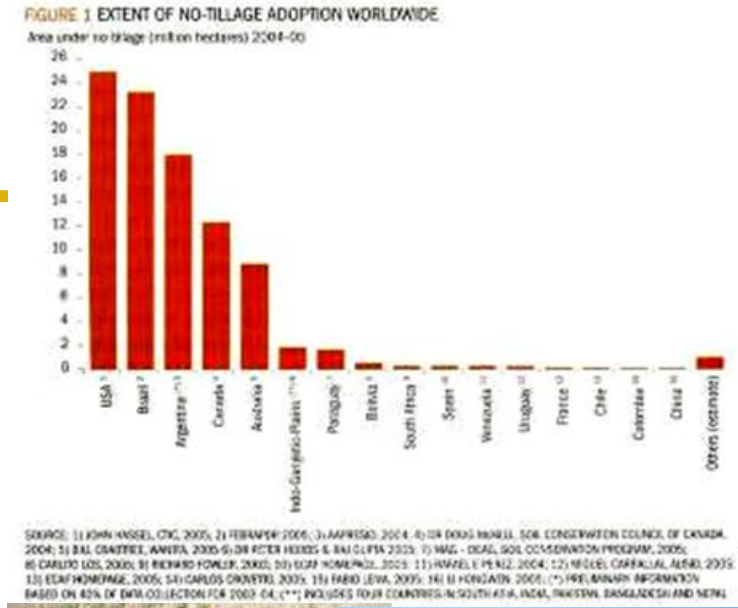
Western Australian wheat yield trends



Source: David Stephens

Zero tillage – key to conservation cropping

- minimum soil disturbance
- stubble retention
- widely adopted around the world
- mainly in developed countries



Strong benefits

- early sowing
- higher yield potential
- savings - time, machinery, fuel
- better soil structure (OM)
- better soil-water dynamics (porosity)
- better nutrient recycling (NPK)
- improved trafficability
- less pollution
- less erosion
- C sequestration (1%C = 33t/ha)

