

Organisk stof I jorden

Professor Jørgen E. Olesen

STØTTET AF

promilleafgiftsfonden
for landbrug

Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne:
Danmark og Europa investerer i landdistrikterne



Miljø- og Fødevareministeriet
NaturErhvervstyrelsen



Den Europæiske Landbrugsfond
for Udvikling af Landdistrikterne

Se EU-Kommissionen, Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne

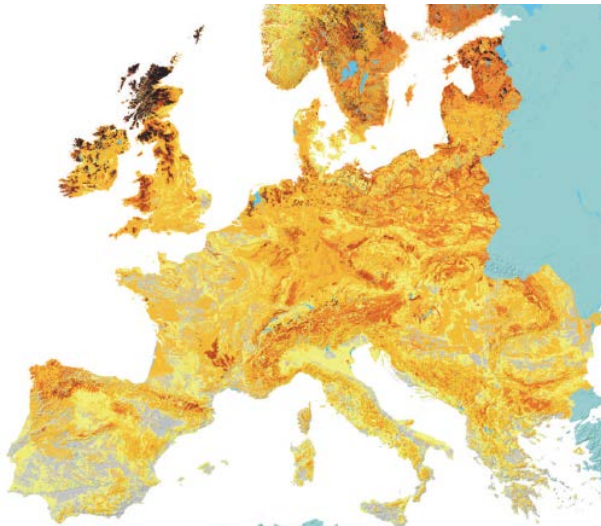


Problemstillinger

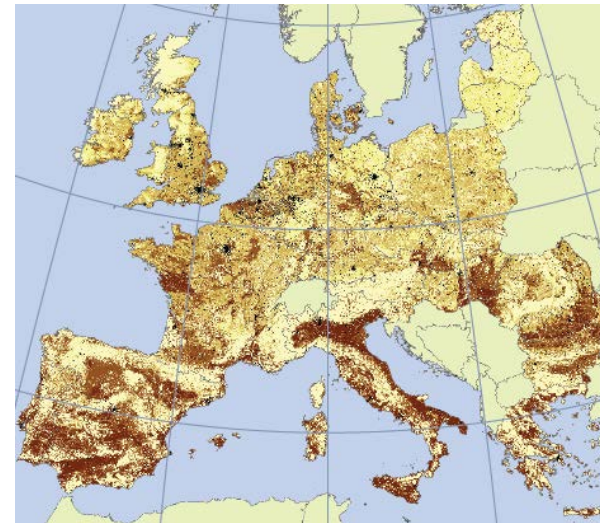
Ændringer i jordens kulstof påvirker klimabelastning (positivt eller negativt)

Jordens kulstof påvirker jordens funktion og produktivitet

Disse problemstillinger indgår ikke tilstrækkeligt i bedriftsmæssig praksis, politikker eller incitamenter for landbruget



Jordens C indhold



Jordens C tabspotentiale

Andre udfordringer

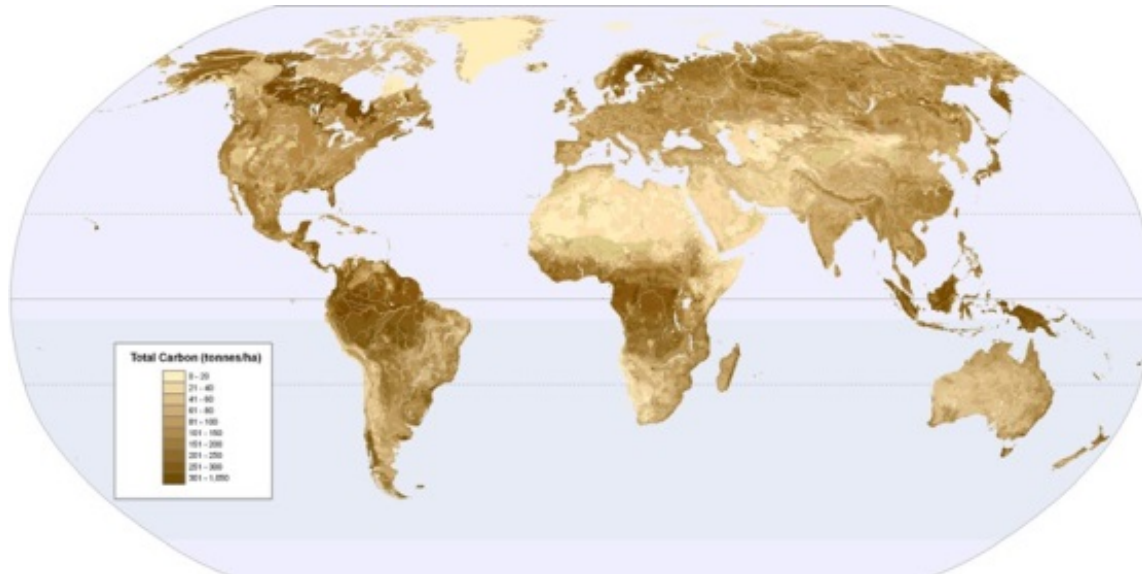
Ufuldstændig videnskabelig forståelse af betydningen af jordens organiske stof for agroøkosystemets funktion

Ufuldstændig kvantificering af effekt af tiltag til håndtering af jordens C

Manglende forståelse af betydningen af organisk stof blandt landmænd og beslutningstagere

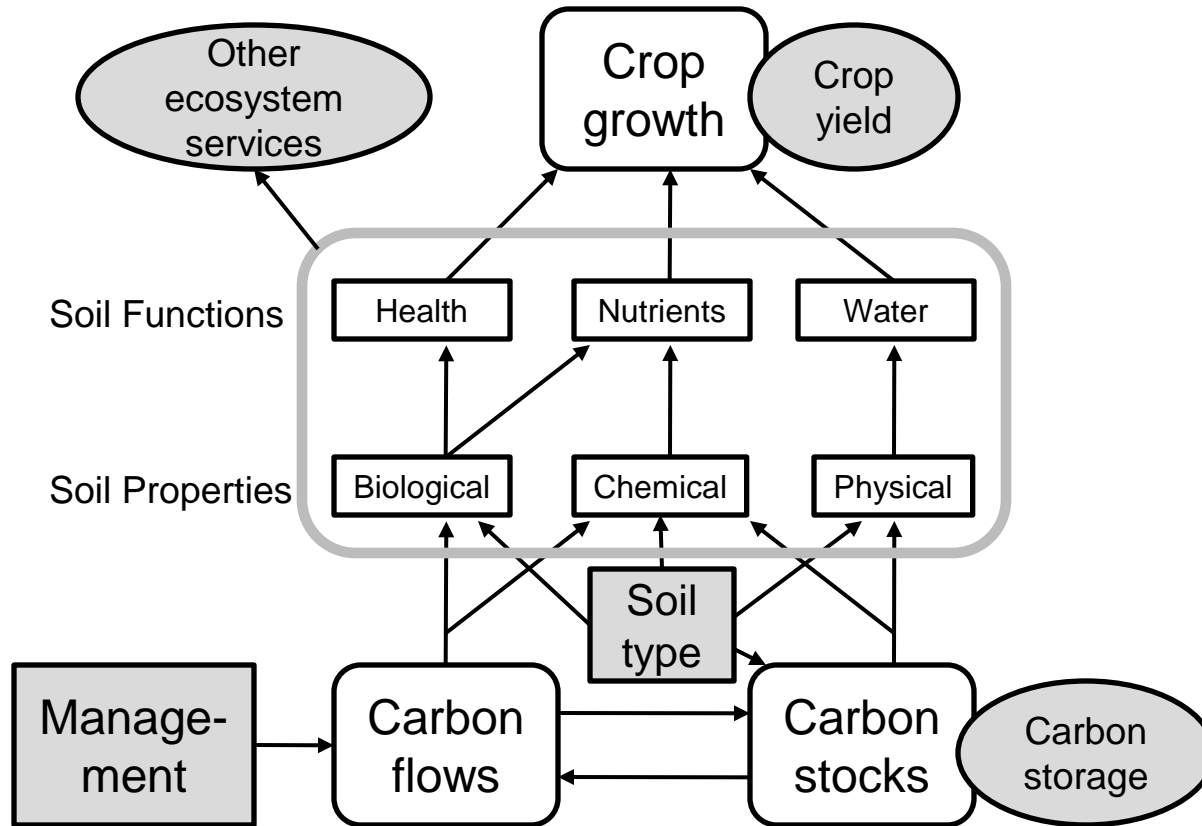
Barrierer for at forbedre organisk stof i jorden

