Technical Working Group on Agricultural Greenhouse Gases (T-AGG):
Experts Meeting, April 22 & 23, 2010 · Chicago, Illinois

Soil carbon management in developing country agricultural systems

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- Agriculture as driver
- Global potentials
- Mitigation strategies
- Mitigation potential
- Conclusions

Greenhouse gas emissions:

- Carbon Dioxide is the most important GHG
- Other GHG (Methane, Nitrous Oxide) more powerful
- Still 77% of total GHG in CO_2 equivalent is due to CO_2
- Agricultural land use contributes 32% of all GHG:
- The major largest components are:
    - Land use change: 18.3%
    - Nitrogen emissions from soils: 6%
    - Methane from livestock: 5%

Agriculture mitigating climate change

- Globally 5 bill ha ($5 \cdot 10^9$) under agriculture
  i.e. managed by mankind (= 40% of total land)
- of this 1.4 bill ha are cropland
- Significant impact on climate change

Agriculture mitigating climate change

- Global pool of Soil Organic Carbon 1,500 Pg (1 Pg = 1 bill. metric tons = 1 Gt)
- Agriculture has released 456 Pg C from SOC which builds the potential for soil as C-sink
- Potential C-capturing from cropland: 0.75 – 1.0 bill t (Pg)/year
- Total potential for increasing the terrestrial C pool is about 3 Pg/year = about the annual increase in global CO_2 concentration
- Additionally emission reductions possible

Agricultural (crop) mitigation strategies:

- **Sequestration:**
  Maximize soil as carbon sink
  - **reduce soil carbon emissions**
  - **maximise biomass production**
  - **enhance soil carbon input**
- **Emission reduction:**
  - **Rice – methane**
  - **Fertilizer – nitrous oxide**
  - **Fuel emissions**
  - **Emissions from input manufacturing**
  - **Manure handling**
  - **Bio energy?**

Sequestration:

Carbon Offset Consultation,

West Lafayette, October 2008:

- CA base for carbon credit protocols
- CA for CC mitigation and adaptation
- CA technologies for Climate Change adaptation and mitigation available