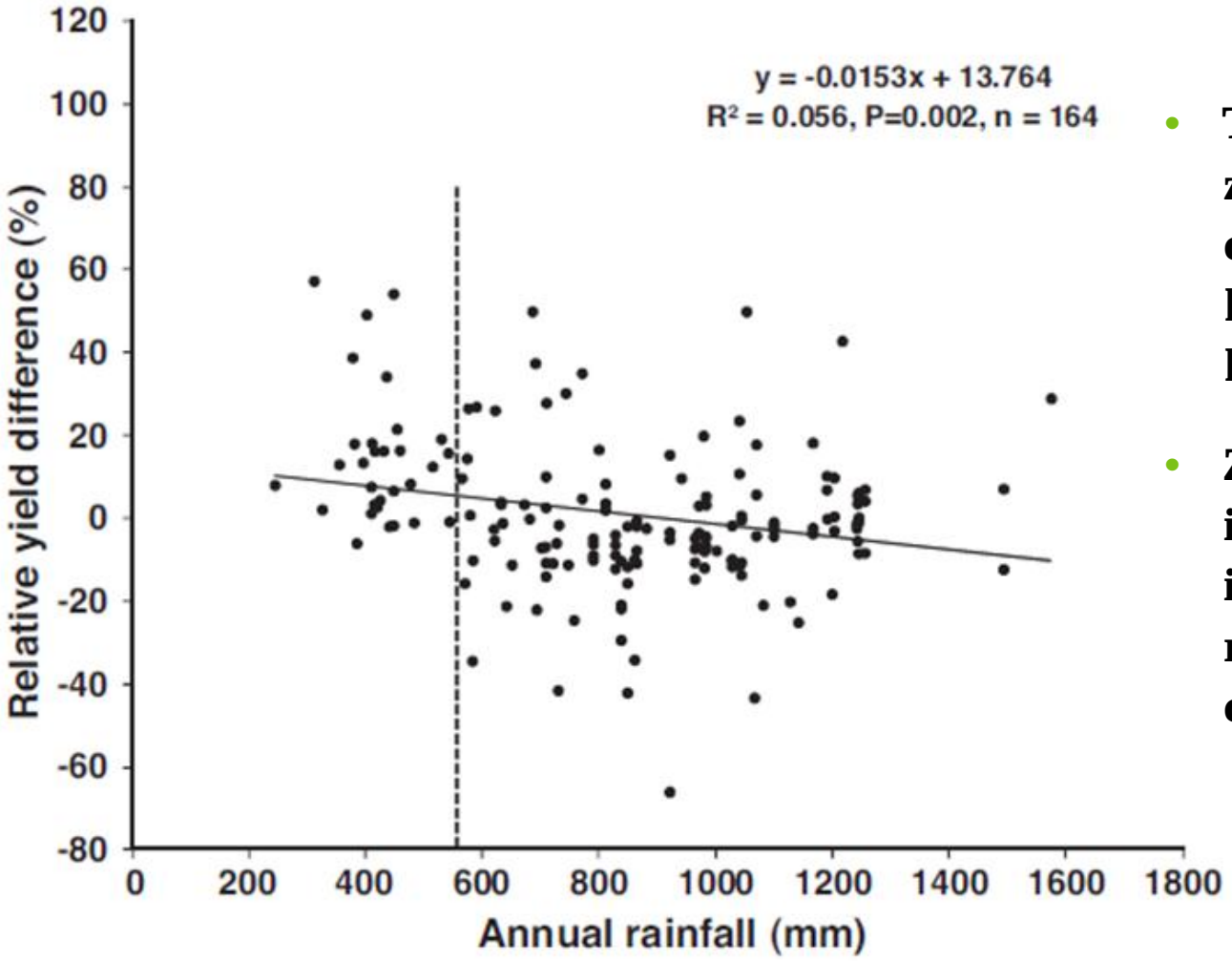

Make sure that every drop of rain goes in for potential use by the crop

No-Till technology with high levels of stubble retention

Long term no-till and controlled traffic (2006)
Water Use efficiency

= Yield / crop water use (Rainfall + stored – evaporation)
= 2000 kg/ha / (129mm + 81mm stored) – 80mm evaporation
= 15.38 kg/mm/ha

Benefits of zero tillage are higher in dry regions



- **The yield benefit of zero tillage over conventional tillage is higher at low than higher rainfall ;**
- **Zero tillage has immediate application in drylands especially in relation to soil water conservation.**

Source: Farooq, Flower, Jabran, Wahid & Siddique (2011). Soil & Tillage Research

Muhammad Farooq · Kadambot Siddique *Editors*

Conservation Agriculture

Conservation agriculture—consisting of four components including permanent soil cover, minimum soil disturbance, diversified crop rotations and integrated weed management—is considered the principal pathway to sustainable agriculture and the conservation of natural resources and the environment. In this book leading researchers in the field describe the basic principles of conservation agriculture, and synthesize recent advances and developments in conservation agriculture research. This book is a ready reference on conservation agriculture and reinforces the understanding for its utilization to develop environmentally sustainable and profitable food production systems. The book describes various elements of conservation agriculture; highlights the associated breeding and modeling efforts; analyses the experiences and challenges in conservation agriculture in different regions of the world; and proposes some pragmatic options and new areas of research in this very important area of agriculture. This book is an invaluable source of information for scientists, teachers and students in the fields of agronomy, farming systems, ecology and environmental sciences.

