# Conservation Agriculture og klimaeffekter

Af Søren Ilsøe

Landmand uden plov i 19 år og praktisering af Conservation Agriculture siden 2011
Næstformand i Foreningen for Reduceret jordbearbejdning i DK, www.frdk.dk
Medlem af bestyrelsen i European Conservation Agriculture Federation, www.ecaf.org
Planteavlsrådgiver i Agrovi, www.agrovi.dk
Forsøgsvært for forskningsprojektet Grønne marker & stærke rødder, www.gmsr.dk

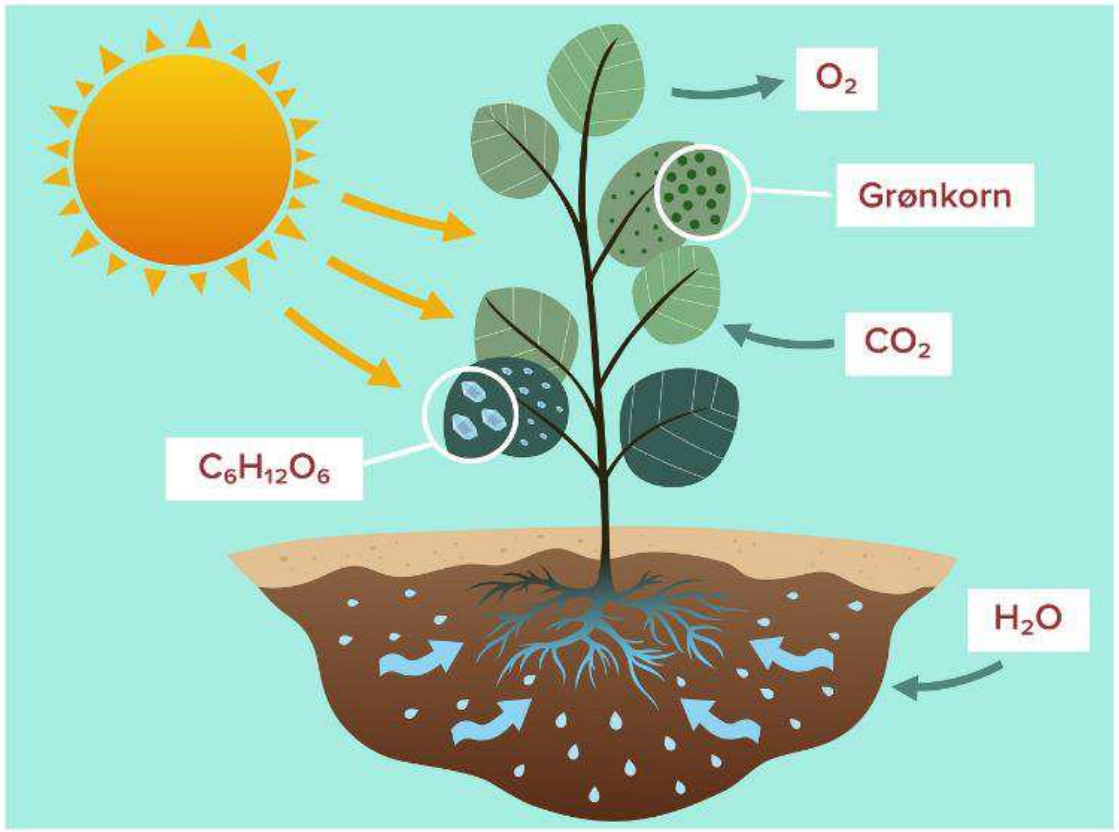


## Livets formel:

$6H_2O + 6CO_2 + \text{solenergi} \rightarrow C_6H_{12}O_6 + 6\ O_2$

Vand kuldioxid druesukker ilt

Landbrugsproduktion er baseret på fotosyntese
En 2,6 mio. hektar stor solfanger!

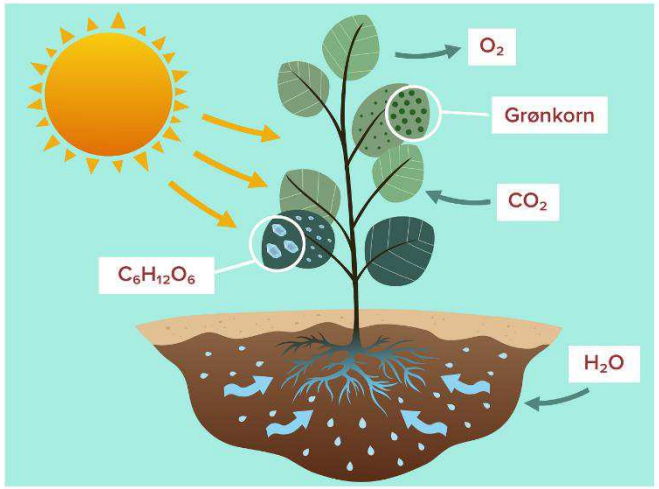


## Optag i en kornafgrøde via fotosyntese på 1 hektar:

| | | |
|---|---|---|
| 5 tons halm | 2089 kg C | 7.650 kg $CO_2$ |
| 7 tons kerne | 2915 kg C | 10.670 kg $CO_2$ |
| I alt: | | 18.300 kg $CO_2$ |

Dertil kommer andel i rødder og avner

Landbrugsproduktion er baseret på fotosyntese
En 2,6 mio. hektar stor solfanger!




Danmarks samlede udledning af $CO_2$: 33.500.000 tons

”Omsætning” i kerne & halm, hvis hele arealet var dyrket med korn:
45.000.000 tons $CO_2$

