The No-Till Show and Conference, Groundswell, Weston Park Farms, Hitchin, Hertfordshire, UK, 29 June 2017

The Revolution of No-Till System: A Global Perspective

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Global Conservation Agriculture Community of Practice (CA-CoP)

Outline

- Why the need for a worldwide No-Till System revolution?

- What does the No-Till System revolution offer in terms of mobilizing greater crop and land potentials?

- What is the global scale and geographical spread of No-Till System revolution

Conventional land preparation
regular tillage, clean seedbed, exposed





Effects:

- Loss of organic matter
- Destruction of biological life & processes
- Loss of pores, structure →→soil compaction, erosion & degradation

LEAF’s Simply Sustainable Soils Solution for improving sustainability of land.

Rothamsted Research – DEFRA’s answer

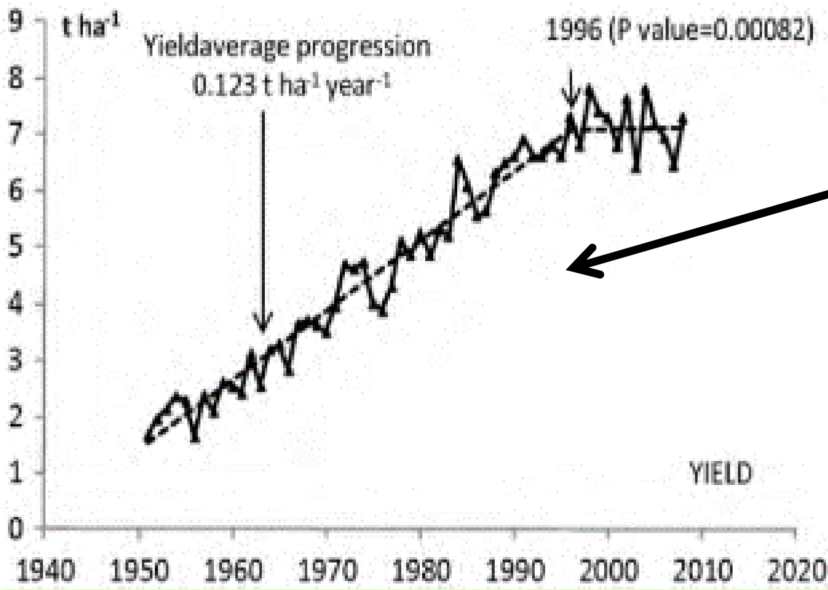
Six simple steps for your soil to help improve the performance, health and long-term sustainability of your land.

Root cause of degradation
Min-till even worse – top soil pulverization

But underneath?

Stagnating Yields (yield gap)

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)

But inputs and input costs going up, diminishing returns setting in,

soil crusts – no mulch low SOM

CLODS OF TOPSOIL FROM ADJACENT PLOTS

Residue retention distinguishes CA from conventional farming systems

Turning healthy soil into bricks with tillage - Tajikistan April 2015

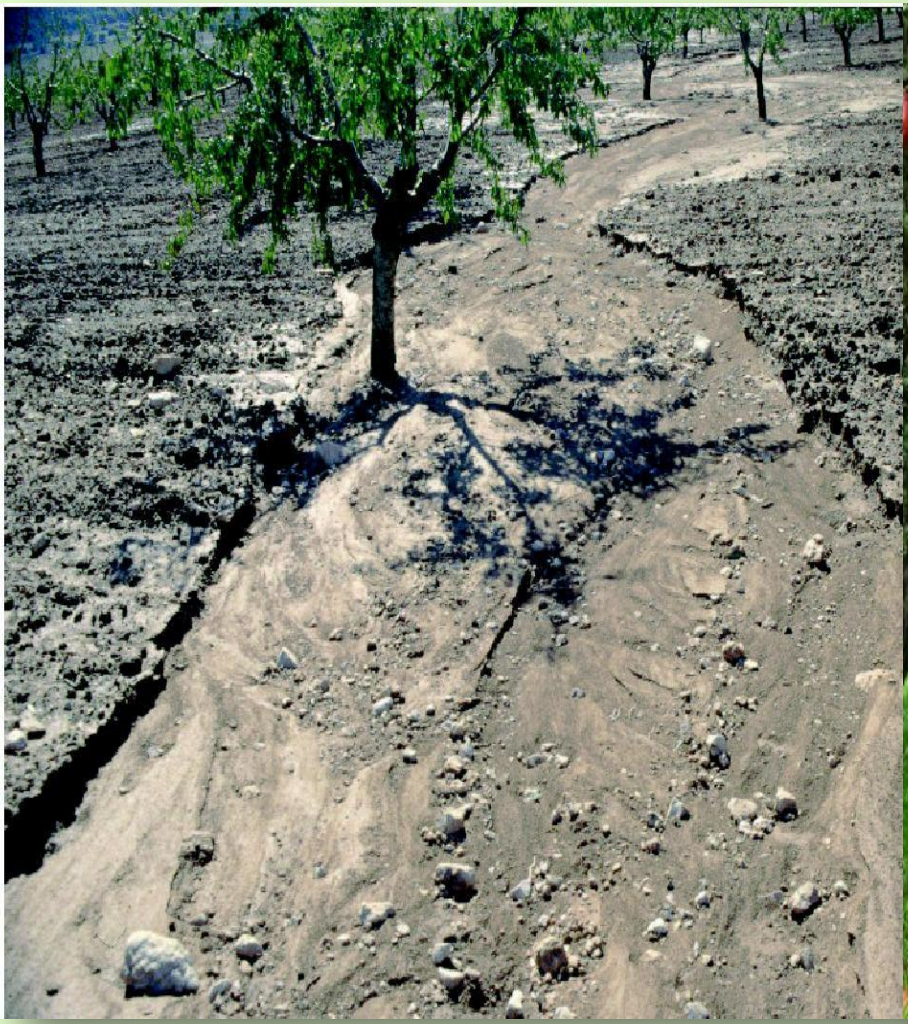
Tillage-induced Carbon Dioxide Loss and wind erosion

Reicosky

Water infiltration, just after a thunderstorm

(THOMAS, 2004)

Runoff and soil erosion



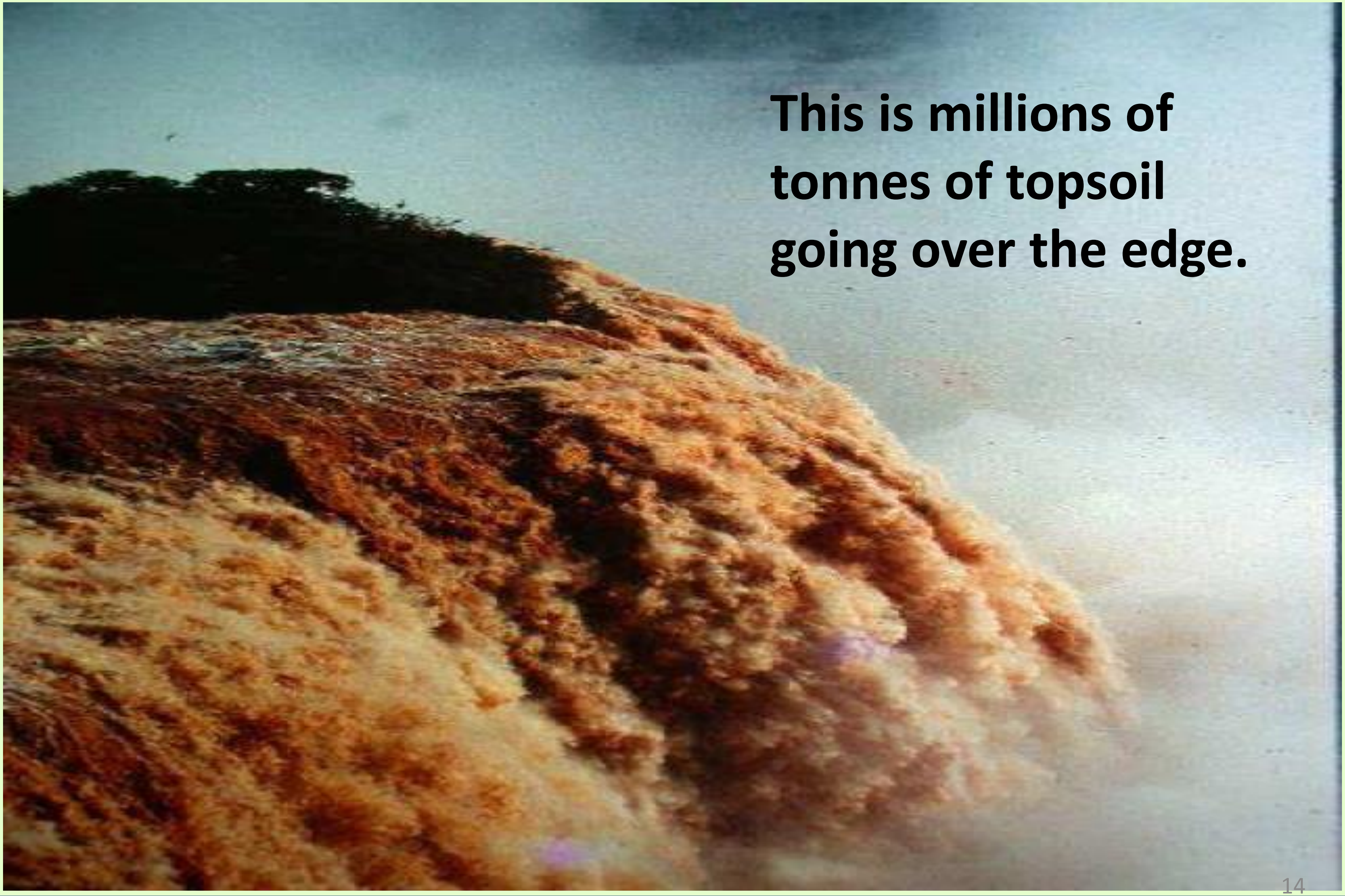
Erosion & water pollution from tillage agriculture

