Conservation agriculture

"Key to intensifying crop production"

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Who are we?

Federation of European National Associations promoting Conservation Agriculture

Non-Profit association

Based in Brussels

Our objectives

- To promote of the concept of Conservation Agriculture throughout Europe

- To be the European platform for exchange of information and experience on Conservation Agriculture

Overview

- Need to produce more? How much?
- Facts and Uncertainties
- How to meet the demand?
- The role of Conservation Agriculture
- The evidence
- Conclusions

Global food demand and need to increase crop production?

Projections range from **<u>60 – 110% until 2050</u>**

Tilman et al., 2011

Ray et al., 2013

Hall and Richards, 2013

FAO, 2009. Global agriculture towards 2050

OECD/FAO, 2012. Agricultural Outlook 2012–2021

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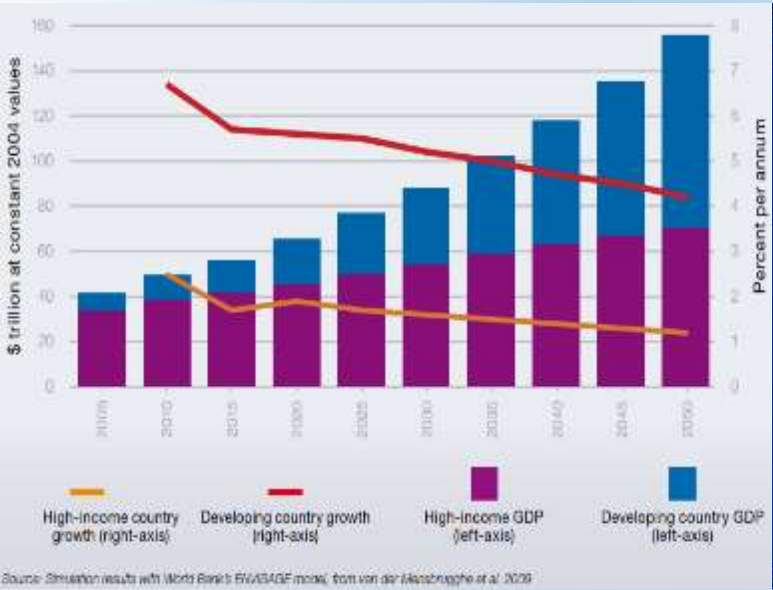
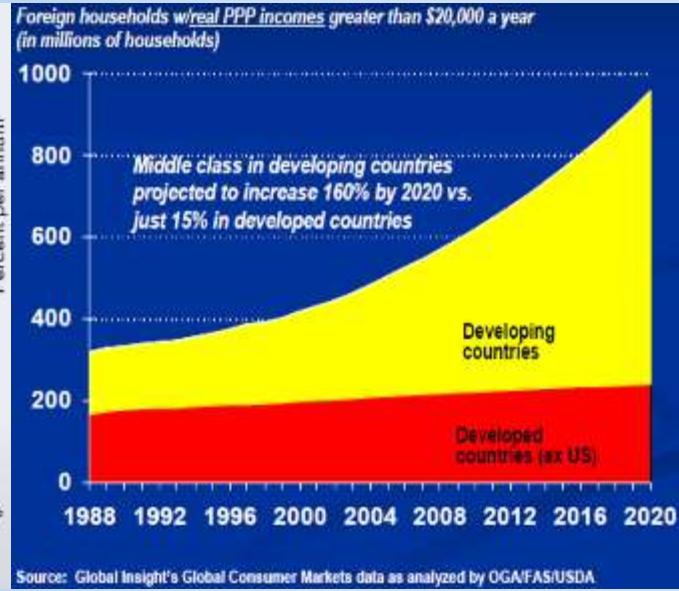
Facts and Uncertainties

- Population growth

Region	2011	2050	Change	Percent
World	6,987	9,587	+2,600	+ 38
High Income	1,242	1,333	+ 91	+ 7
Low Income	5,745	8,254	+2,509	+ 44
East & S.E. Asia	2,183	2,308	+ 125	+ 6
South Central Asia	1,795	2,574	+ 779	+ 43
Sub-Saharan Africa	883	2,069	+1,186	+134
Lat. America/Carib	596	746	+ 150	+ 25
N. Africa & W. Asia	451	725	+ 274	+ 61

❑ **Income growth**





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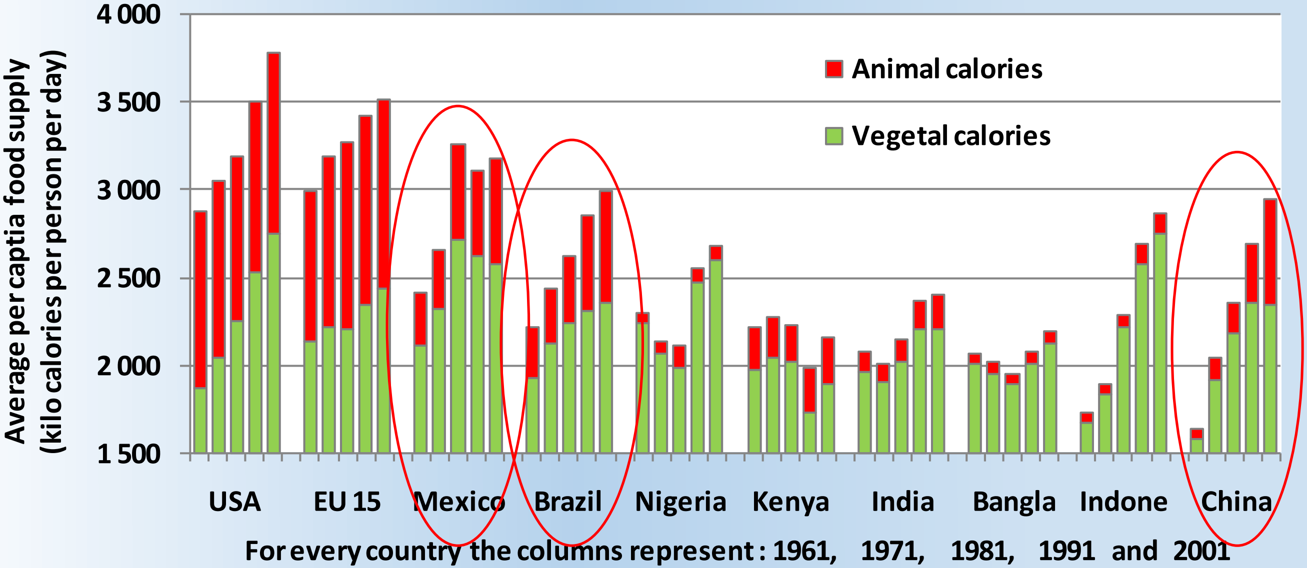
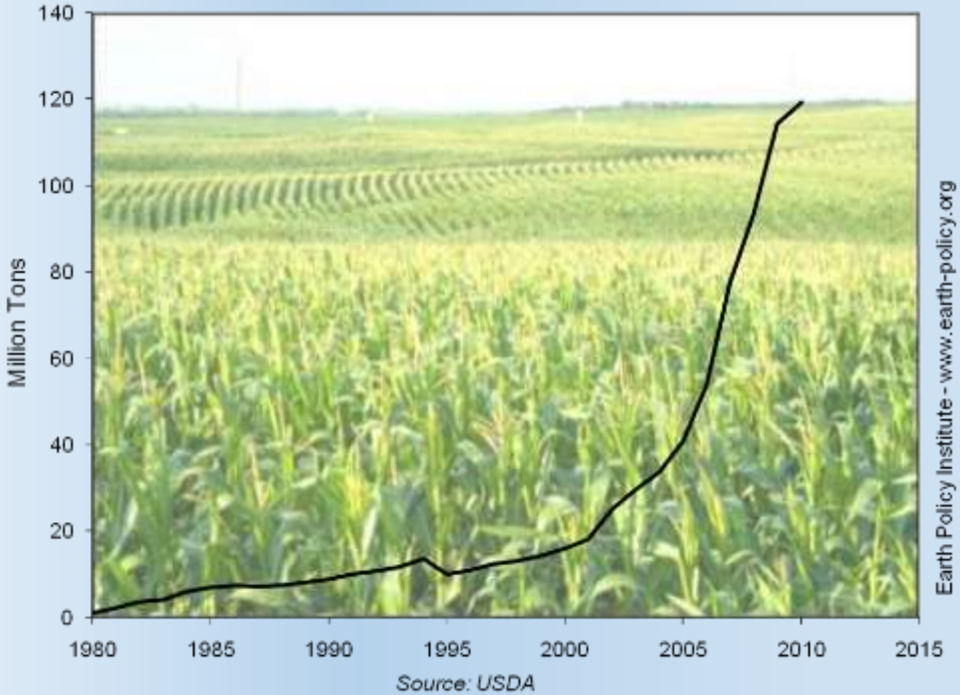
❑ Contribution of Dietary Changes