Manglende incitament for at øge jordens organiske stof

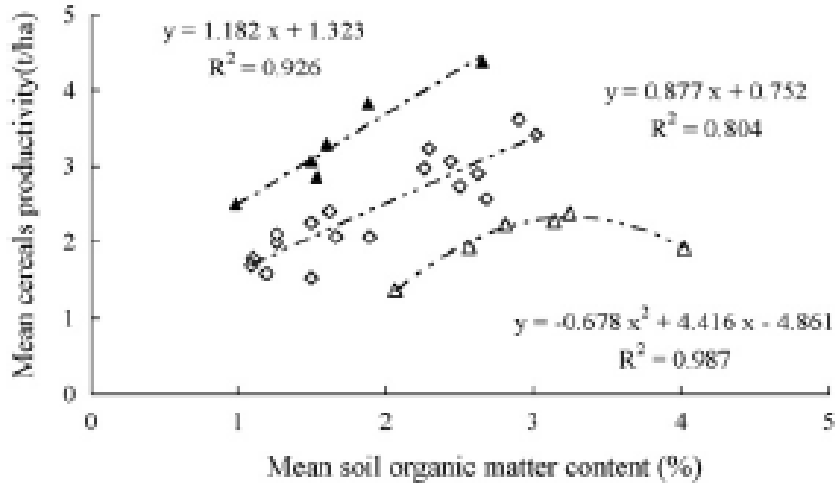


Total kulstof (t/ha) [UNEP-WCMC updated Global Carbon Map]

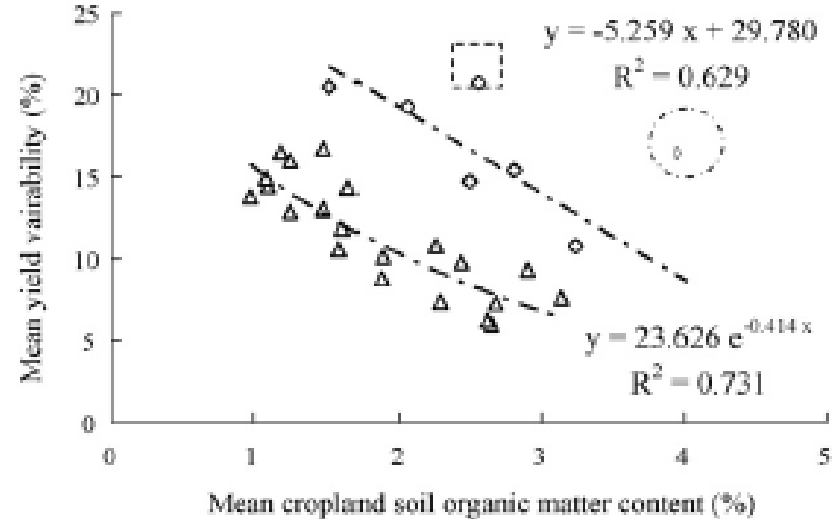
Kulstof og jordens funktioner



Hvad gør jordens kulstof for os?



Kina: Gns. udbytter mod organisk stof i jord for kinesiske provinser, 1949-1998

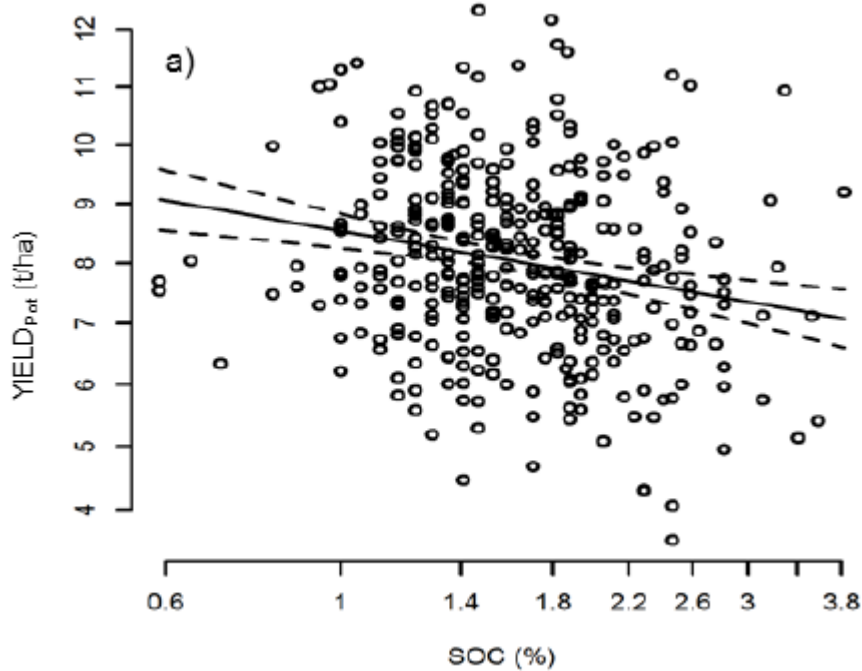


Kina: Variation i kornudbytter mod organisk stof i jord

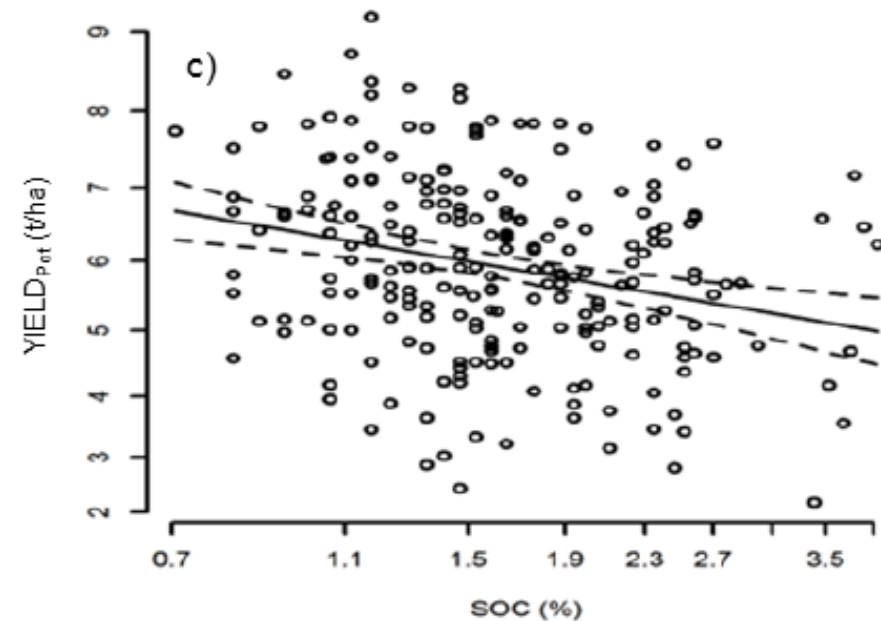
Men hvad er årsager og hvad er effekter?