silting

picture: Dr. Strobel, LfA/Germany

TILLAGE AGRICULTURE -- Erosion

Iguassu Falls, Brazil

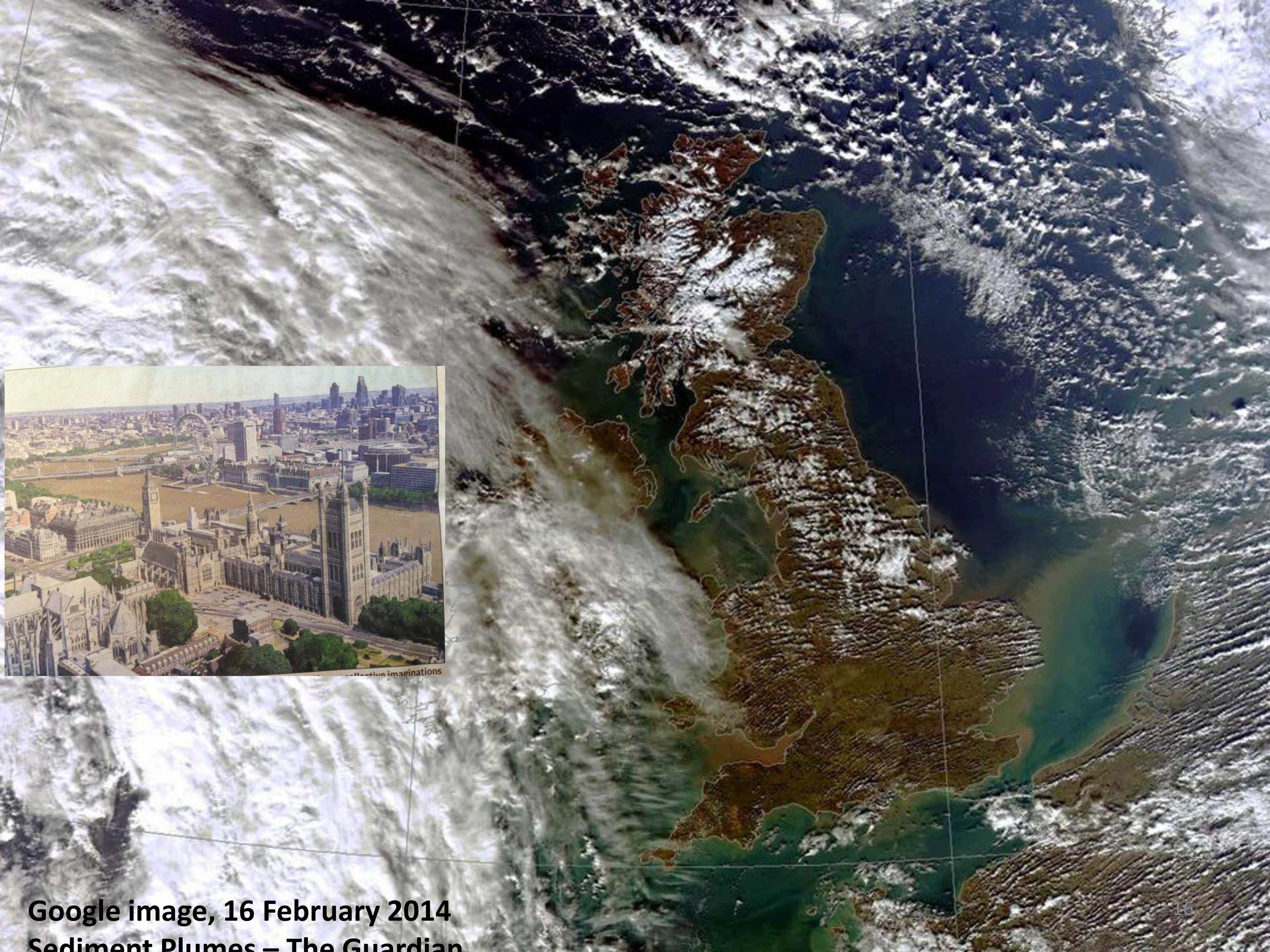


This is millions of tonnes of topsoil going over the edge.

River Lodden, lower Earley, Reading, February 2013

River Tiber, north of Rome, April 2013

River Thames, London House of Parliament



Google image, 16 February 2014
Sediment Plumes – The Guardian

The Future of Farming and Food in the UK

Donald Curry policy commission report 2002, UK Cabinet

"Farming and food industry is on an unsustainable course in economic terms. We believe it is also unsustainable environmentally ….. in the last 50 years…soil organic content has declined…

Agriculture is now the number one polluter of water in the country. Land use changes have contributed to increased danger of extreme flood events, affecting thousands of homes.

Beyond any doubt the main cause of this decay has been the rise of modern, often more intensive, farming techniques. …things are still getting worse…in soil compaction and erosion, in the loss of certain species. A lot of the environmental damage in the countryside over the last 50 years has to be laid at the door of modern farming techniques. …. Much damage by farmers is not willful but arises out of ignorance.

We believe a major advice effort will be needed… to help farming meet its new challenges. It will be very important that advice should also cover environmental issues."

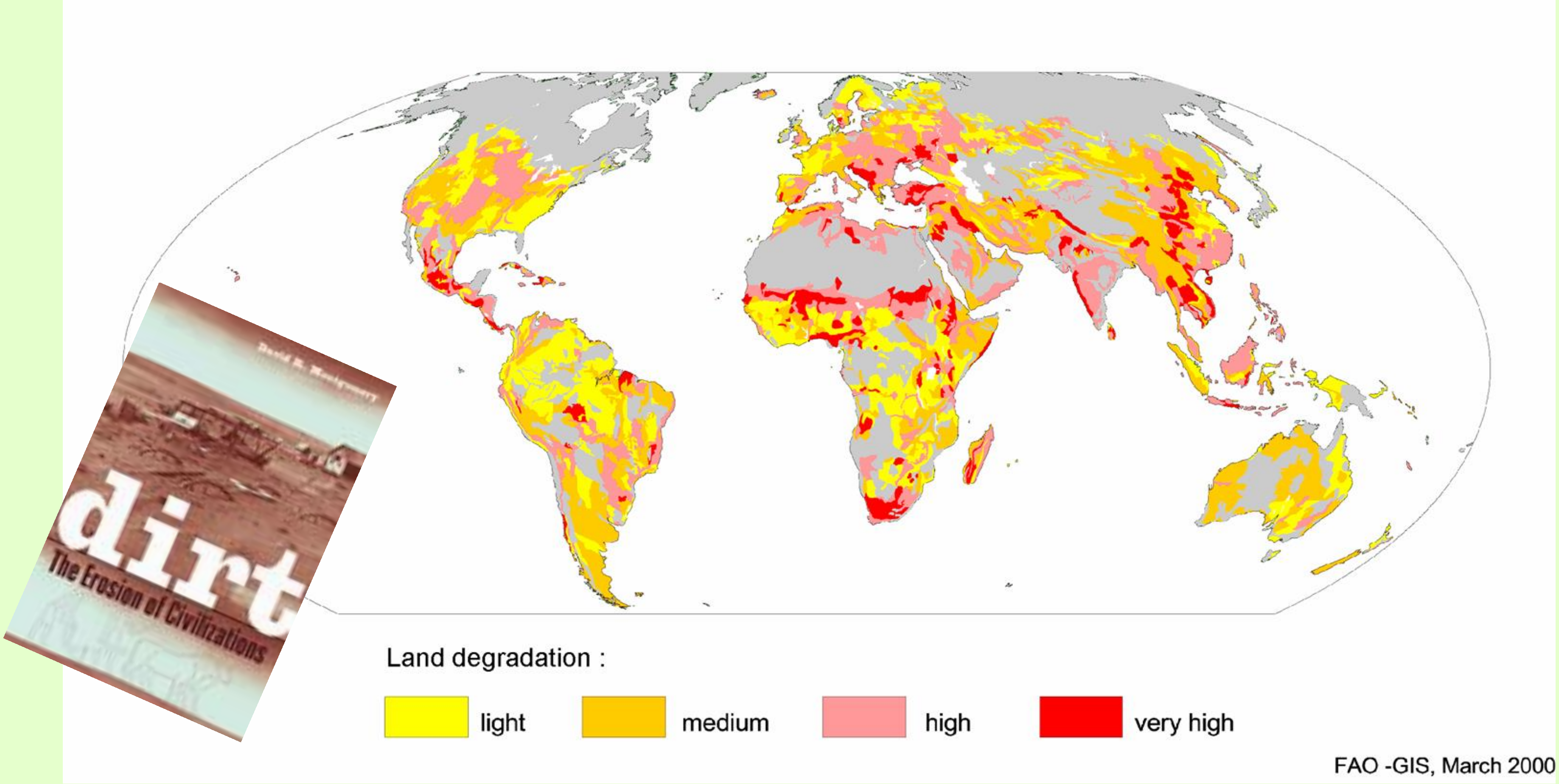
Soil Strategy for England

- **UK plus 4 other EU countries walked out of soil directives discussions in Brussels**
- **Defra → Health check etc**
- **Then soil strategy for England**
- **Seven major threats to soils**
- **Top three – loss in soil organic matter, compaction and erosion**
- **Conclusion: Not enough information to feed into policy**
- **So more research**