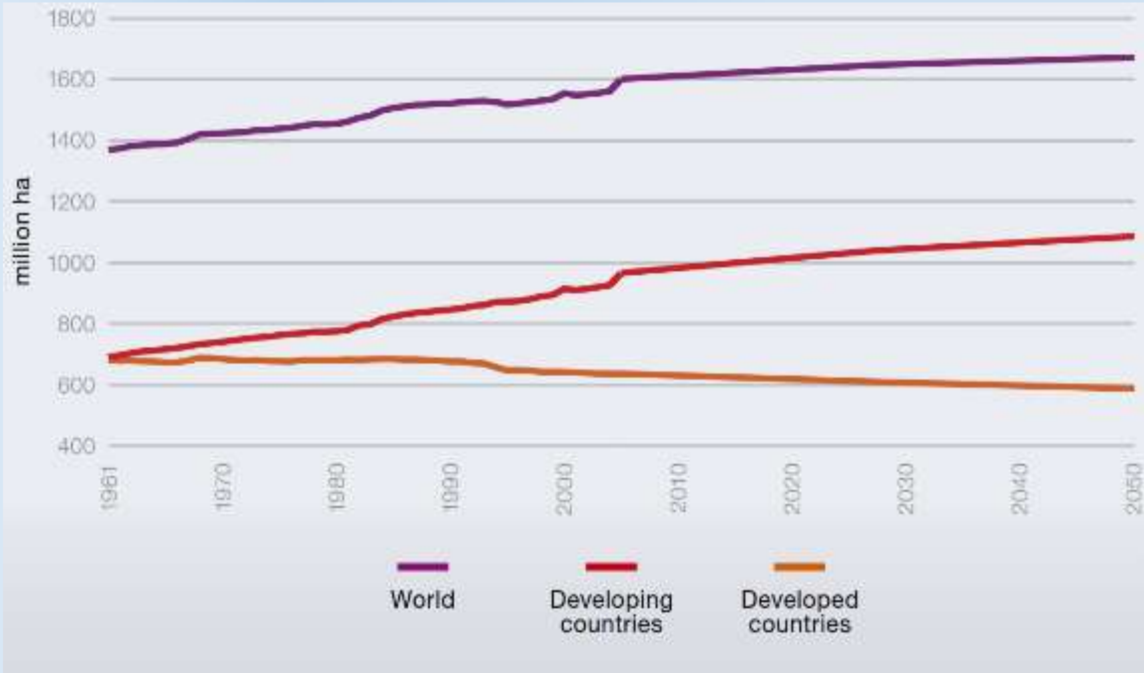
Lannerstad 2009

❑ **Requirements for biofuels**



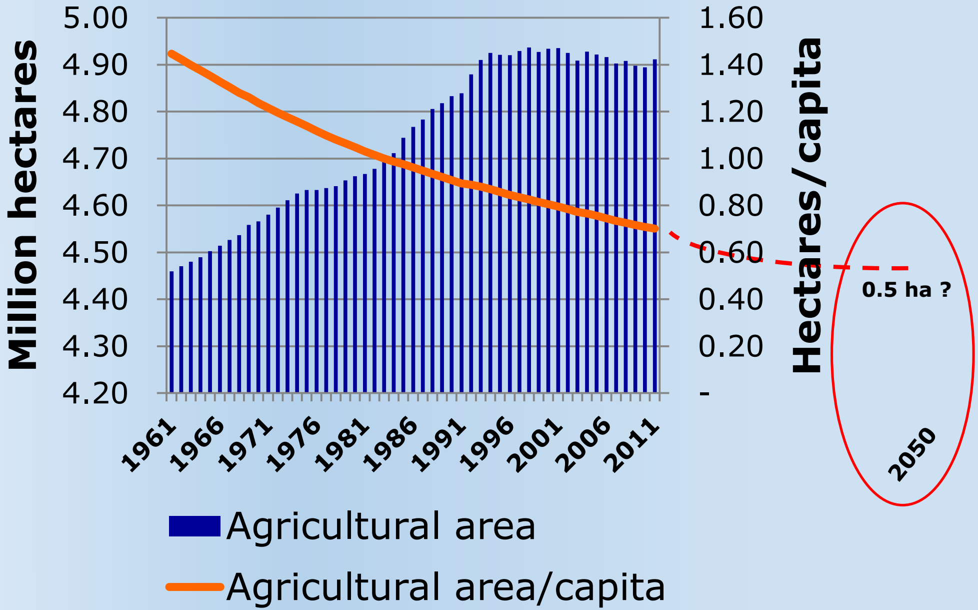
❑ Land availability and Land loss

Arable Land



Source: Bruinsma, 2009

❑ Land availability and Land loss



Source: FAOstat, Rabobank 2014

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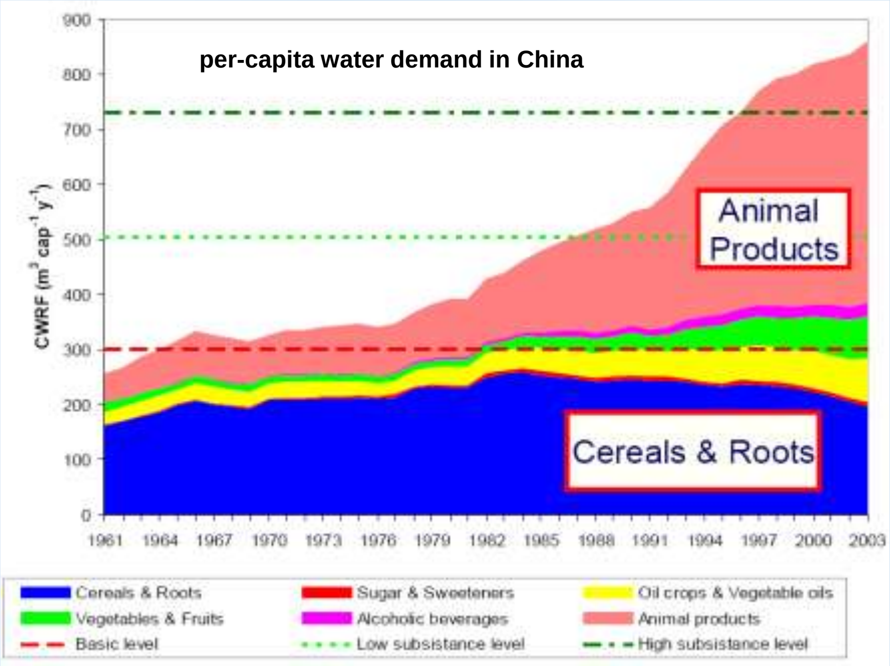
❑ The Water constraint

The global use of blue water

Year	Total	Agriculture	Industrial	Urban	Agriculture (% of total)
	-----------------------$10^9 m^3/a$-------------------				
1900	430	**350**	30	20	**81.4**
1940	870	**660**	120	40	**75.9**
1950	1190	**860**	190	60	**72.3**
1960	1990	**1510**	310	80	**75.9**
1970	2630	**1930**	510	120	**73.4**
1975	3080	**2100**	630	150	**68.2**
1985	3970	**2400**	1100	250	**60.5**
1995	4750	**2760**	1560	320	**58.1**
2000	6000	**3400**	1900	440	**56.7**