# More with less!

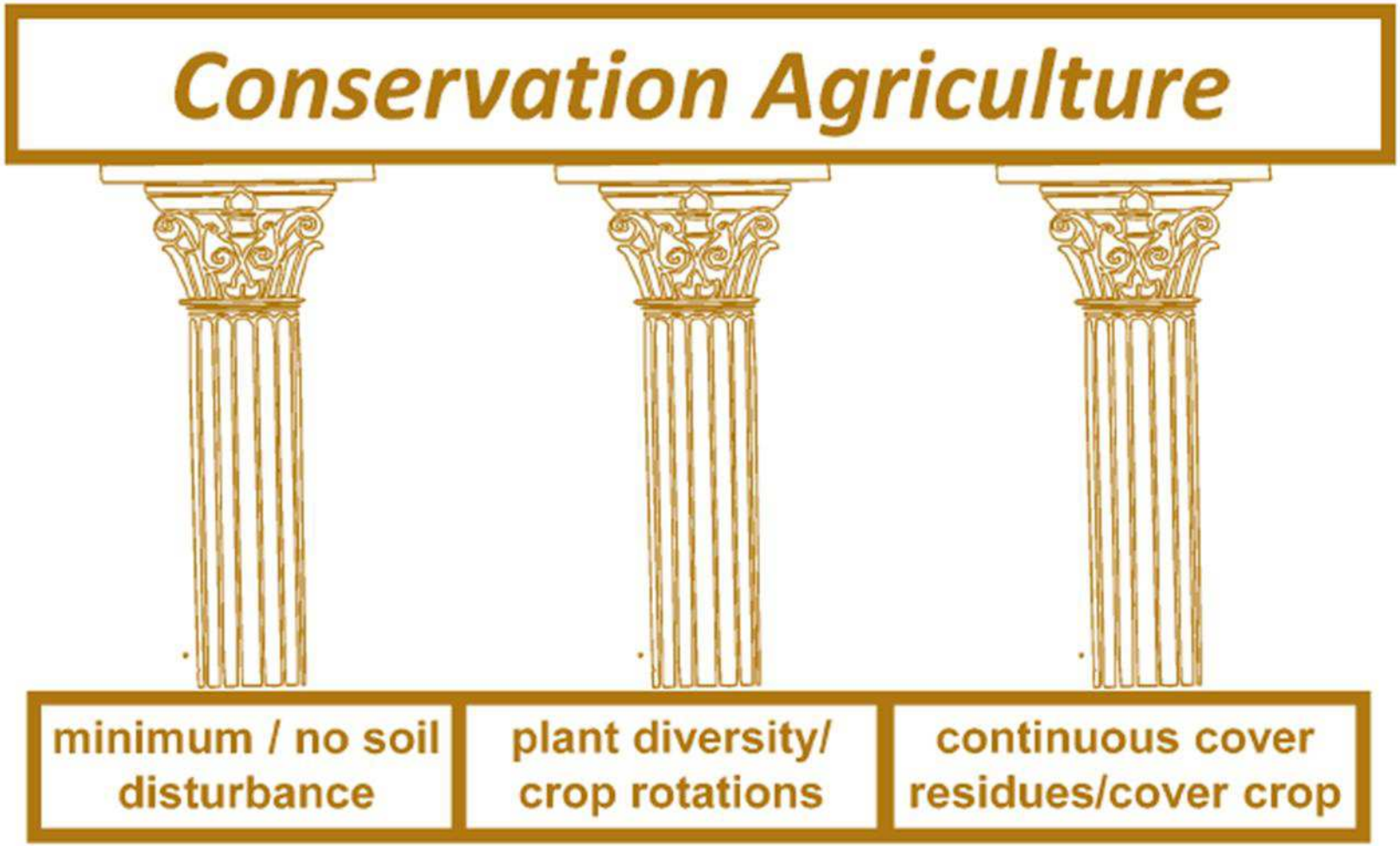
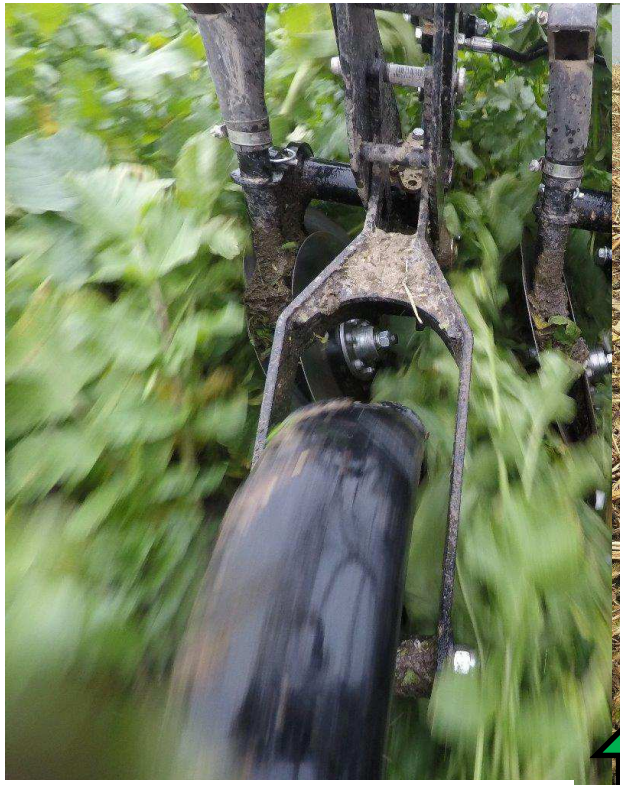



Figure 2: Principles of Conservation Agriculture

# More with less!

| minimum / no soil disturbance | plant diversity/ crop rotations | continuous cover residues/cover crop |
|---|---|---|

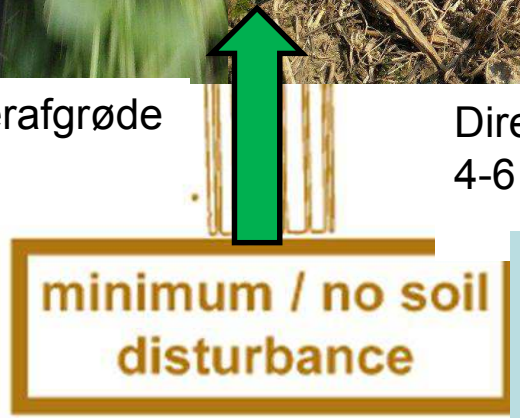
Figure 2: Principles of Conservation Agriculture



Direkte såning i efterafgrøde

Direkte såning i foråret
4-6 liter diesel/hektar

Traditionel pløjning og såning
30-40 liter diesel/hektar




**Betydelig mindre erosion** (tab af fosfor til vandløb elimineres)
**Nytteinsekter overlever**. (Flere nytteinsekter og færre insekticider)
**Flere regnorme** (op til 2000% mere biomasse i regnorme)
**Flere viber, agerhøns & lærker** (fødegrundlag, skjul for reder)

# More with less!

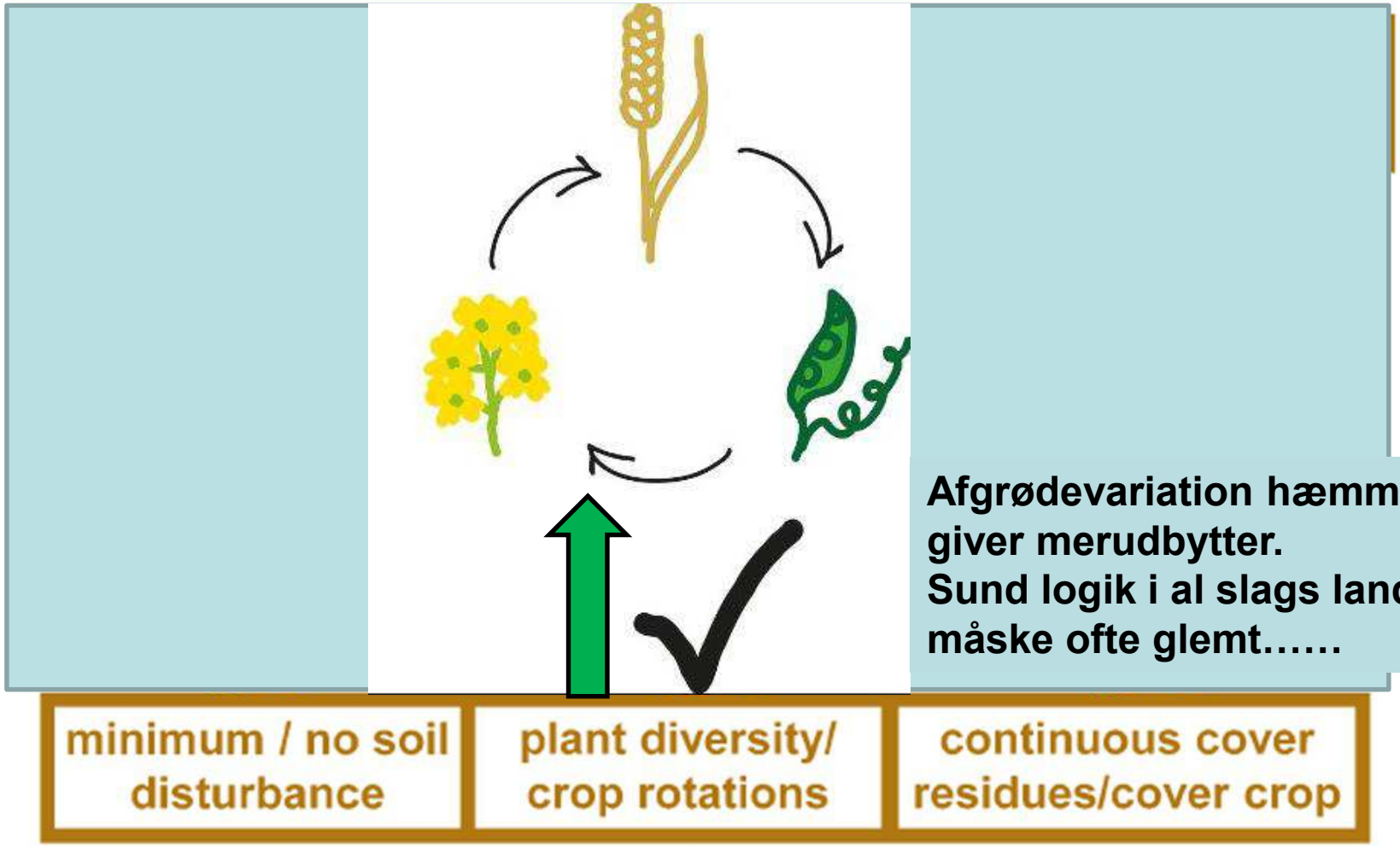



Figure 2: Principles of Conservation Agriculture

**Afgrødevariation hæmmer sygdomme og giver merudbytter.**
**Sund logik i al slags landbrugsdrift, men måske ofte glemt……**