Udbytte ved max N niveau i danske gødningsforsøg

Vinterhvede



Vårbyg



Udbytter i vårbyg i forhold til N-input

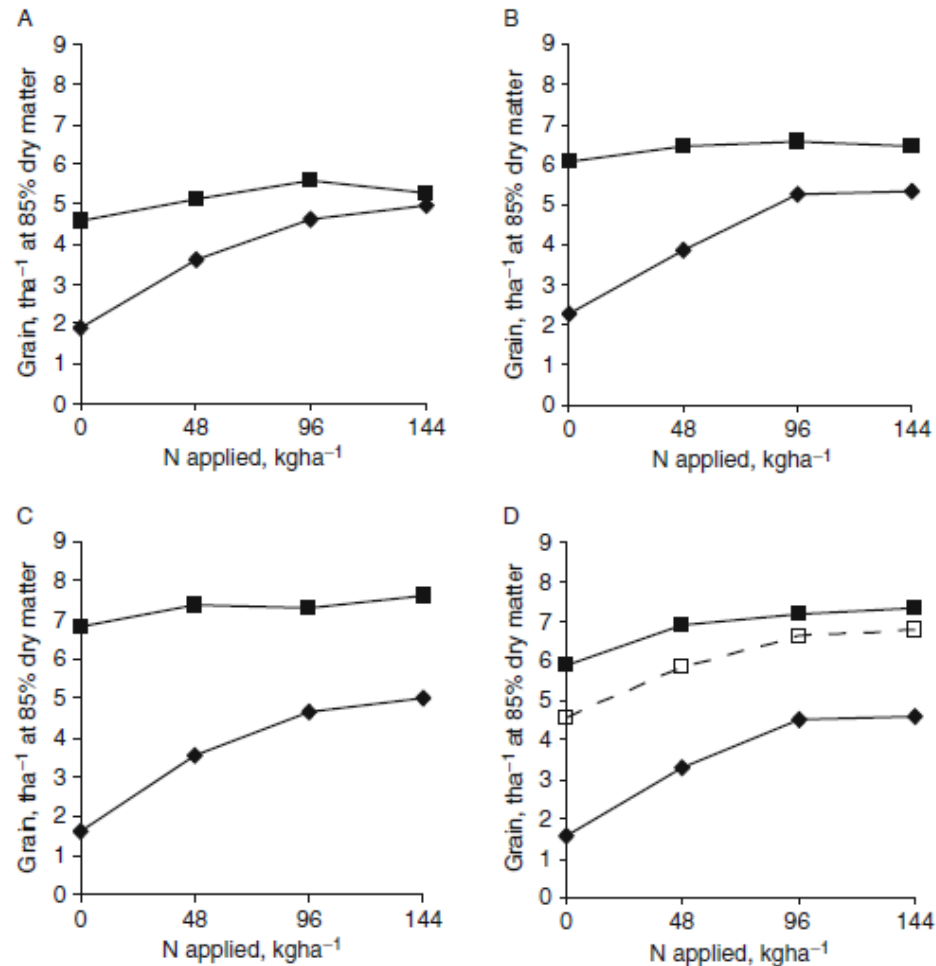
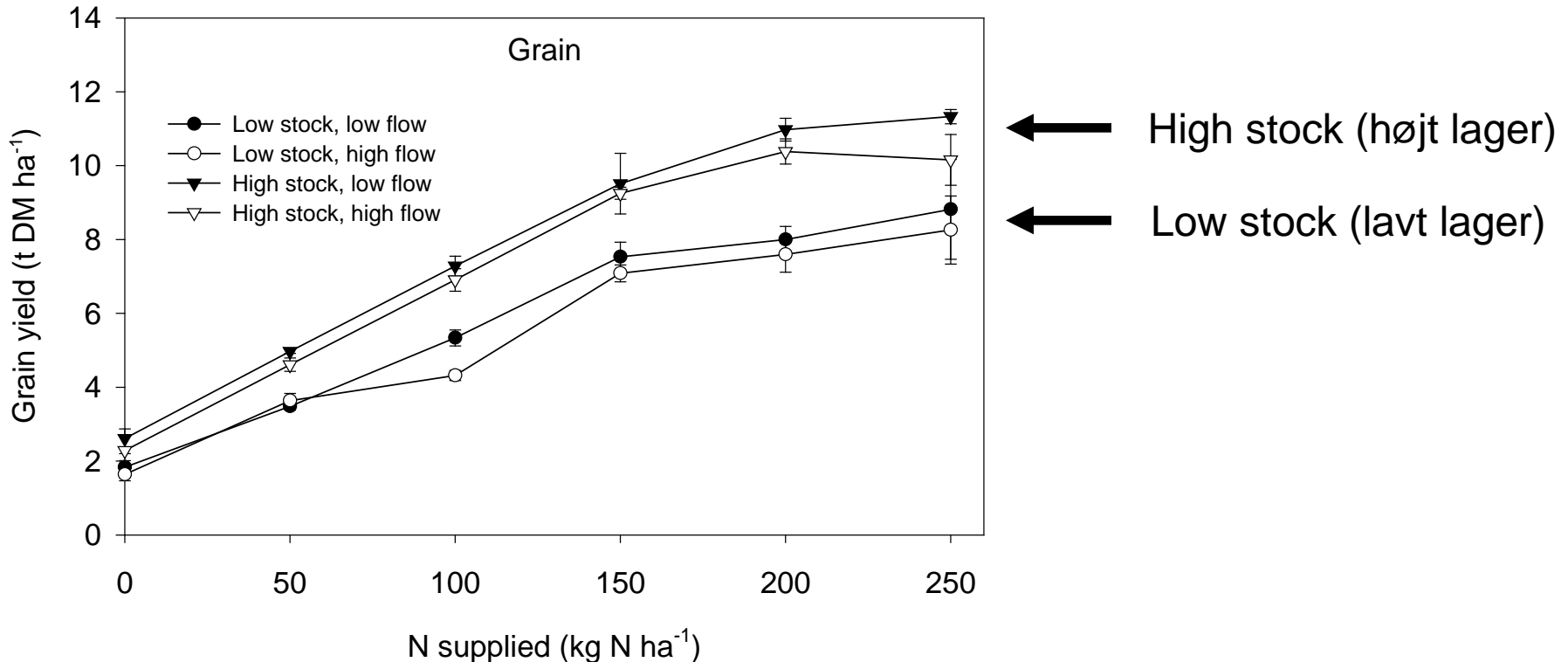


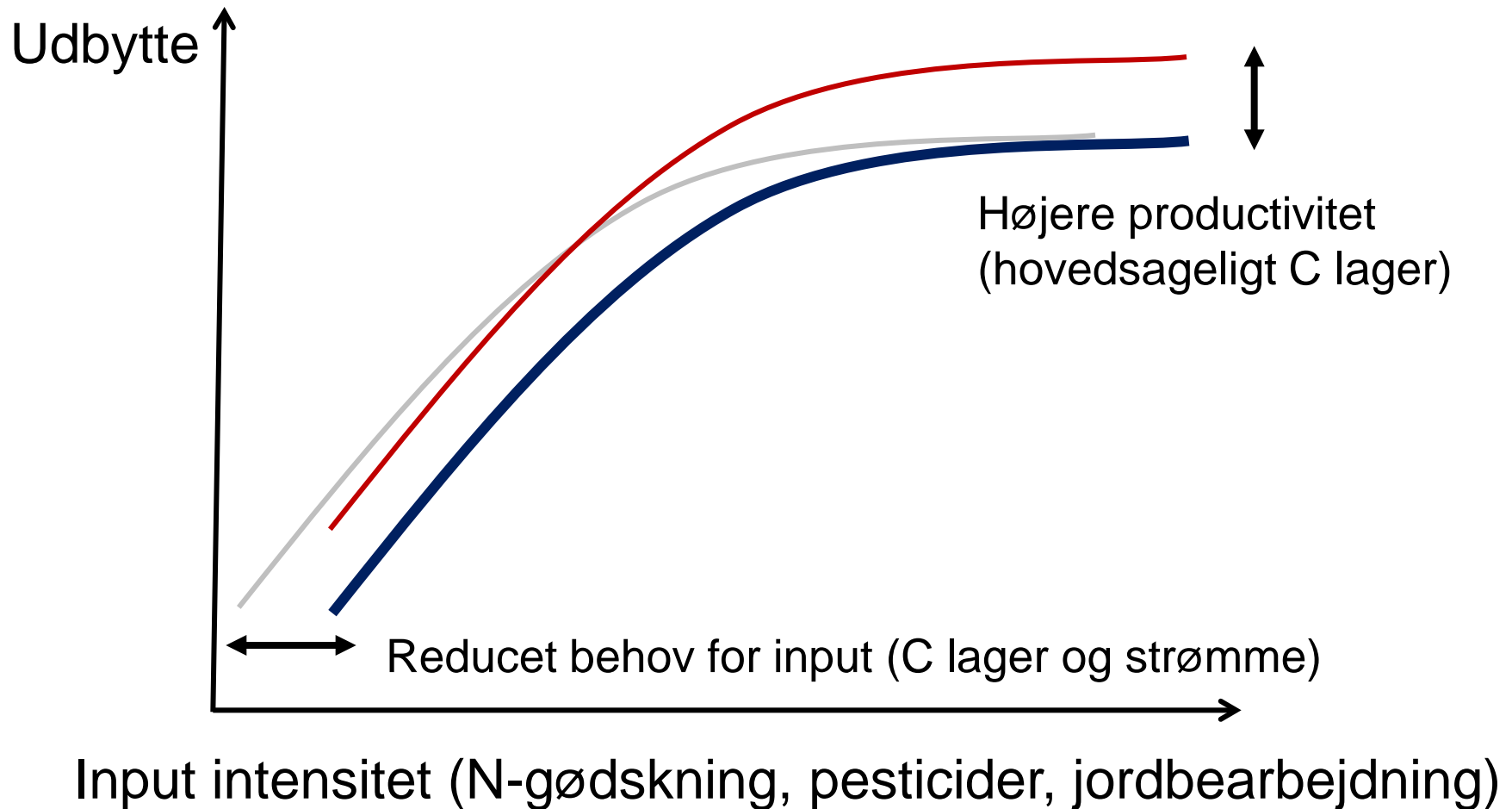
Figure 10 Yields of spring barley grain (t ha⁻¹) Hoosfield Continuous Barley, Rothamsted. Annual treatment 1852–2006: PK fertilizers, \blacklozenge ; 35 t ha⁻¹ FYM, \blacksquare ; annual treatment only from 2001 to 2006: 35 t ha⁻¹ FYM, \square . (A) *cv.* Julia, 1976–1979, (B) *cv.* Triumph, 1988–1991, (C) *cv.* Cooper, 1996–1999, and (D) *cv.* Optic 2004–2007.