The **simultaneous** combination of

- **Continuous zero tillage**
- **Permanent soil cover**
- **Crop rotations**

has become known as

Conservation Agriculture

Conservation Agriculture

Soil Organic Matter = Drought Resistance

Conventional Agriculture

Zero Tillage

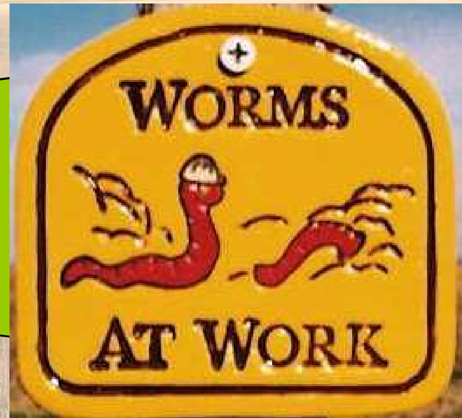
Action of Soil Biota

Structure/Porosity

High Soil Organic Matter

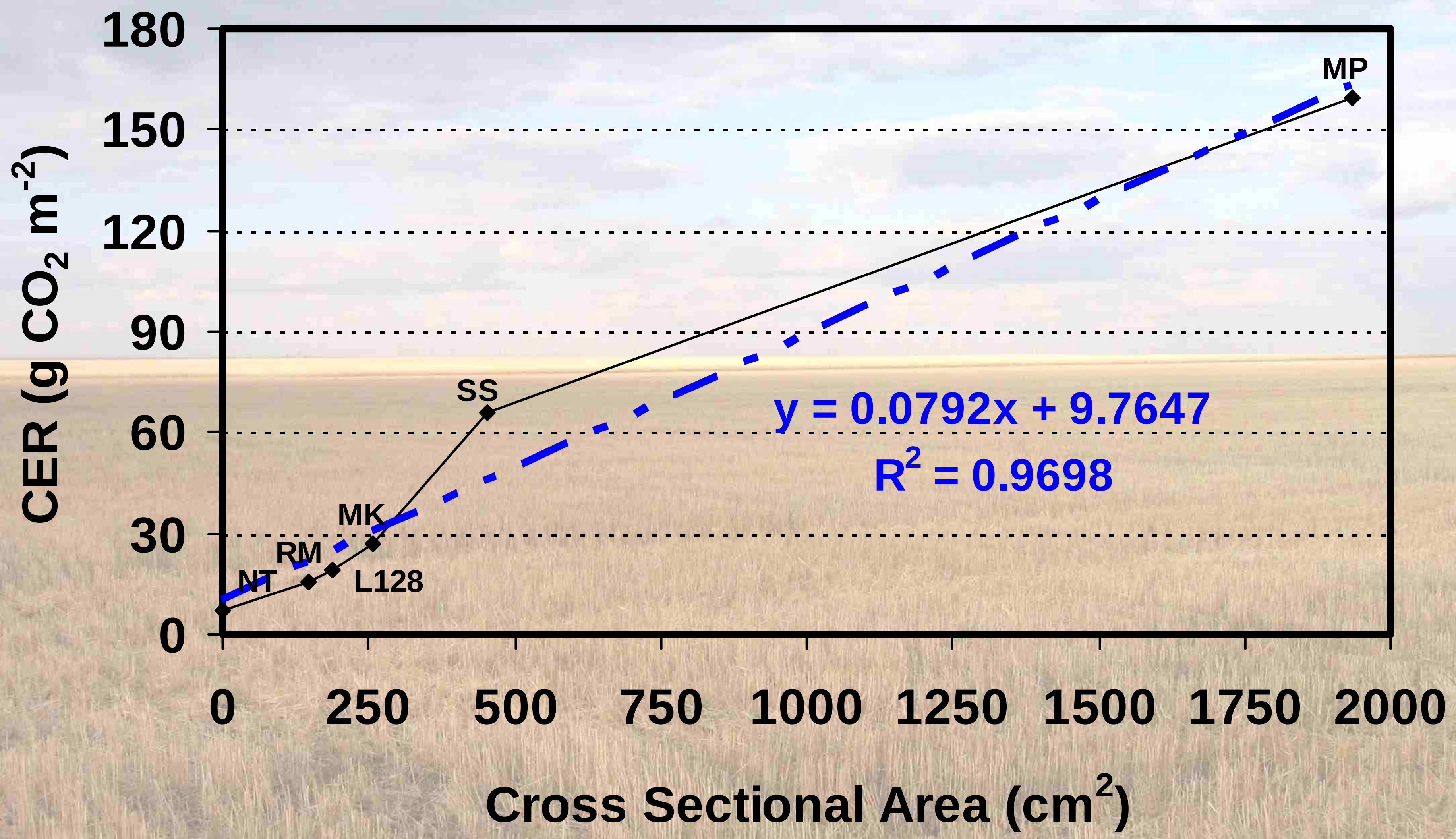