Life Sciences

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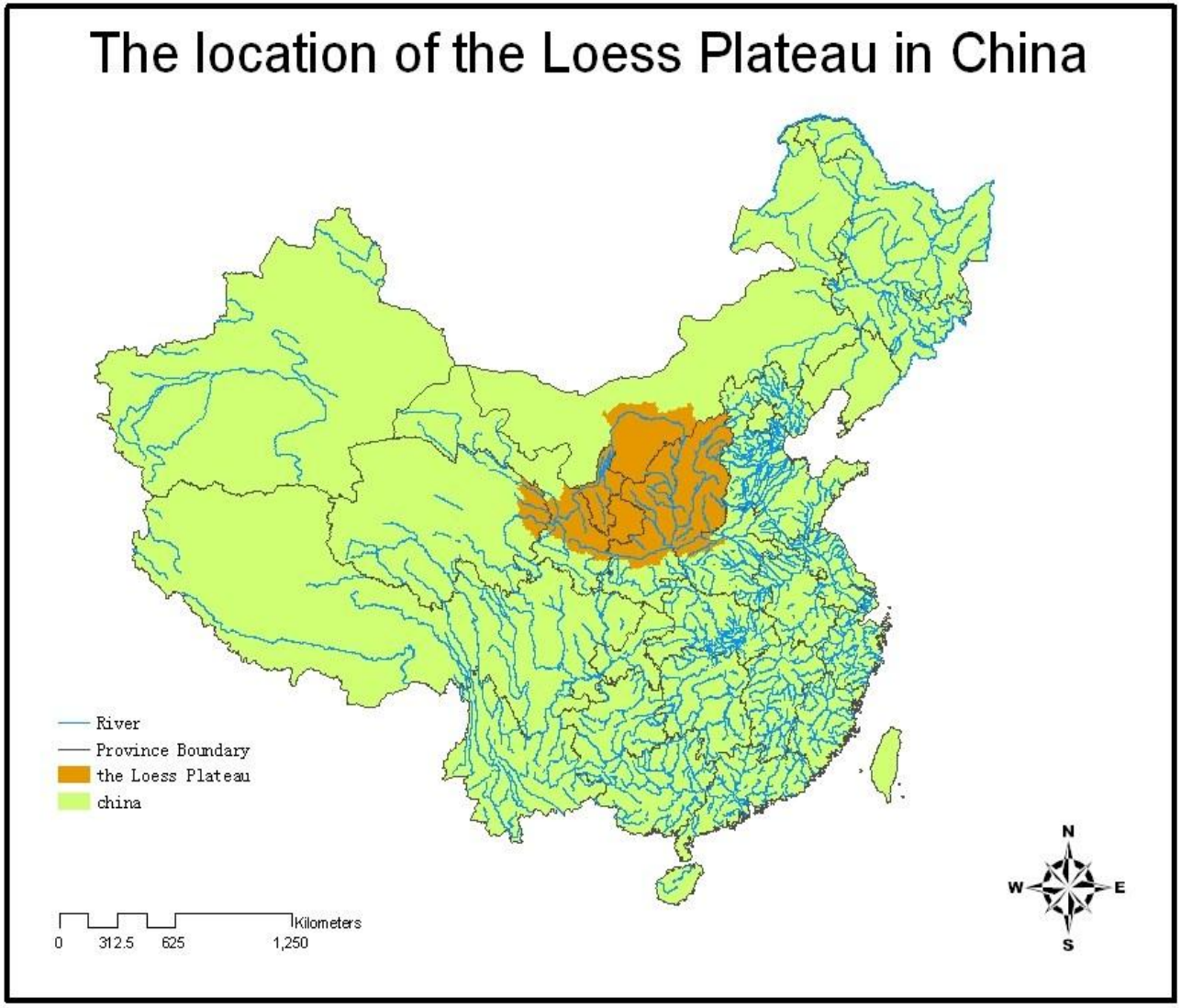
Conservation Agriculture

Muhammad Farooq
Kadambot Siddique *Editors*

Conservation Agriculture

Springer

Loess Plateau – Gansu Province



- The Loess Plateau covers 640,000 km2 in seven provinces and supports a population of 34 million people;
- 15 million ha is cultivated and half of this is on slopping land;
- Monsoonal continental climate- cold dry winters and warm wet summer.

