EURACADEMY - 28.08.2023 - Győr


(SCHNEIDER, 2008)


(HOFER, 2004)

Towards a climate and soil friendly Regenerative Agriculture of the future

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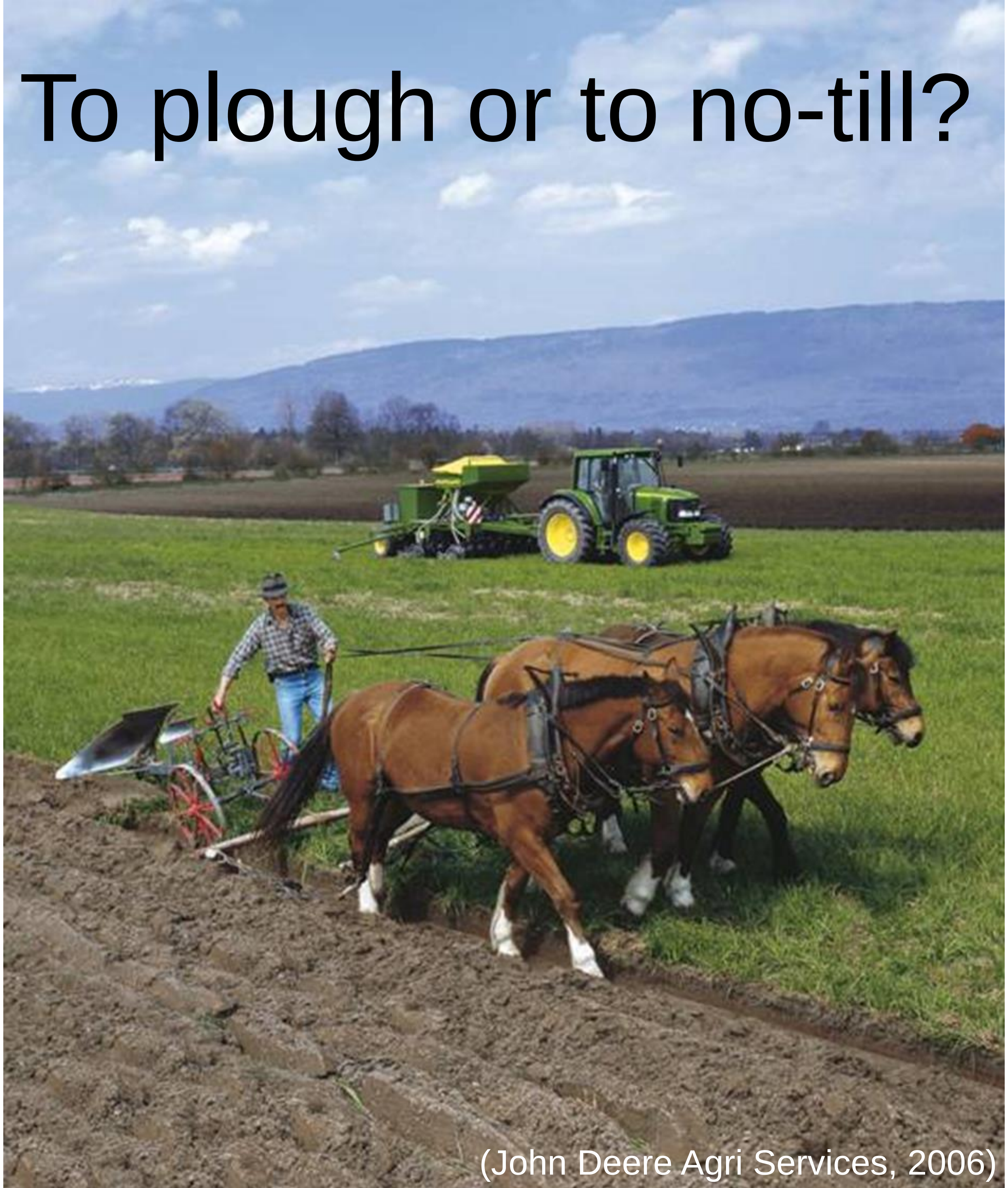
Wolfgang G. STURNY
SWISS NO-TILL

(Soil Service Canton of Berne & HAFL Zollikofen & Agroscope Zurich-Reckenholz, 2012)

To plough or to no-till?



(John Deere Agri Services, 2006)

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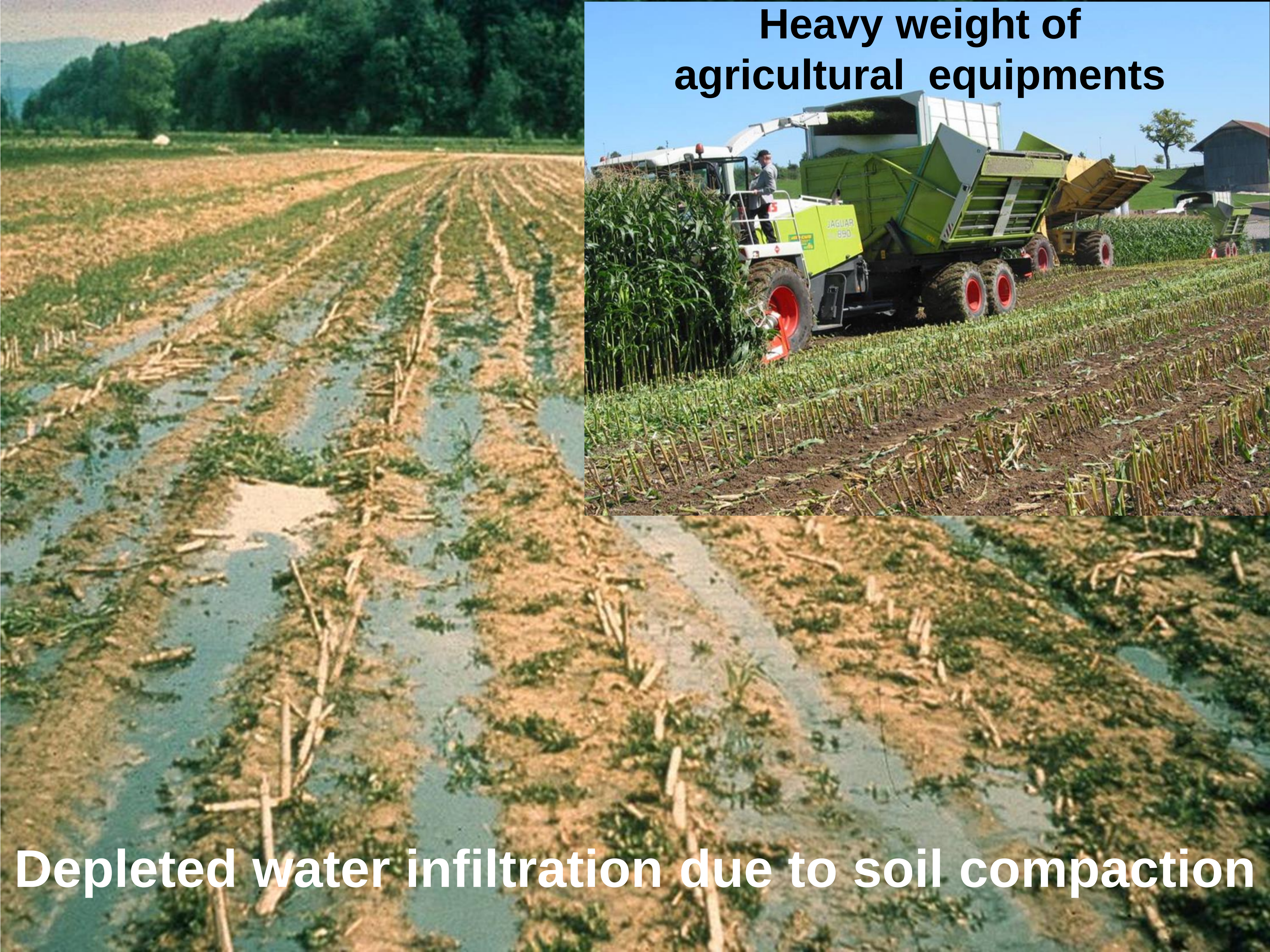
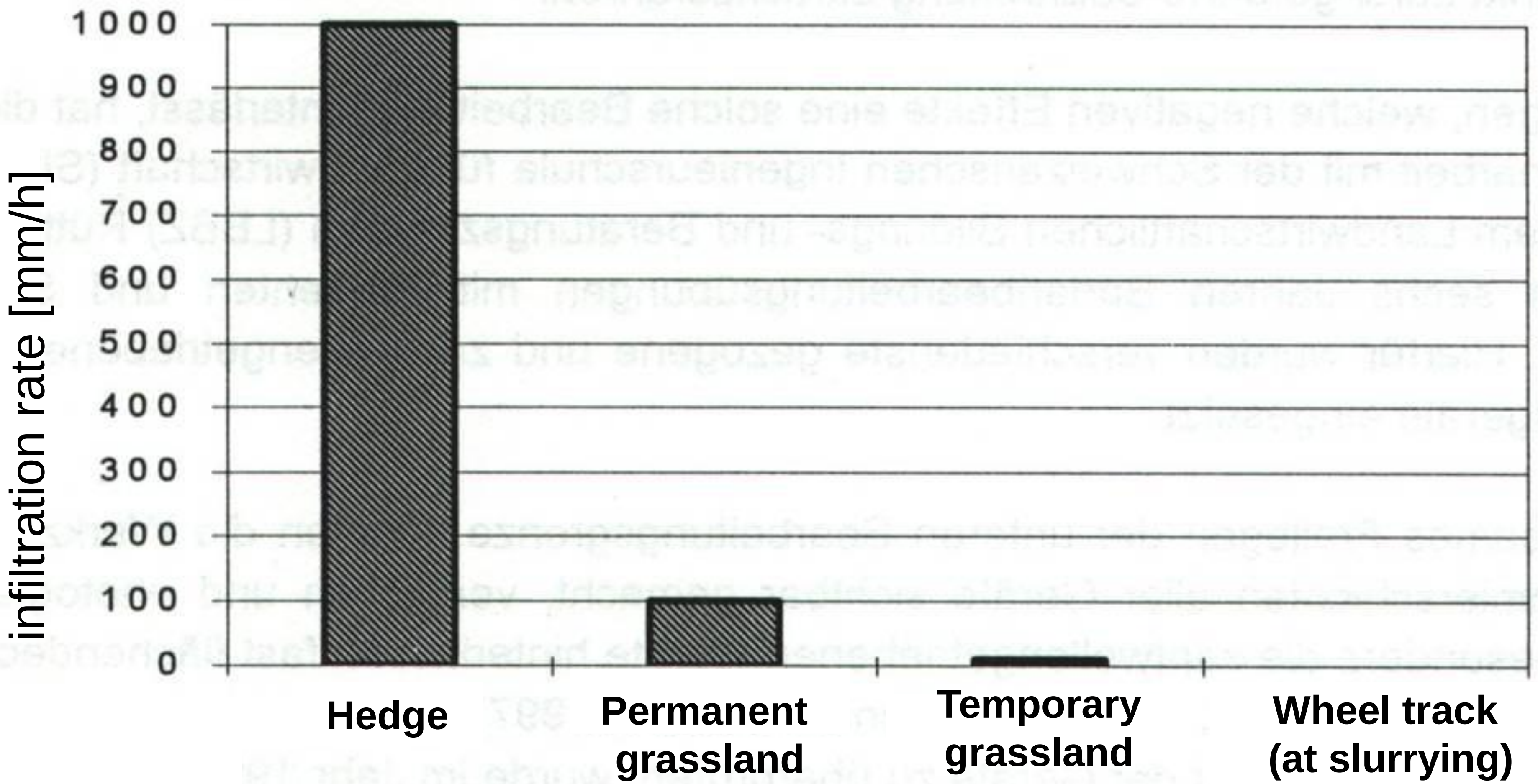
  ➡ Long term demonstration field experiment (*no-tillage vs. plough*)
- 4. Conclusions
  ➡ Outlook

1. Soil tillage

➡ **Problems and crucial experiences**


Heavy weight of
agricultural equipments
Depleted water infiltration due to soil compaction

Water infiltration



(VÖKT, 1997)

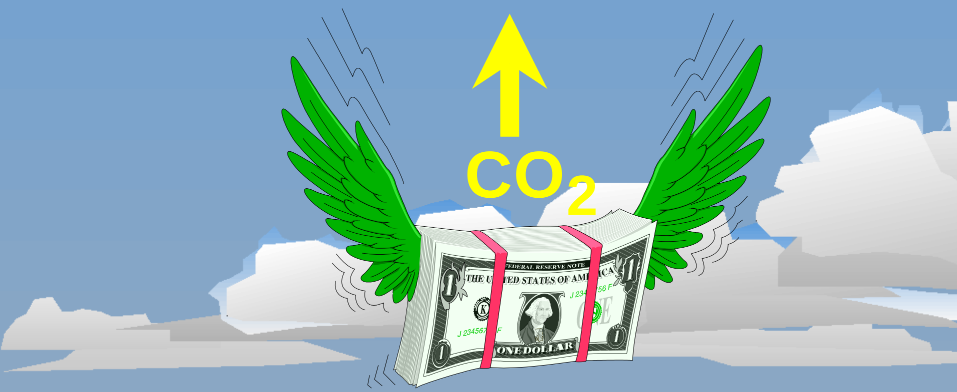
Water requirement of some important crops (transpiration coefficient)