low soil organic matter

Biological Tillage

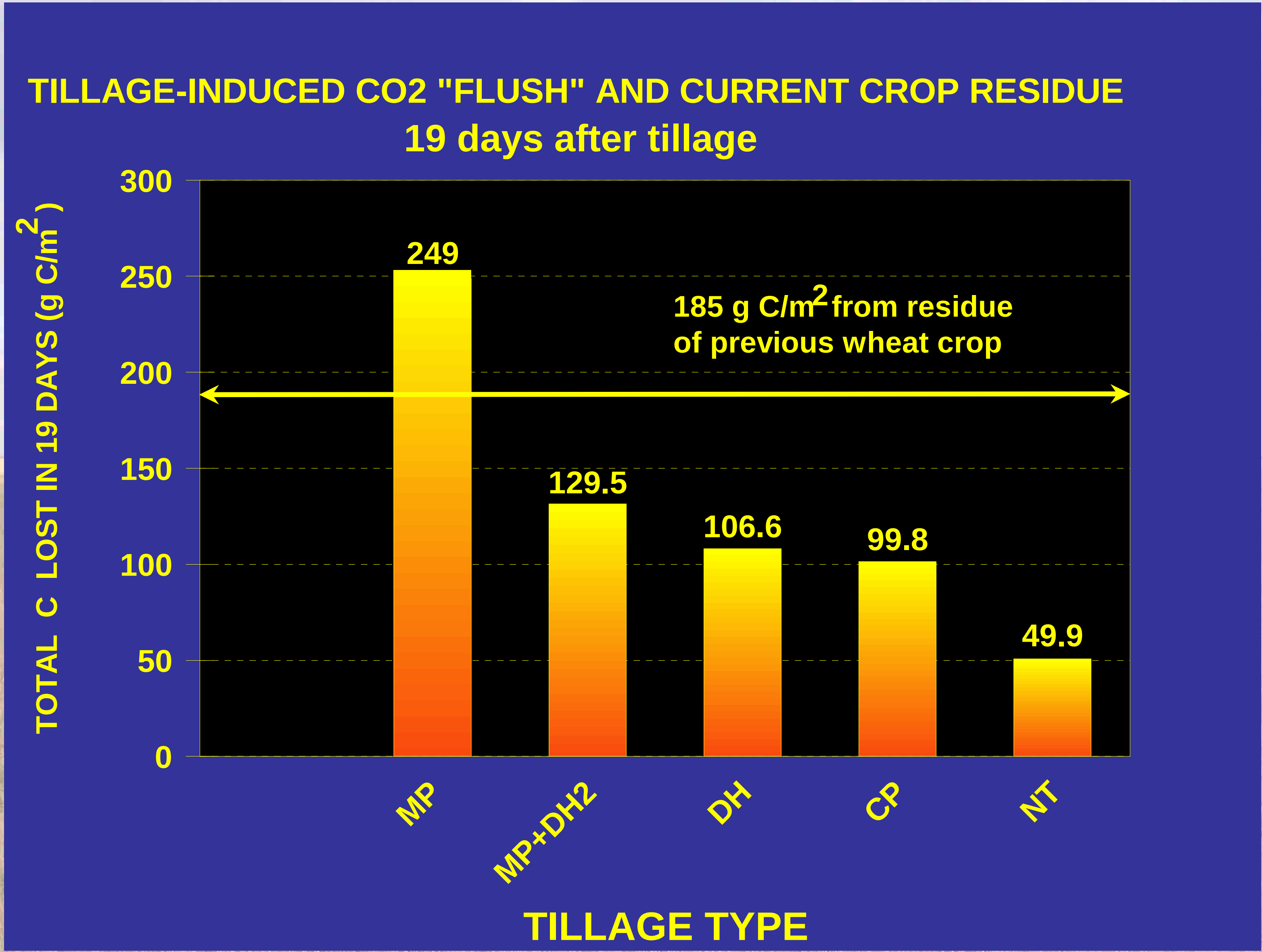


Mechanical Tillage

Cumulative Carbon Dioxide Loss after 24 hours



Reicosky


TILLAGE-INDUCED CO2 "FLUSH" AND CURRENT CROP RESIDUE
19 days after tillage
TOTAL C LOST IN 19 DAYS (g C/m2)
300
250
200
150
100
50
0
249
129.5
106.6
99.8
49.9
185 g C/m2 from residue
of previous wheat crop
MP
MP+DH2
DH
CP
NT
TILLAGE TYPE