SmartSOIL stock and flow experiment (Askov)

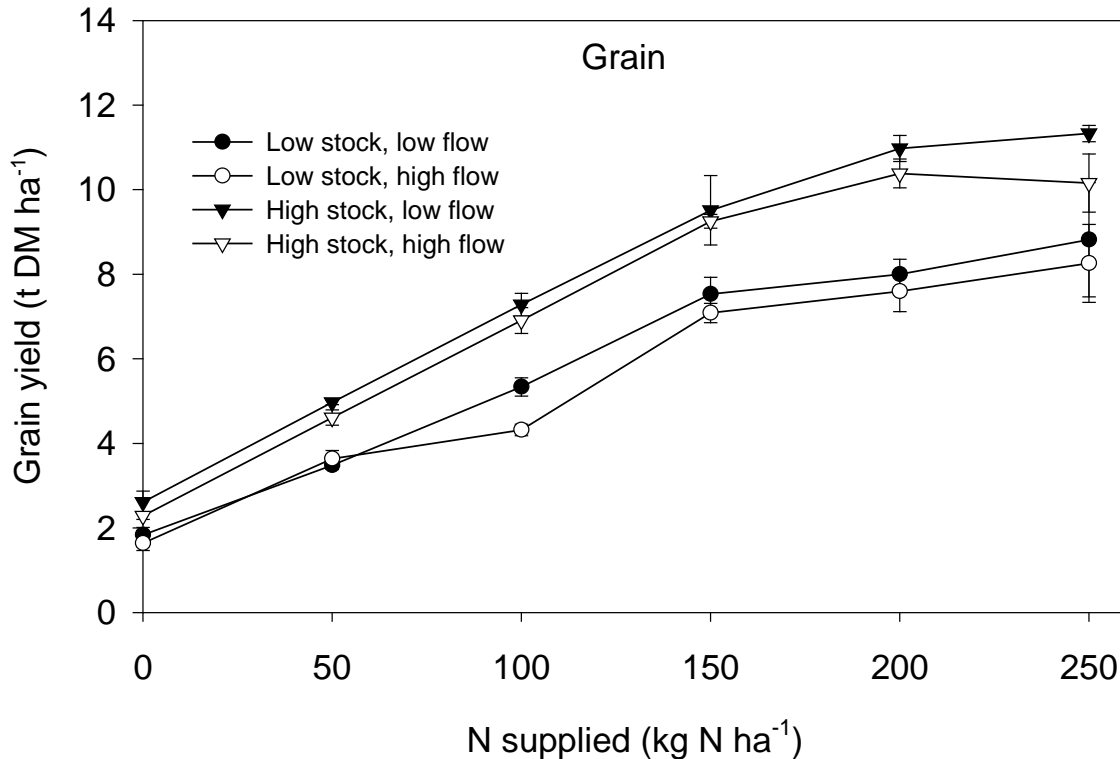


- Højt kulstoflager øgede udbytter af hvede, både ved lav og høj N-forsyning
- Tilførsel af halm (høj kulstofstrøm) reducerede udbyttet (muligvis N immobilisering)

Hvordan påvirker kulstof udbyttet?



SmartSOIL stock and flow experiment (Askov)

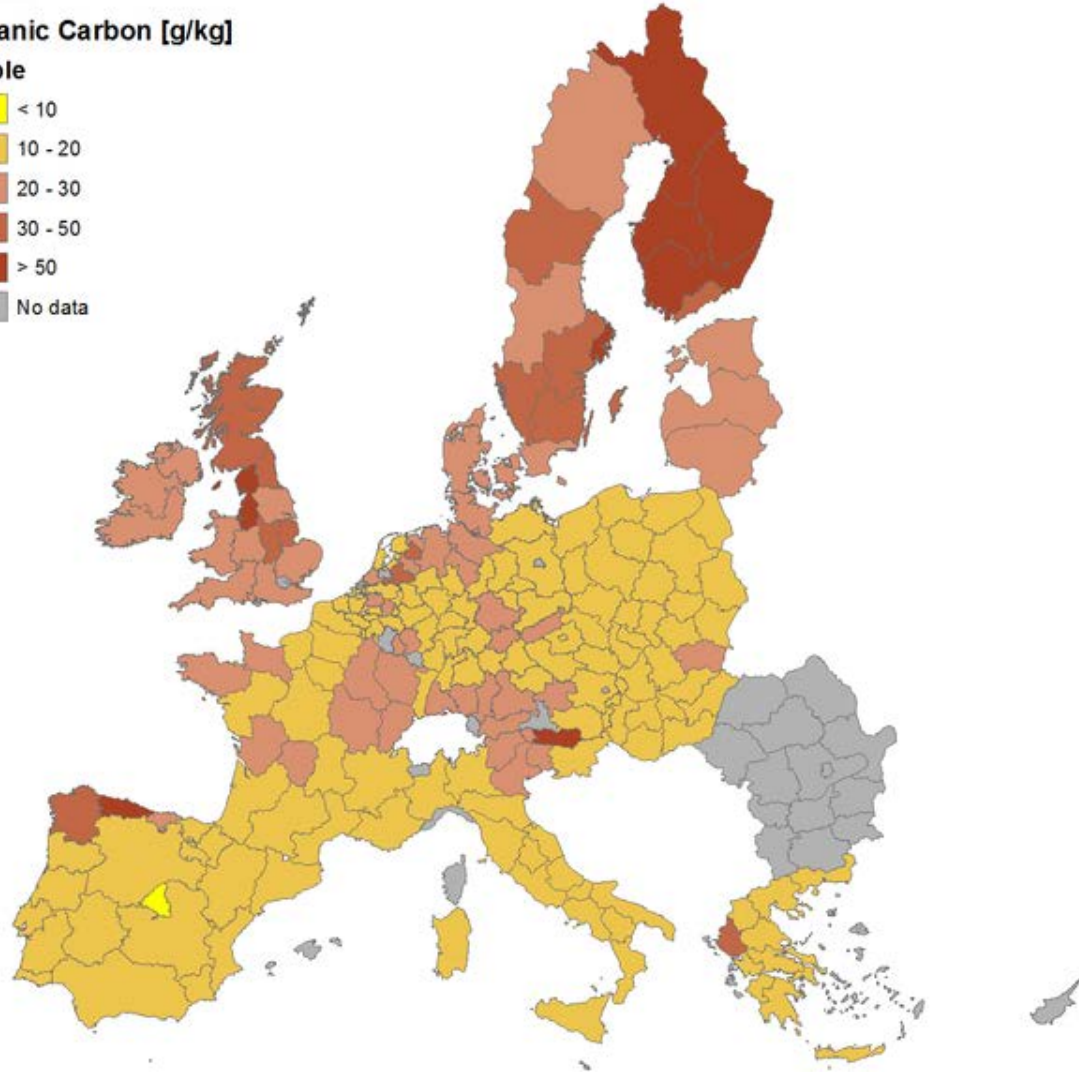
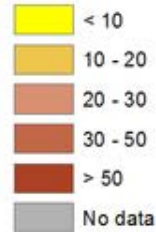