• winter wheat[1)]	500 l H2O/kg DM
• winter rye[1)]	400 l H2O/kg DM
• winter barley[1)]	425 l H2O/kg DM
• sugarbeets[1)]	200 l H2O/kg DM
• maize[2)]	368 l H2O/kg DM
• field peas[2)]	650 l H2O/kg DM

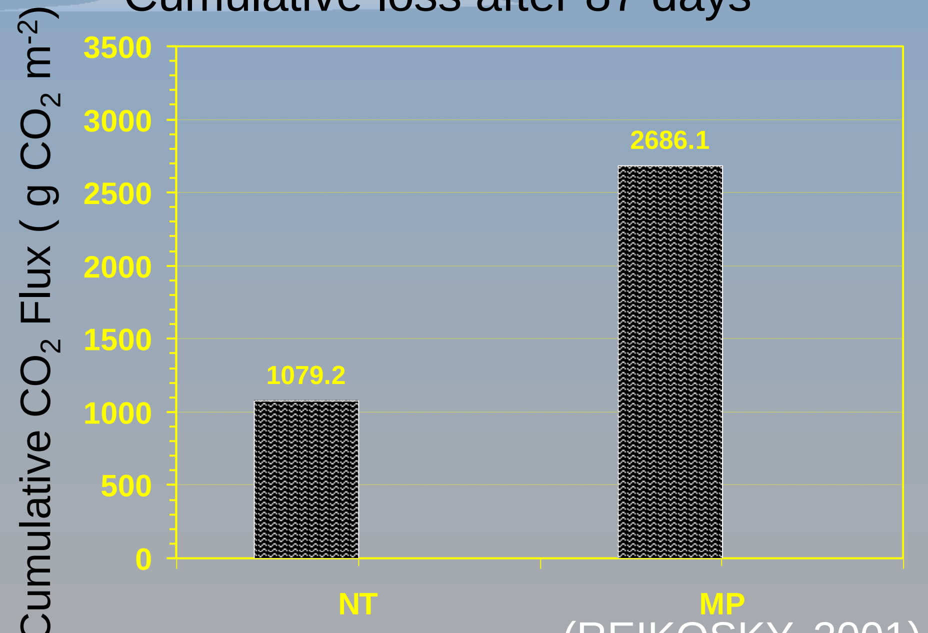
1) according to LÜTKE ENTRUP und OEHMICHEN (2000)

2) according to KELLER et al. (1997)

Tillage-induced carbon dioxide loss



Long Term Study: July 14 - October 9, 1998
Cumulative loss after 87 days



(REIKOSKY, 2001)