(Kondratyev et al., 2003)

❑ The Water constraint



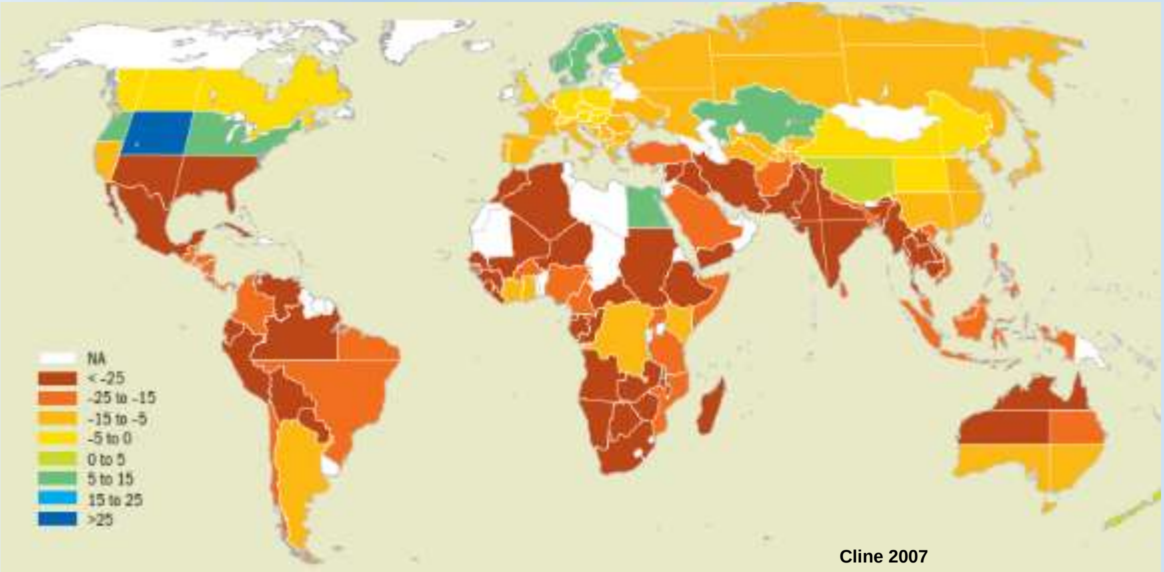
250 -> 860 m^3 between 1960 and 2000

China's population doubled during that period

Liu et al 2008

❑ The Climate constraint

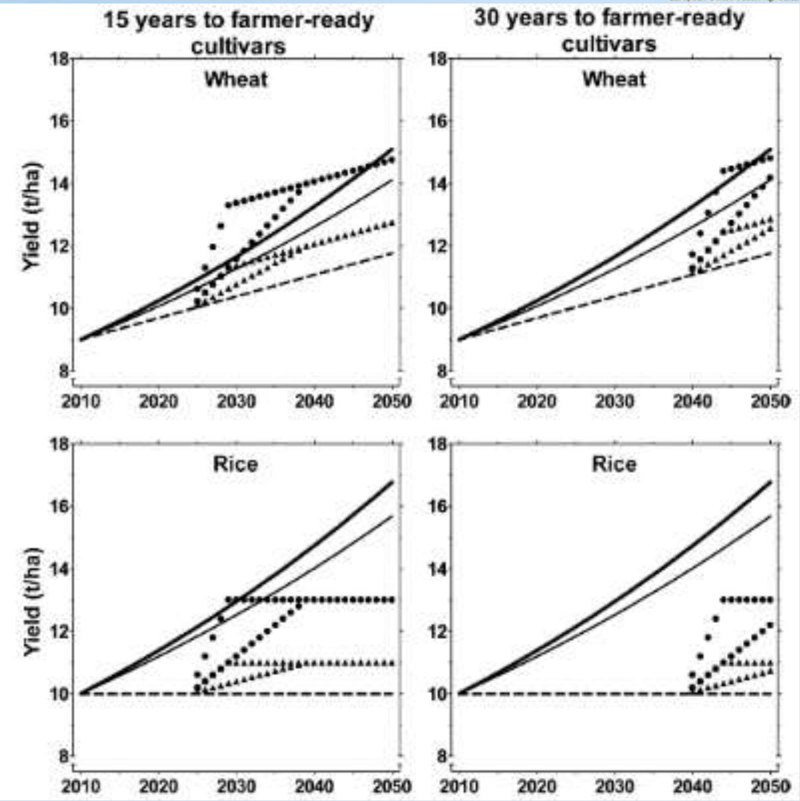
Climate-induced percent change in agricultural productivity between 2003 and the 2080s (without carbon fertilization)



How to meet the demand?

Rely on our capacity for a new Green Revolution?

❑ Genetic yield potential improvements?