# More with less!

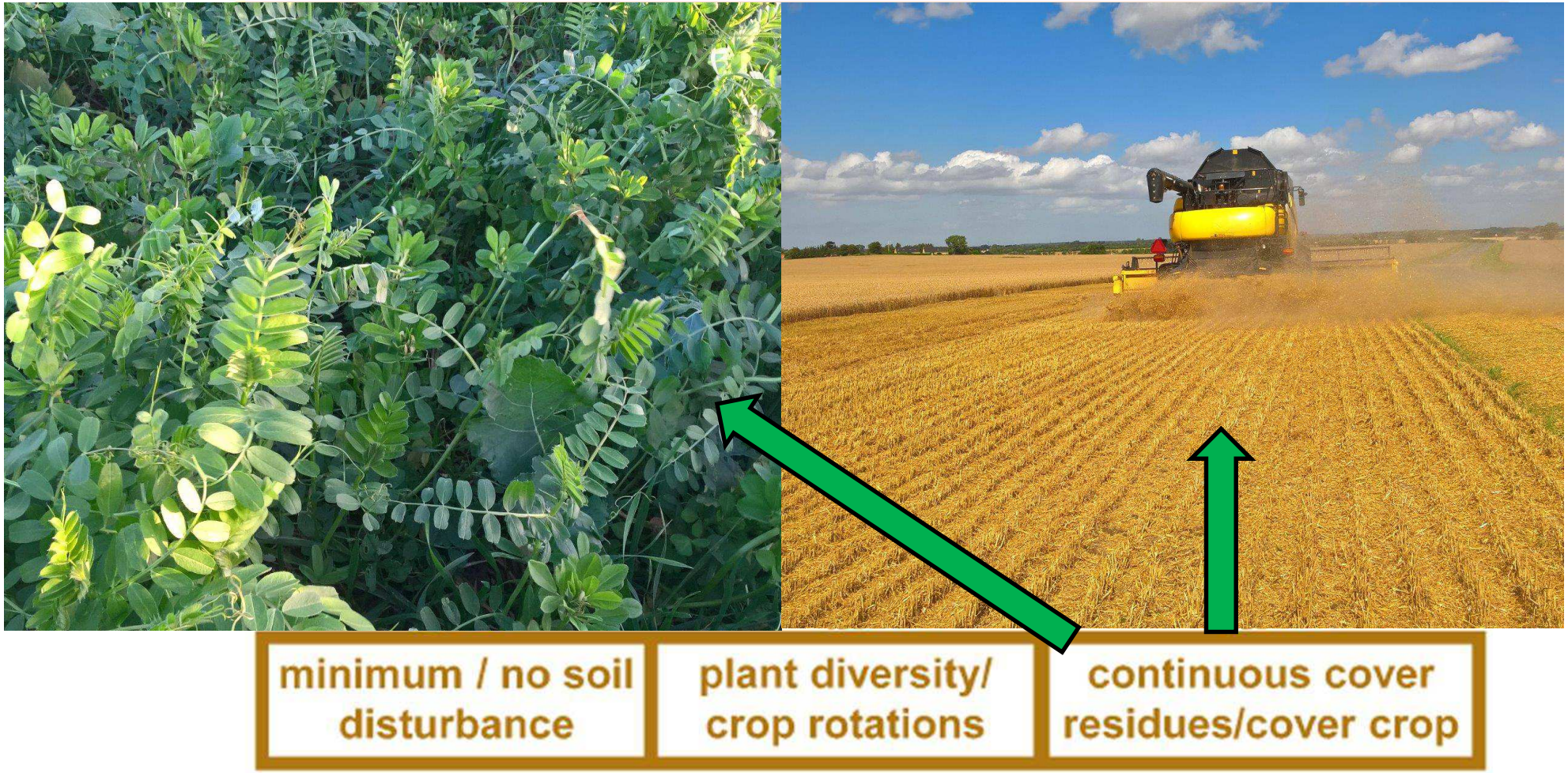
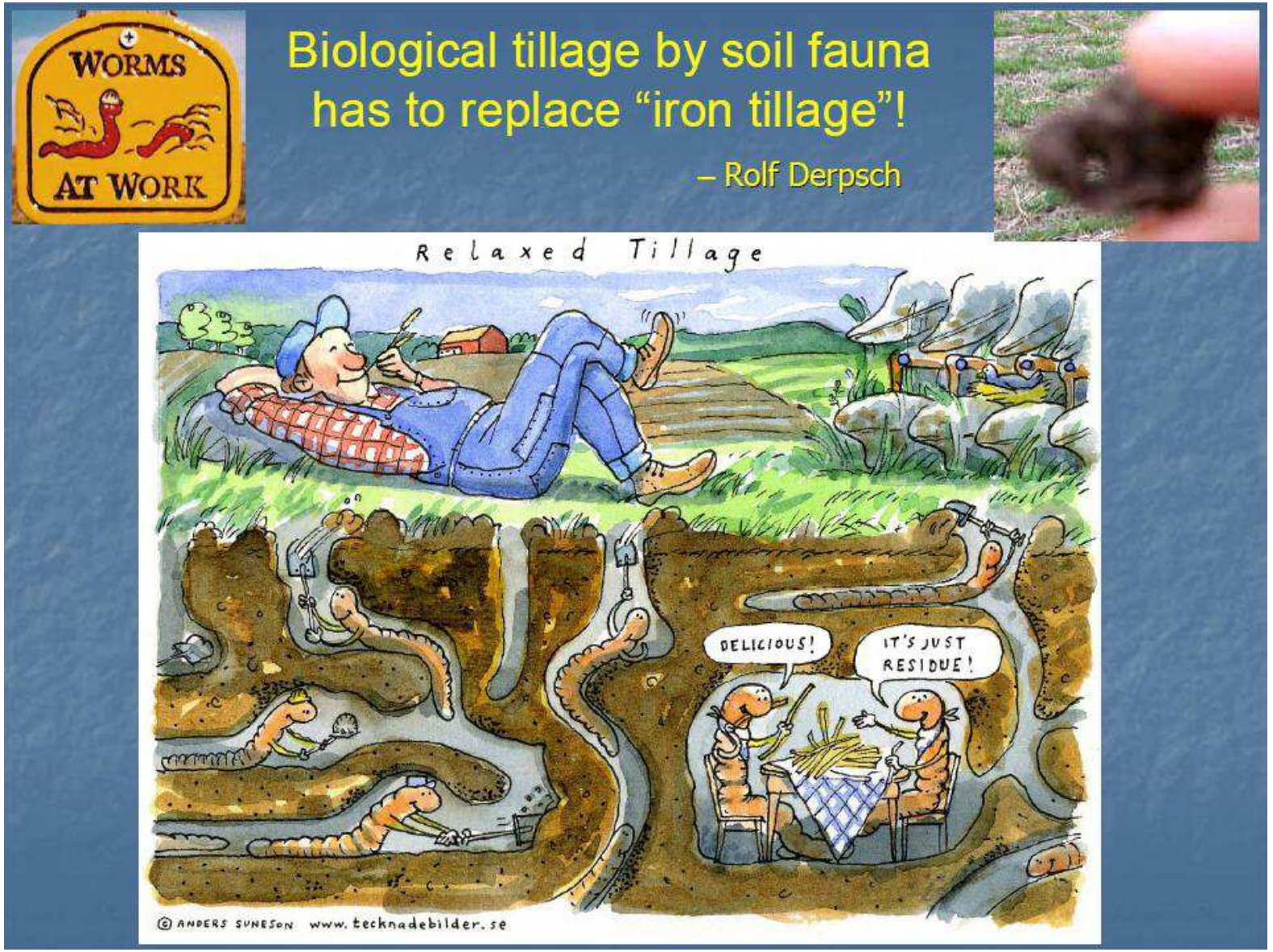