- Plots in long-term experiments with low and high stock were used
- Sub-treatments with low and high flow (straw) was imposed
- Increasing rates of mineral N was applied in miniplots.
- Data from N¹⁵ fertiliser labelling not yet available

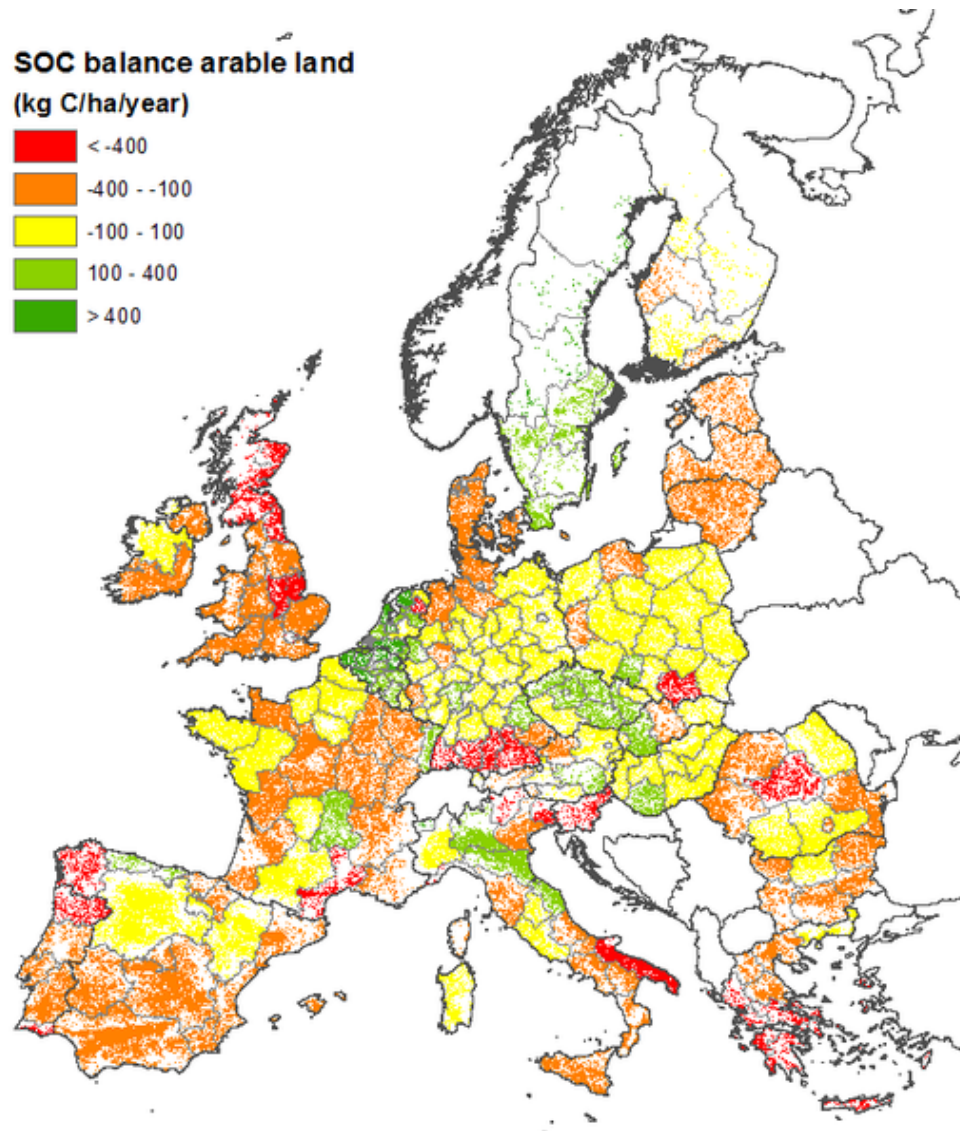
Kulstof i jord i omdrift

Organic Carbon [g/kg]