- - · Current linear increase rates

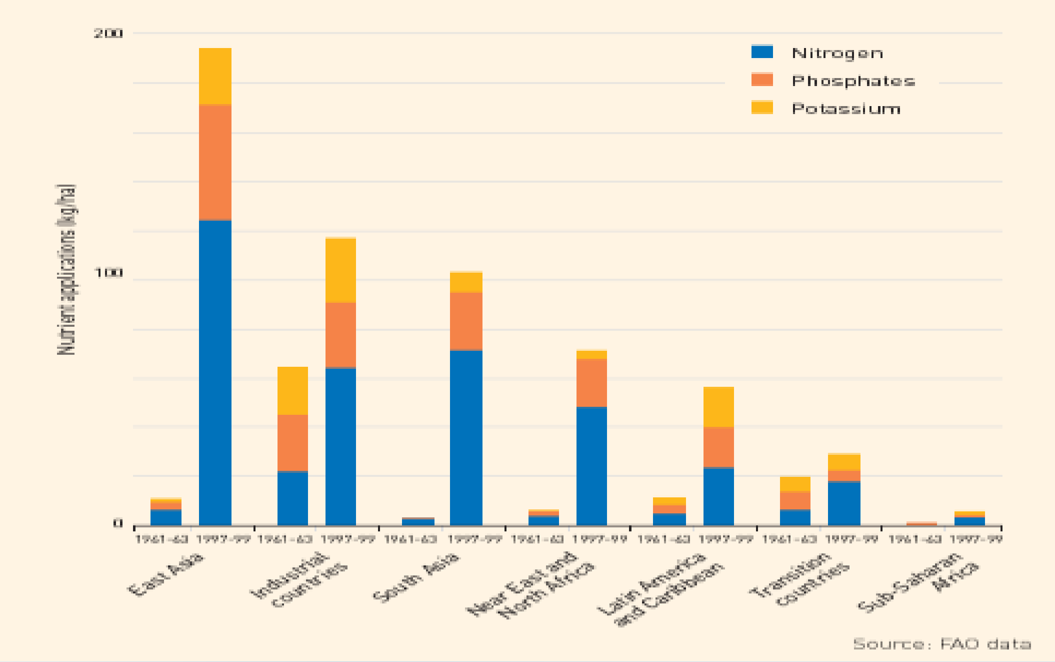
—— yield increase of 1.16% y^{-1}

—— yield increase of 1.31% y^{-1}

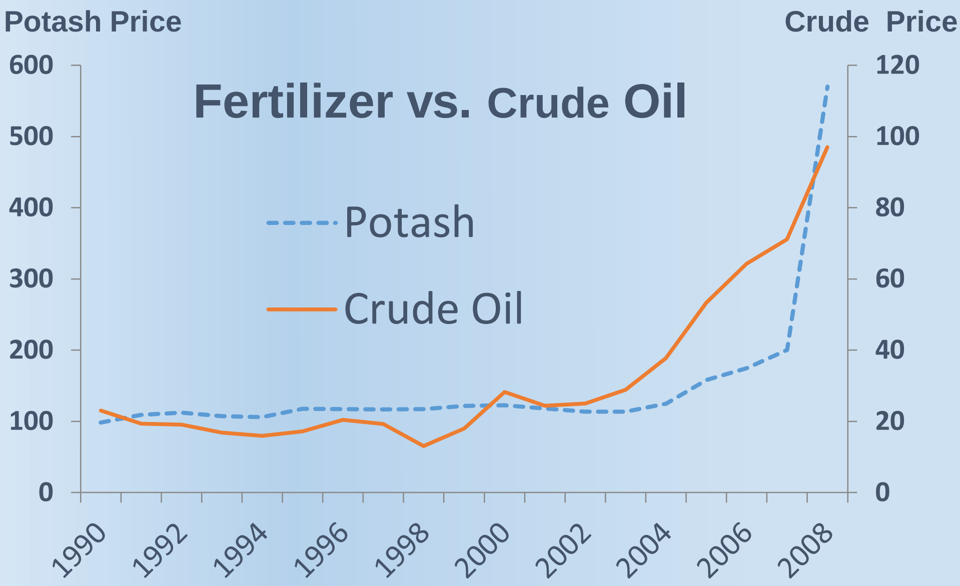
• and ▲ - **Different rates of adoption**

Hall and Richards, 2013

❑ Increase inputs to boost productivity?



- Increase inputs to boost productivity?

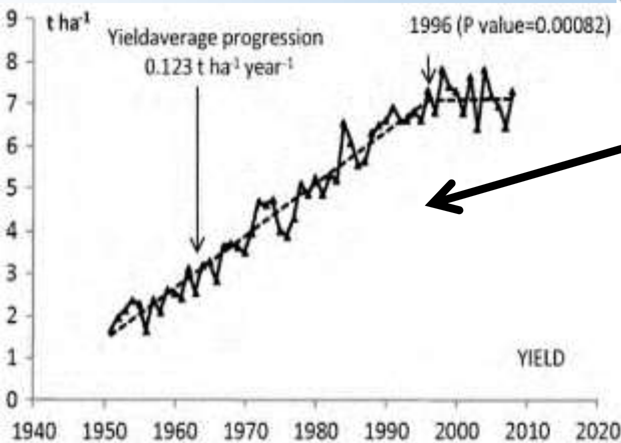


Source: IMF International

Reality and model previsions tell a different story

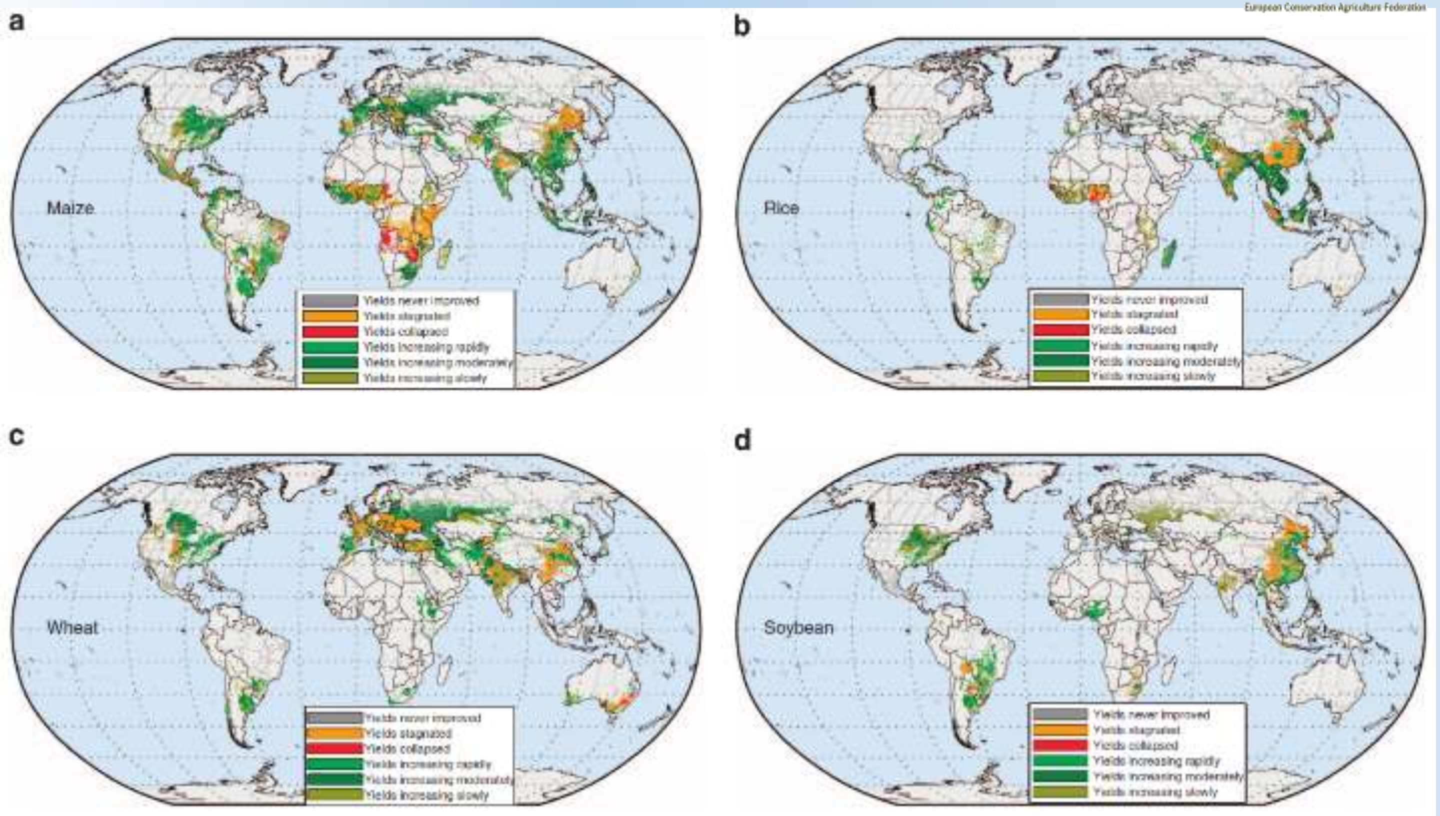
❑ Stagnating Yields

Rising-plateau regression analysis of wheat yields throughout various European countries

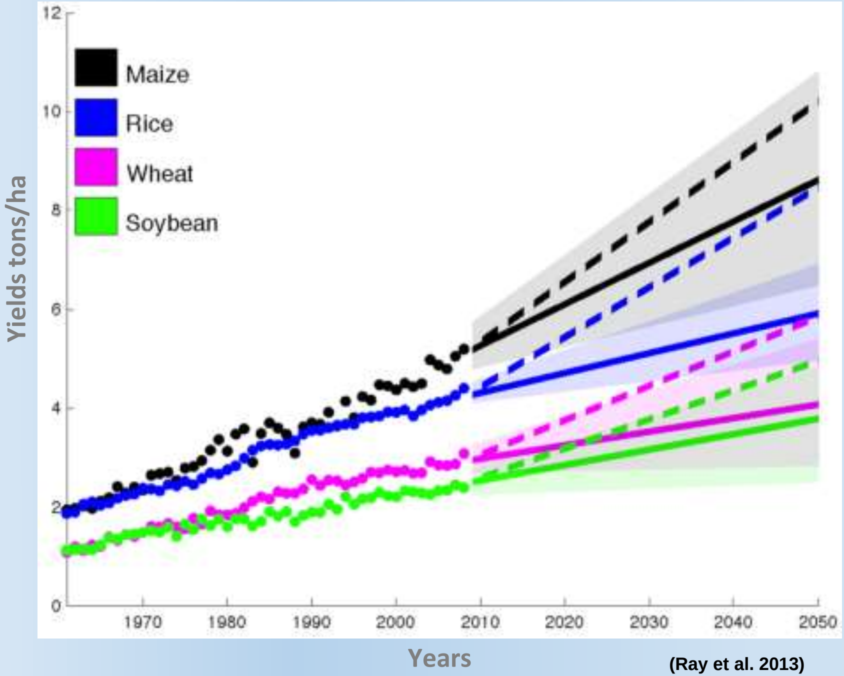


Country	Year of stagnation
Denmark	1995 (**)
France	1996 (**)
Germany	1999
Italy	1994
Netherlands	1993 (**)
Spain	1989
Switzerland	1990 (**)
United Kingdom	1996 (**)