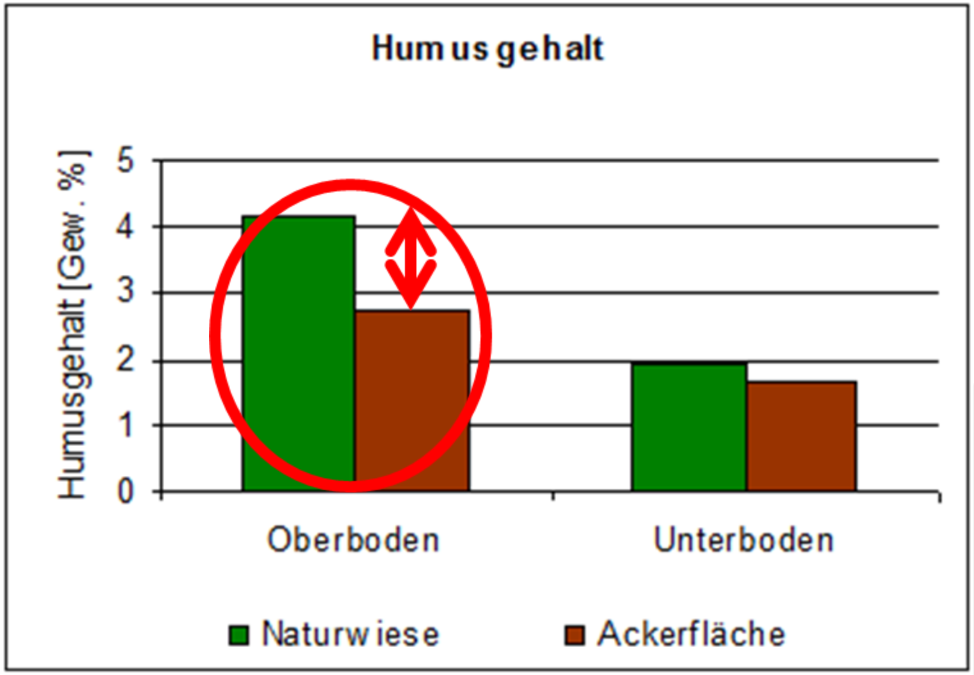
Tillage-induced organic carbon loss

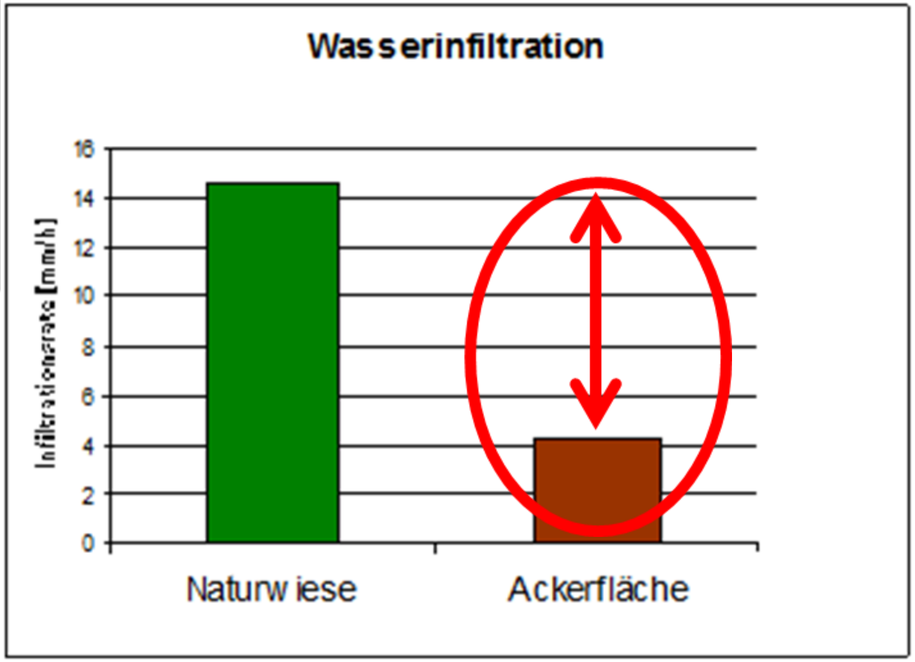
Witzwil/BE

~ 1938

1980

Bernese soil monitoring program: organic matter content & water infiltration



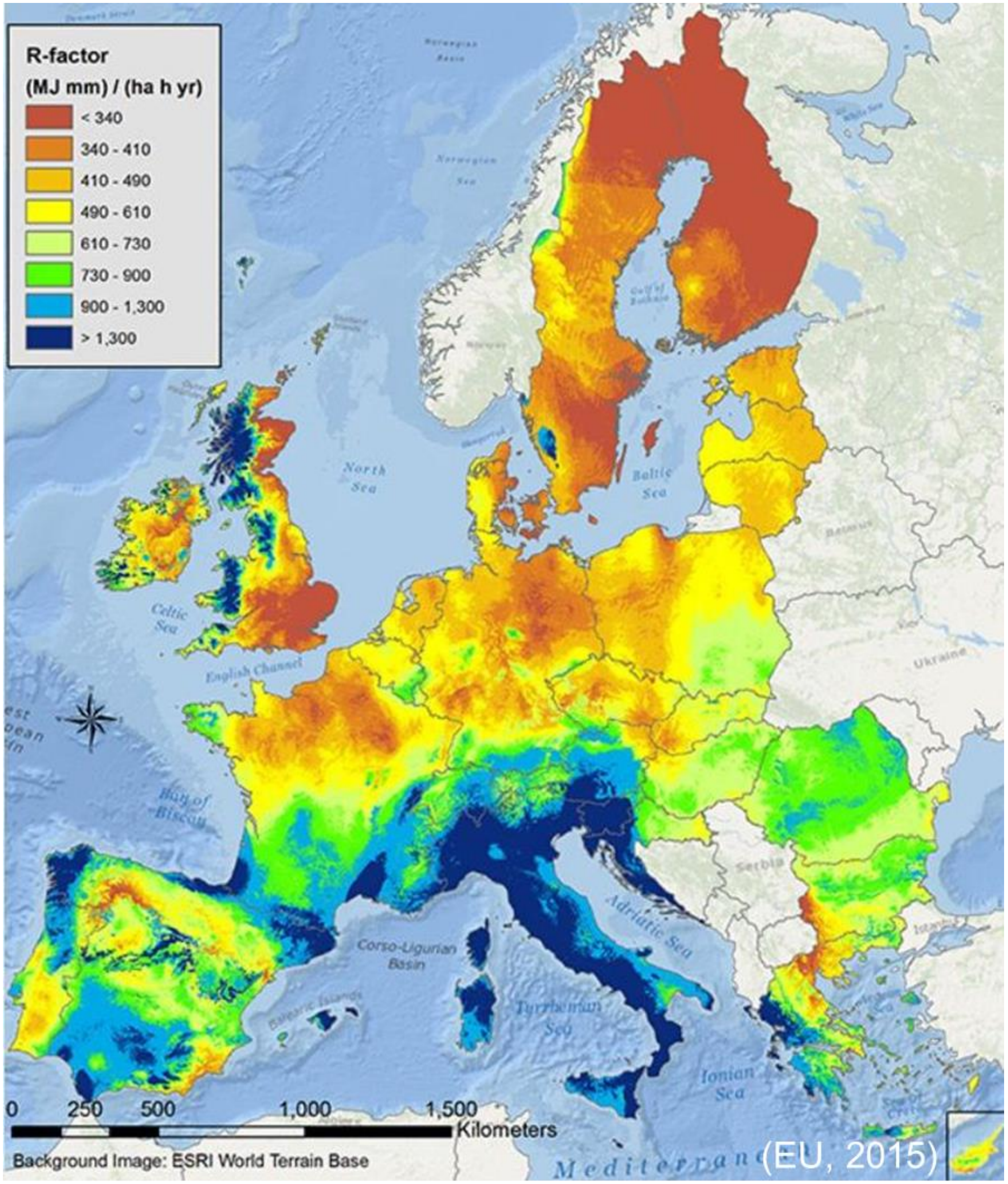


High tillage intensity causes soil erosion

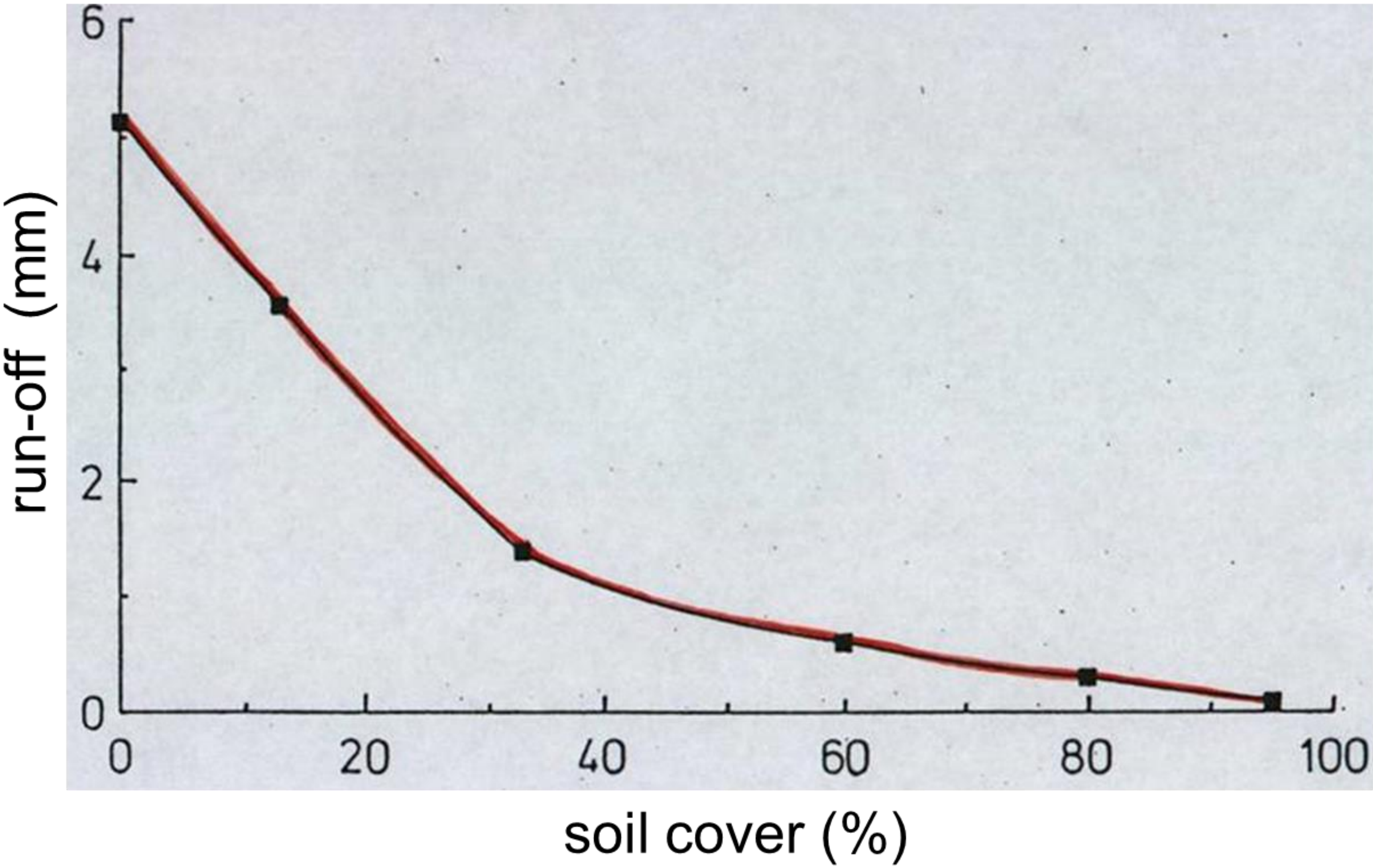
(FLÜCKIGER, 2007)

Soil degradation can cause water pollution

Rainfall erosivity in Europe



Soil cover and surface run-off



(ROTH et al., 1990)

Ground/soil surface temperature

at CH-Kerzers/FR; June 22nd, 2022

Source and photos: H.P. Liniger, CDE (Berne University)

Ground/soil surface temperature

at CH-Kerzers/FR; June 22nd, 2022

Source and photos: H.P. Liniger, CDE (Berne University)

2. Transition phase to no-till

➡ Regenerative Agriculture


(DERPSCH, 2005)

Transition phase

Maize strip tillage (PTO-driven)

Maize strip tillage (soil-driven)

Combine followed by no-till drill

(RITCHIE , 2002)

„Combined seeding“

No-till as a remedy: a systems approach

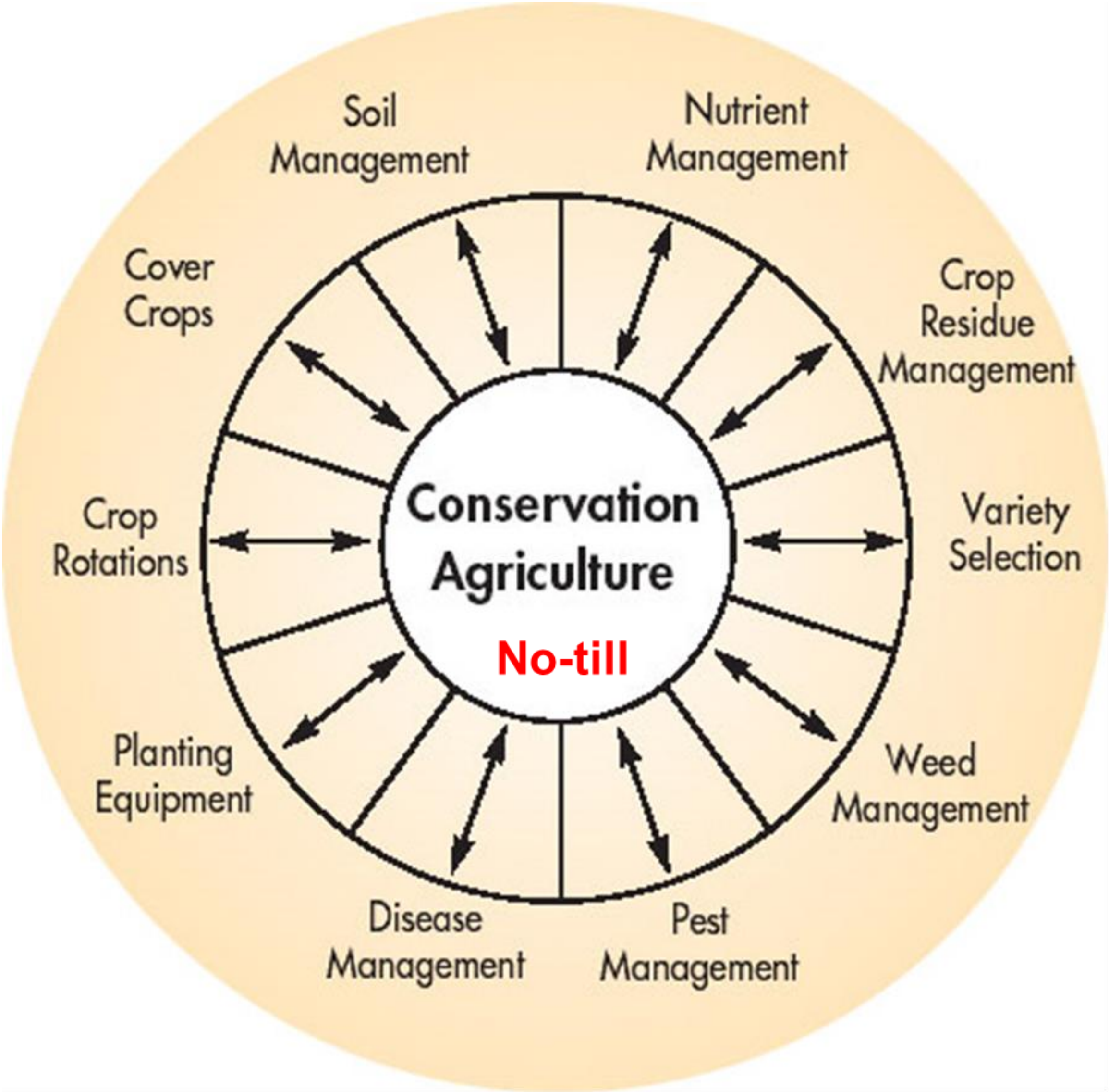
Regenerative / Conservation Agriculture

(definition by FAO)

3 principles

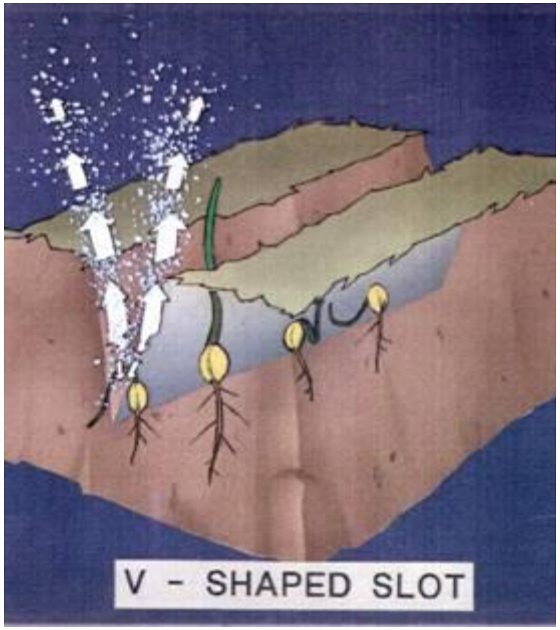
1. minimum soil disturbance (<25%)
2. permanent organic soil cover (>30%)
3. crop diversity (crop rotation, associations)

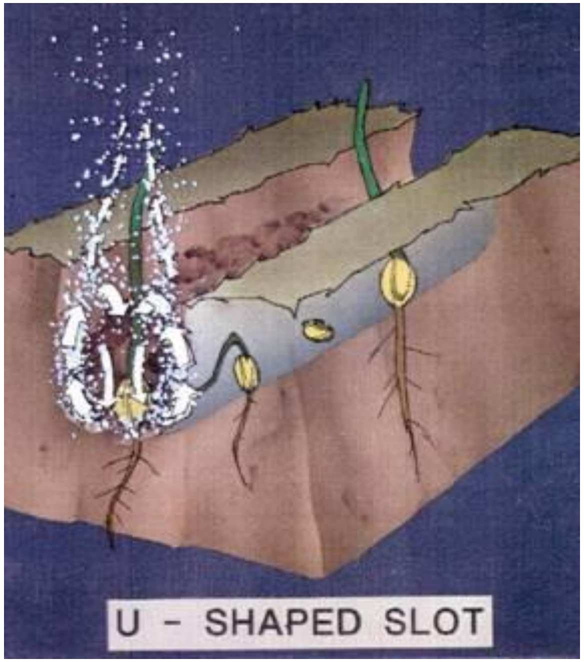
Systems Approach

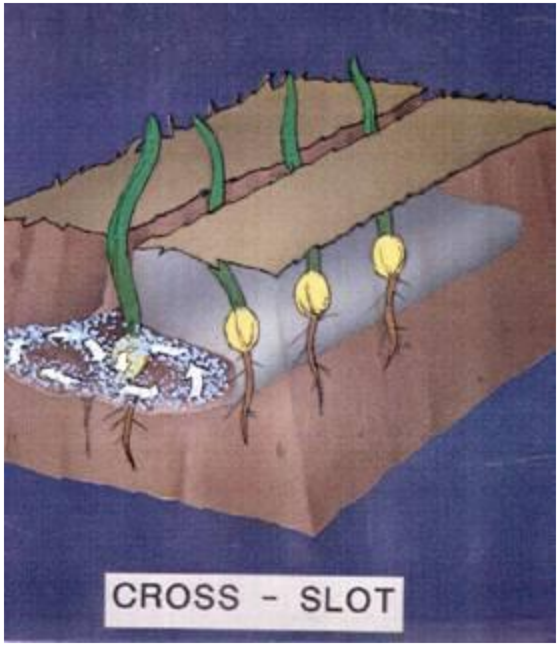


(CA decision making guide / UK, 2001)

Slot shape micro-environment
=> dry soils



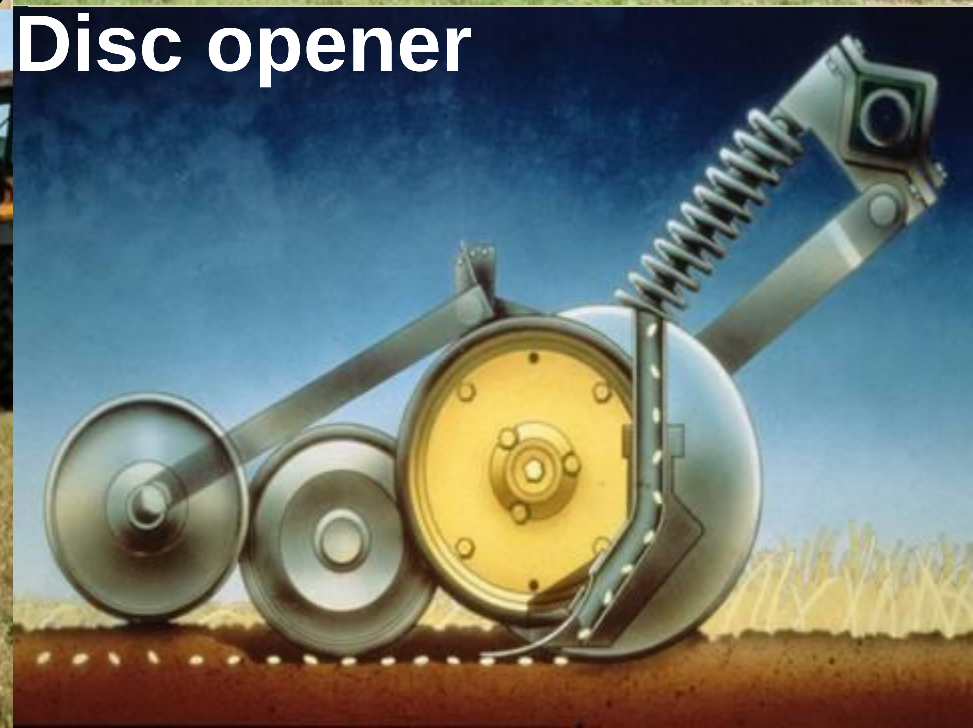




(RITCHIE / NZ, 2002)


(DERPSCH)