Plastic Mulching Technology

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Ridge-Furrow Mulching Systems—An Innovative Technique for Boosting Crop Productivity in Semiarid Rain-Fed Environments

Yantai Gan[*,†], Kadambot H. M. Siddique[‡], Neil C. Turner[‡], Xiao-Gang Li[§], Jun-Yi Niu[*], Chao Yang[†], Liping Liu[¶], Qiang Chai[*,1]

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Advances in Agronomy, First Edition, 2013, 429-476

Water Productivity in China

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Water-Saving Innovations in Chinese Agriculture

Qiang Chai[*,‡,1], Yantai Gan[†,1], Neil C. Turner[¶], Ren-Zhi Zhang[*,‖], Chao Yang[†], Yining Niu[*,‡] and Kadambot H.M. Siddique[¶]

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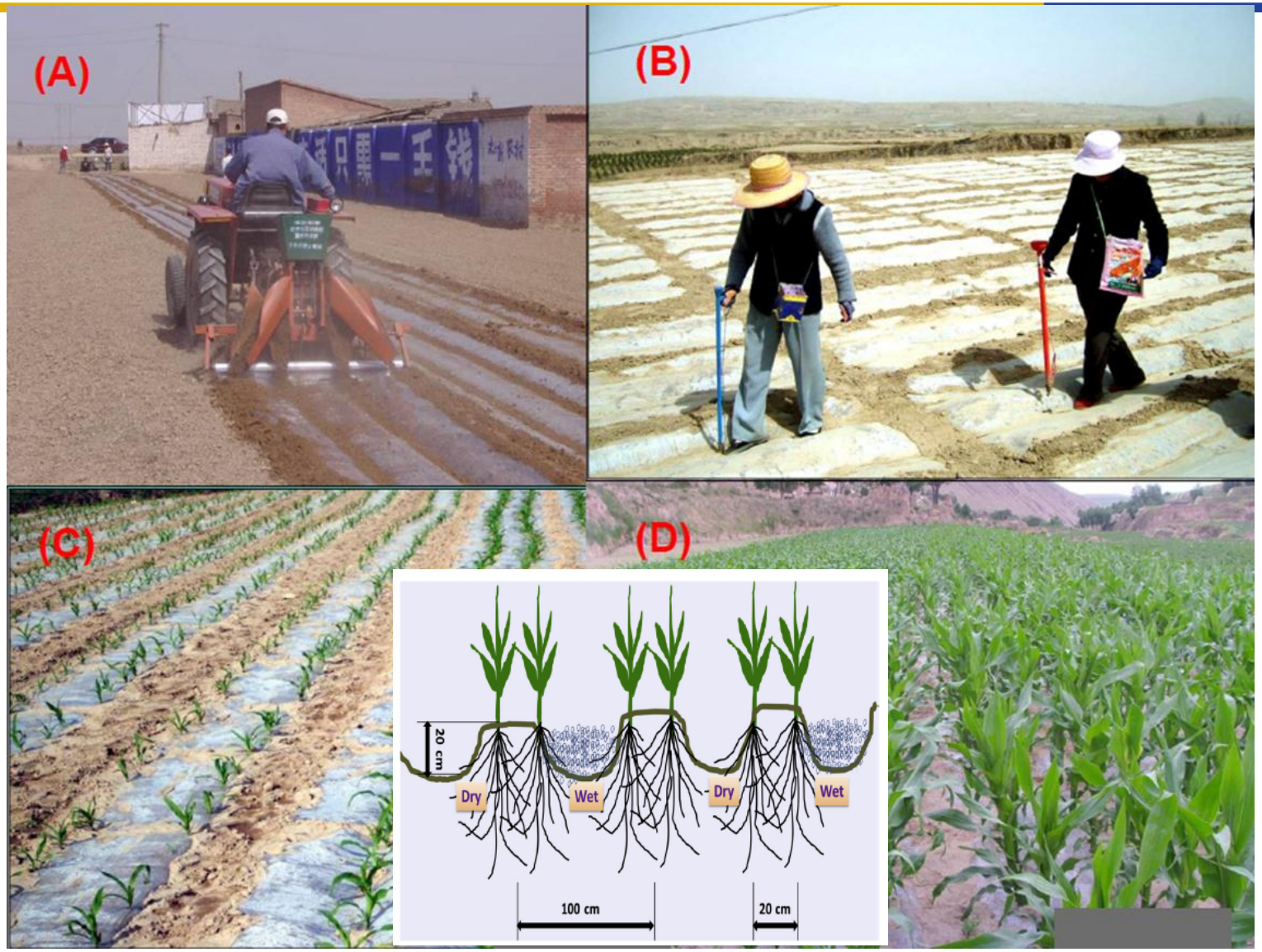
Plastic Mulch- Locally Developed Technology- Gansu Province, China