(Brisson et al. 2010)


a
Maize
Yields never improved
Yields stagnated
Yields collapsed
Yields increasing rapidly
Yields increasing moderately
Yields increasing slowly
b
Rice
Yields never improved
Yields stagnated
Yields collapsed
Yields increasing rapidly
Yields increasing moderately
Yields increasing slowly
c
Wheat
Yields never improved
Yields stagnated
Yields collapsed
Yields increasing rapidly
Yields increasing moderately
Yields increasing slowly
d
Soybean
Yields never improved
Yields stagnated
Yields collapsed
Yields increasing rapidly
Yields increasing moderately
Yields increasing slowly

❑ The Yield gap



(Ray et al. 2013)

How to meet the demand?

In terms of **technology options** this means to **identify and address** regionally/locally **biotic and abiotic factors** that limit the increase of sustainable productivity growth

These must include:

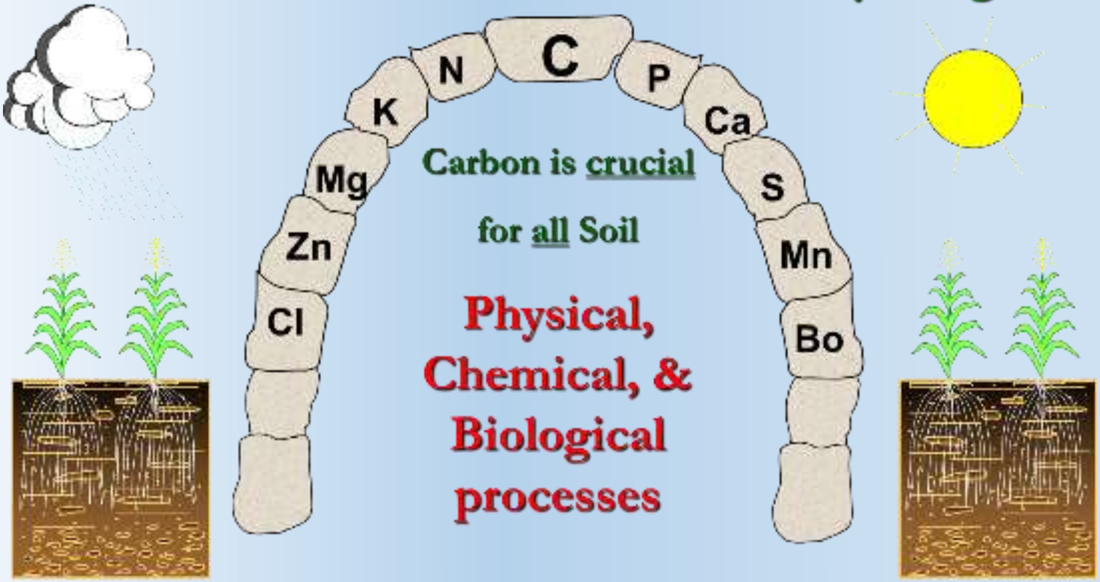
- **Breeding efforts towards:**
  - ✓ Productivity
  - ✓ Resistance to diseases and pests
  - ✓ Adaptation to warmer climates
- **Adoption of production systems that reduce risks and enhance resilience and sustainability**
  - ✓ Climate variability and change
  - ✓ Improvement of use efficiency of production factors and resources

The role of CA, the ‘Brown Revolution’…

and its proven capacity to:

- **Enhance Soil ‘Quality’, based on SOC**

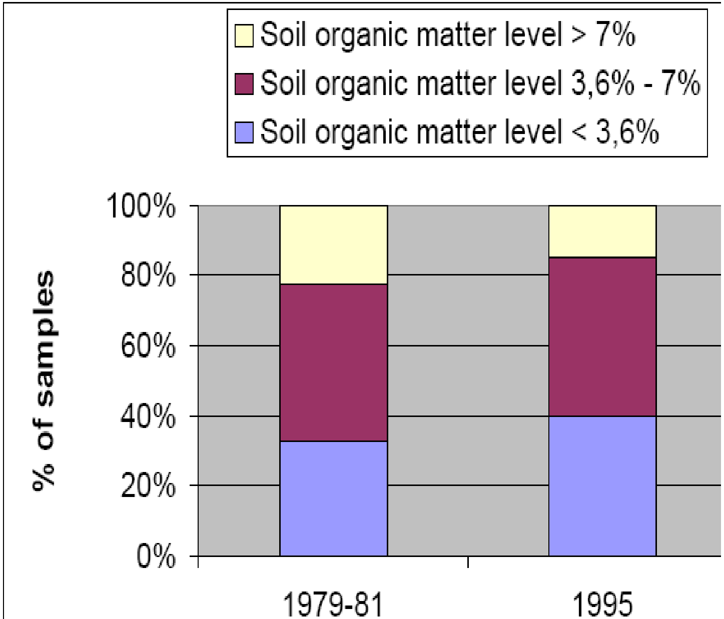
Soil Carbon for Nutrient Cycling



climate, soil type, production system, rotations, cover crops, fertility, organic manures, variety, inputs, irrigation etc.

Credit: Reicosky 2005

❑ Changes in soil organic matter in UK (left) and France (right)



Data cover England and Wales. Source : MAFF (2000)

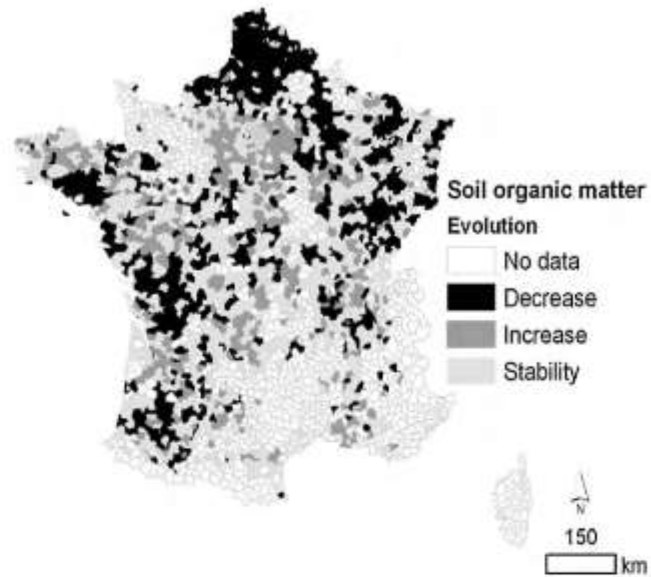


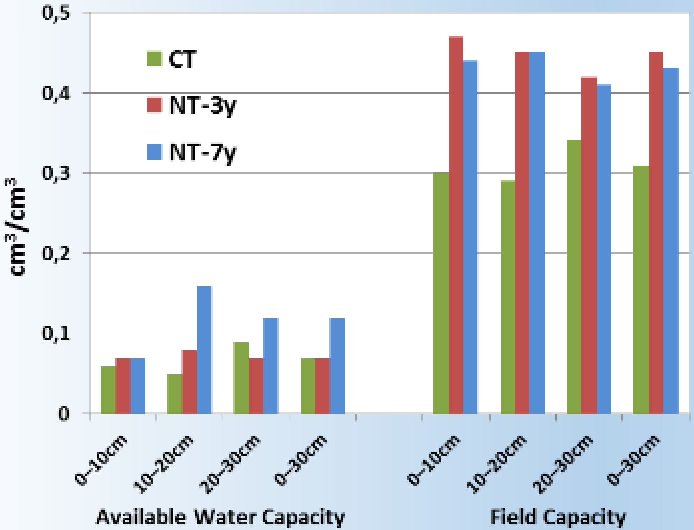
Fig. 8. Soil organic matter (organic C in g kg^{-1}) evolution between 1990 and 1994 and 2000 and 2004 periods. *Source*: INRA.