Arable

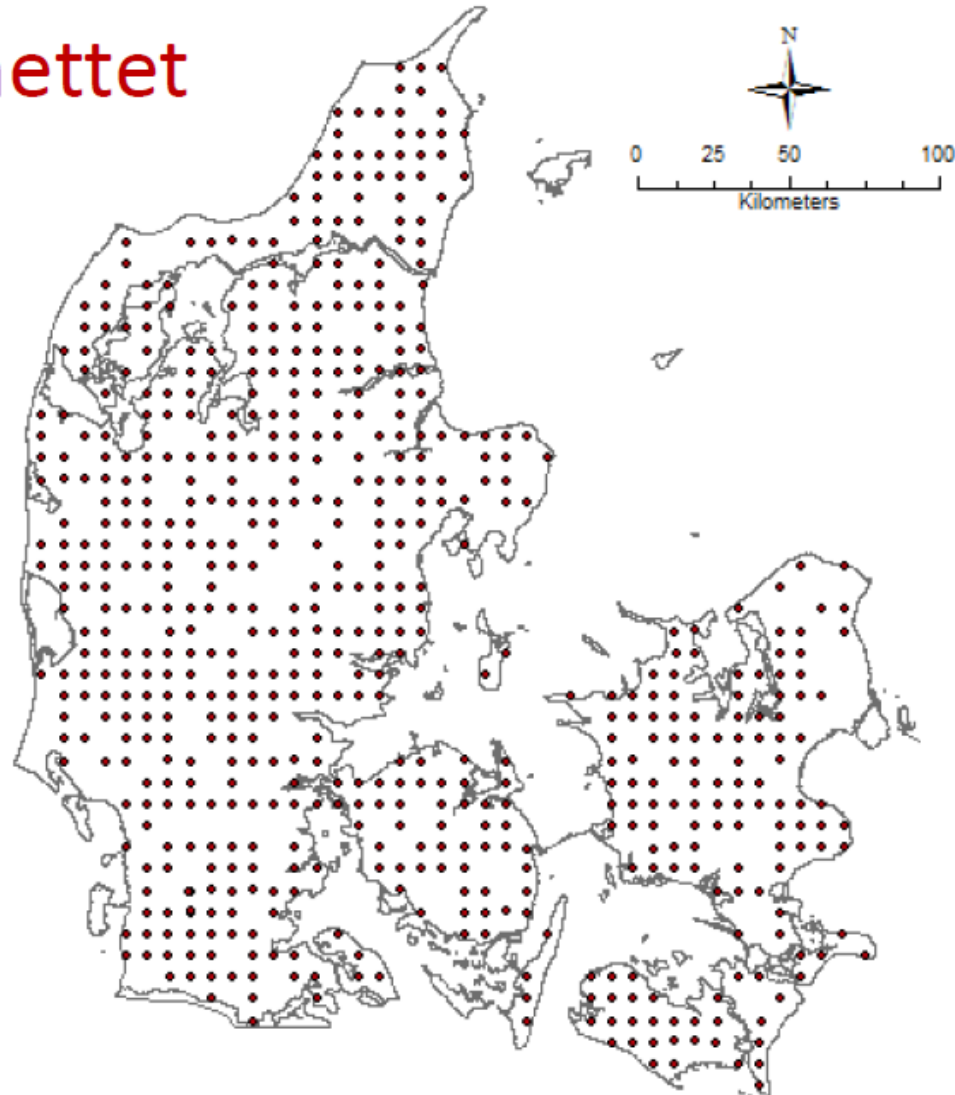


Kulstofbalance på jord i omdrift

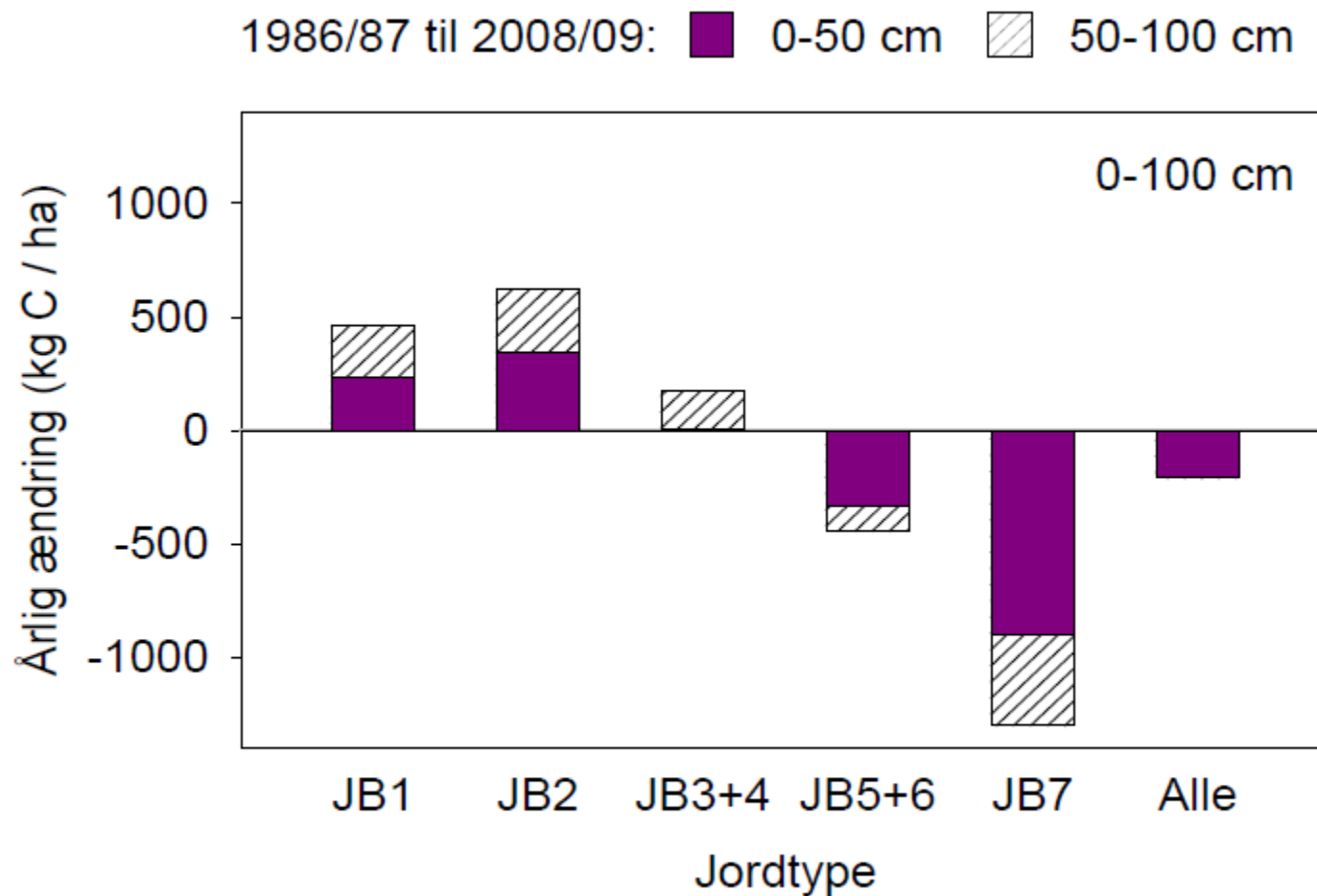


Monitering af kulstof i jord i Danmark

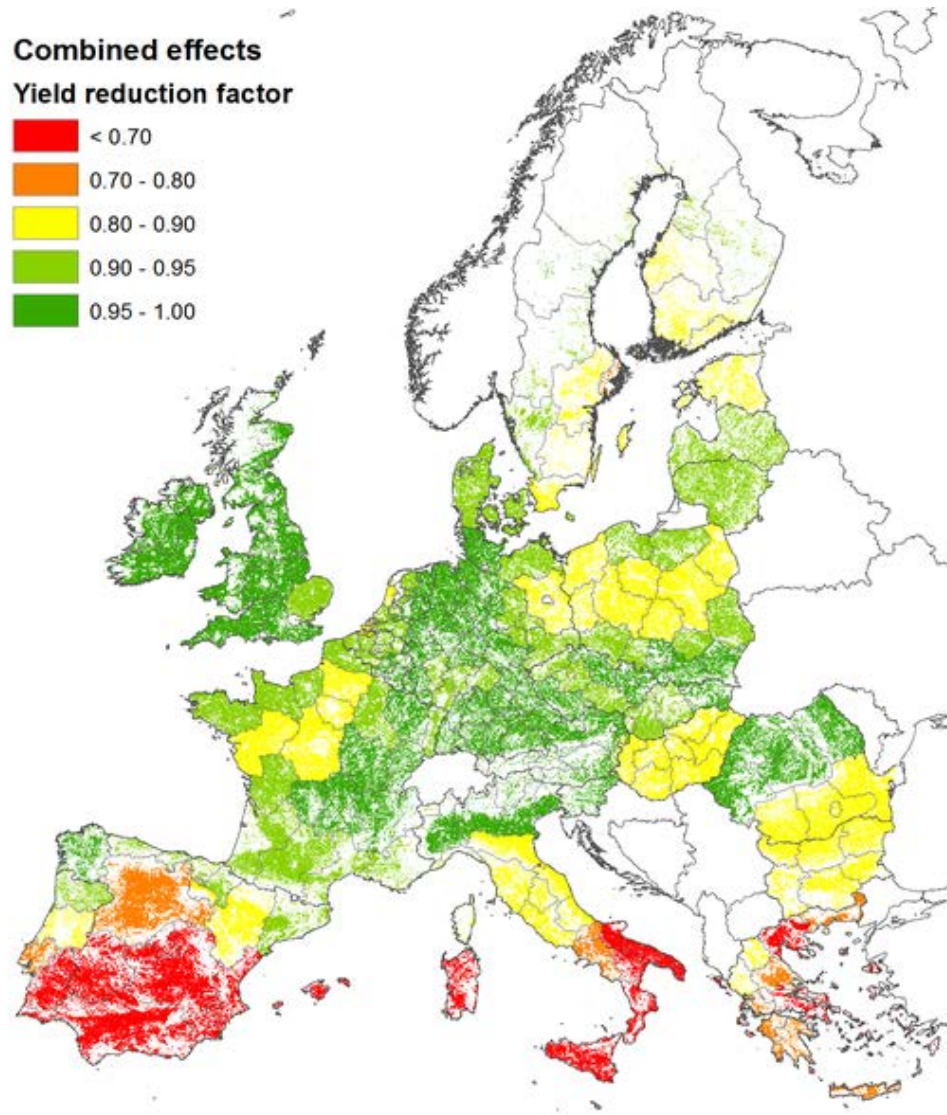
Kvadratnettet



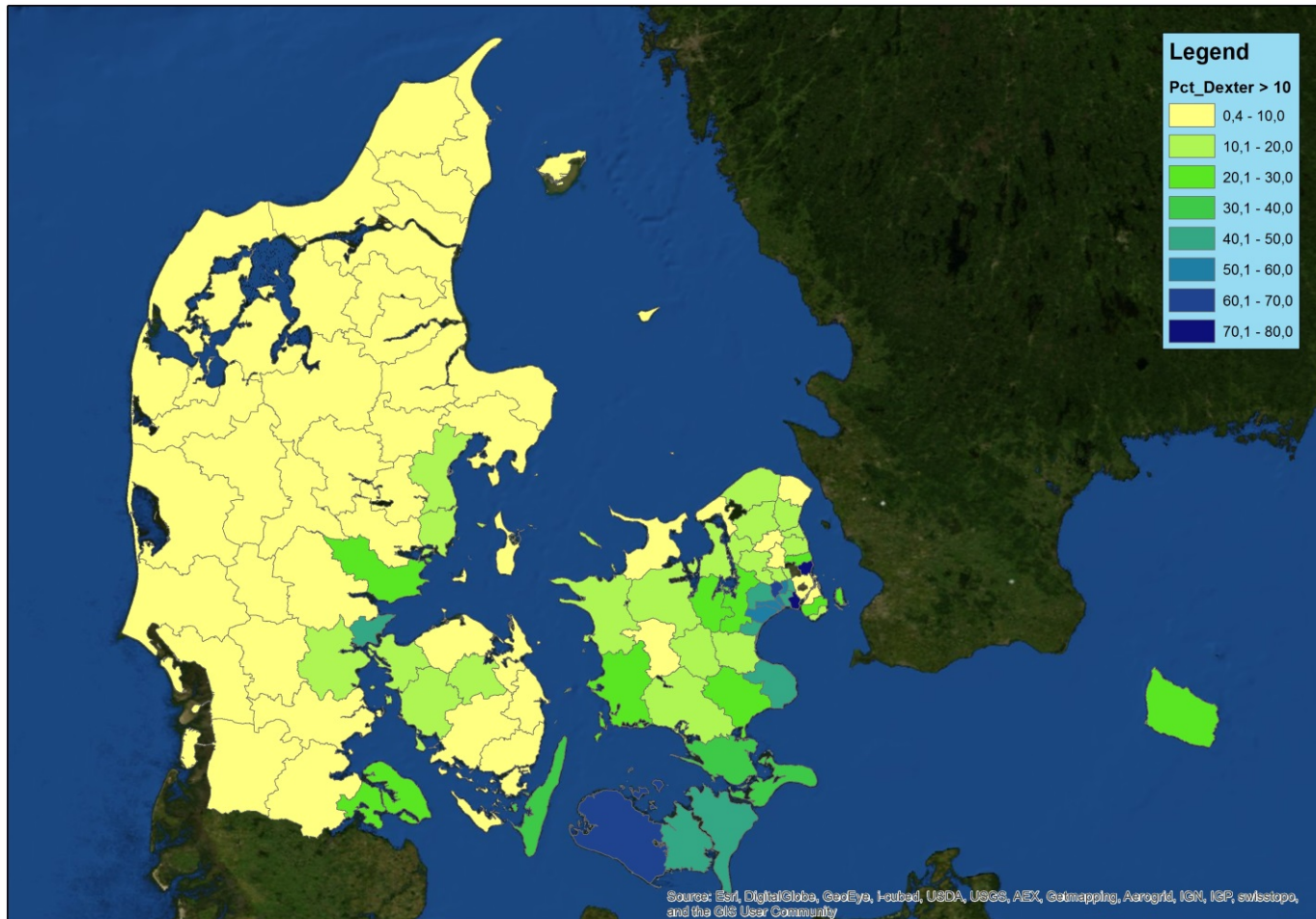
Ændring af jordkulstof på grundlag af Kvadratnettet



Udbytteeffekt af lavt kulstof (SmartSOIL modellen)



Procentdel af arealet med kritisk lavt kulstofindhold i forhold til jordstruktur



Baseret på Dexter index: ler / kulstof

Kulstoflagring og klimaforandringer

- Meget stor udveksling af CO₂ mellem atmosfæren og jordens pulje af organiske stof
- 2/3 af det danske areal dyrkes
- 150 tons C/ha i den øverste meter
- 2,6 mio. ha dyrket jord = 1400 mio. t CO₂
- 70 mio. tons CO₂-ækv. udledes årligt fra DK
- 21 % mindre udledning = 15 mio. t CO₂-ækv.
- **Altså: den nationale forpligtigelse modsvarer en årlig relativ stigning i jordens kulstoflager på 1 %**

Hvordan kan jordens kulstofindhold øges?

- Vi kan øge tilførslen af kulstof til jorden:
 - nedmulde afgrøderester
 - tilføre husdyrgødning
 - flerårige græsmarker
- Vi kan nedsætte omsætnings-hastigheden af jordens kulstoflager
 - reduceret intensitet i jordbearbejdningen