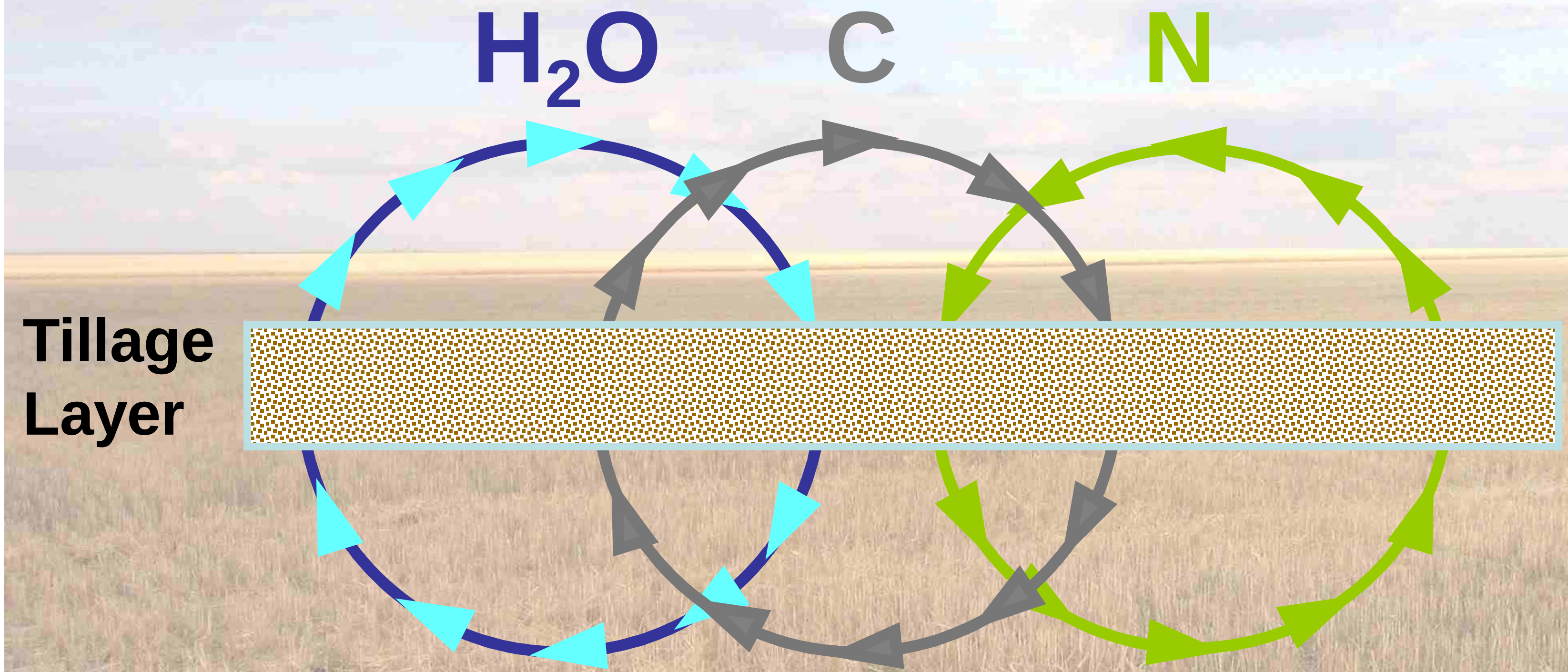
Reicosky

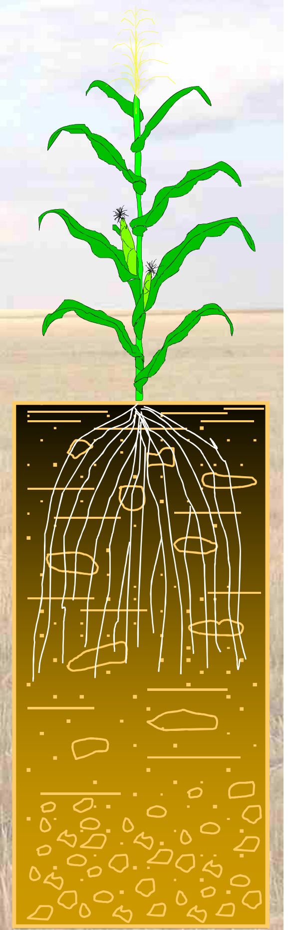
mitigation strategies

Nature's Interdependent Tri-Cycles:

Water, Carbon, Nitrogen,

Tillage disrupts the natural cycles!