Figure 2: Principles of Conservation Agriculture

# More with less!

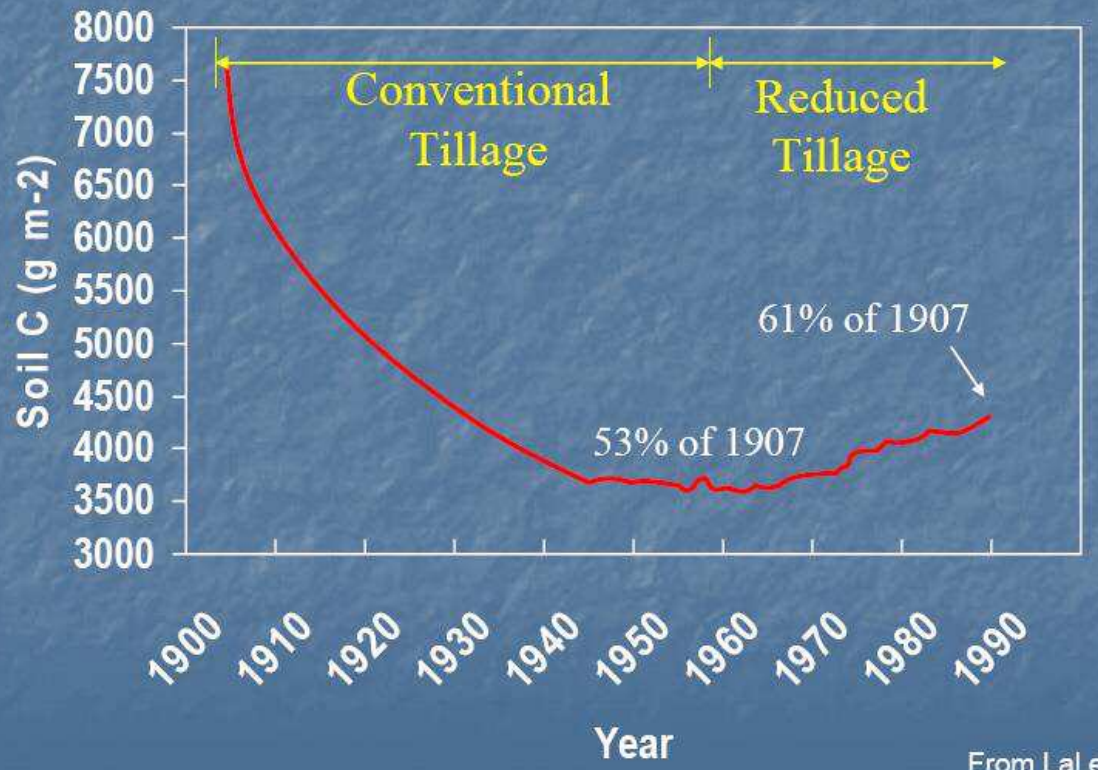
**Efterafgrøder ”fanger” endnu mere $CO_2$ og opbygger humus**
**Gavnligt for jordstrukturen, vildtet, bier, insekter og regnorme**
**Opsamler kvælstof fra luften, hvis bælgplanter bruges**
**Stopper erosion**

**Halm tilbagefører kulstof til jorden**
**Føde for de store regnorme (biodiversitet)**
**Sparer fosfor, kalium**
**Øger den mikrobiologiske aktivitet**

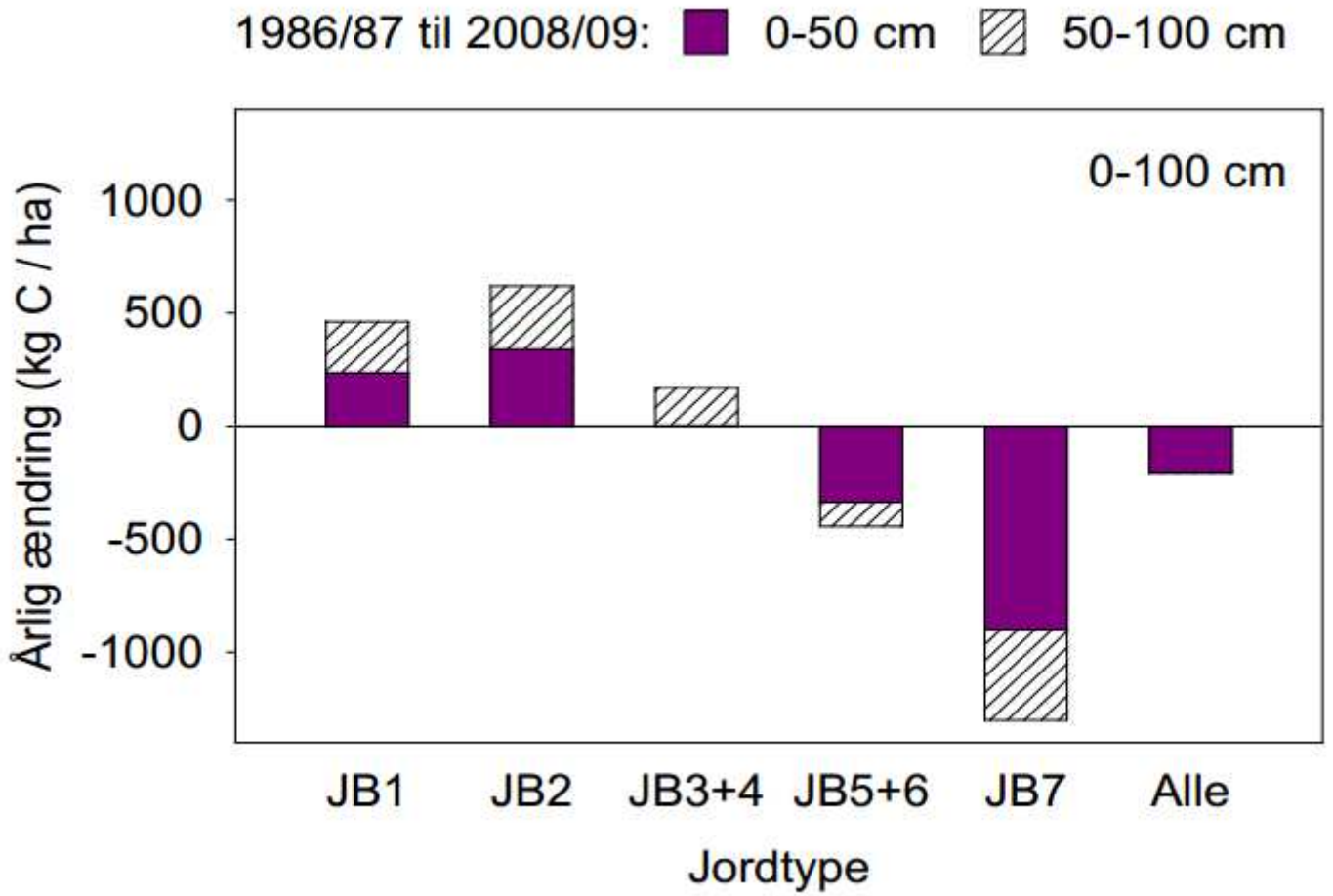

WORMS AT WORK
Biological tillage by soil fauna has to replace "iron tillage"!
– Rolf Derpsch
Relaxed Tillage
DELICIOUS!
IT'S JUST RESIDUE!
© ANDERS SUNESON www.tecknadebilder.se

Søren Ilsøe
www.ilsoe.info

# Historic Loss of Soil Carbon




From Lal et al., 1998




Lerjorde JB5+6 taber i gennemsnit 500 kg C/ha årligt (1800 kg $CO_2$)
Lerjorde JB7 taber i gennemsnit 1200 kg C/ha årligt (4300 kg $CO_2$)