 - *øget vandmætning (nedsat luftskifte) ?*
 - *nedsat omsættelighed – delvis forkulning ?*

Kulstoflagring: Resultater af markforsøg

- Ved årlig nedmuldning af planterester tilbageholdes 10-20 % af det tilførte kulstof
 - Ved årlig tilførsel af husdyrgødning tilbageholdes 30 - 40 % af det tilførte kulstof
- set over en periode på 10-30 år

Kulstoflagring: Resultater af markforsøg

- Rod, stub, bladtab mv. 300 kg C/ha/år
- Halmnedmuldning (5 t TS/ha) 300 kg C/ha/år
- Gylle (30 t/ha, 5 %TS) 200 kg C/ha/år
- Efterafgrøde (rajgræs, udlagt forår) 400 kg C/ha/år
- Vedvarende græsmark (slæt) 1100 kg C/ha/år

- set over en periode på 10-30 år

Kulstoflagring: Resultater af Kvadratnettet

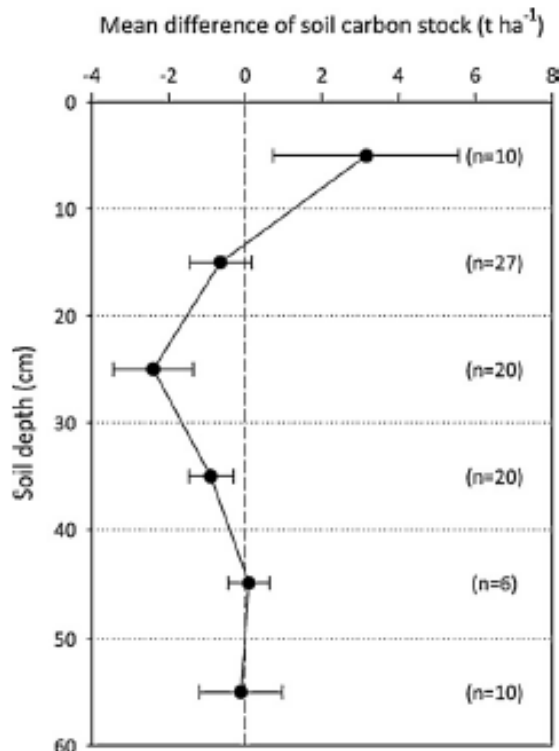
- For 0-25 cm:
 - Græsmark 950 kg C/ha/år
 - Vintersæd + halmnedmuldning 400 kg C/ha/år
 - Kvæggødning 200 kg C/ha/år
- For 25-50 cm:
 - Græsmark 580 kg C/ha/år

Kornafgrøder under økologisk dyrkning har mere rodbiomasse end konventionel dyrkning

Produktionssystem Art		Rod tørstof g m ⁻²
Kornafgrøder	Økologisk	
	Hvede	243 ± 41
	Byg	193 ± 40
	Korn	218 ± 47
	Konventionel	
	Hvede	147 ± 24
	Byg	129 ± 19
	Korn	143 ± 24
Efterafgrøder og ukrudt	Efterafgrøder	119 ± 45
	Ukrudt	35 ± 36