- **Press release at Rothamsted by Hilary Benn**

Degradation of soil, water and biodiversity resources

All agricultural soils show signs of degradation



World map of severity of land degradation – GLASOD (FAO 2000)

Also, the Millennium Ecosystem Assessment 2005 – 89% our ecosystems Degraded or severely degraded, only 11% in reasonable shape. 400-500 M ha lost

Consequences of tillage-based agriculture *at any level of development*

FOR THE CROP (AND SOCIETY)

- ***Higher production costs, lower farm productivity and profit, sub-optimal yield ceilings, poor resilience***

- **less use efficiency of mineral fertilizer: "*The crops have become 'addicted' to fertilizers"***
- **loss of (agro)biodiversity in the ecosystem, below & above soil surface**
- **more pest problems (breakdown of food-webs for micro-organisms and natural pest control)**
- **falling input efficiency & factor productivities, declining or stagnating yields**
- **reduced resilience, reduced sustainability**
- **Poor adaptability to climate change & mitigation**

Consequences of tillage-based agriculture
at any level of development

FOR THE LAND (AND SOCIETY)

- ***Dysfunctional ecosystems, loss of biodiversity, degraded ecosystem services -- water, carbon, nutrient cycles, suboptimal water provisioning & regulatory water services etc. Low livestock and human carrying capacity.***

- **loss of OM, porosity, aeration, biota (=decline in soil health -> collapse of soil structure -> compaction & surface sealing -> decrease in infiltration)**
- **water loss as runoff & soil loss as sediment**
- **loss of time, energy, seeds, fertilizer, pesticide (erosion, leaching)**
- **less capacity to capture and slow release water & nutrients**

So we are back to ????

- Sustainable production or
- Sustainable production intensification or
- Sustainable land management or
- Climate smart agriculture or
- Doubly green revolution or
- Evergreen revolution, or
- Sustainable agriculture and
- Sustainable development -- UN’s role

Sustainable Intensification:

What does No-Till System revolution offer in terms of greater crop and land potentials?

Technical objectives of SPI

- Agricultural land productivity
- Natural capital and flow of ecosystems services

Simultaneously

- Enhanced input-use efficiency
- Build farming system resilience (biotic and abiotic), including being climate-smart
- Contribute to multiple-outcome objectives at farm, community & landscape, and national scales e.g. climate change mitigation

And

- Capable of rehabilitating land productivity and ecosystem services in degraded and abandoned lands

These objectives can be and are being met with No-Till CA

Conservation Agriculture

adoption of
Agriculture

FAO Definition: www.fao.org/ag/ca

Conservation Agriculture (CA)
is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterized by three linked principles, namely:

1. **Continuously avoiding mechanical soil disturbance (NT).**
2. **Permanent soil mulch cover - crop residues, cover crops.**
3. **Diversification of crop species grown in sequences or associations or rotations.**

Along with other GAPs → SPI & CSA

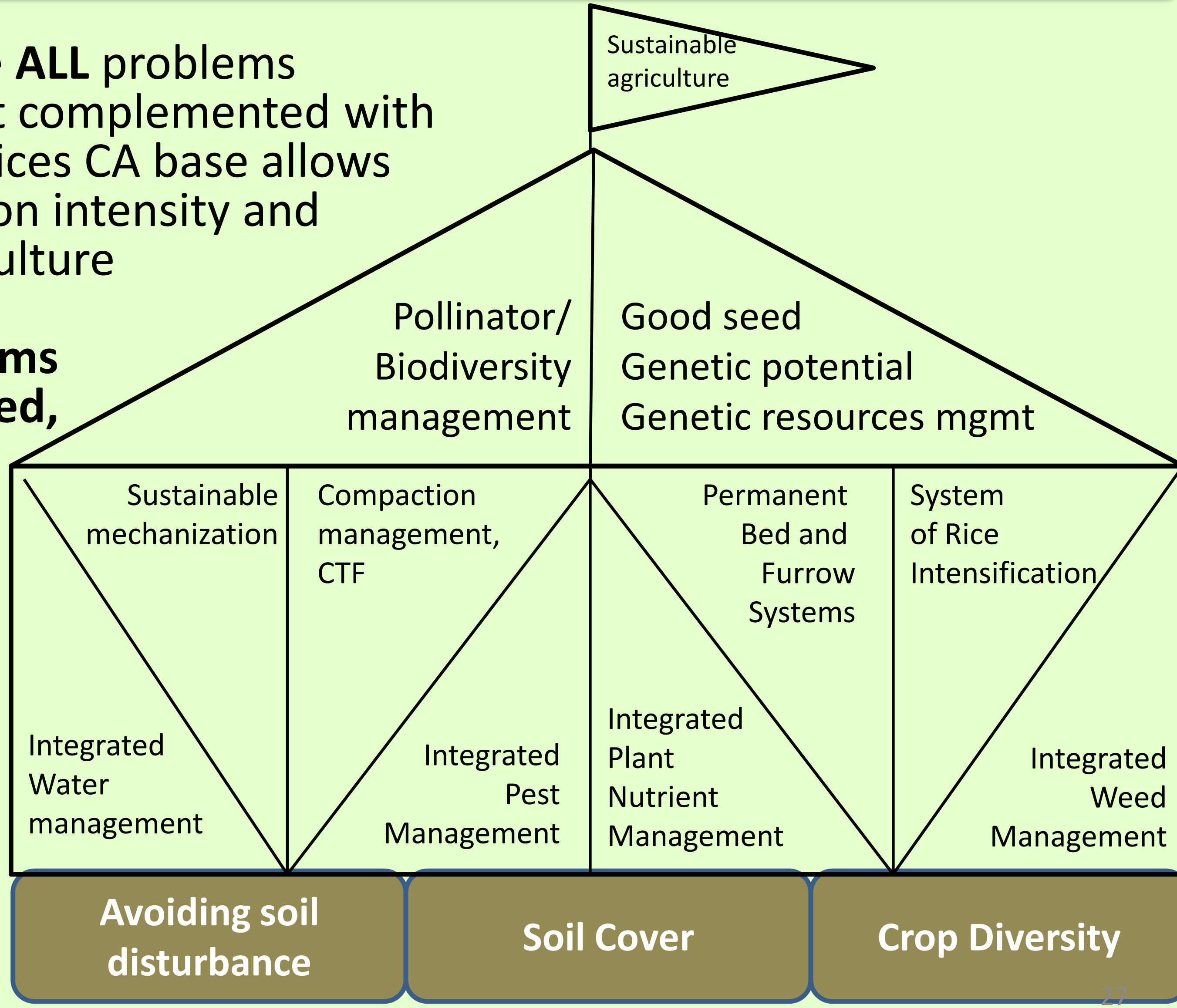
No-Till CA works because

It is regenerative, self-repairing & self-protecting
It pays attention to maintaining:

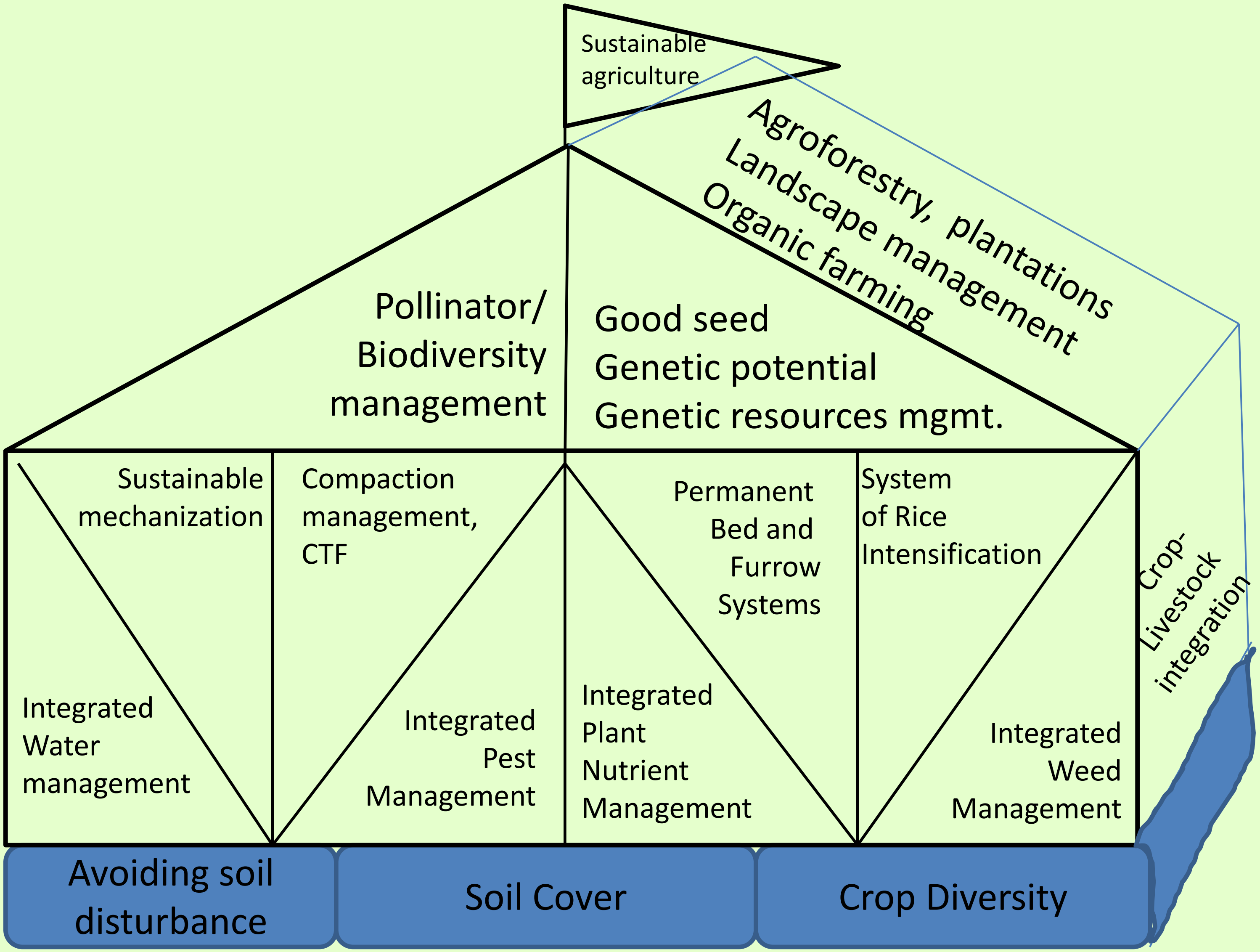
- **Ecological foundation of production systems**
- **Soil health and biology**
- **Healthy plant root system relationships**
- **Enhanced biodiversity**
- **Ecosystem societal services**
- **Integration, including with pasture, livestock, trees**
- **Maximum efficiency & resilience (& profitability)**

CA principles operate as ecological foundation to CA Systems

CA does not solve **ALL** problems (NO panacea) but complemented with other good practices CA base allows for high production intensity and sustainable agriculture **in all land-based production systems (rainfed & irrigated, annual, perennial, plantation, orchards, agroforestry, crop-livestock, rice systems**



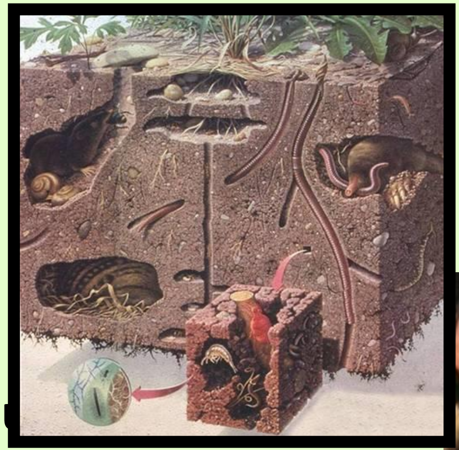
Ecological Foundation of CA Systems



Pays attention to soil health -- soil as a 'complex' biological system, not just as a geological entity

Soil productive capacity (vs. fertility) is derived from several components which interact dynamically in space and time:

- ***Physical*: architecture - pore structure, space & aeration**
- ***Hydrological*: moisture storage - infiltration**
- ***Chemical:* nutrients, CEC, dynamics**
- ***Biological*: soil life & non living fractions**
- **Thermal: rates of biochemical processes**
- **Gravity: retention & flows of liquids**
- **Cropping system: rotation/association/seq**



A productive soil is a living system and its health & productivity depends on managing it as a 'complex' biological system, not as a geological entity.

Pays attention to biodiversity

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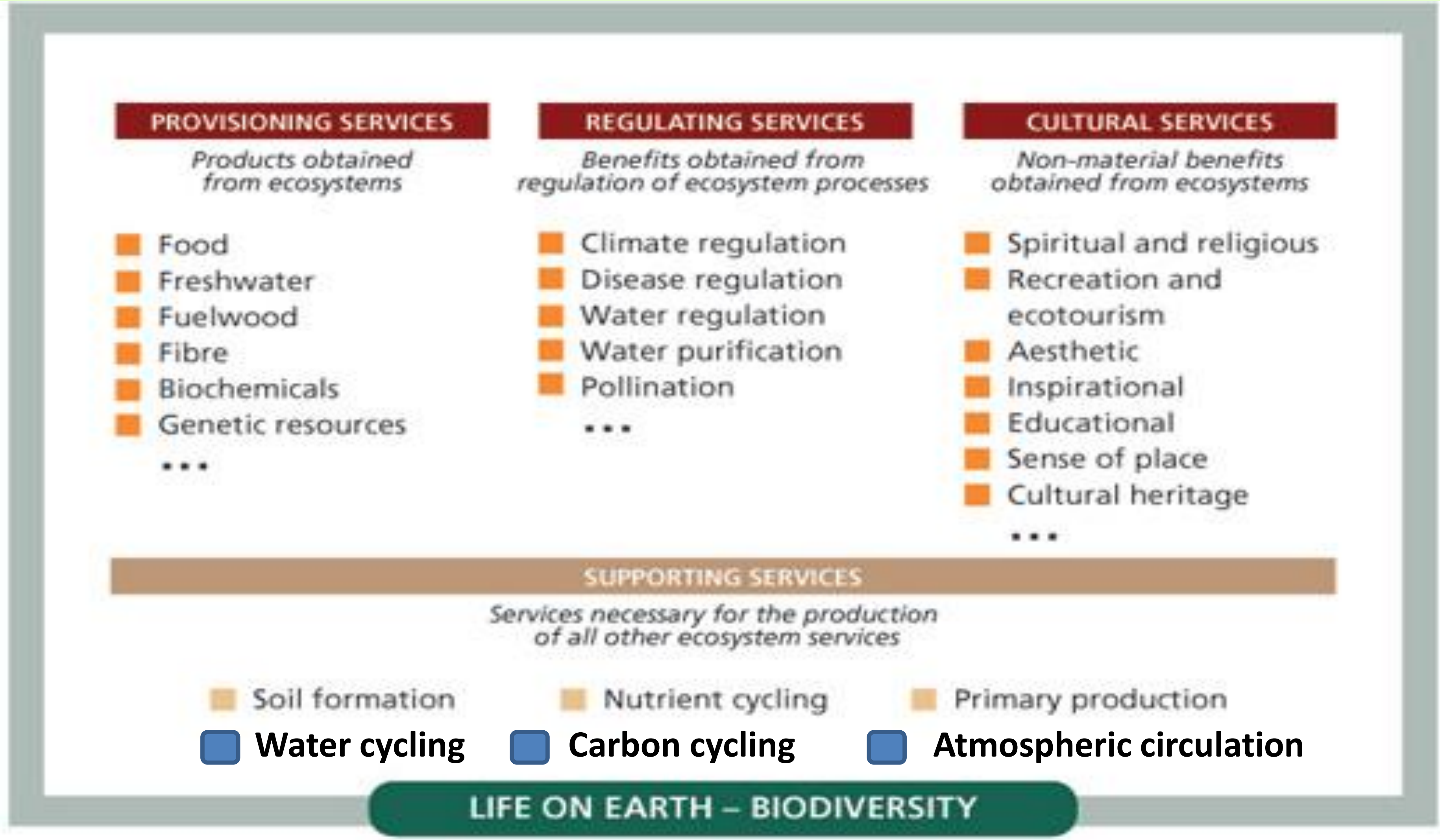
Pays attention to eco-agriculture landscapes: harmonizing multiple objectives at farm, community, landscape scales

Landscapes for People, Food and Nature
International Conference and Knowledge Exchange

Pays attention to harnessing ecosystem services from Land



Source: The Millennium Ecosystem Assessment (2005)

Sustainable Land Preparation - smallholders

Planting holes, ripping or mulching, direct drill





No-till in Europe

(W. Sturny)

Scale and Geography of No-Till System Revolution

With evidence of superior performance of crop and land productivity in the tropics, subtropics and temperate regions