Chai *et al*. (2014). Advances in Agronomy

Yield: 7000-11000kg·ha-1
WUE: 19-30 kg·ha-1·mm-1

Yield: 2000-3500kg·ha-1
WUE: 7-10 kg·ha-1·mm-1

Protected Agriculture

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Facility Cultivation Systems "设施农业": A Chinese Model for the Planet

Jianming Xie*, Jihua Yu*,[1], Baihong Chen*, Zhi Feng*, Jie Li[†], Cai Zhao[‡,§], Jian Lyu*, Linli Hu*, Yantai Gan[¶], Kadambot H.M. Siddique[‖]

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Facility Cultivation System

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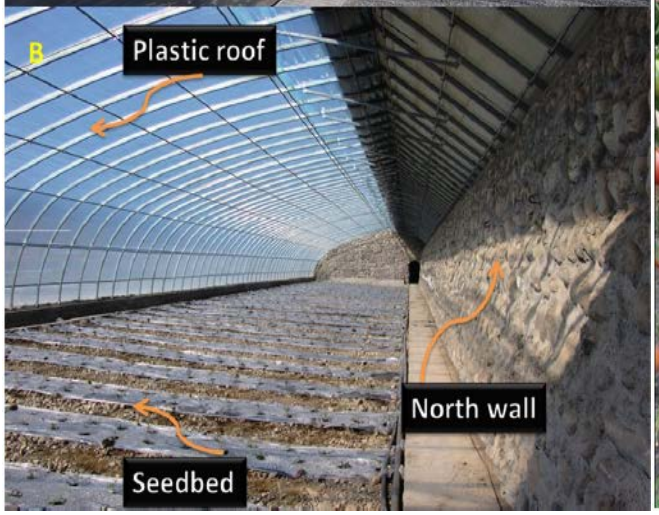