The role of CA, the 'Brown Revolution'…

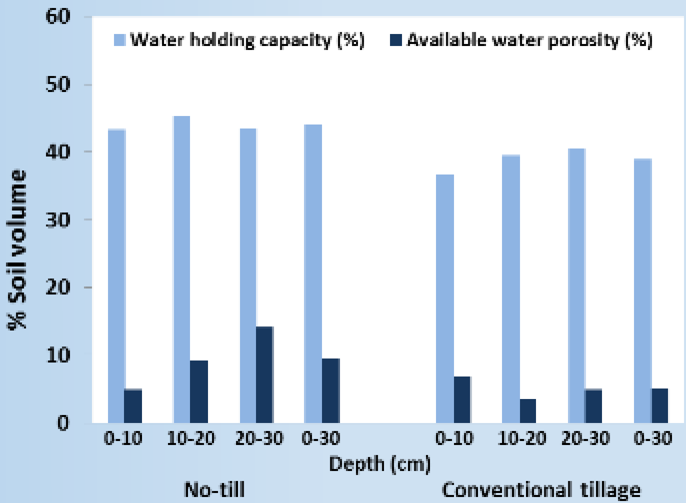
and its proven capacity to:

- Enhance Soil 'Quality', based on SOC
- **Improve Water Use Efficiency**

❑ Water availability under different soil management systems



Source: Jemai et al. 2013



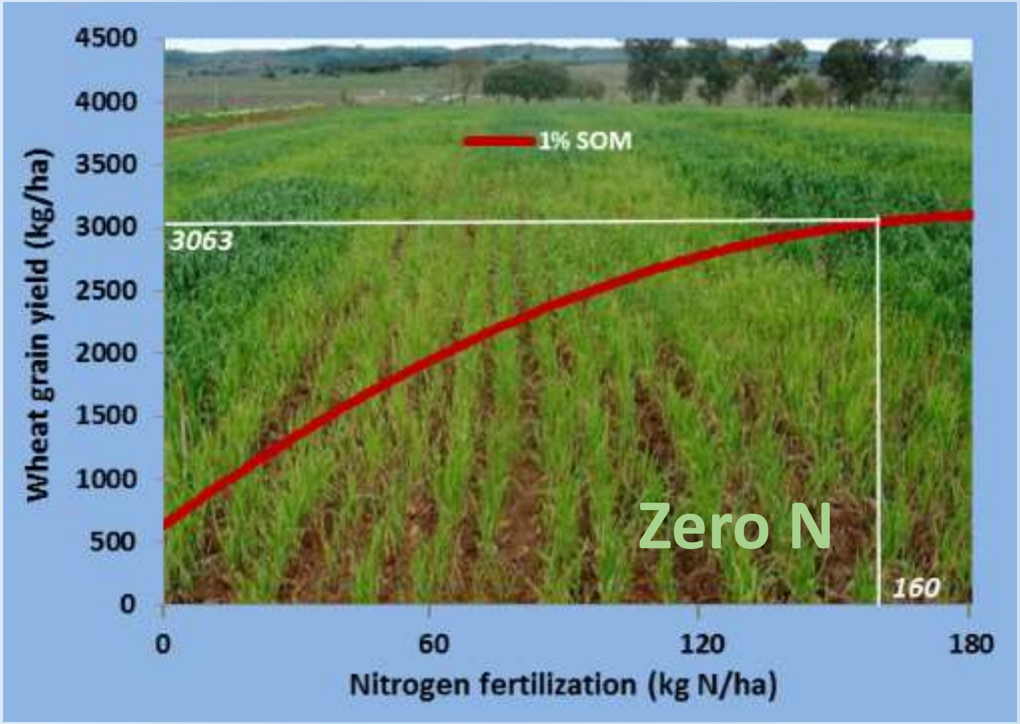
Source: Carvalho and Basch, 1995

The role of CA, the 'Brown Revolution'…

and its proven capacity to:

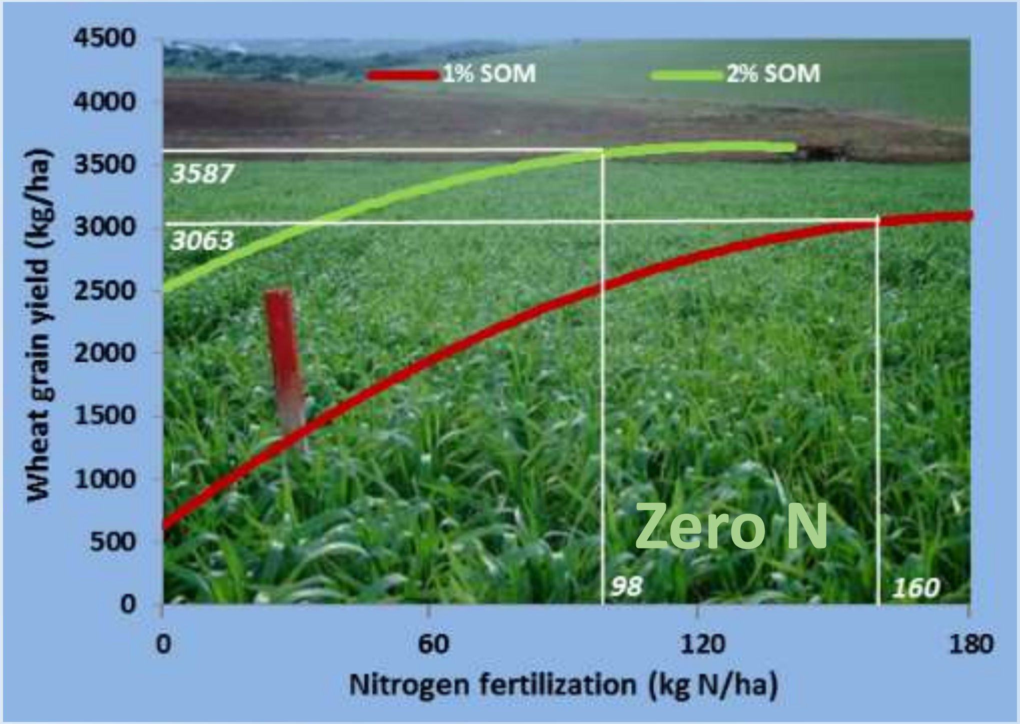
- Enhance Soil 'Quality', based on SOC
- Improve Water Use Efficiency
- **Reduce the need for external inputs**

❑ Wheat yield response to nitrogen fertilization (Conv. Tillage)