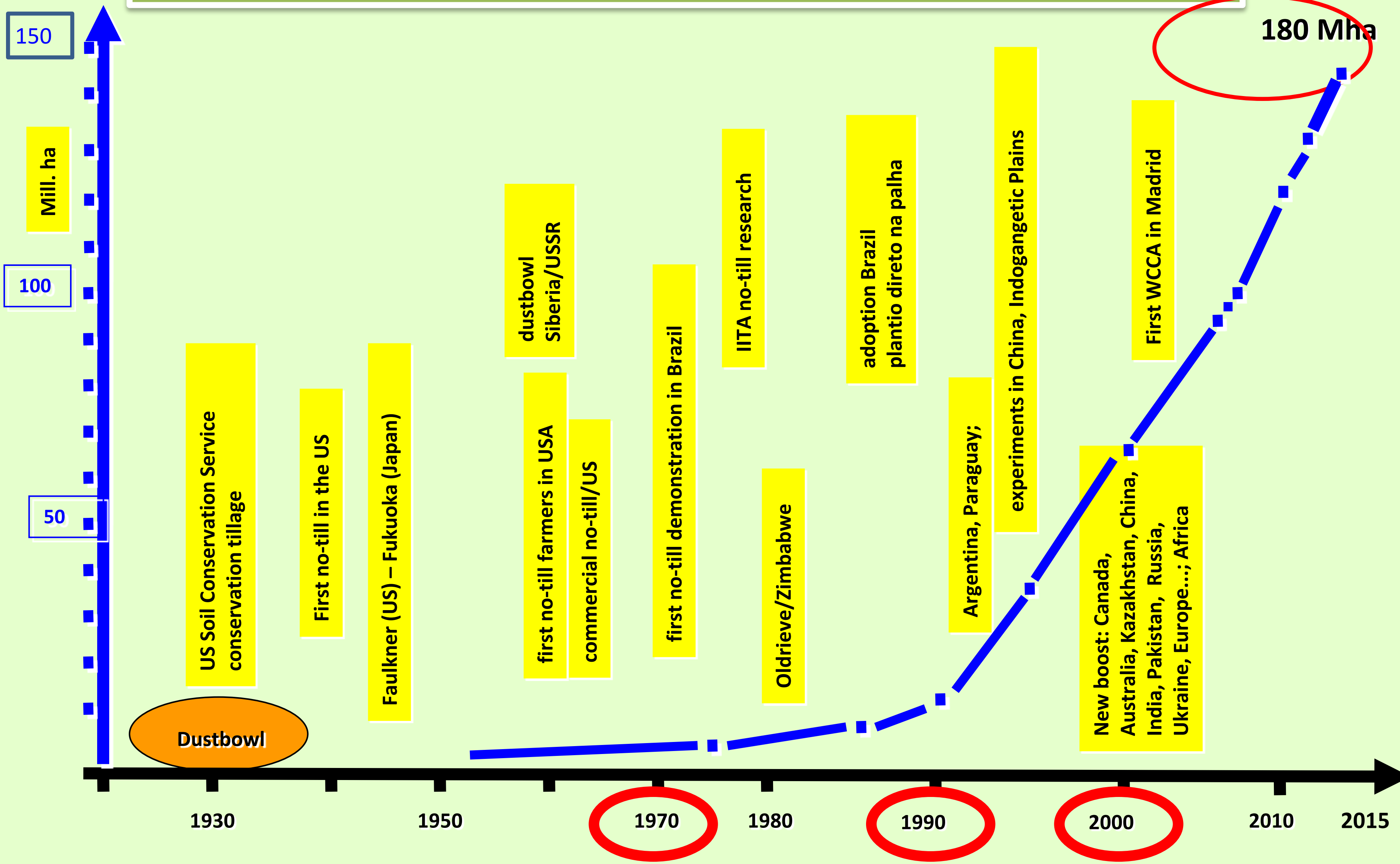
Drivers for adoption of CA

on Agriculture

- **Erosion:** North America, Brazil, China
- **Drought:** China, Australia, Kazakhstan, Zambia
- **Cost of production:** global
- **Soil degradation:** global
- **Ecosystem services:** global
- **Climate change A&M:** global
- **Sustainable intensification:** global
- **Pro-poor:** developing regions

Spread is farmer-led but needs policy & institutional support, specially for smallholders

History and Adoption of CA (2015/16). Since 2008/09 increasing at 10 M ha annually



Area of cropland under CA by continent – 2015/16

(source: FAO AquaStat: www.fao/ag/ca/6c.html & personal database)

Continent	Area (Mill. ha)	Per cent of global total	Per cent of arable land of reporting countries
South America	69.9 (49.6)*	39.0 (40.9)#	63.2
North America	63.2 (40.0)	35.2 (58.0)	28.1
Australia & NZ	22.7 (12.2)	12.7 (86.1)	45.5+
Asia	13.2 (2.6)	7.4 (80.3)	3.8
Russia & Ukraine	5.2 (0.1)	2.9(5000)	3.3
Africa	2.7 (0.5)	1.5 (447)	2.0
Europe	2.5 (1.6)	1.4 (56.3)	3.5
Global total	179.5 (107)* ( )* 2008/9	100 (69.2)# ( )# % change since 2008/09	12.5 (7.4)* %global cropland + includes non-cropland

~50% in developing regions, ~50 % in industrialized regions

Conservation Agriculture globally 179 Million ha (2016) (~12.5% of annual cropland)

Documented benefits of CA for food security, environment, sustainability, rehabilitation

Small scale -- Paraguay, Tanzania, India, China, Lesotho, Zimbabwe, Zambia, Mozambique, Spain, Italy ……

Large scale – Canada, USA, Brazil, Australia, Argentina, Kazakhstan …..

publications

CA in the UK

- **2011 – 150,000 3.3%**
- **2012 – 160,000 3.5%**
- **2013 – 168,000 3.7%**
- **2014 – 180,000 4.0%**
- **2015 – 225,000 6.0%**
- **2016 – 362,000 8.0%**

UK arable area – 4.5 million hectares

If OSR tine planting included, additional 2% = 10%

Challenges/issues/considerations of transformation and transition

- **Weeds/herbicides**
- **Labour**
- **Larger farms**
- **Livestock**
- **Community engagement**
- **Temperate areas**

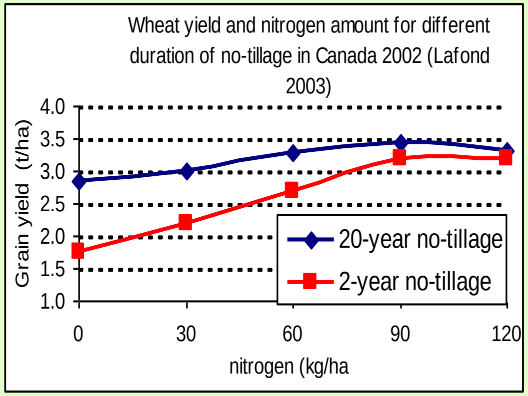
- **Farmers working together**
- **Equipment and machinery**
- **Knowledge and technical capacity**
- **Risk involved in transforming to no-till systems**
- **Approaches to adoption and scaling**
- **Policy and institutional support – private, public, civil society**

Patterns of benefits and evidence of superior performance with Conservation Agriculture

Impact pattern with CA – small or big farms

CROP

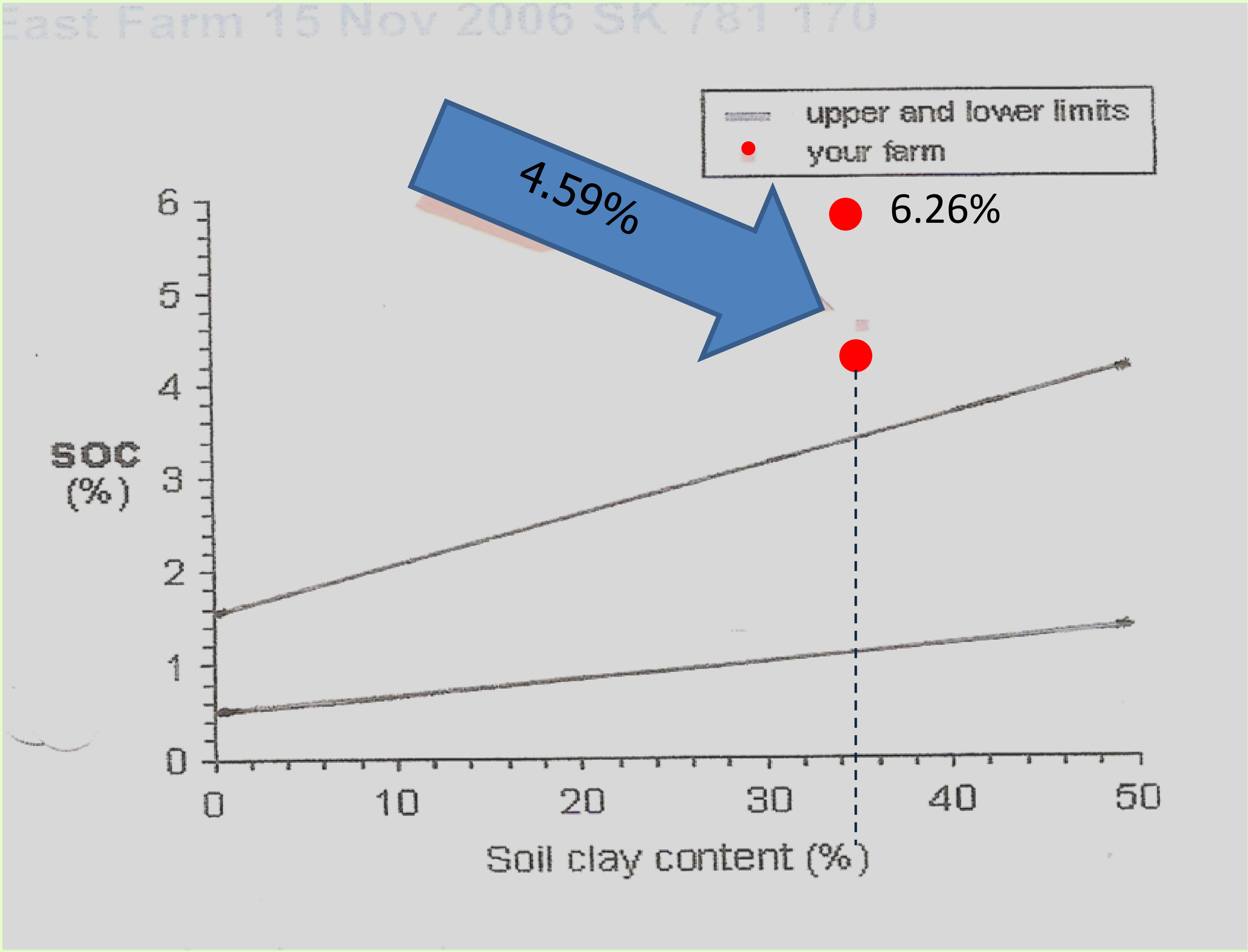
- Increased & stable yields, productivity, profit (depending on level and degradation)
- Less fertilizer use (-50%) no fertilizer less pesticides (-20->50%) no pesticides
- Less machinery, energy & labour cost (50-70%)
- water needs (-30-40%)