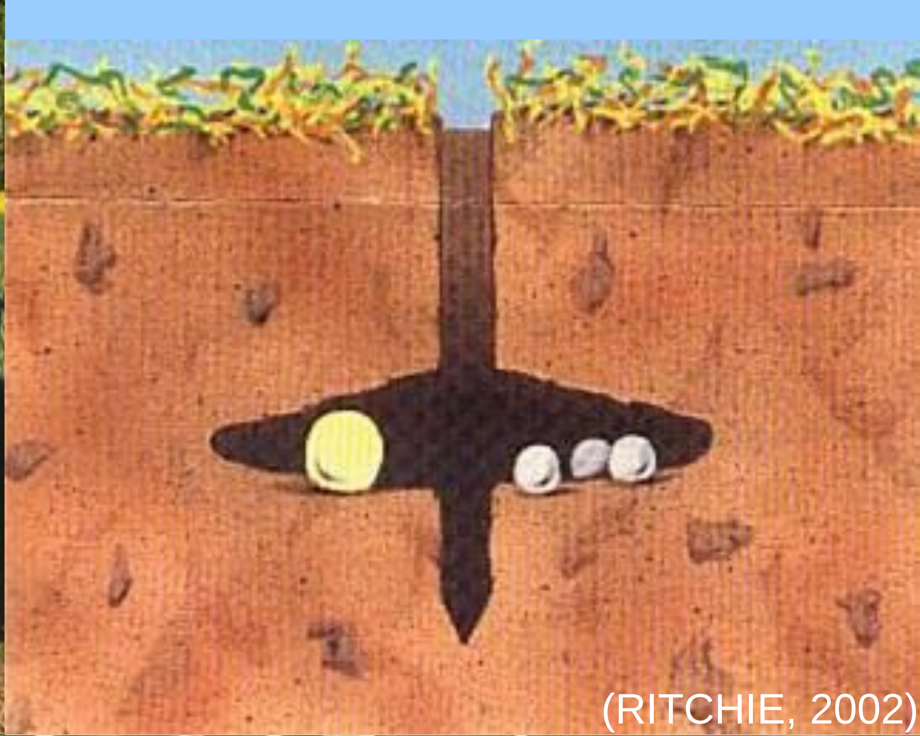

SD 3000P


Disc opener


CONSERVA PAK


AMAZONE
Hoe opener

Cross slot opener



(RITCHIE, 2002)

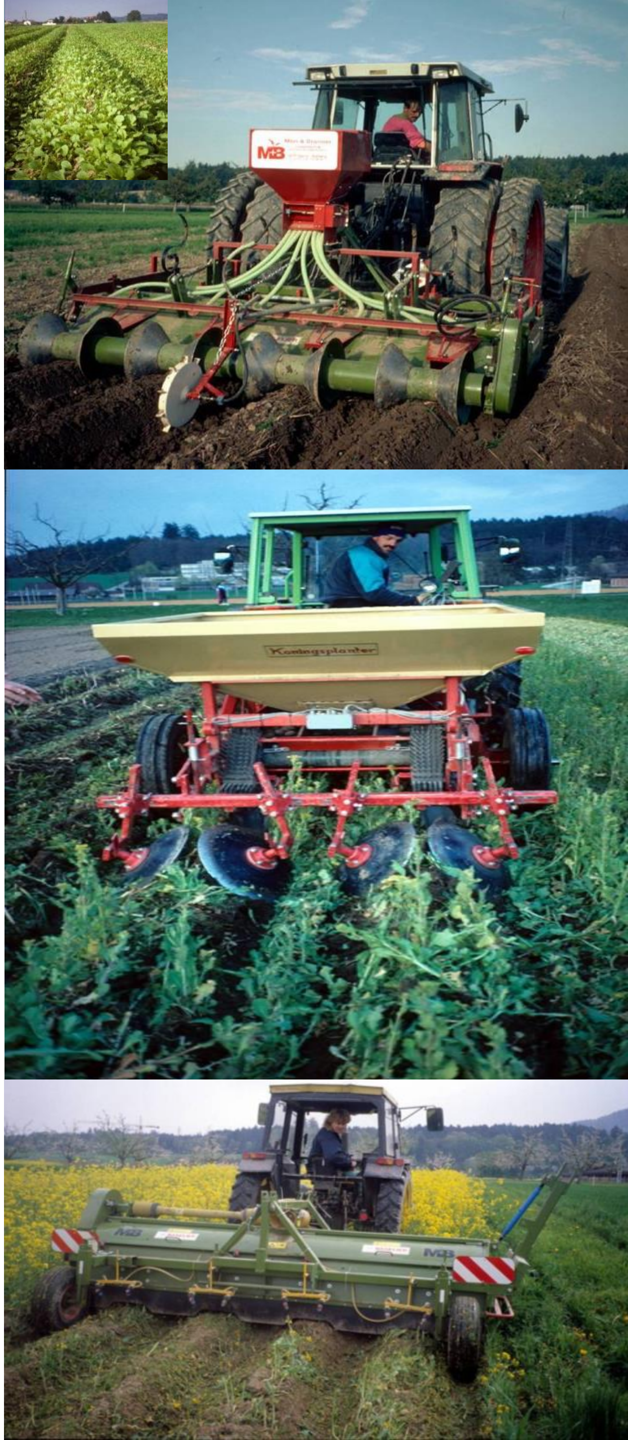
(RITCHIE, 2006)

Significantly less cereal foot diseases with no-till

Fusarium - mycotoxins

- crop rotation
- chop crop residues
- variety

(WYSS, 2008)



Koningsplanter

Spade test => on YouTube

Knowledge transfer (field days, consulting)

FROM FARMER TO FARMER => https://www.vonbauernfuerbauern.ch/en/

« De paysan – à paysan »

Wissensmanagement Umwelt
Patricia Fry

Projet de recherche et de diffusion d'expériences paysannes favorables à une exploitation durable du sol

Bénéficier des acquis d'autres agriculteurs

- Les agriculteurs qui mettent en application une protection mécanique du sol dans leur exploitation possèdent un savoir-faire spécifique.
- Le savoir transmis par des agriculteurs sera plus facilement reçu par les autres agriculteurs (cf. Davenport & Prusak 1998).

Une nouvelle approche «de paysan – à paysan» favorise la protection mécanique du sol dans l'agriculture

- Recherche du savoir acquis par les paysans en matière de protection du sol
- Diffusion du savoir par le biais du cinéma et des réseaux paysans

Extraits du film pilote «De paysan – à paysan»

Langue et … … métaphore | Processus d'apprentissage | Arguments | Expériences positives

SWISS NO-TILL

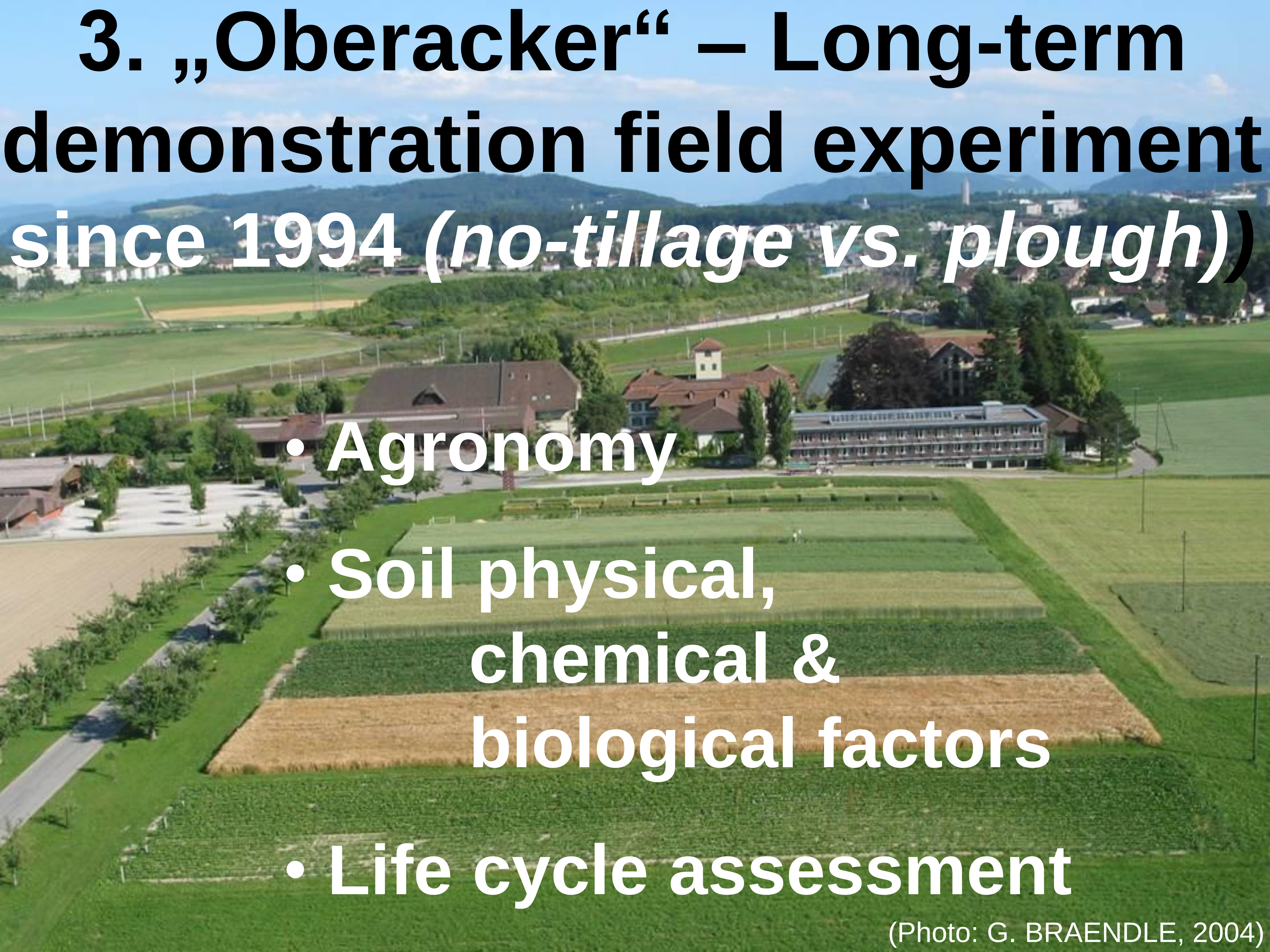
Swiss soil conservation association

= platform for knowledge exchange

General assembly
Annual meeting (~150 attendees)
Official field days (in German and in French), organized by members of SWISS NO-TILL
Research projects
[8WCCA 2021]

SWISS NO-TILL

3. „Oberacker“ – Long-term demonstration field experiment since 1994 (*no-tillage vs. plough*)



- Agronomy
- Soil physical, chemical & biological factors
- Life cycle assessment

(Photo: G. BRAENDLE, 2004)


Zollikofen

Experimental design

Parzelle	I (DS / PF)	II (DS / PF)	III (DS / PF)	IV (DS / PF)	V (DS / PF)	VI (DS / PF)
1997	Zuckerrüben	Winterweizen	Kartoffeln	Hafer / Kunst-wiese	Silomais	Wintergerste
1998	Winterweizen	Kartoffeln	Winterweizen	Silomais	Wintergerste	Zuckerrüben
1999	Kartoffeln	Winterweizen	Silomais	Wintergerste	Zuckerrüben	Winterweizen
2000	Winterweizen	Silomais	Wintergerste	Zuckerrüben	Winterweizen	Eiweisserbsen
2001	Silomais	Wintergerste	Zuckerrüben	Winterweizen	Eiweisserbsen	Winterroggen
2002	Wintergerste	Zuckerrüben	Winterweizen	Soja	Winterroggen	Silomais
2003	Zuckerrüben	Winterweizen	Eiweisserbsen	Winterroggen	Silomais	Wintergerste
2004	Winterweizen	Eiweisserbsen	Winterroggen	Silomais	Wintergerste	Zuckerrüben
2005	Eiweisserbsen	Winterroggen	Silomais	Wintergerste	Zuckerrüben	Winterweizen
2006	Winterroggen	Silomais	Wintergerste	Zuckerrüben	Winterweizen	Eiweisserbsen
2007	Ackerbohnen	Wintergerste	Zuckerrüben	Eiweisserbsen	Winterweizen	Körnermais
2008	Wintergerste	Zuckerrüben	Winterweizen	Silomais	Eiweisserbsen	Soja
2009	Zuckerrüben	Winterweizen	Eiweisserbsen	Silomais	Ackerbohnen	Wintergerste
2010	Silomais	Eiweisserbsen	Winterweizen	Ackerbohnen	Wintergerste	Zuckerrüben
2011	Eiweisserbsen	Winterweizen	Ackerbohnen	Wintergerste	Zuckerrüben	Silomais
2012						