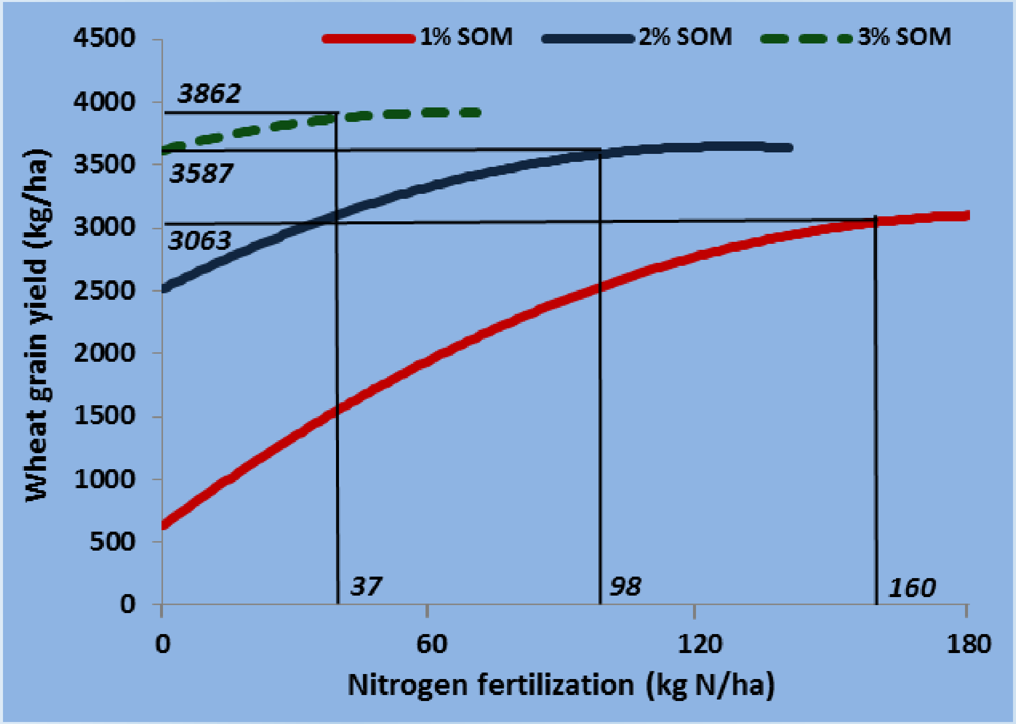
Carvalho et al., 2012

❑ **Wheat yield response to nitrogen fertilization (after 11 years of CA)**



Carvalho et al., 2012

❑ Wheat yield response to nitrogen fertilization (according the model)



Carvalho et al., 2012

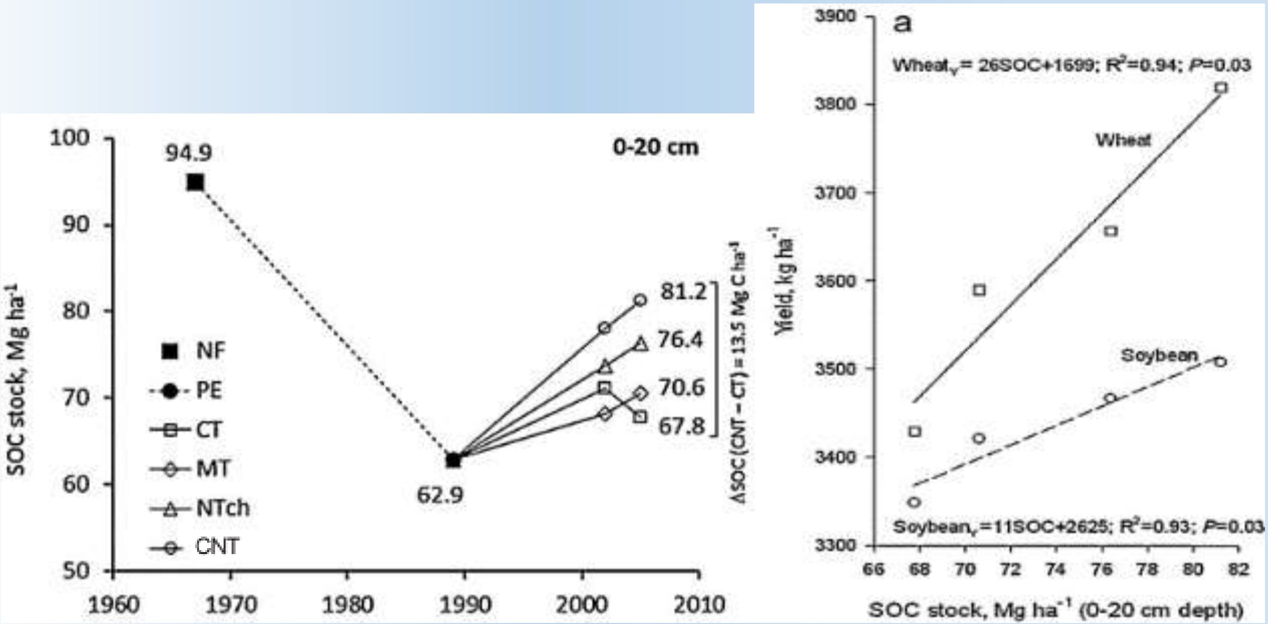
The role of CA, the ‘Brown Revolution’…

and its proven capacity to:

- Enhance Soil ‘Quality’, based on SOC
- Improve Water Use Efficiency
- Reduce the need for external inputs
- **Provide much more…**

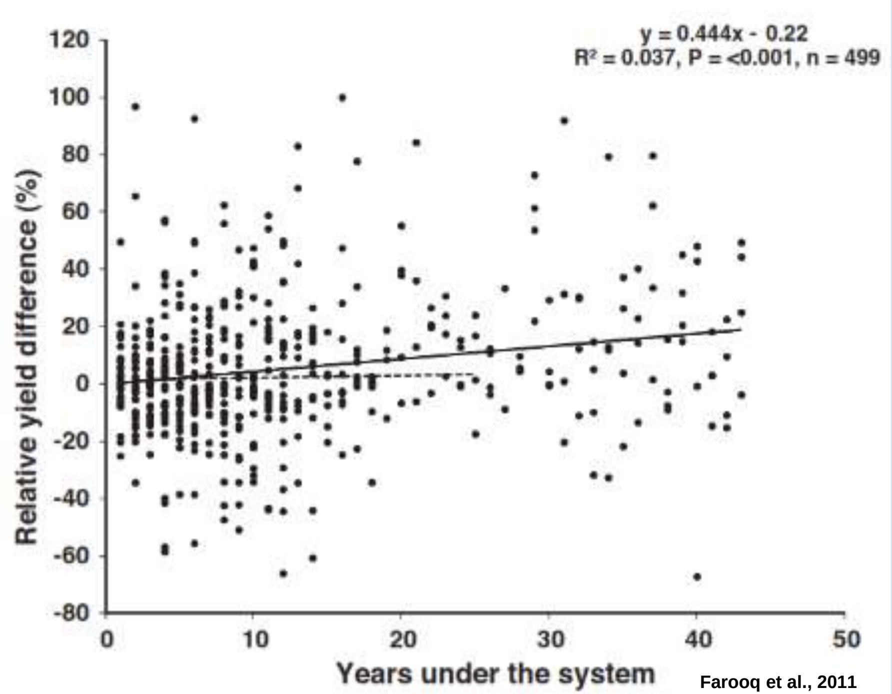
The evidence

❑ Evolution of SOC under different soil management systems and its effect on agronomic productivity



Sá et al. 2013

❑ **Regression of relative yield difference [(CA - CVT)/CVT) x 100]**



Farooq et al., 2011

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❑ Empirical evidences: the case of 'likoti' in Lesotho