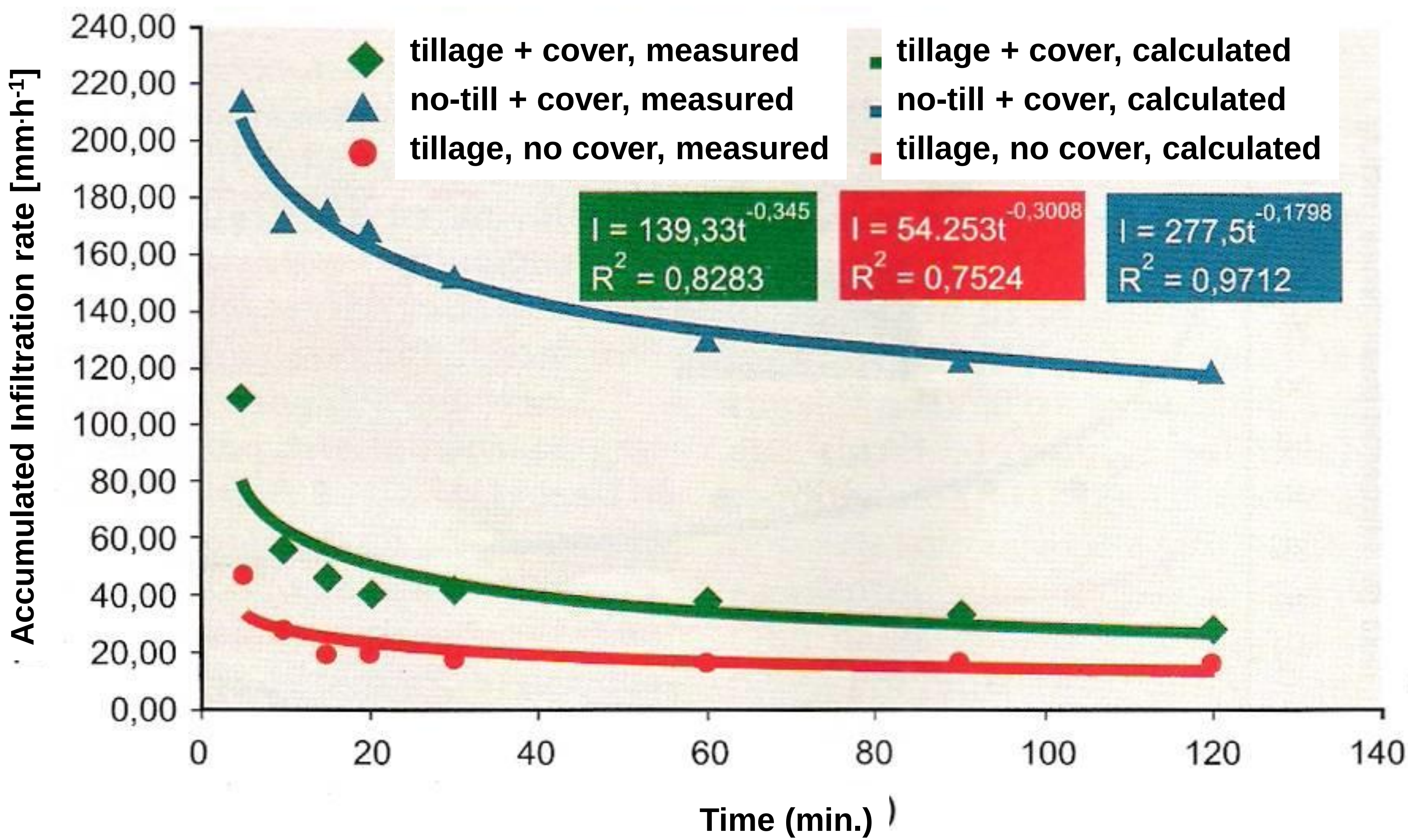
LAND

- Greater livestock and human carrying capacity
- Lower impact of climate (drought, floods, heat, cold) & climate change adaptation & mitigation
- Lower environmental cost (water, infrastructure)
- Rehabilitation of degraded lands & ecosystem services