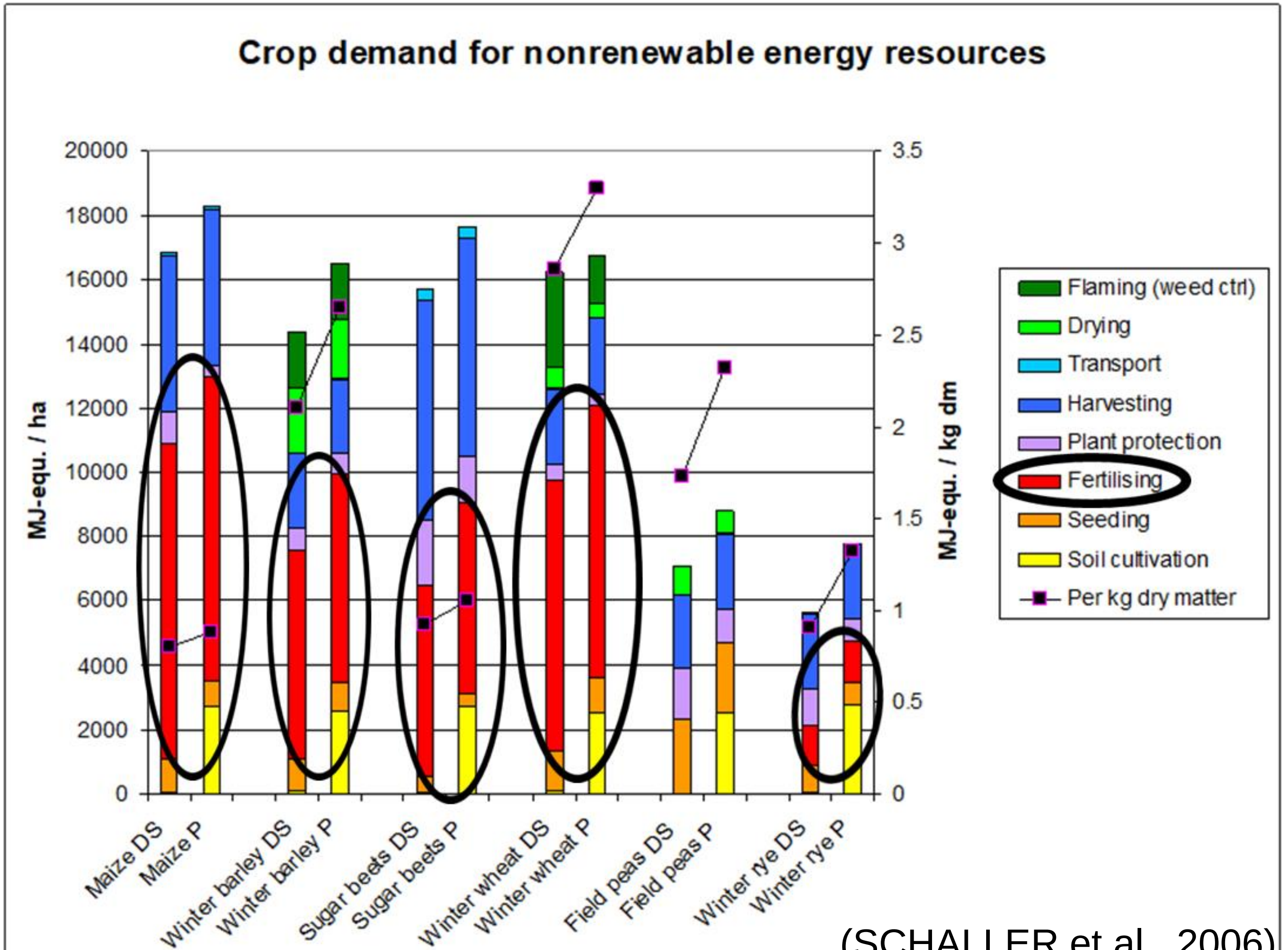
18m

78m

DS = Direktsaat
PF = Pflug


FENDT
0-40 cm
Clay: 14.6%
Silt: 21.3%
Sand: 62.0%
SOM: 2.1%
pH: 6.1

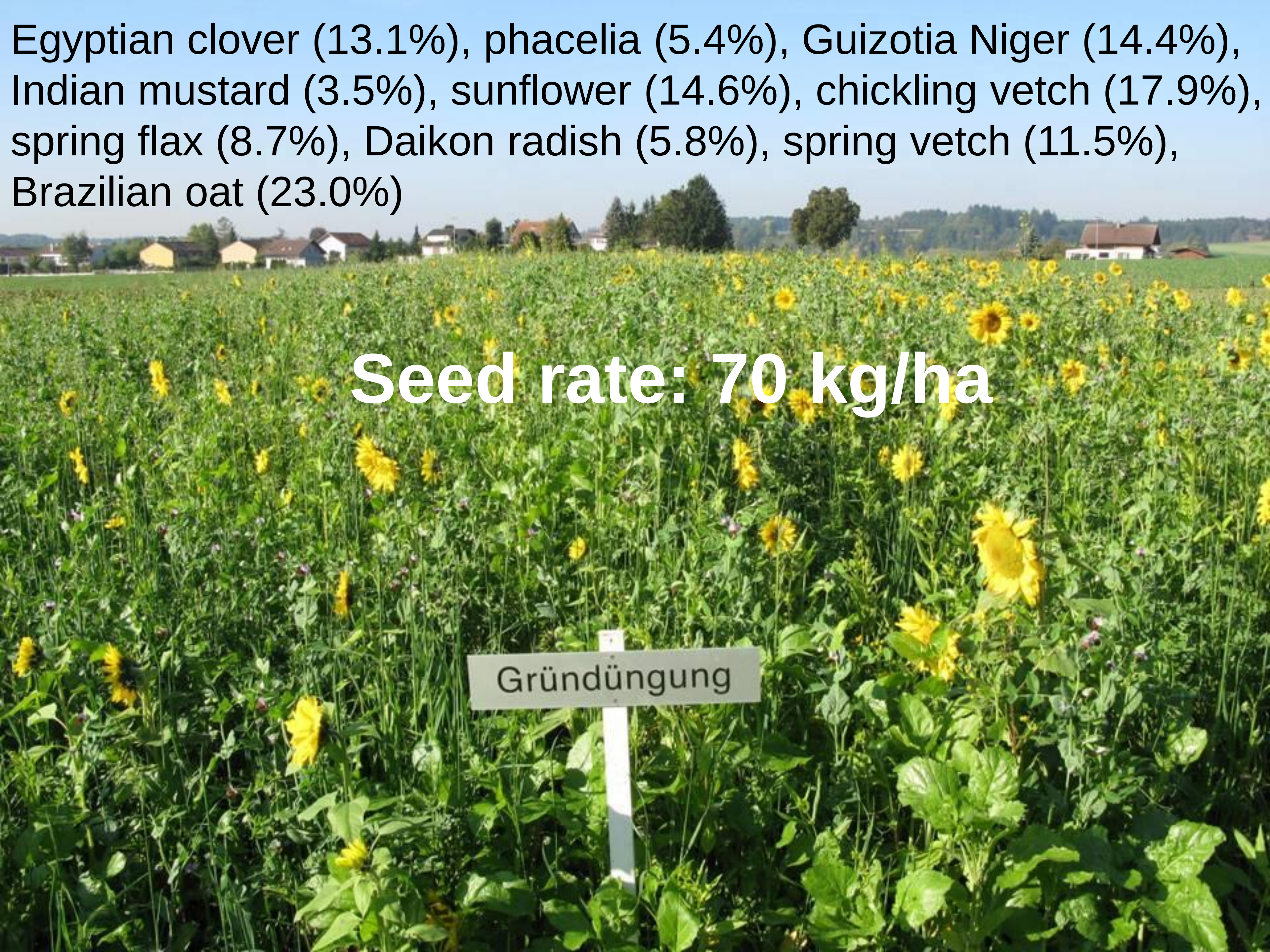
Life cycle assessment: 1999 – 2005 for no-till (NT) and plough (PL)



(SCHALLER et al., 2006)

Egyptian clover (13.1%), phacelia (5.4%), Guizotia Niger (14.4%), Indian mustard (3.5%), sunflower (14.6%), chickling vetch (17.9%), spring flax (8.7%), Daikon radish (5.8%), spring vetch (11.5%), Brazilian oat (23.0%)

Seed rate: 70 kg/ha



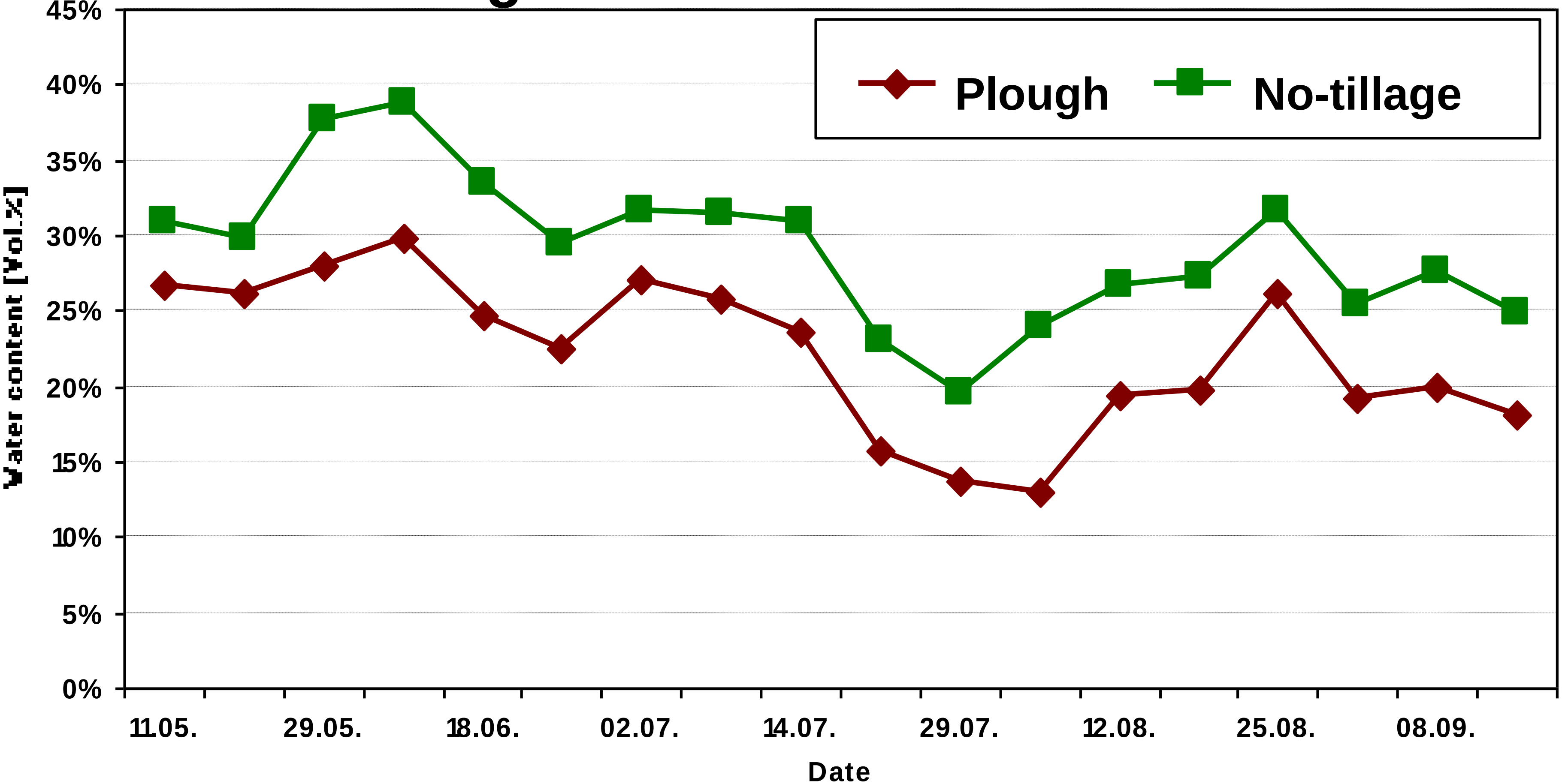
Retention of soil fertility: soils should be used in such a way to fix more carbon than to loose

Criterias for the choice of cover crop species:

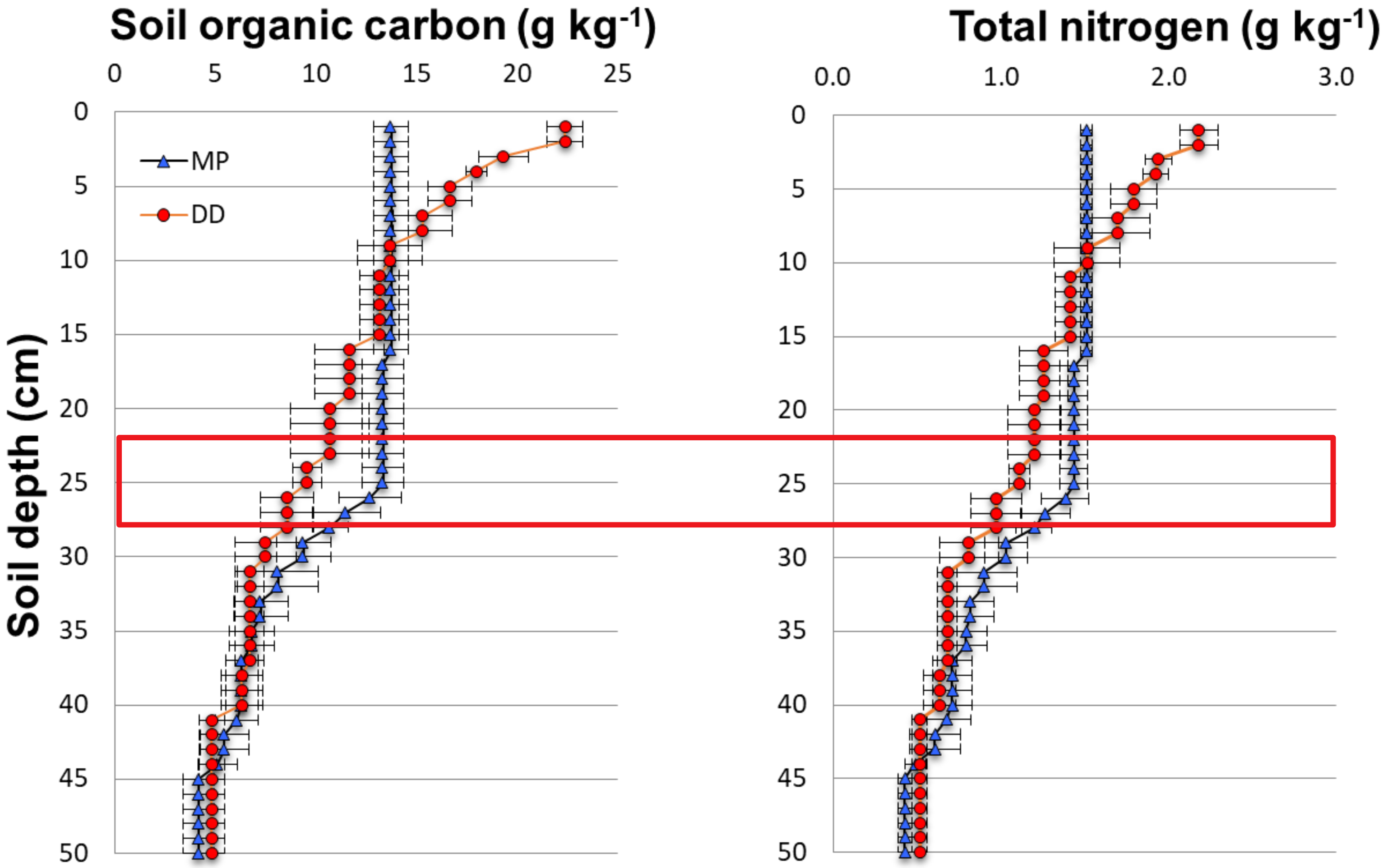
- **Concurrence for undesired flora = less herbicide use: plant length in minimum 80 cm**
- **Nitrogen fixation: legumes**
- **Soil loosening: deep roots**
- **Reduction of glyphosate use: no winter hardiness**
- **Organic matter increase: production of in minimum 5 t/ha DM a year (better 10 t)**
- **Proliferation of mycorrhizae**


CLAAS
CLAAS

Soil water content in 0-30 cm soil depth; average of 1998 & 1999 under maize

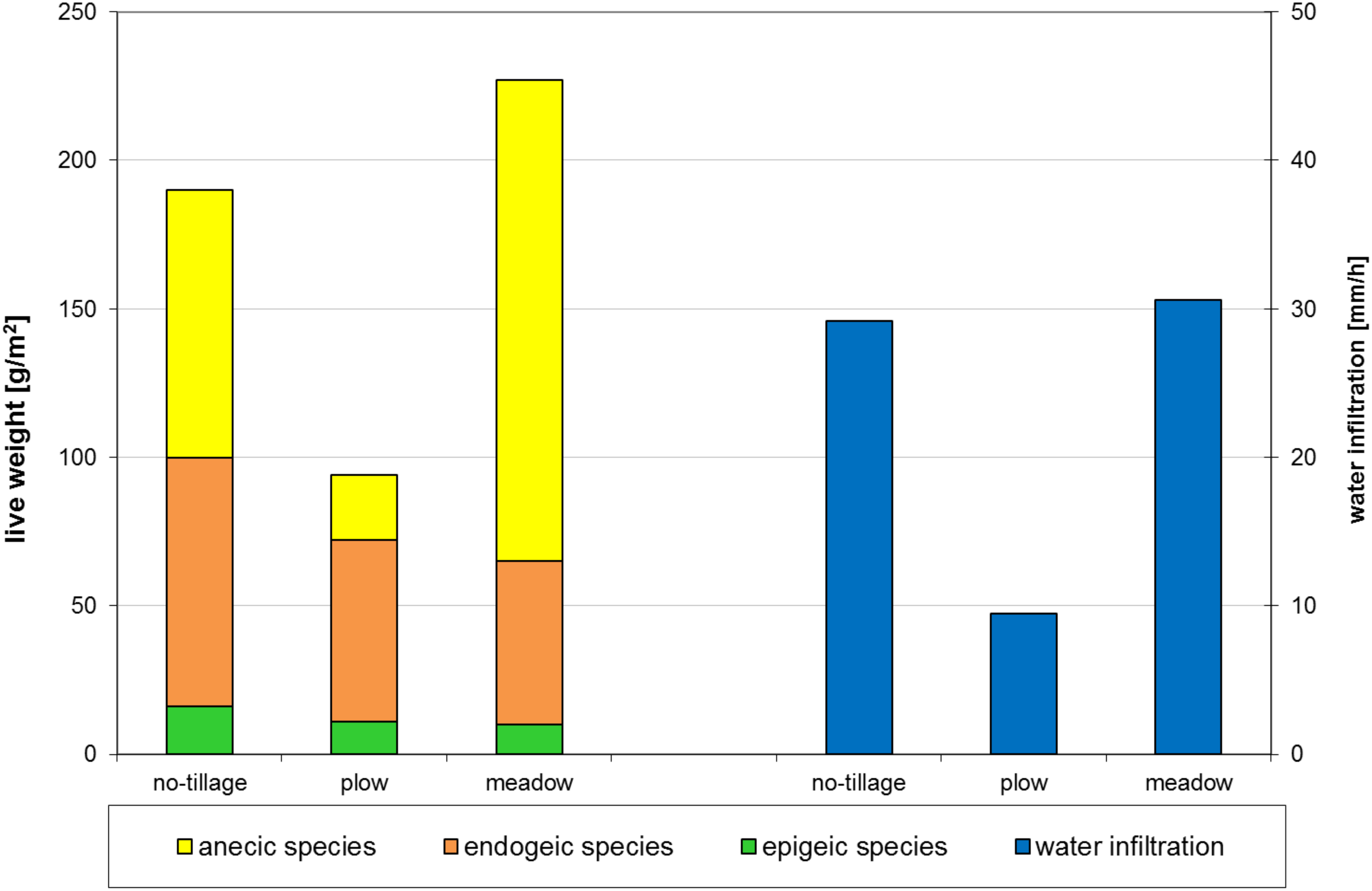


Soil organic carbon & total nitrogen for no-till (NT) and plough (PL)

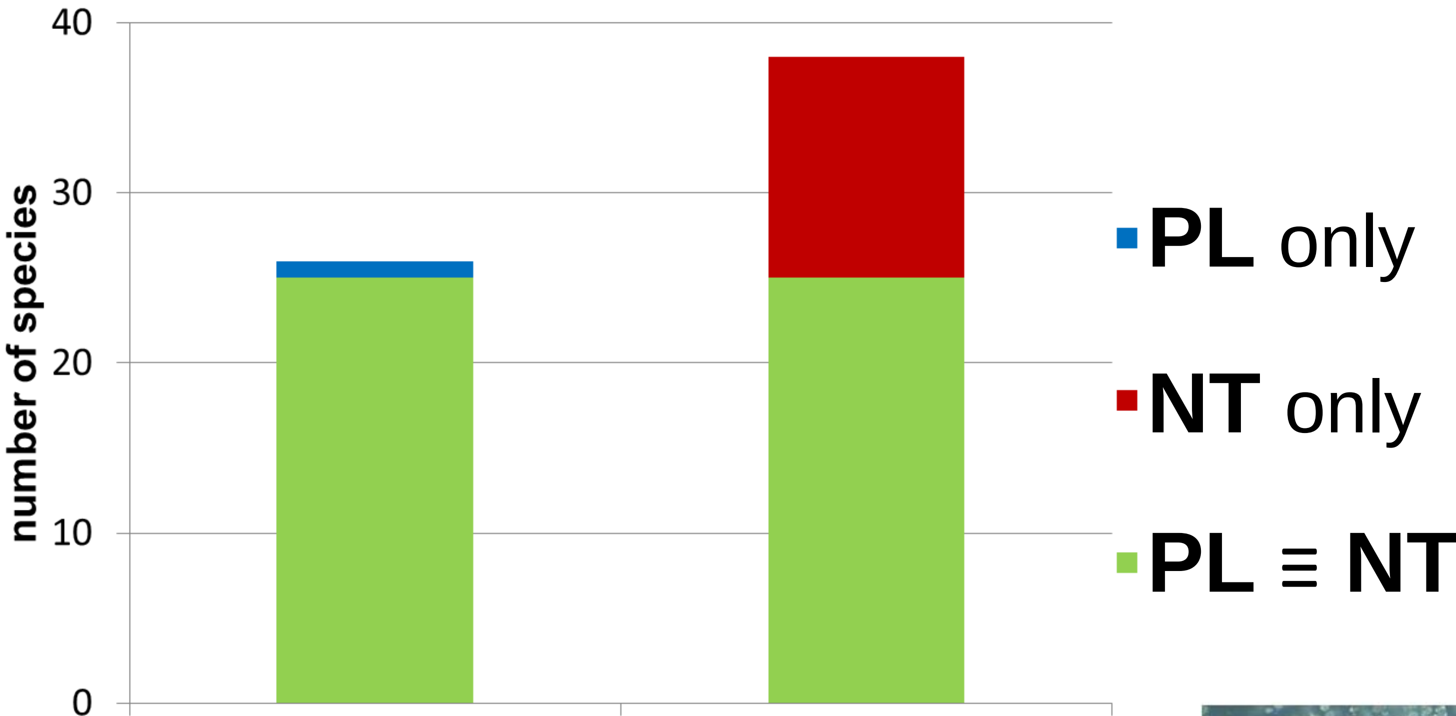


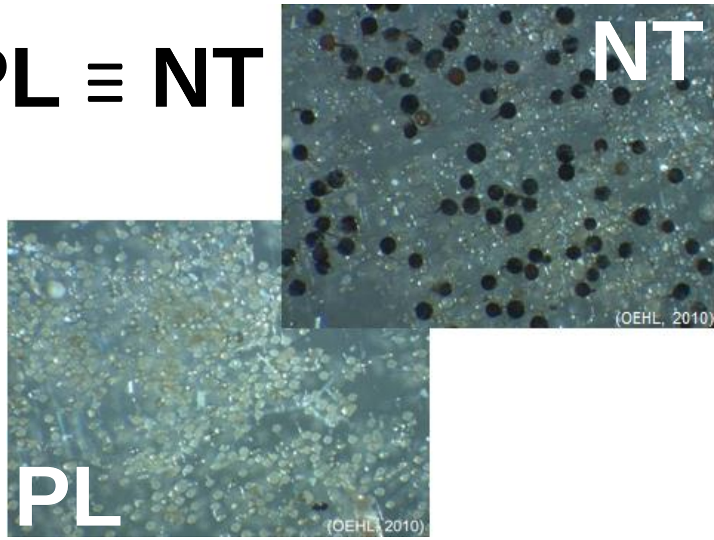
(KELLER et al., 2016)