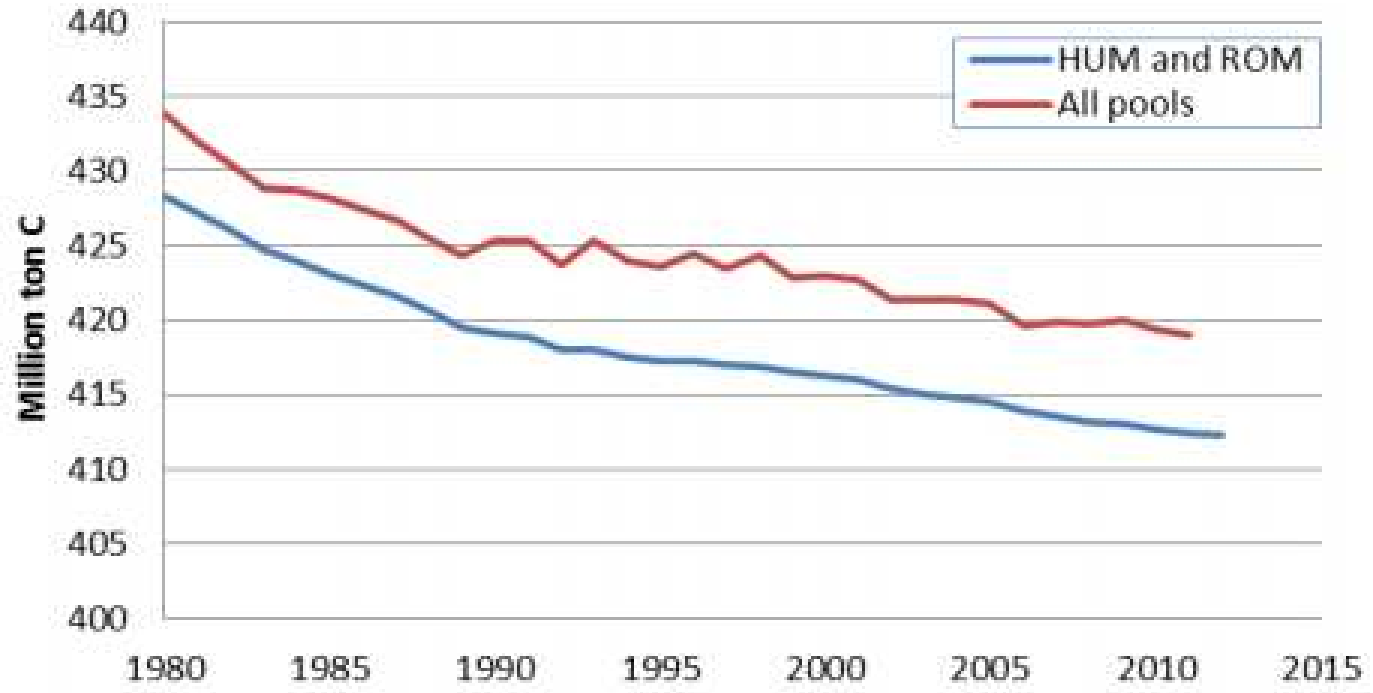



Figure 4.8 The modelled development in the Danish Agricultural mineral soils, 1980 to 2012. Million tonne C.

"The overall outcome from C-TOOL is a loss of 16 million tonnes C from 1980 to 2012, equivalent to 3.7 % of the total carbon stock. From 1990 to 2012 the estimated loss is 7 million tonne C equivalent to 1.7 %."

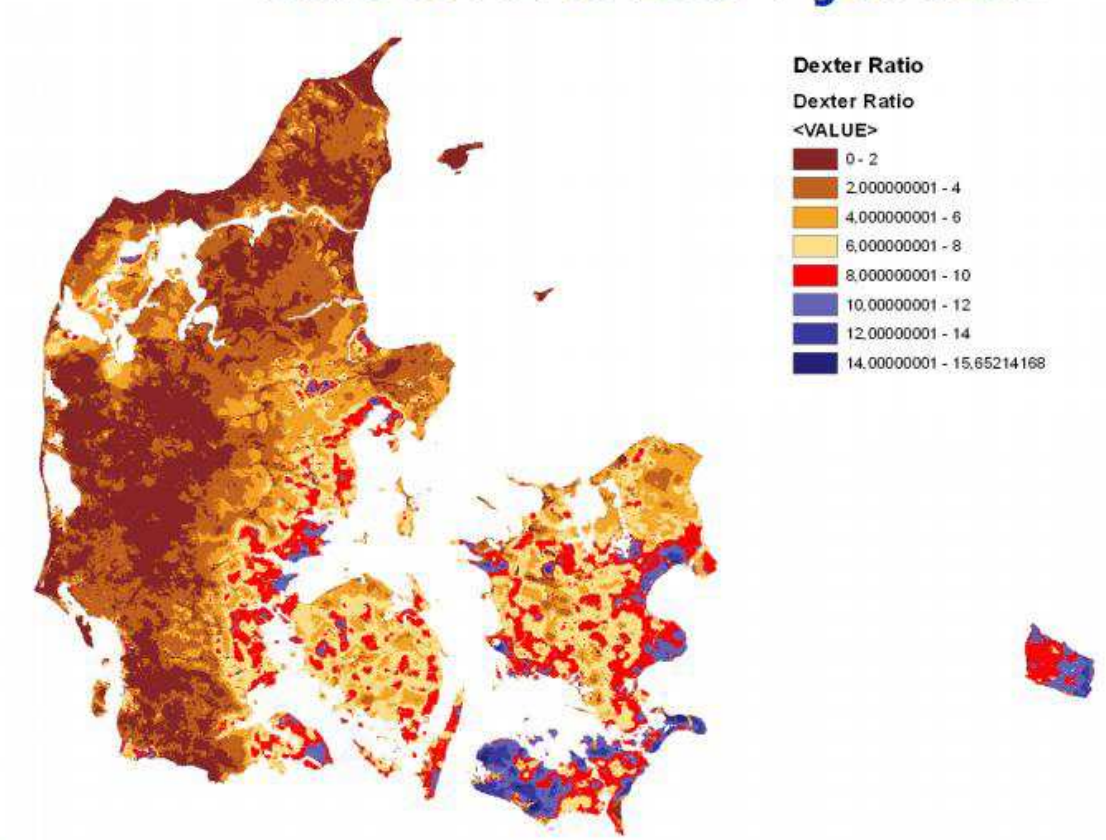
*THE DANISH SINKS PROJECT, 2015*

16 mio. Tons C = 59 mio. Tons CO2 = 1,8 mio. tons CO2/år
7 mio. Tons C = 25 mio. Tons CO2 = 1,2 mio. tons CO2/år

Humified Organic Matter (HUM)

Resilient Organic matter (ROM)