SOIL CARBON – Mr. Reynolds' farm in Lincolnshire

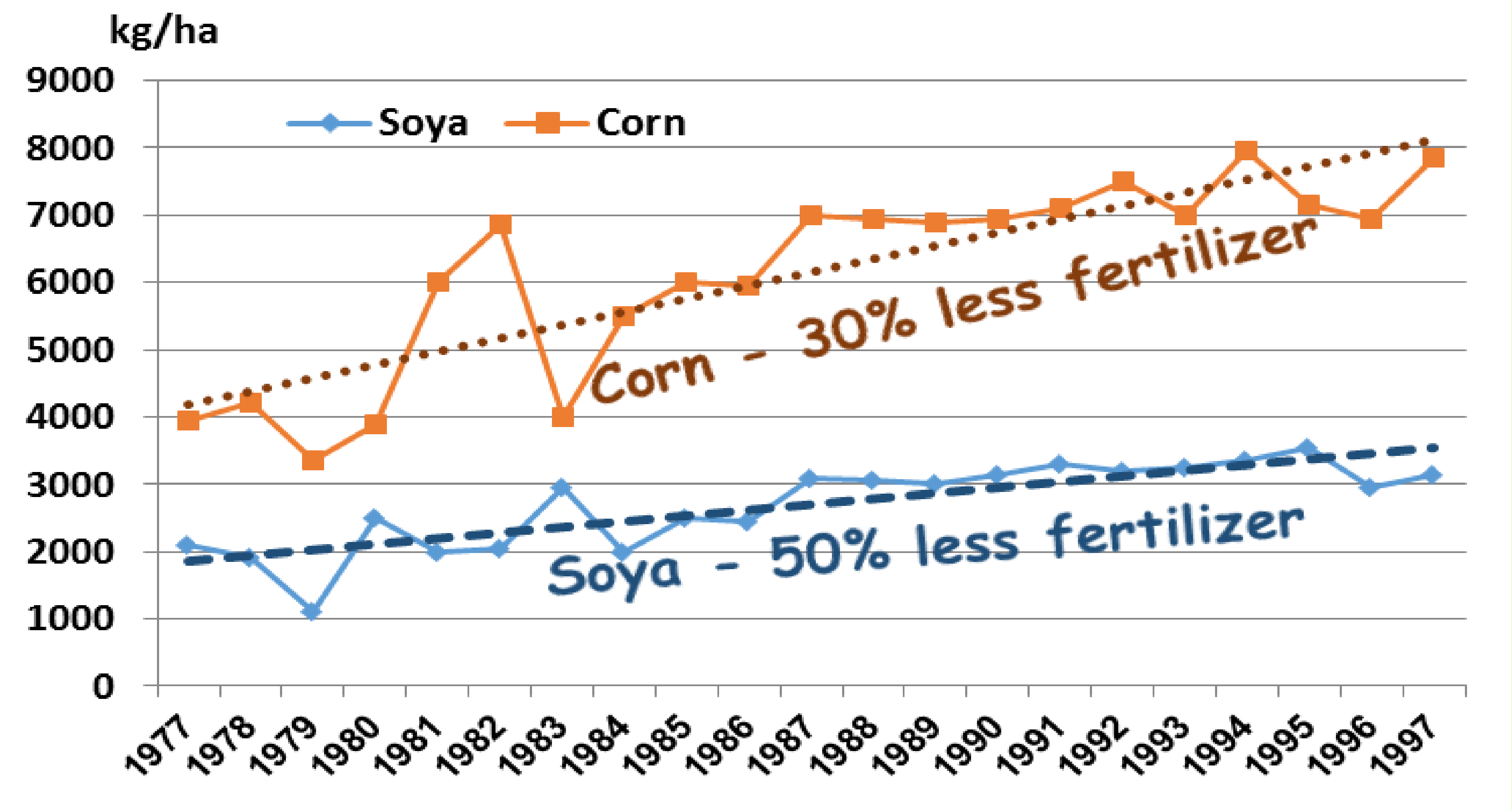


Gains in Rainfall Infiltration Rate with CA
Less flooding – improved water cycle



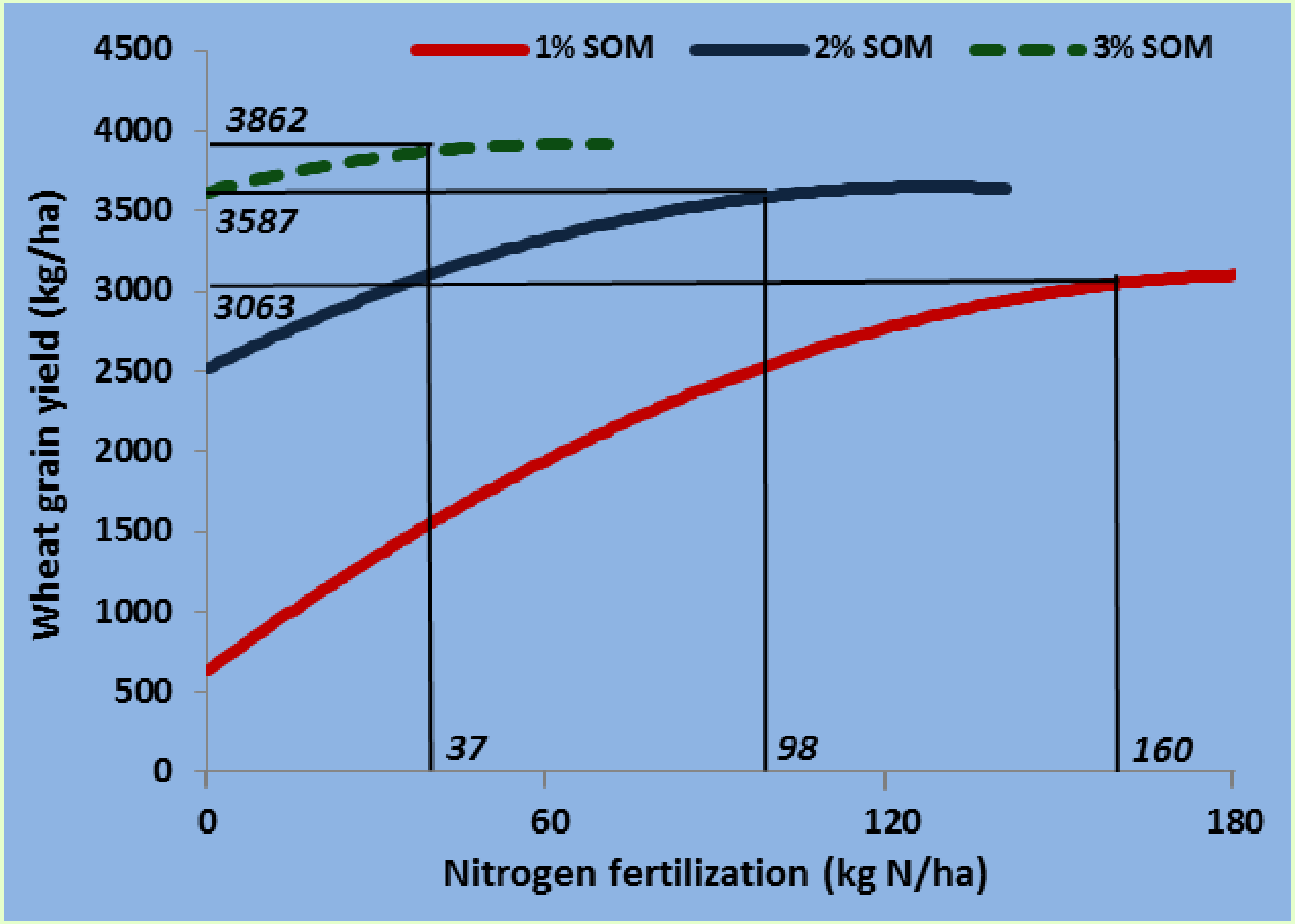
Landers 2007

Empirical evidence: The Frank Dijkstra farm in Ponta Grossa, Brazil – Sub-humid tropics



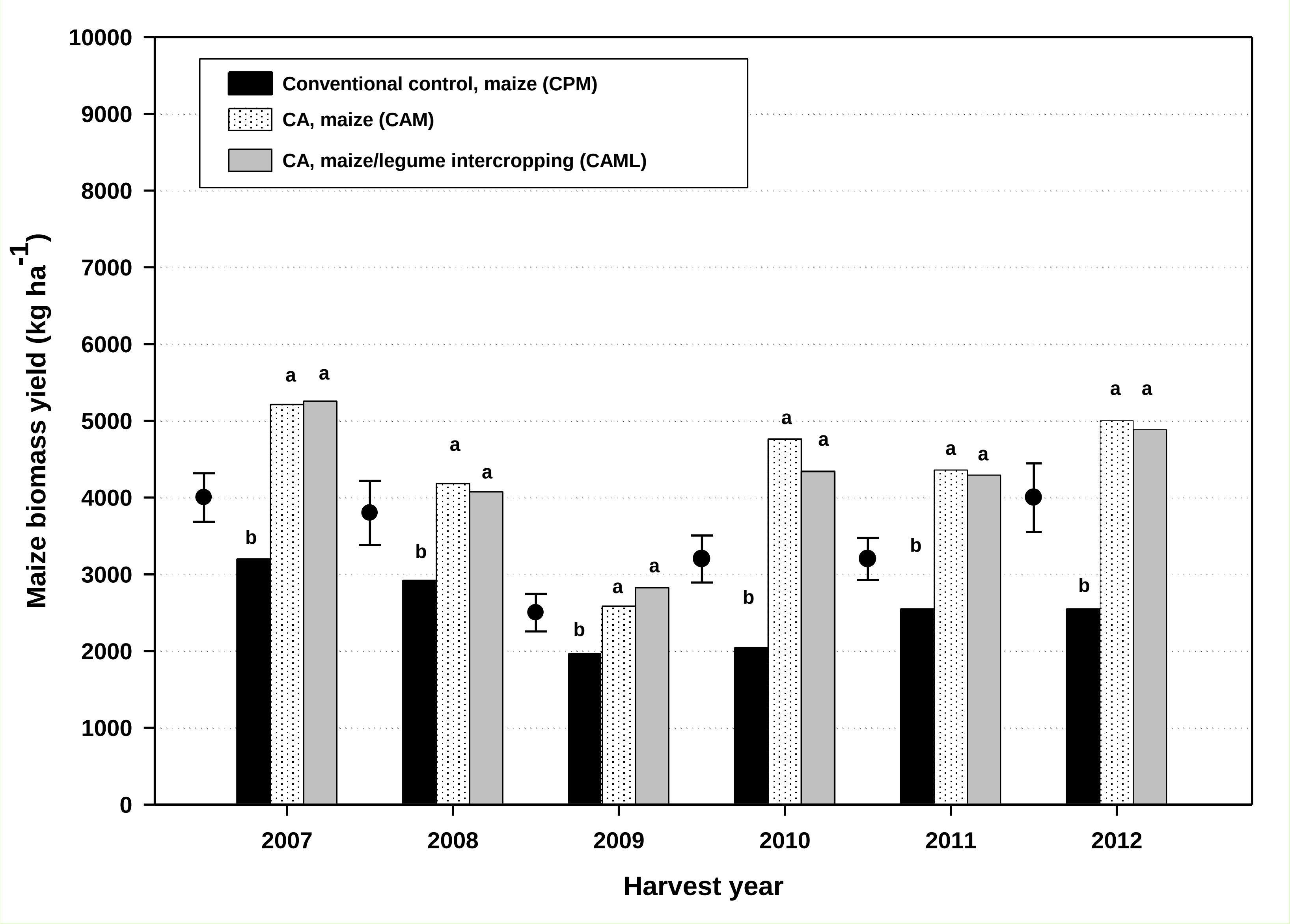
Source: Dijkstra, 1998

Wheat yield response to nitrogen fertilization (--- according to the model) - Dry sub-tropics WR