Properties and Processes

Physical **Chemical** **Biological**

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CA and climate change:

- **No single practice safely qualifies for carbon credits (no-till, compost, organic)**
- **No-till a necessary, not sufficient condition for Carbon Sequestration in most climates**
- **<u>Protocols</u> for optimized systems to be established**
- **Attention to lifecycles and other GHG (compaction, irrigation)**

Emission reductions: Rice (CH_4)

- CA-rice: no-till/no puddling
- residue retention
- no permanent flooding
- evtl. permanent beds
- SRI agronomy for better root development

Emission reductions: N-Fertilizer

- Use of legumes in rotation
- Careful use of N fertilizer
- Placement of N fertilizer (urea)
- Irrigation (no flooding)
- Compaction: CTF

Emission reductions:

- Fuel emissions: - 40 to 70%
- Emissions from input manufacturing: biological processes replacing functions of
  - machinery: - 50%
  - fertilizer: - 30-50%
  - pesticides: - 20%
- Manure handling:
  - biogas
  - aerobic composting
  - application into cover crops/crop residues
  - knifing into soil (small quantities)
- No burning – avoidance of fire

Bio energy:

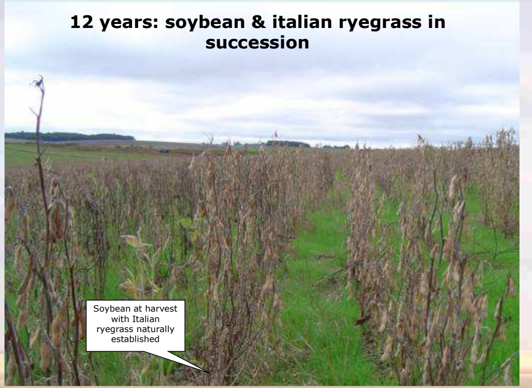
- Bio energy = low efficiency solar energy
- Carbon: either for bio energy or for carbon sequestration
- Carbon in soils has other beneficial effects beyond carbon sequestration
- Diversion of carbon towards bio energy reduces the speed of soil carbon build up

Biochar:

- residues are a better C-source for soils

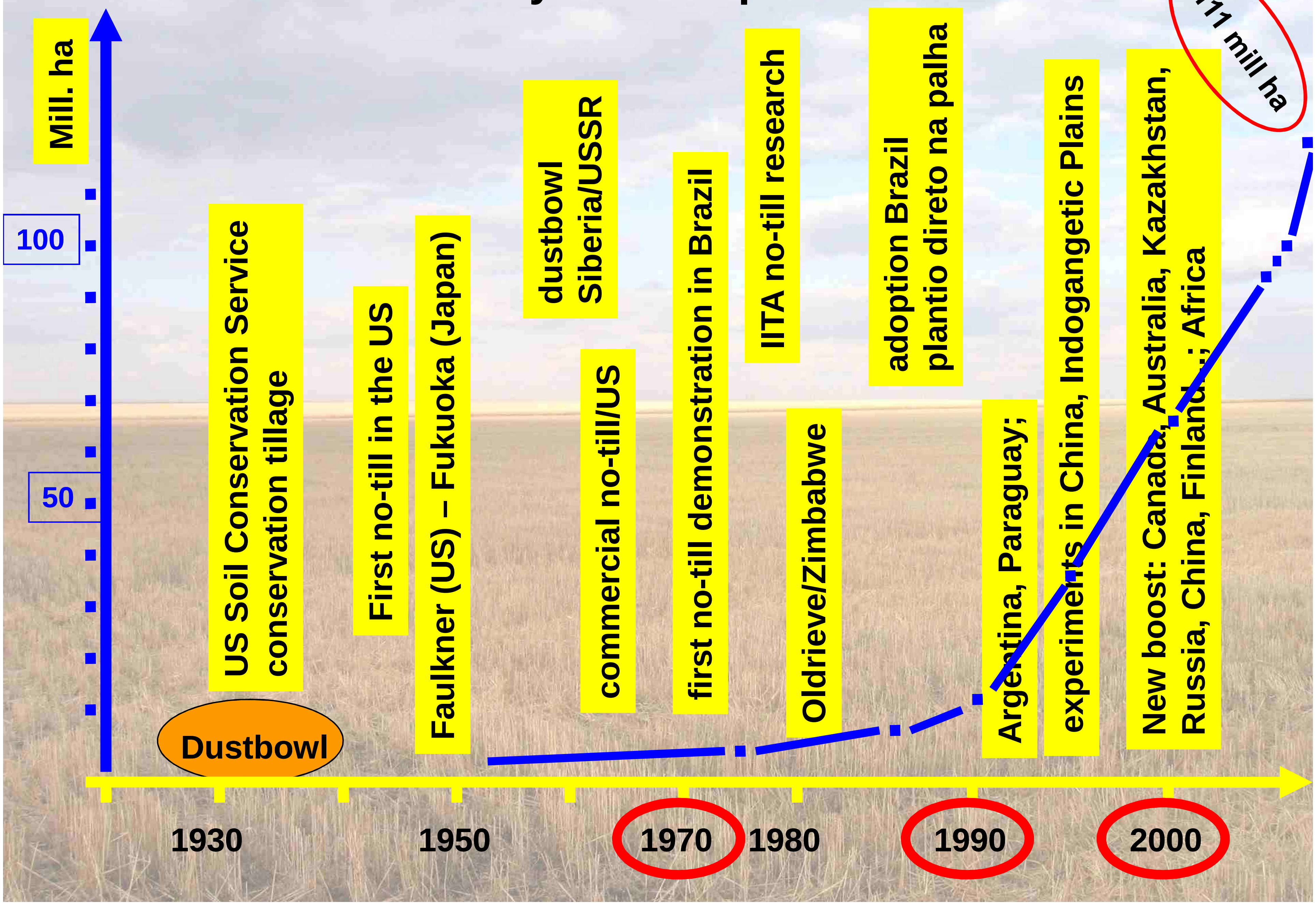
Further options:

- **Integrated Crop-livestock-systems**



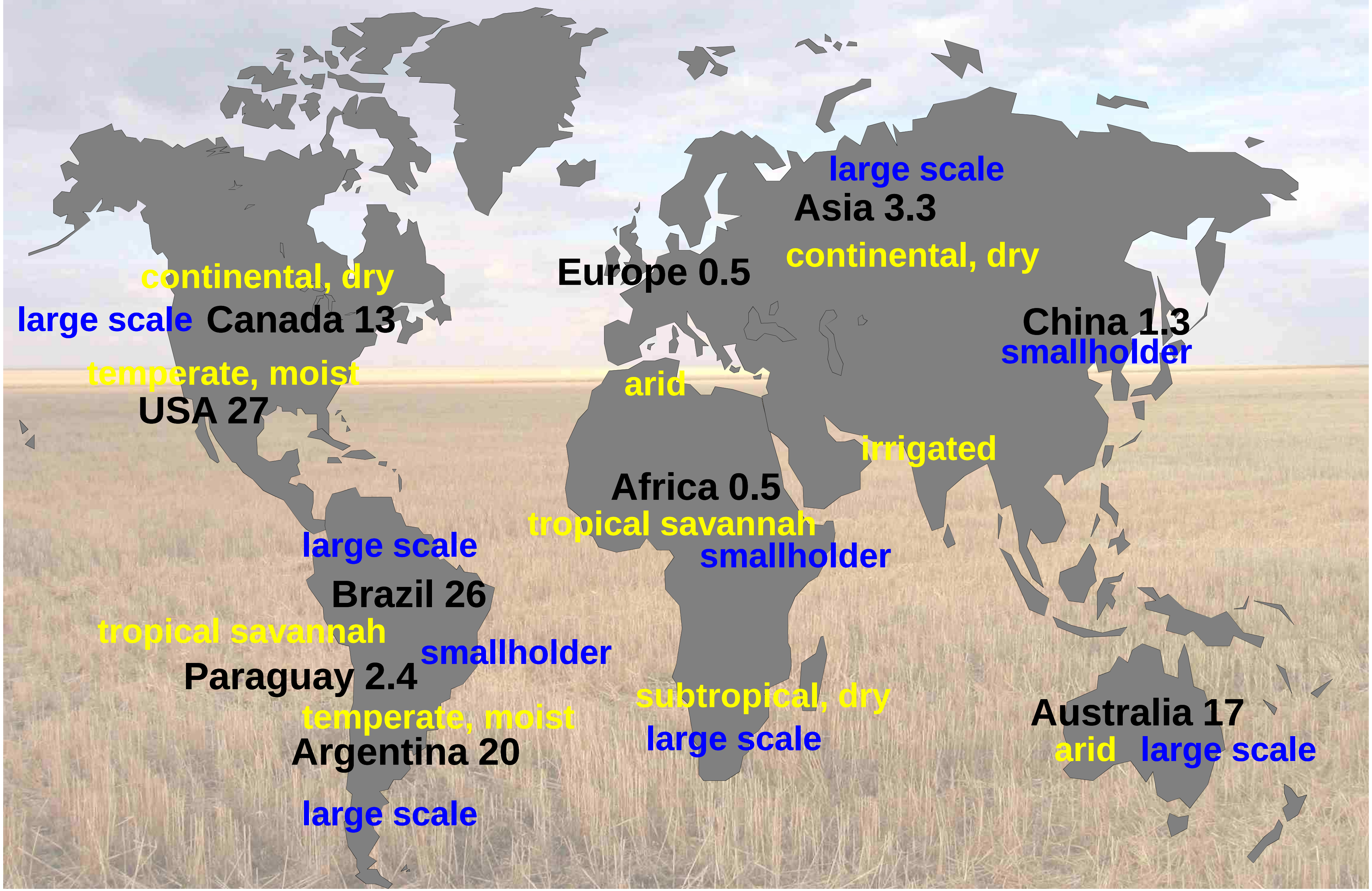
- **Agroforestry:**
  CA with trees (CAWT)

History and Adoption of CA



mitigation potential

Conservation Agriculture worldwide 111 Million ha



Sequestration:

Some soil carbon sequestration rates

Brazil

Region		Rate
		Mg ha^{-1} yr^{-1}
Tropical (West-Central BR)	Range	0.04 – 0.63
	Mean	0.39
Subtropical (Southern BR)	Range	0.04-0.97
	Mean	0.58
Temperate (USA)	Range	0.1-0.5
	Mean	0.34
GLOBAL	Mean	0.57

Tropical: Corazza et al. (1999), Silva et al. (2001), Leite et al. (2001)
Subtropical: Bayer et al. (2000a,b), Lovato (2001), Amado et al. (2001), Freixo et al. (2002)
Temperate: Lal et al. (1999); West & Marland (2002)
Global: West & Post (2002)

Slide taken from Amado 2008, CACOC/CTIC-FAO

Sequestration:

- Intensive grassland: 2-7 $Mg \cdot ha^{-1} \cdot a^{-1}$
- New saturation:
  - cropland 30-50 years
  - grassland 15-20 years
- Actual growth in CA: 6 mill ha/a, increasing
- outlook: in 20 years global CA adoption rate at 50%?

Conclusions:

- Agricultural land management: big player in climate change
- Agriculture is not an option: need to reduce environmental footprint
- CA responds to many global problems and is expanding globally
- Agriculture with CA could become a major element for global environmental policies
- CA is more profitable – payments not required to sustain it, but to accelerate adoption
- "Carbon" as new produce from farming
- BUT: no quick fix; complementary measures needed – optimized protocols


Sustainability and Food for all:
With CA agriculture can become
part of the solution!
Thank you for your attention!
More information:
http://www.fao.org/ag/ca