Earthworm live weight and water infiltration



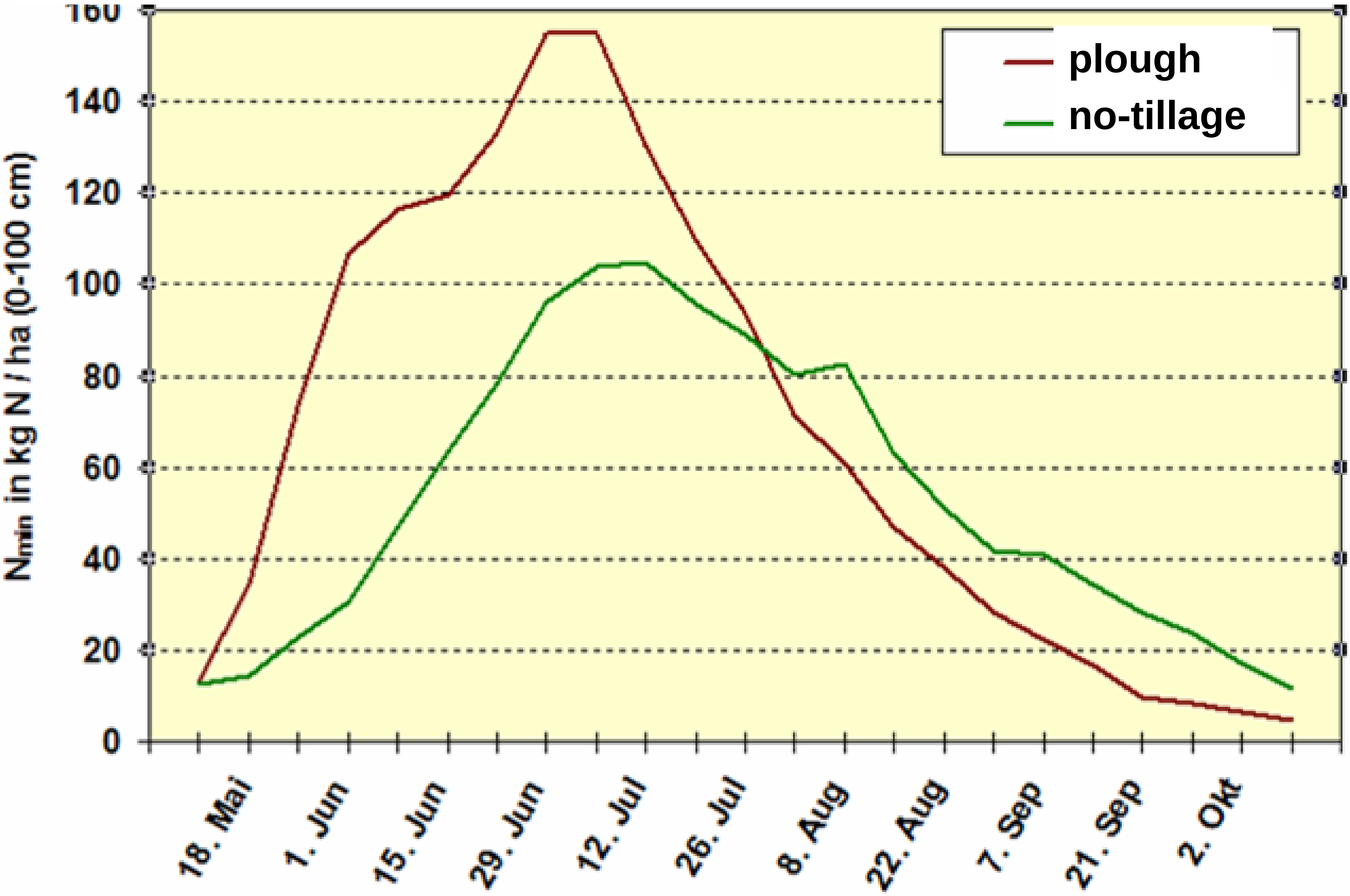
Mycorrhizae: number of species for no-till (NT) and plough (PL)

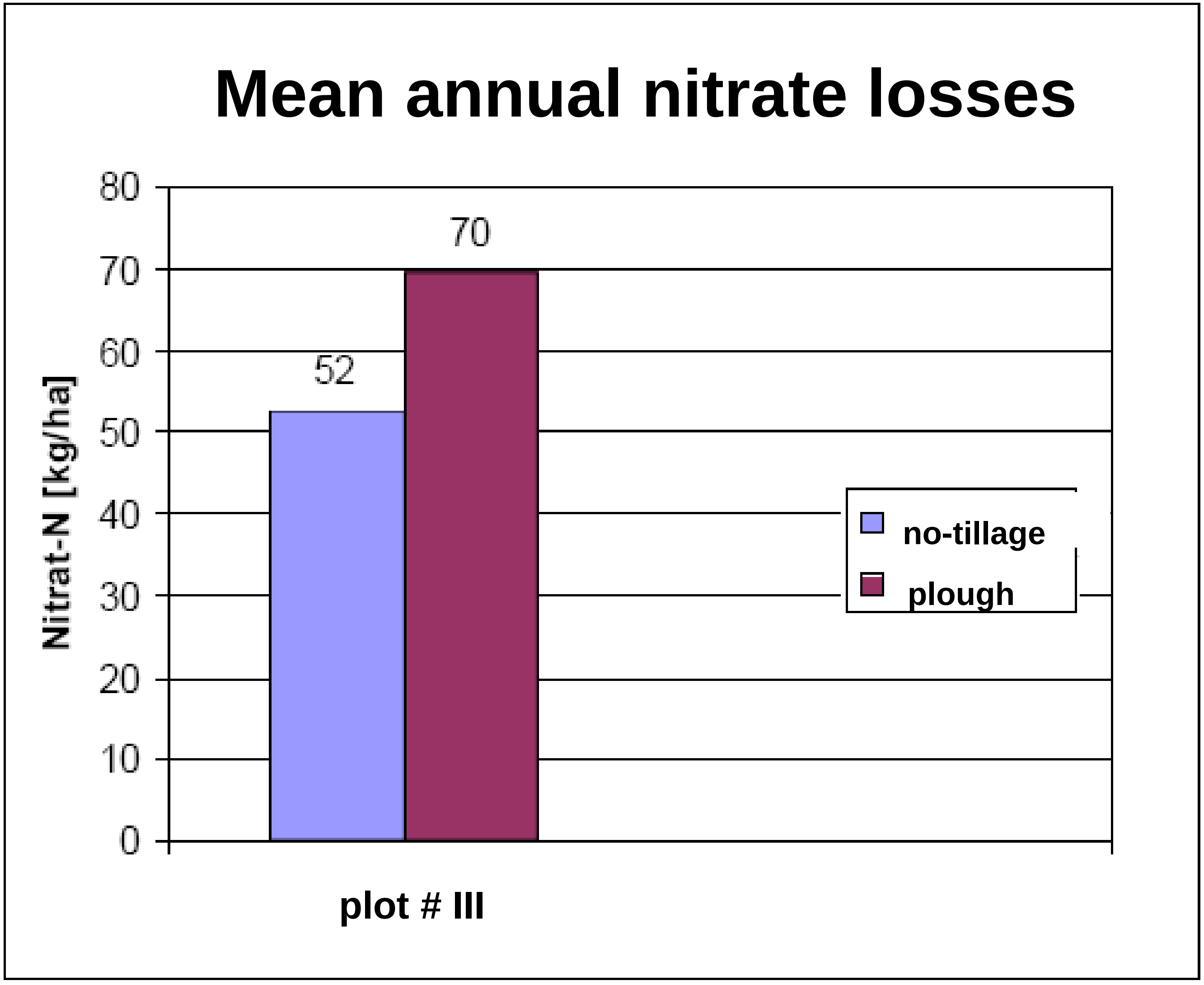




Nitrogen mineralisation under sugar beets in 2001

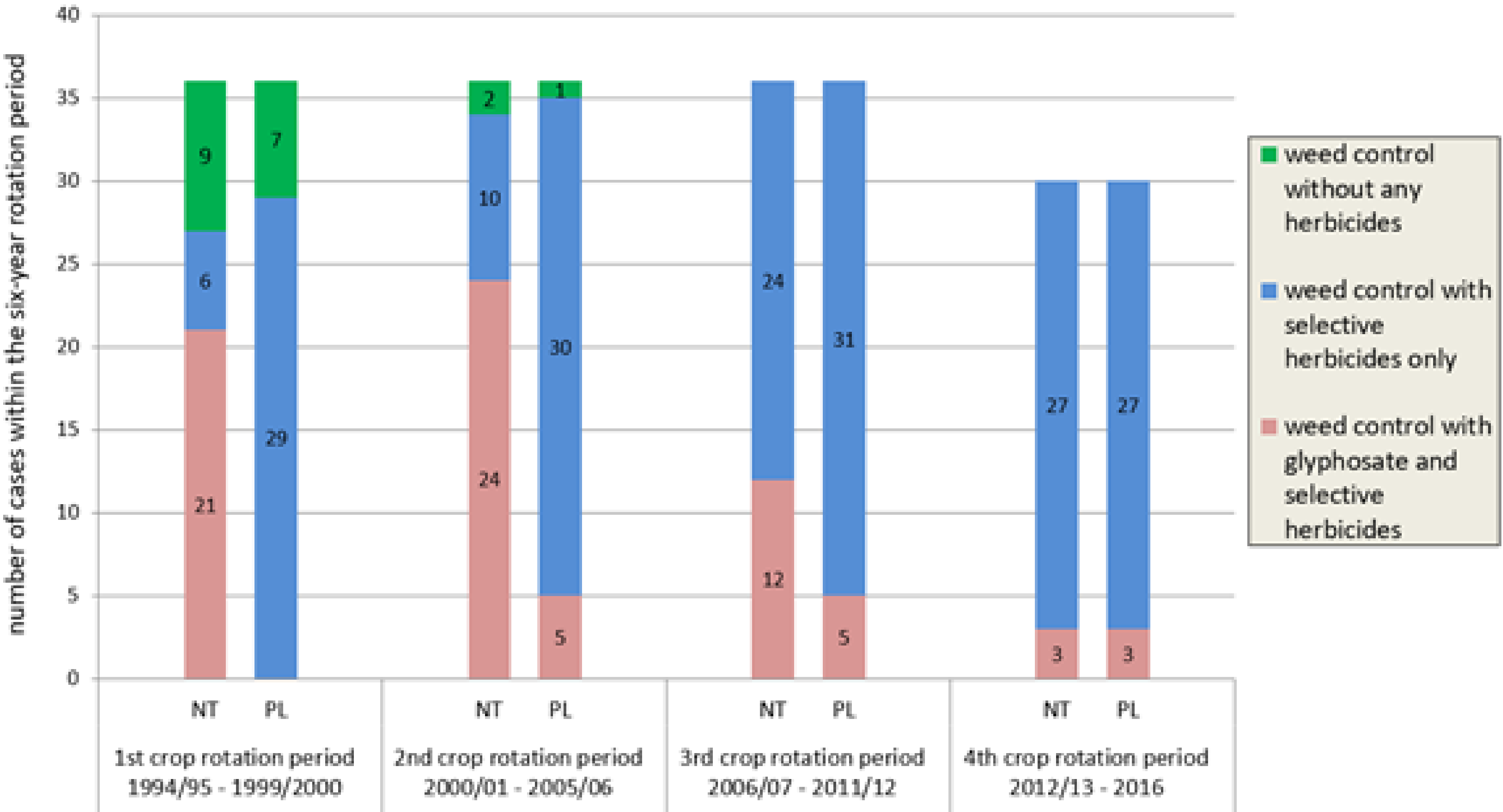
at planting on May 3rd: 37 kg N/ha



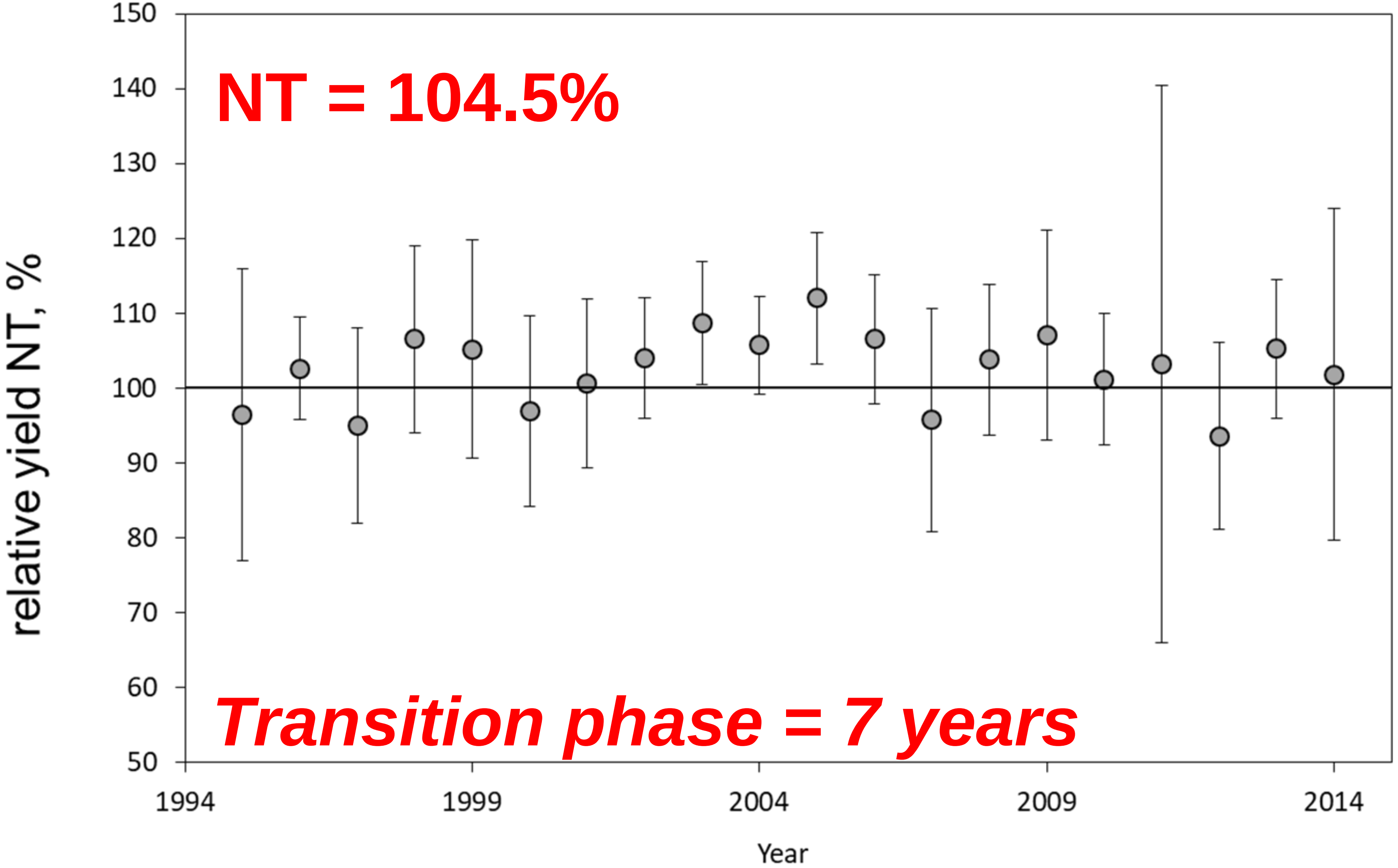


Mean annual nitrate losses
80
70
60
50
40
30
20
10
0
70
52
Nitrat-N [kg/ha]
no-tillage
plough
plot # III