# Dexter ratio >10 indikerer kritisk lavt kulstofindhold i jorden




AARHUS
UNIVERSITET
INSTITUT FOR AGROØKOLOGI

Schjønning et al, 2009

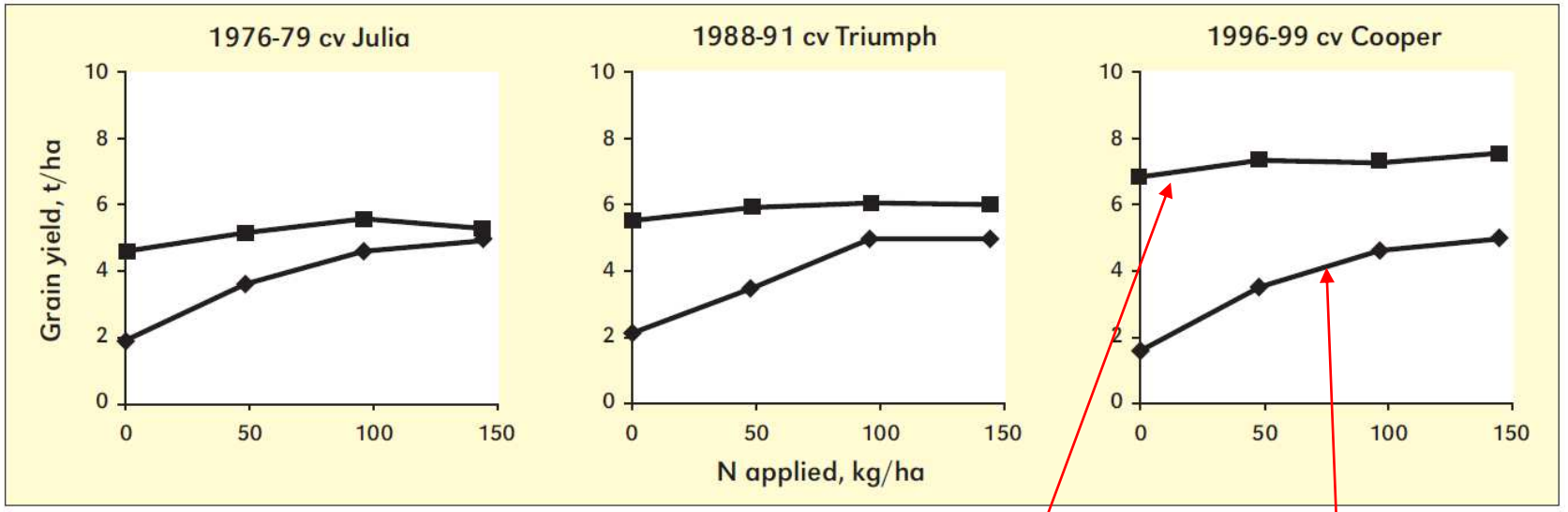
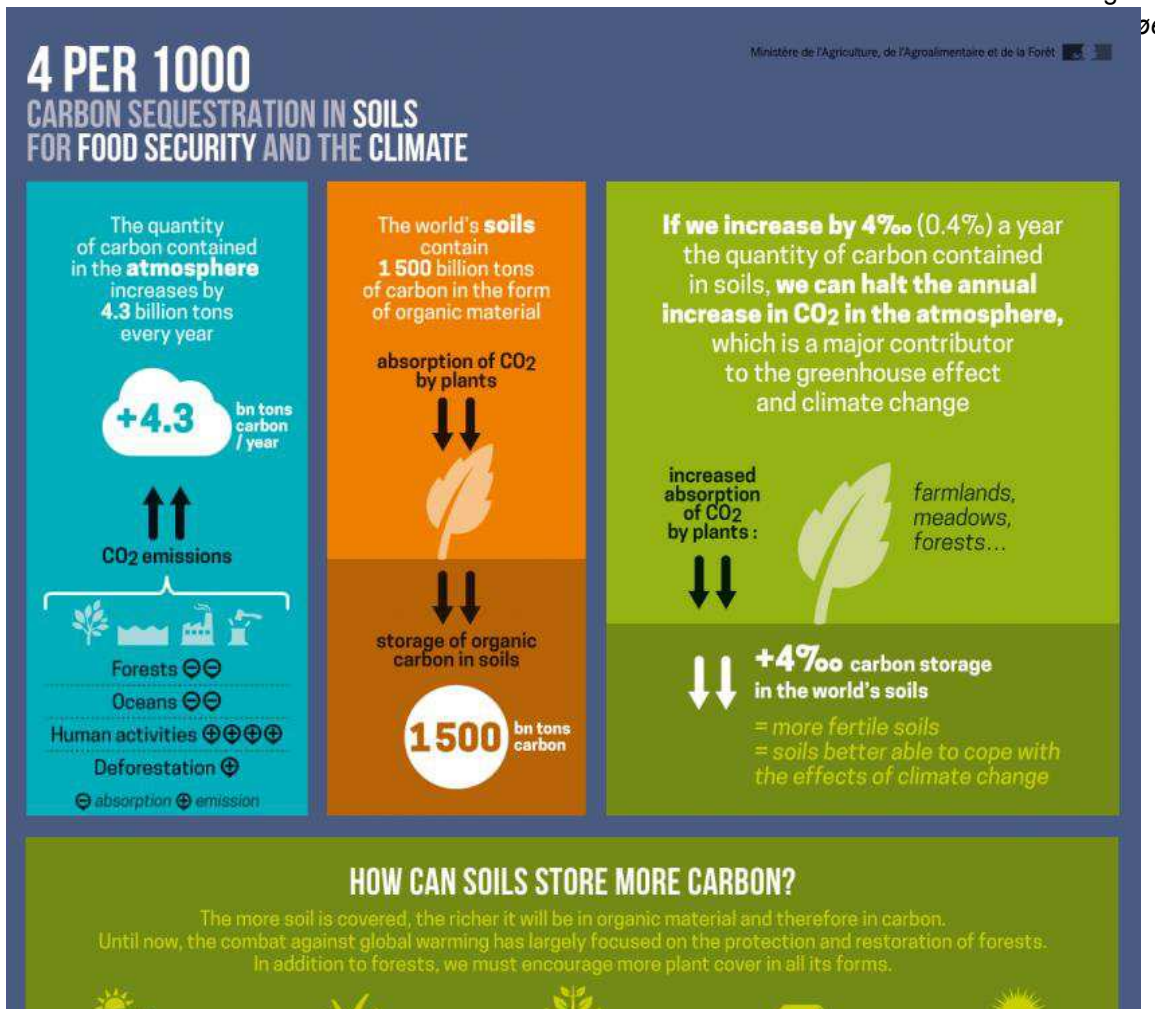



**Figure 1.** Grain yield response to applied N from three spring barley cultivars with increasing yield potential (left to right) grown on two soils with 1.74 (◆) or 6.16 (■) % SOM, Hoosfield Continuous Barley experiment, Rothamsted.

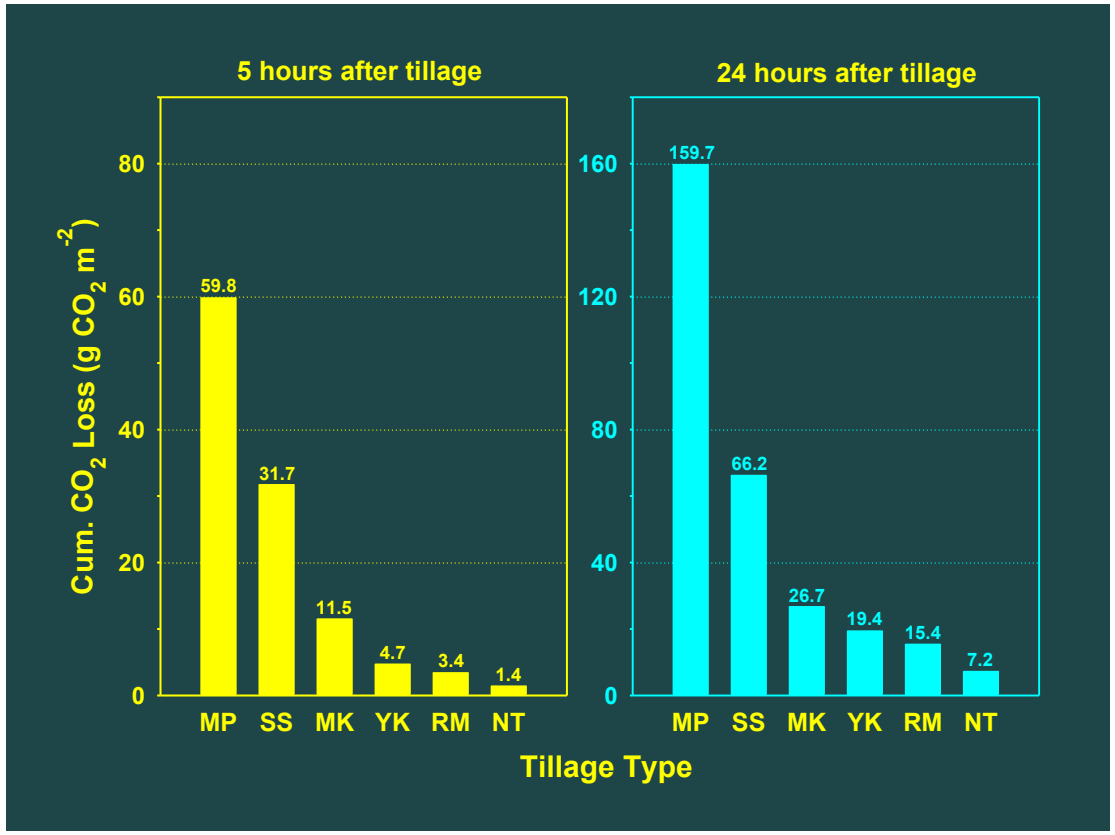
6,16 % SOM
(3,6% C)

1,74 % SOM
(1,0% C)

SOM= soil organic matter (humus)




Der er i dansk landbrugsjord typisk lagret 80-110.000 kg kulstof/ha, der svarer til >300.000 kg $CO_2$ per hektar!




159 g $CO_2/m^2$ = **1590** kg/ha

Intensiv jordbearbejdning igangsætter nedbrydning af kulstof/humus i jorden med $CO_2$ udledning til følge….