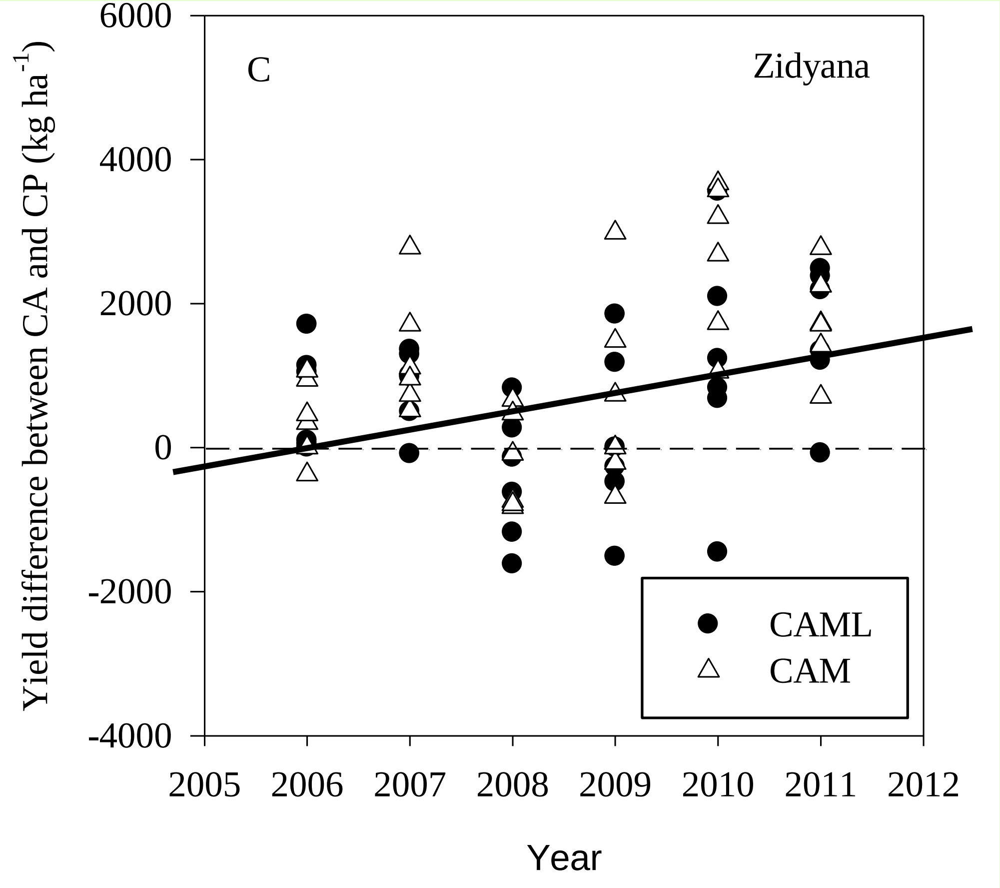


Carvalho et al., 2012

Longer term maize grain yields on farmers fields in Malawi – Lemu – Semi-arid tropics



Longer term maize grain yields on farmers fields in Malawi - Zidyana



CIMMYT– Thierfelder et al.

Economic viability-Malawi

	Lemu			Zidyana		
	CP	CA	CAL	CP	CA	CAL
Gross Receipts	528.6	881.5	979.7	1047.2	1309.5	1293.7
Variable costs						
Inputs	238.5	341.0	353.6	221.7	323.7	346.1
Labour days (6 hr days)	61.7	39.9	49.4	61.7	39.9	49.4
Labour costs	159.5	103.2	127.9	155.6	100.7	124.7
Sprayer costs		1.7	1.2		1.7	1.2
Total variable costs	398.1	445.9	482.8	377.3	426.1	472.1
Net returns (US$/ha)	**130.5**	**435.5**	**497.1**	**669.9**	**883.3**	**821.9**
Returns to labour (US$/day)	1.8	5.2	4.9	5.4	9.8	7.6

Source: Ngwira et al., 2012

CGIAR

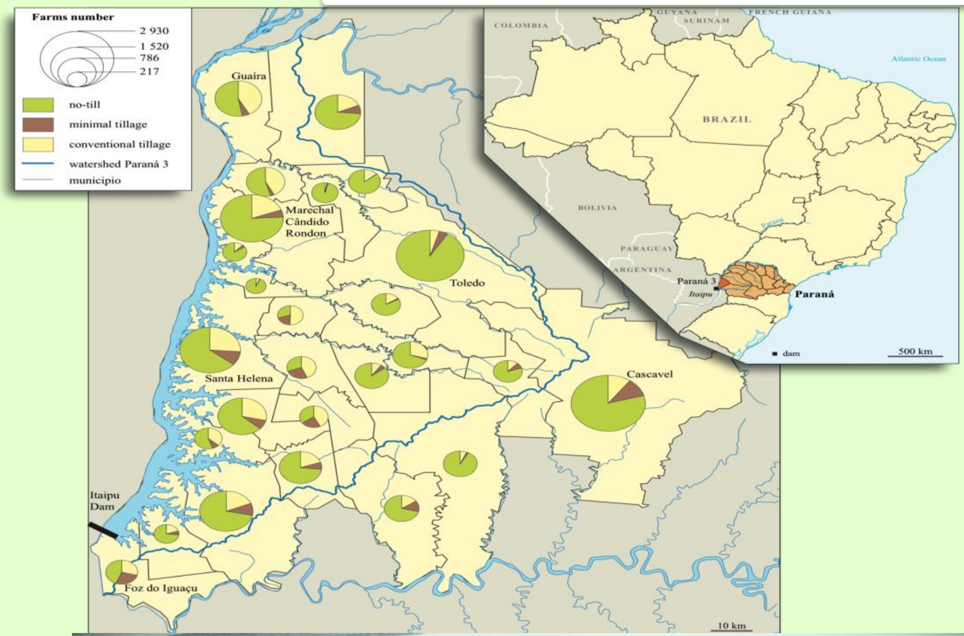
CIMMYT MR

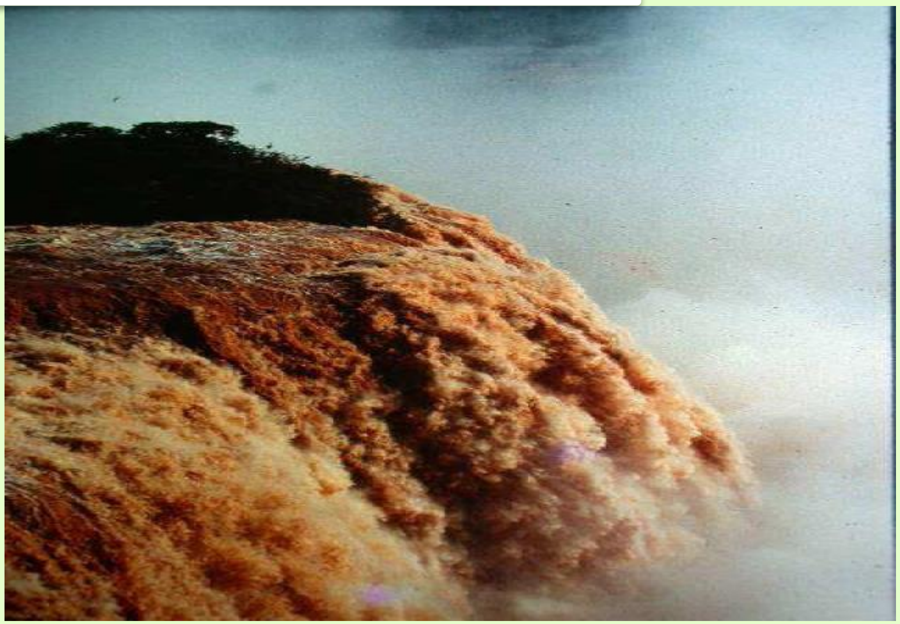
SUMMARY OF ANNUAL EXPENSES

	CONVENTIONAL TILLAGE (Year 2000)	DIRECT DRILLING (Year 2003)	REDUC-TION (%)
Maintenance and repair of tractors	10 450,47 €	1 507,15 €	85
Maintenance and repair of tillage/ drilling implements	8 158,41 €	1 840,40 €	77,5
Fuel	17 460 €	7 110 €	60
Labour	25 000 €	15 000 €	40
TOTAL ANUAL	61 068,88 €	18 347,55 €	70

Farm power – 4 tractors with 384 HP under tillage & 2 tractors with 143 HP under no-till
Farm near Evora, South Portugal

Example 2 -- Watershed services in Parana Basin, Brazil





Water resources are threatened by conventional tillage agricultural practices. Conservation Agriculture is an alternative to reduce impacts on river's quality and to maintain a higher level of productivity and sustainability.

Cultivating Good Water Programme

Itaipu reservoir dam today (source: *Itaipu Binacional*)

Example 1-- Canada: Carbon offset scheme in Alberta

Sequestering soil Carbon with CA and trading offsets with regulated companies
to offset their emissions by purchasing verified tonnes
(from ag and non-ag sectors)
Source: Tom Goddard et al.

Broad conclusions

- **CA can sustainably mobilize greater crop and land potentials with increased efficiency and resilience.**
- **CA offers greater output and profit to smallholders and larger-scale farmers, with less resources, and minimum land degradation.**
- **CA is increasingly seen as a real alternative to conventional tillage-based agriculture for SPI and ES, and it is spreading at an annual rate of 10 M ha.**

Good news: CA with 'rattle' worms is ready to help!
Tony Reynolds Farm, June 2011

More information: amirkassam786@googlemail.com

http://www.fao.org/ag/ca Join CA-CoP and www.conservation-agriculture.co.uk