Weed control: herbicide strategy for no-till (NT) and plough (PL)



Crop yields: ø 1994 – 2014 for no-till (NT) and plough (PL = 100%)



(KELLER, 2015)

4. Conclusions

➡ Outlook

Challenges of no-tillage → possible solutions

• Develops risk of mycotoxins
→ crop rotation

• Requires substantial amounts of non-selective herbicides
→ cover crops that freeze off

• Novel, expensive no-till technology
→ requires corporate ownership and utilisation

• Lack of know-how
→ „learning by doing“
→ research necessity (plant nutrition)
→ soil support programs

Life cycle assessment (e.g. demand for nonrenewable energy resources)

1 cm in soil depth = 150 t/ha moved

1 cm in soil depth = ca. 1 l/ha Diesel burnt

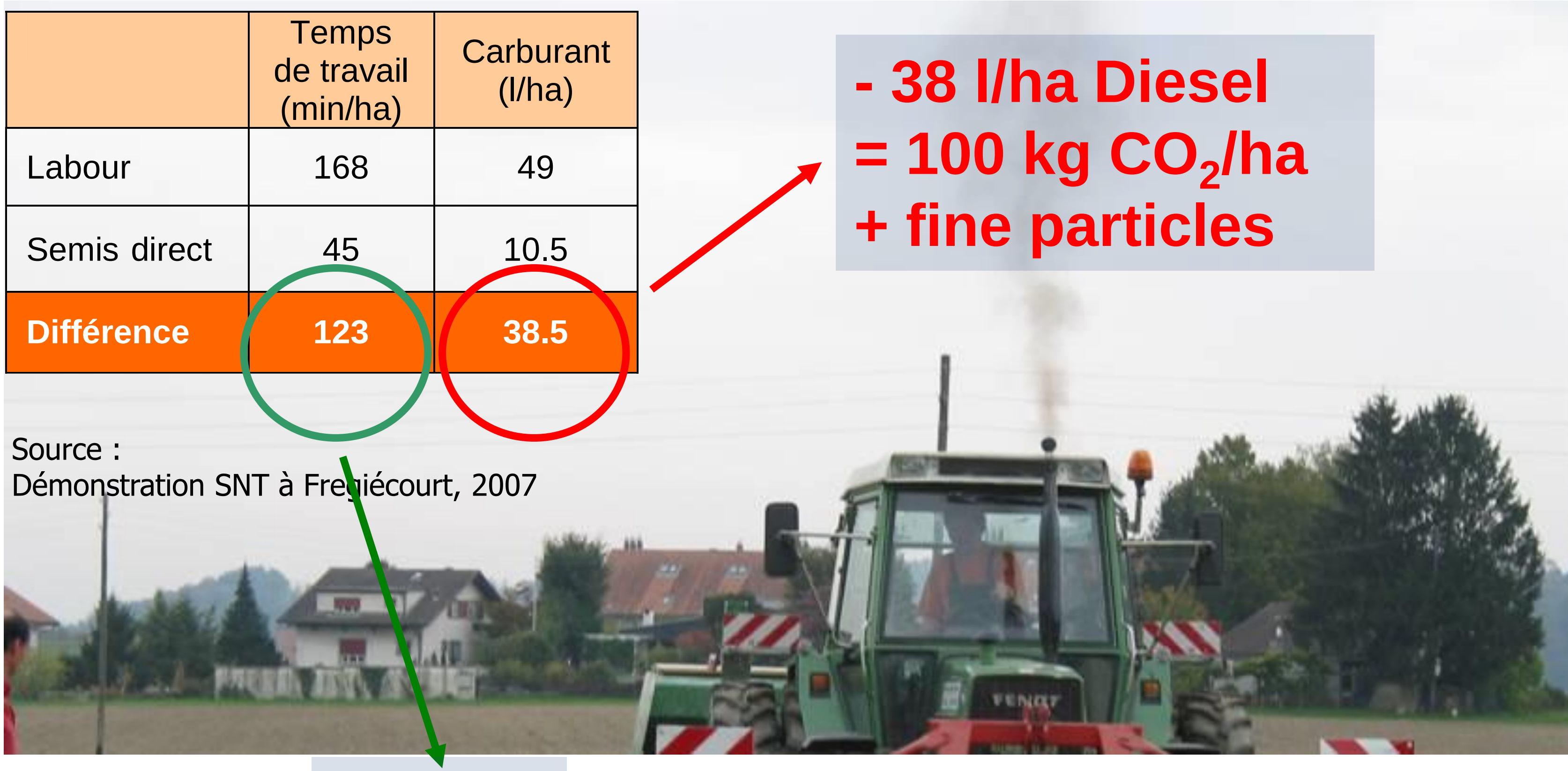
↓

time – energy – material – costs

Consumption of Diesel & Time

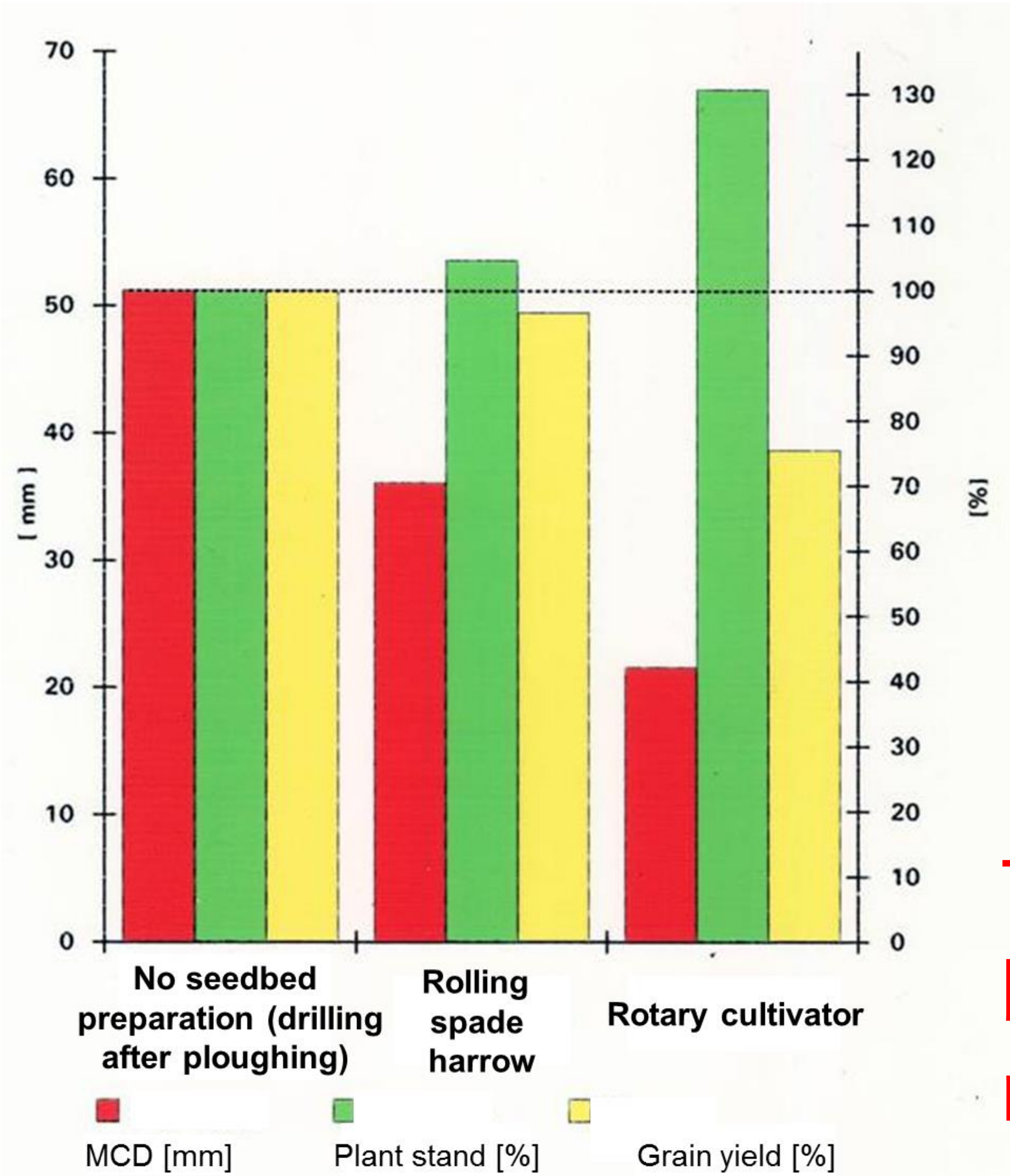
		Temps de travail (min/ha)	Carburant (l/ha)
Plough	Labour	168	49
No-Till	Semis direct	45	10.5
	Différence	**123**	**38.5**

Source :
Démonstration SNT à Fregiécourt, 2007



- 38 l/ha Diesel
= 100 kg CO_2/ha
+ fine particles

- 2 h/ha



There is no correlation between seedbed fine-ness and plant yield!

(STURNY, 1990)

Crop rotations with legumes

Substitution of non-selective herbicides: remedy with frost-sensitive green manure mixtures or electroherb


Wintergerste
Wintergerste

Mob Grazing

Burkhard Fromme,

D-Königslutter am Elm/
Lower Saxony

Living Mulch:
undersown white clover

GKB

companion crops:
e.g. rapeseed & buckwheat

(COURTOIS, 2010)

« relay intercropping »

(UEBELHARDT, 2018)

e.g. perennial wheat (Canada)

Targets for the future of Regenerative Agriculture:

- a **low-input** (relay) cropping system based on legumes and N- & P-recycled fertilizers – with maximum energy and resource efficiency – while pollutant inputs are reduced to the max
- a **holistic approach** that takes into account simultaneously: protecting the climate, conserving the soil, maintaining the landscape, reducing natural hazards, keeping waters clean and – last but not least – producing our food

The developing process of a long-term no-tillage system in South America

Initial phase (0-5 years)

- *Aggregate aufbauen*
- *Niedrige OS-Werte*
- *Niedrige Ernte-rückstände*
- *Wiederher-stellung der mikrobiell. Biomasse*
- *> N*

Transition phase (5-10 years)

- *Erhöhung d. Bodendichte*
- *Ernte-rückstände nehmen zu*
- *OS beginnt zuzunehmen*
- *P beginnt zuzunehmen*
- *Imob. N ≥ Min.*

Consolidation phase (10-20 years)

- *Erhöhte Ernte-rückstände*
- *Hohe C-Werte*
- *> KAK*
- *> H_2O*
- *Imob. N < Min.*
- *> Nährstoff-kreislauf*

Preservation phase (> 20 years)

- *Hohe Akkum. von Ernterück.*
- *Kontinuierl. N- u. C-Flux*
- *C + Hoch*
- *> H_2O*
- *> Nährstoff-Kreislauf*
- *< N- und P-Düngung*

0-5 | 5-10 | 10-20 | > 20

Years

(SÁ, 2004)

Thank you for your kind attention!

„CHANGE IS FIRST DENIED,

THEN VEHEMENTLY OPPOSED,

FINALLY ACCEPTED AS BEING SELF-EVIDENT."

Bill Crabtree (13.03.1997)