Hvor meget og hvor længe? Dansk forskning er akut nødvendig!

Don Reikosky, USDA (MP= muldplade plov, NT=No-till)

Stor international uenighed om potentialet for kulstoflagring ved Conservation Agriculture / No-till.
Her er nogle resultater med positive effekter:

| By Management System | Tons of Carbon Stored Per Acre |
|---|---|
| Cropland | .107 Tons C/acre |
| CRP/Grassland Conversion | .397 Tons C/acre |
| Trees/Wetland Conversion | .209 Tons C/acre |
| Cultivation of Organic Soils | -3.52 Tons C/acre |
| **By Tillage System** | **Tons of Carbon Stored Per Acre** |
| Intensive Tillage | .042 Tons C/acre |
| Moderate Tillage | .169 Tons C/acre |
| No-Till | .223 Tons C/acre |

→ 0,56 t C/ha = 2 t CO2/ha

*Purdue University - Consortium for Agricultural Soils Mitigation of Greenhouse Gases*

Stor international uenighed om potentialet for kulstoflagring ved Conservation Agriculture / No-till.
Her er nogle resultater med positive effekter:

**Tabelle 4: Literaturüberblick: Speicherpotentiale durch Bodenbearbeitungsverfahren**

| Autor/en | Region | Speicherpotential *[t CO2 ha$^{-1}$ a$^{-1}$]* | |
|---|---|---|---|
| | | Mulchsaat | Direktsaat |
| Angenendt et al., 2007 | Deutschland | 1,3 | |
| Tebrügge, 2003a | Deutschland | | 3,2 |
| Tebrügge, 2003b | Deutschland | | 2,2 |
| Tebrügge, 2007; Basch und Tebrügge, 2001 | Deutschland | 1,9 | 2,9 |
| Hülsbergen, 2010; Reinicke, 2011 | Deutschland | 0 - 0,9 | 0 - 0,9 |
| Vleeshouwers und Verhagen, 2002 | Europa | 0,9 | |
| Tebrügge und Epperlein, 2007 | Europa | 1,9 | 2,8 |
| Freibauer et al., 2004 | Europa | < 1,5 | 1,5 |
| Antle und McCarl, 2002 | Europa | 1,3 | |
| European Climate Change Programme, 2002 | Europa | 1,1 | |
| Chatskikh et al., 2008 | Dänemark | 0,4 | 1,1 |
| Klik et al., 2010 | Österreich | 3,7 | 4,1 |
| West und Marland, 2002 | USA | | 1,1 |
| Antle und McCarl, 2002 | Welt | 0,4 - 4,8 | |

Mørke regnormegange  af Lumbricus Terrestris i 1,5 dybde

Hvad er deres potentiale for lagring af kulstof?

# Frivillig efterafgrøde med 5 forskellige arter
# 6,5 tons $CO_2$ optaget fra luften

# Kulstofindholdet i jorden forøges ved:

**Snitning af halm**

**Minimal / ingen jordbearbejdning**

**Efterafgrøder – artsblandinger med bælgplanter!**

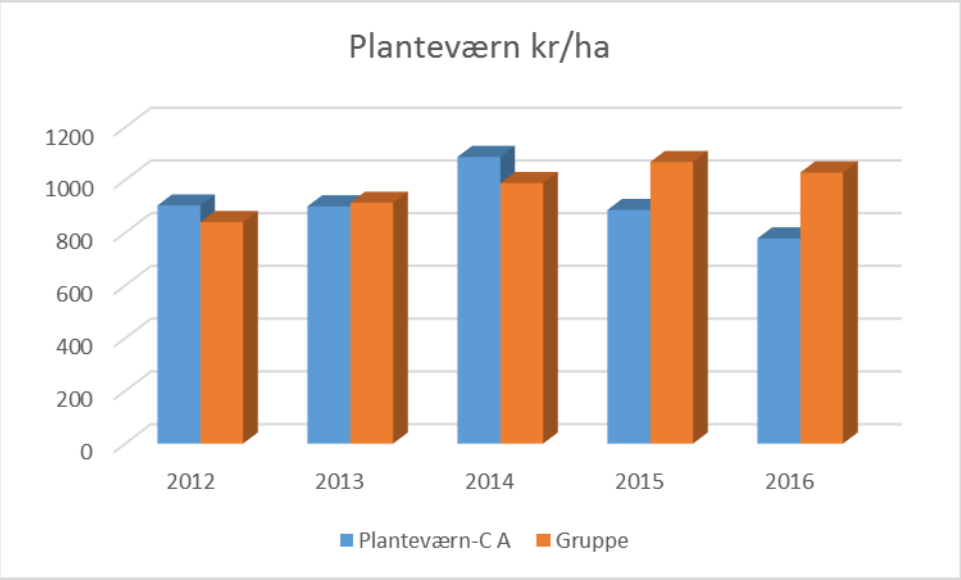
**Tilstrækkelige mængder af N,P og S**

**Husdyrgødning**

# Bruges der flere pesticider i Conservation Agriculture systemet?

Benchmark Conservation Agriculture kontra gruppe på ca. 300 bedrifter med planteavl, >200 hektar og JB 5-9

| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| Planteværn-CA | 903 | 900 | 1087 | 886 | 778 |
| Gruppe | 840 | 913 | 988 | 1068 | 1028 |




Insekticider (mod skadedyr) i hvede og byg er udfaset.

I vinterraps har angreb af rapsjordlopper efter forbuddet mod neonikotinoiderne udløst mere sprøjtning generelt, men raps dyrket i Conservation Agriculture systemet har ingen angreb haft i efteråret 2018!

Flere edderkopper, rovbiller, løbebiller m.fl.

**Biologisk kontrol i storskala**

Husk

8th World Congress on Conservation Agriculture

**Bern, Switzerland**

*June 29th-July 2nd, 2020*

www.8wcca.org


Tak for opmærksomheden

# Study: No-Till Farming Reduces Greenhouse Gas

by THE ASSOCIATED PRESS

Enlarge Associated Press

This 2006 photo provided by Purdue University agronomy professor Dr. Tony J. Vyn shows a researcher using a syringe to extract an air sample from a test chamber at a no-till field in the school's test fields near West Lafayette, Ind. Vyn, who led a three year study into greenhouse gases emissionis, said he was stunned by the large amounts of nitrous oxide his team detected in the air above the plowed fields compared with those that had long been farmed using the erosion-fighting no-till approach.

*INDIANAPOLIS January 5, 2011, 08:55 am ET*

text size A A A

Cropland that's left unplowed between harvests releases significantly smaller amounts of a potent greenhouse gas than conventionally plowed fields, according to a new study that suggests no-till farming can combat global warming.

Researchers said the findings could also help farmers make more efficient use of the costly nitrogen-based fertilizers used to promote plant growth. No-till farming apparently slows the breakdown of fertilizers in the soil, they said.

The three-year, federally funded Purdue University study looked at the amount of nitrous oxide released by no-till fields compared to plowed fields. No-till farmers don't plow under their fields between crops and disrupt the soil surface as little as possible, although they do cut into it to plant seeds and inject fertilizers.

The study found no-till fields released 57 percent less nitrous oxide than chisel tilling, in which plants are plowed back into the soil after harvest, said Purdue agronomist Tony Vyn, who led the research. They also produced 40 percent less gas than fields tilled with moldboard plows, which turn the dirt over onto itself.

**57% reduktion af udslip af lattergas**

Klimapåvirkningen af lattergas er
300 gange værre end CO2

OPEN

SUBJECT AREAS:
CLIMATE-CHANGE MITIGATION
BIOGEOCHEMISTRY

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21 October 2013

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13 February 2014

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4 April 2014

Correspondence and requests for materials should be addressed to S.S. (sofie.sjogersten@nottingham.ac.uk)

# To what extent can zero tillage lead to a reduction in greenhouse gas emissions from temperate soils?

Shamsudheen Mangalassery[1,2], Sofie Sjögersten[2], Debbie L. Sparkes[2], Craig J. Sturrock[2], Jim Craigon[2] & Sacha J. Mooney[2]

[1]Central Arid Zone Research Institute, Regional Research Station, Kukma-Bhuj, Gujarat 370105, India, [2]School of Biosciences, Sutton Bonington Campus, University of Nottingham, Sutton Bonington, Loughborough, Leicestershire, LE12 5RD, UK.