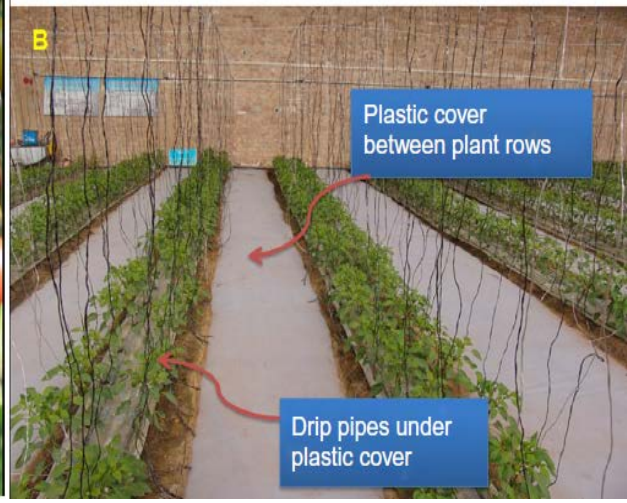

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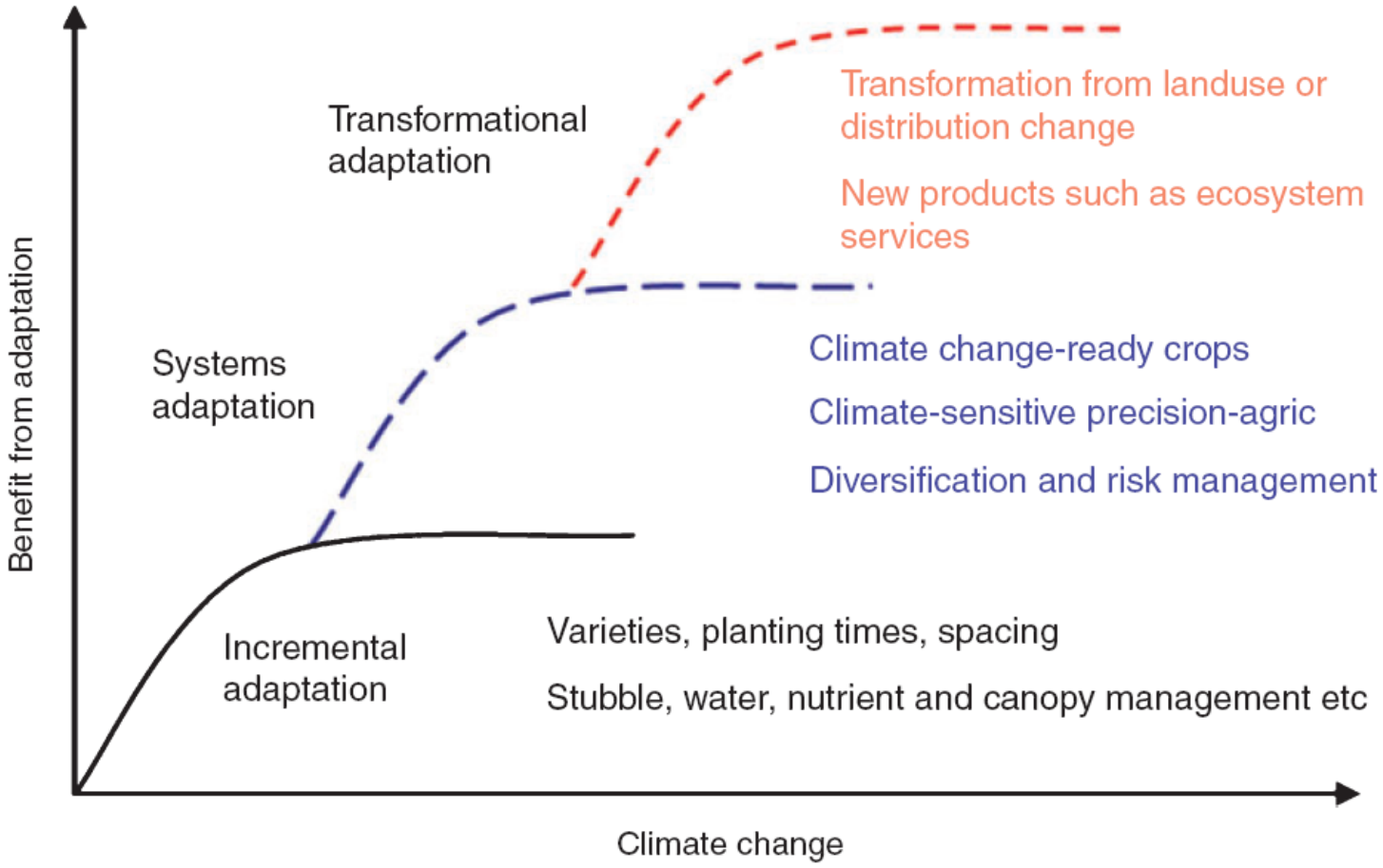
Levels of adaptation in relation to benefits from adaptation actions and degree of climate change