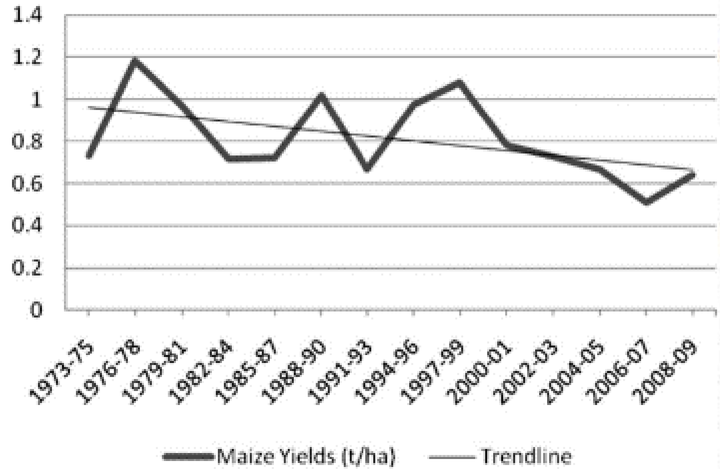


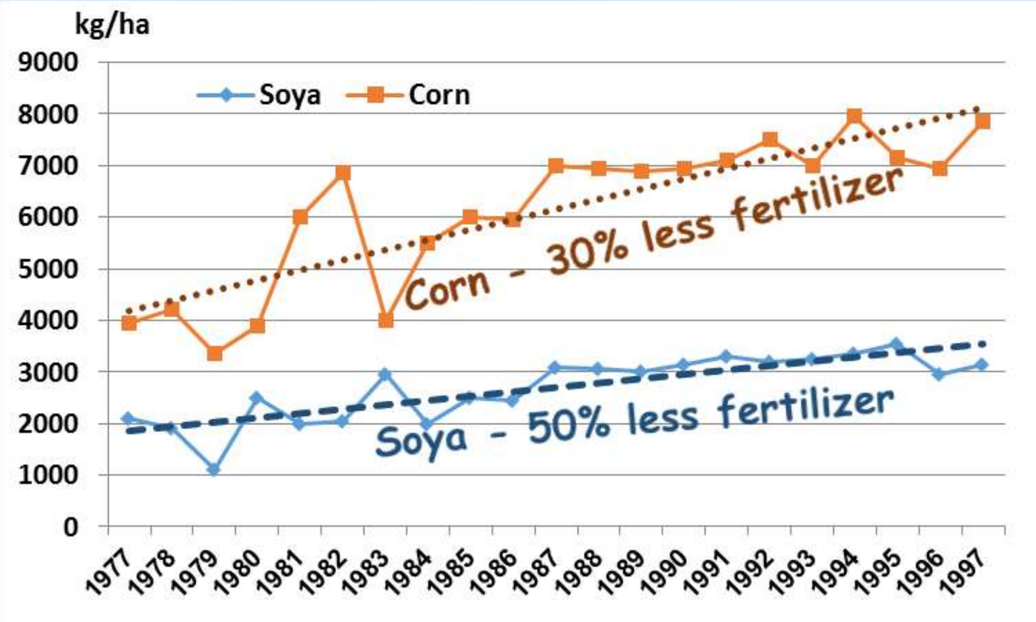
Table 1 | **Average maize yields (t/ha), by location and tillage method**

Location	**Number of observations**		**Average yield (t/ha)**	
	Likoti	**Ploughed**	***Likoti***	**Ploughed**
Makhoakhoeng (Butha-Buthe)	14	15	1.36	0.87
Tebellong and Tsoelike (Qacha's Nek)	21	n/a[1]	0.73	0.2[1]

[1]District average yields, 2005/2006 agricultural production season (WFP and FAO, 2006).

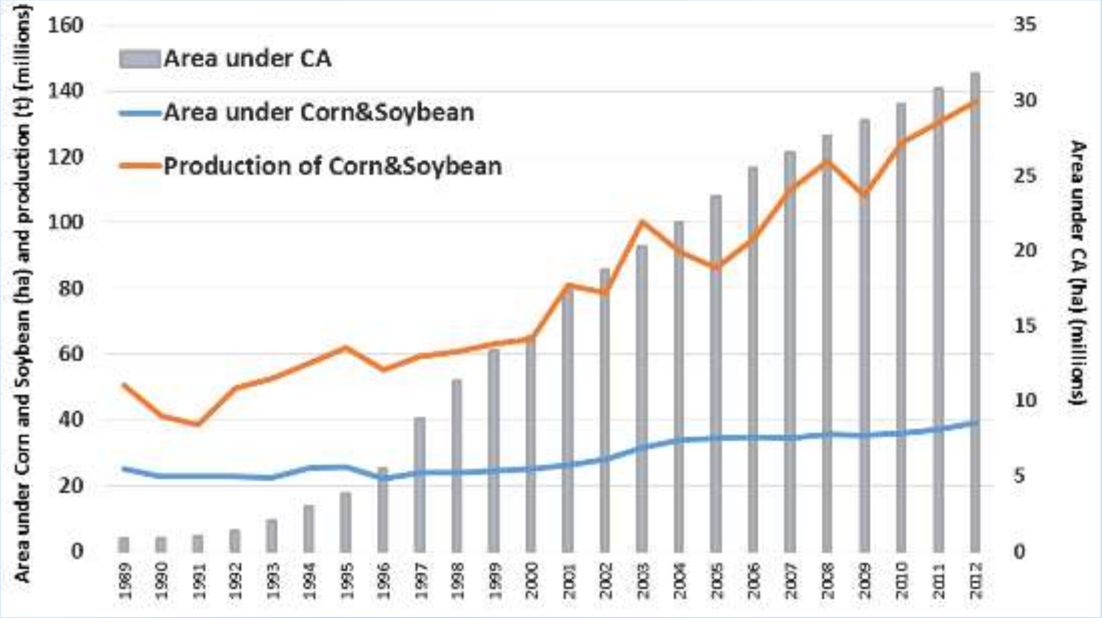
Silici et al. 2011

❑ Empirical evidences: the Frank Dijkstra farm in Ponta Grossa, Brazil



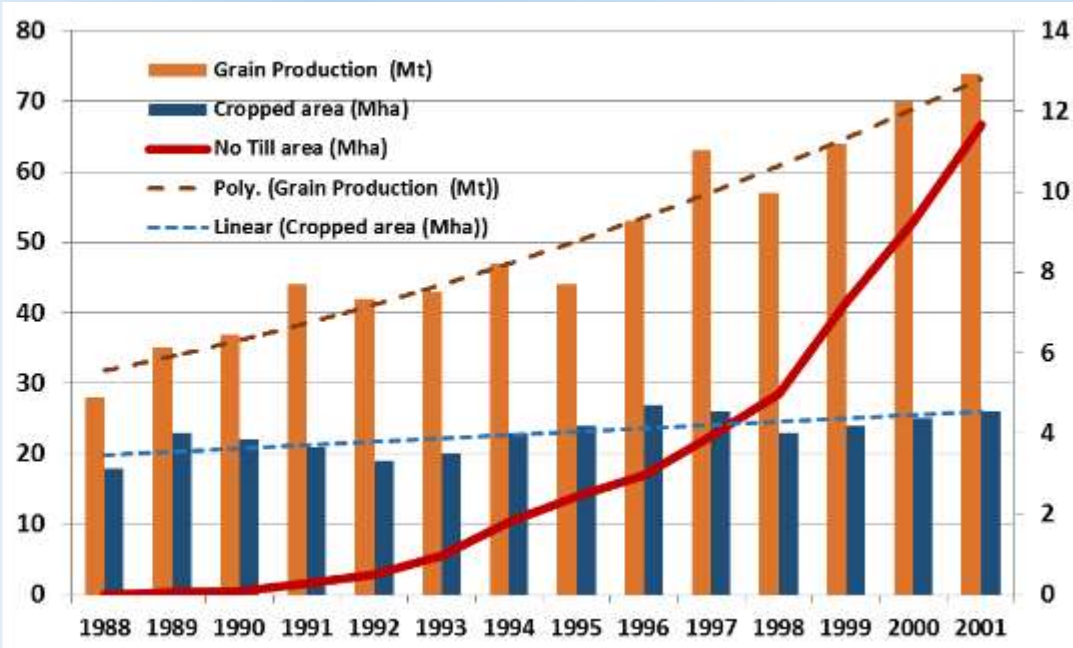
Source: Dijkstra, 1998

❑ Empirical evidences: Brazil - adoption of CA and evolution of yields



Source: FEBRAPDP & CONAB, 2012, FAO 2013

❑ Empirical evidences: Argentina - adoption of CA and evolution of grain yields



Source: Peiretti, 2002

Conclusions

- **BAU not an option to intensify production as necessary**
- **Production systems must and can contribute much more to meet future demand**
- **CA production systems do this more efficiently**
- **Land, water and climate constraints affect regions differently. Especially resource-poor regions would benefit from CA.**

Conclusions (2)

- **Policy and institutional support is needed for CA to be adopted and to fully contribute to future food demand**

- **For developed regions, there is potential to improve sustainability and efficiency of production at high yields with CA**

- **For developing regions, greater output is possible with less resources with CA.**

Thank you for your attention