Soil tillage practices have a profound influence on the physical properties of soil and the greenhouse gas (GHG) balance. However there have been very few integrated studies on the emission of carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$) and soil biophysical and chemical characteristics under different soil management systems. We recorded a significantly higher net global warming potential under conventional tillage systems (26–31% higher than zero tillage systems). Crucially the 3-D soil pore network, imaged using X-ray Computed Tomography, modified by tillage played a significant role in the flux of $CO_2$ and $CH_4$. In contrast, $N_2O$ flux was determined mainly by microbial biomass carbon and soil moisture content. Our work indicates that zero tillage could play a significant role in minimising emissions of GHGs from soils and contribute to efforts to mitigate against climate change.

# Humus har en konstant ratio af C:N:P:S

Humus er som mursten (kulstof), der igennem mørtel (NPS) skaber en stabil mur

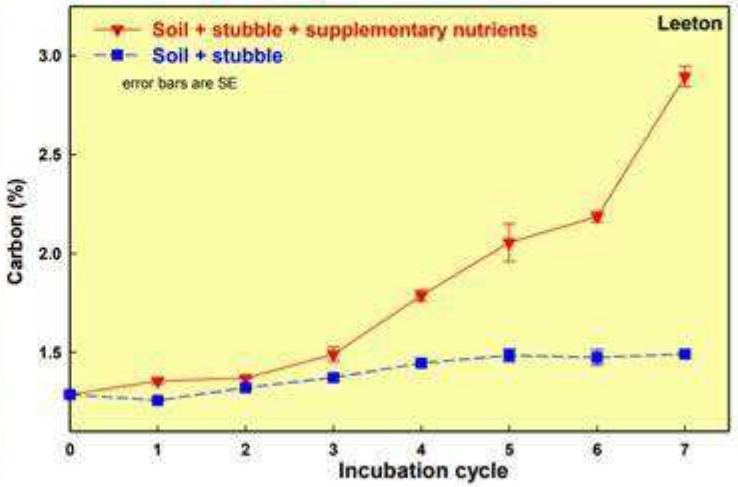
Næringsstofmangel, **og ikke kulstof**, begrænser humusdannelsen

Formation af 1 t C i humus/ha kræver: 92 kg N; 20 kg P and 14 kg S

*Clive Kirkby og John Kirkegaard CSIRO, Australien*

***Vi skal derfor sikre den rette næringsstofsammensætning under den mikrobielle omsætning i marken***

## Tilførsel af halm hver 3 måned




*Kilde: Kirkby et al 2016*

# SmartSOIL 7 principles of C management (6)

Soil organic carbon management also involves management of nitrogen and phosphorus.

Where soil carbon levels are targeted to be enhanced, this will only be effective if supported with sufficient input of nitrogen and phosphorus to ensure this carbon storage.


Østrig 2011 (forsøg grundlag 1997)
156 m o.h.
Nedbør: 546 mm
Jordtype: Sandig Lehm
Humus: 2,5 – 3 %

Universität für Bodenkultur Wien
Department für Nutzpflanzenwissenschaften
Institut für Pflanzenbau und Pflanzenzüchtung

**Tabelle 7: Rübenertrag in t ha$^{-1}$, Zuckergehalt in % TM und Zuckerertrag in t ha$^{-1}$, Groß Enzersdorf 2011**

| BoBeSy | Rübenertrag [t ha$^{-1}$] | | Zuckergehalt Rübe [%] | | Zuckerertrag [t ha$^{-1}$] | |
|---|---|---|---|---|---|---|
| | $\bar{x}$ | σ | $\bar{x}$ | σ | $\bar{x}$ | σ |
| Pflug | 66,2 c | 7,3 | 19,9 a | 0,26 | 13,2 b | 1,5 |
| Direkt | 74,7 a | 6,3 | 19,3 a | 0,60 | 14,4 a | 1,4 |
| Reduziert | 66,2 c | 8,1 | 19,9 a | 0,41 | 13,2 b | 1,6 |
| Minimal | 71,1 b | 9,0 | 19,9 a | 0,58 | 14,2 a | 1,8 |
| Integriert | 74,7 a | 11,7 | 19,7 a | 0,63 | 14,7 a | 2,4 |
| Signifikanz | *** | | + | | *** | |

| | |
|---|---|
| Ort: | Bernburg-Strenzfeld / Salzlandkreis<br>Lößlandschaft im mitteldeutschen Trockengebiet |
| Niederschlag: | 511 mm<br>(langjähriges Mittel 1981 – 2010) |
| Temperatur: | 9,7°C<br>(langjähriges Mittel 1981 – 2010) |
| Grundwasserstand: | grundwasserfern |
| Höhenlage: | 80 m über NN |
| Körnungsklassifizierung: | Ut4: stark toniger Schluff<br>(Ton 22 %, Schluff 70 %, Sand 8 %) |
| Bodenzahl: | 86 - 95 |

**P:** Pflug/Packer, jährlicher Pflugeinsatz (Arbeitstiefe ≥ 25 cm),
**MI:** Mulchsaat, Bodenbearbeitung mit Scheibenegge/ Scheibengrubber (10 - 15 cm),
**MII:** Mulchsaat nach flacher Vorsaatbearbeitung (4 - 6 cm),
**DS:** Direktsaat ohne Bodenbearbeitung.

## ERGEBNISSE

**Tab. 1.7-1:** Vom Pflug zur Direktsaat – Ertrag [dt/ha] einer 4-feldrigen Fruchtfolge „Casinoplan“ 1998- 2011.

| | | P | MI | MII | DS |
|---|---|---|---|---|---|
| ZR | 98 - 10 | 600 | 616 | 658 | 627 |
| | ***2011*** | ***881*** | ***962*** | ***886*** | ***829*** |
| SG | 98 - 10 | 60,6 | 64,4 | 66,4 | 63,8 |
| | ***2011*** | ***65,3*** | ***63,8*** | ***67,6*** | ***64,4*** |
| WW | 98 - 10 | 75,8 | 80,9 | 83,3 | 80,4 |
| | ***2011*** | ***72,0*** | ***68,4*** | ***73,8*** | ***73,7*** |
| WG | 98 - 10 | 78,6 | 77,9 | 76,3 | 76,5 |
| | ***2011*** | ***48,1*** | ***56,3*** | ***51,0*** | ***44,9*** |

| Kroner/ha | Ejendom 1<br>Konventionel m. plov | Ejendom 2<br>Pløjefri dyrkning | Forskel pr ha. |
|---|---|---|---|
| Areal | 260 ha | 260 ha | |
| | | | |
| Brændstof | 579 | 379 | -200 |
| Vedligehold | 1.063 | 626 | -437 |
| | | | |
| Maskinsaldo | 8.076 | 1.900 | -6.176 |
| Afskrivninger | 1.115 | 307 | -808 |
| Forrentning | 250 | 39 | -211 |
| | | | |
| Maskinomkostninger pr ha | 3.007 | 1.351 | 1.656 |

# Pesticiders vekselvirkning med jordbearbejdning og gødskning

## Effekter på fauna, mikroorganismer og udvalgte økosystem-funktioner

Bekæmpelsesmiddelforskning nr. 162, 2016

The researchers used a long-term tillage experiment at AU Foulum, the research centre of Aarhus University in Tjele, for the study. The researchers studied pesticide effects in both moldboard ploughed soil and directly seeded (no-till) soil. Either mineral fertiliser or cattle slurry was applied to the soil and either a fungicide or an insecticide, or both. All combinations of these treatments were included in the study which had in total 20 different treatments, all in four replicates.

Following the spring application of pesticides, and again after the winter wheat harvest in September, the researchers quantified populations of earthworms, springtails, mites, and microbial populations in the soil. They also examined nitrification potential, leaching risk, and several other aspects.

The study confirmed that that there are significant interactions between management factors, including pesticide application, with respect to effects on soil organisms. There are many sources of variation, and the disturbance of tillage alone may be greater than the effects of pesticides, says senior researcher Søren O. Petersen from the Department of Agroecology. He states that the results have no direct implications for the current use of pesticides, but show that the authorities should be critical about the documentation offered on pesticide effects.