Source: Crop & Pasture Science L. Rickards and S.M. Howden 2012

Innovations in Dryland Agriculture

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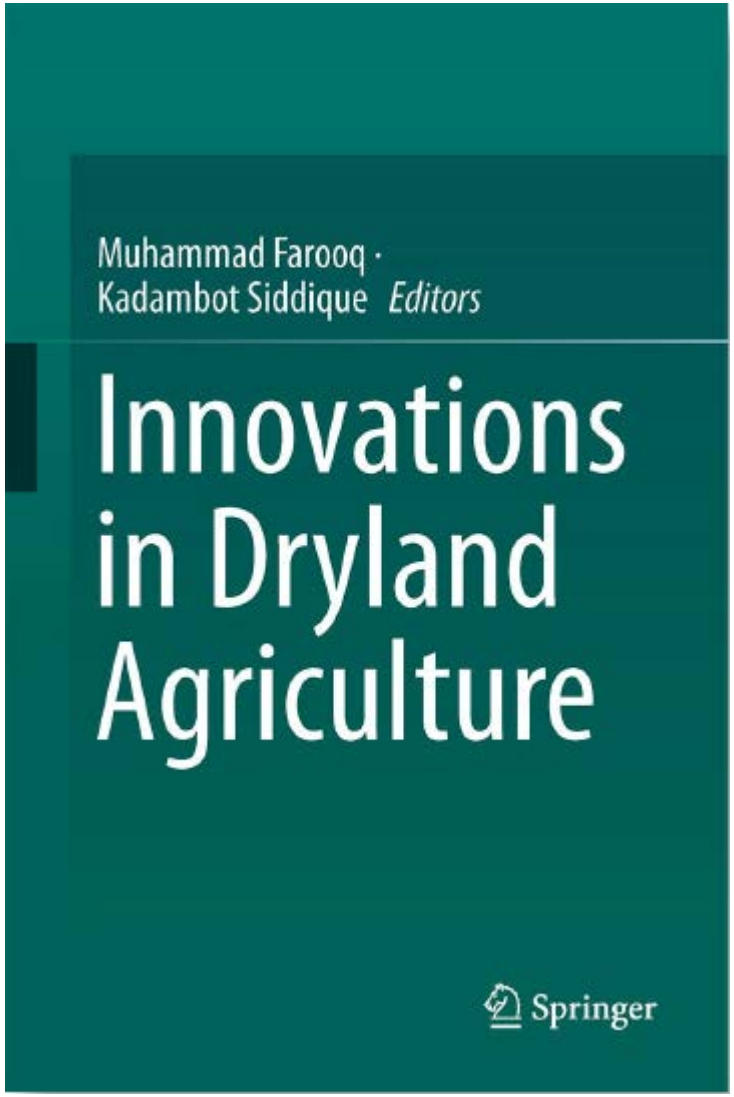

- **Written by experts in the fieldPresents innovations in dryland agriculture researchFocuses on sustainable and profitable food production systems in drylands**

In this book leading scientists in the field describe the basic principles of dryland agriculture, and synthesize recent experiences and innovations in dryland agriculture research and development. It is a ready reference on the subject and reinforces the understanding for its utilization to develop environmentally sustainable and profitable food production systems. Various elements of dryland agriculture are described, highlighting associated breeding and modelling efforts, analysing the experiences and challenges of dryland agriculture in different regions, and it proposes some practical innovations and new areas of research in this critical area of agriculture. This book is an invaluable source of information for scientists, teachers and students in the fields of agronomy, ecology, environmental sciences, range management, land and water management and sustainable livestock grazing systems.

Printed book

Hardcover

- **214,00 € | £159.50 | $249.00**
- ***228,98 € (D) | 235,40 € (A) | CHF 235.00**

eBook

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- **springer.com/shop**

Conclusions

Adaptation to climate change: R,D&E!

1. **Understand past changes and past adaptation, improve systems understanding, quantifying impact of change**
2. **Understand future climate change (regional downscaling, uncertainty & risk management)**
3. **Specific breeding:**
   - Increase WUE (also good now!)
   - Increase heat resistance (more critical in future)
   - Maximise benefits from elevated CO2 (ignored in past!)

Conclusions

4. Seasonal forecasts (rainfall, extreme T) – is needed now, but even more critical in future
5. Thresholds & critical events (e.g. more or less erosion with climate change?); new weeds, pests & diseases
6. Communicate with farmers what we know & do not know