- men mindre i halm og stub

Jordbearbejdning påvirker kun i ringe omfang jordens samlede kulstoflager

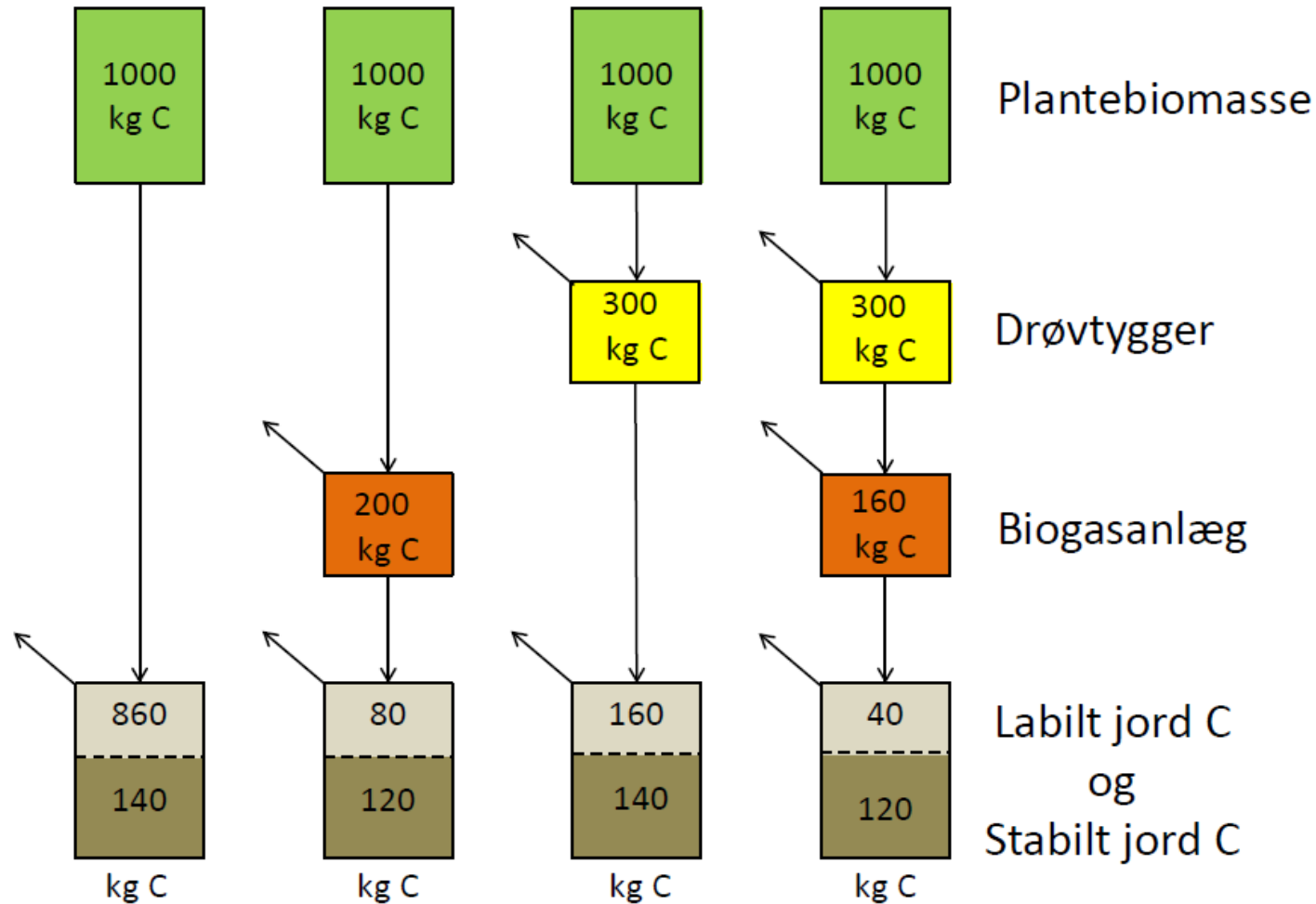


Review: 69 paired tillage experiments. Mean difference of carbon contents of soils under conventional tillage and no-tillage. (Luo et al. 2010)

Ændring fra pløjning til direkte såning øgede ikke det samlede kulstoflager men øgede den andel der ligger tæt på jordoverfladen.



Biogas mindsker kun kulstoflagringen minimalt



(Thomsen et al., 2013)

Betragtninger om udbytteeffekter af kulstof

- Kvælstof følger kulstof
- Udbytter påvirkes betydeligt af N-strømme
- C/N forholdet i afgrøderester påvirker N-strømme
- Afgrødens vandforsyning spiller en stor rolle under tørre klimaforhold
- Vandforsyning påvirkes af vandhøst, retention i jorden og af beskyttelse mod fordampning (C lager og strømme)
- Jordens C lager påvirker jordstruktur og afgrødeetablering
- Jordens C strømme påvirker biologien i jorden og dermed plantesundhed

The SmartSOIL Tool and Toolbox



SmartSOIL Tool
Welcome to SmartSOIL Tool

The SmartSOIL tool enables you to explore changes in soil carbon, crop yield and economics due to changes in cropping management

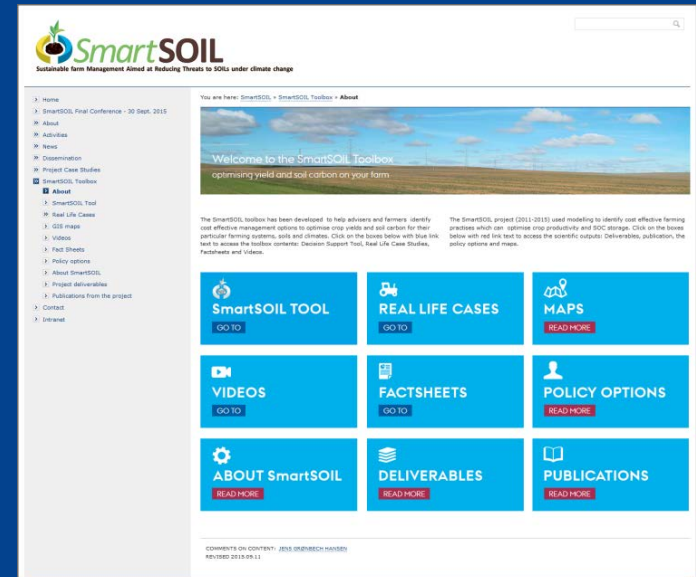
Select your language using the flags and press the start button

[Start now](#)

[About the tool](#)
[Get additional information](#)

 The SmartSOIL project received funding from the European Union's 7th Framework Programme for research, technological development and demonstration under grant agreement no 289694
  Sustainable farm Management Aimed at Reducing Threats to SOILs under climate change

Web site provided by Aarhus University, Faculty of Science and Technology, Department of Agroecology. Report technical problems to webmaster: Margit S. Jørgensen. Optimized for screen size 1280x800










SmartSOIL
Sustainable farm Management Aimed at Reducing Threats to SOILs under climate change

You are here: [SmartSOIL](#) > [SmartSOIL Toolbox](#) > [About](#)

Welcome to the SmartSOIL Toolbox
optimising yield and soil carbon on your farm

The SmartSOIL toolbox has been developed to help advisors and farmers identify cost effective management options to optimise crop yields and soil carbon for their particular farming systems, soils and climates. Click on the boxes below with blue link text to access the toolbox content: Decision Support Tools, Real Life Case Studies, Factsheets and Videos.

The SmartSOIL project (2011-2015) used modeling to identify cost effective farming practices which can optimise crop productivity and SOC storage. Click on the boxes below with red link text to access the scientific outputs: Deliverables, publications, the policy options and maps.

 SmartSOIL TOOL GO TO	 REAL LIFE CASES GO TO	 MAPS READ MORE
 VIDEOS GO TO	 FACTSHEETS GO TO	 POLICY OPTIONS READ MORE
 ABOUT SmartSOIL READ MORE	 DELIVERABLES READ MORE	 PUBLICATIONS READ MORE

COMMENTS ON CONTENT: JESS GRUBBECH HANSEN
REVISED 2015 09 11

<http://smartsoil.eu/>

TATION

The Toolbox - Factsheets

Crop Rotation

SmartSOIL FACTSHEET
INCREASING SOIL ORGANIC MATTER THROUGH IMPROVED CROP ROTATION

What is it?
A time rotation when the sequence of different crops on the same parcel over the course of several growing seasons. It can be used in conjunction with other practices such as intercropping, cover crops and reduced tillage to increase soil organic matter and reduce soil erosion. It can be used in conjunction with other practices such as intercropping, cover crops and reduced tillage to increase soil organic matter and reduce soil erosion.

What are the benefits?
• Enhance soil fertility and soil structure
• Reduce soil erosion and soil loss
• Increase soil water capacity
• Reduce soil compaction
• Increase soil biodiversity
• Reduce soil pH fluctuations
• Reduce soil salinity
• Reduce soil acidity
• Reduce soil alkalinity
• Reduce soil salinity
• Reduce soil acidity
• Reduce soil alkalinity

Soil Quality Indicators
This practice improves soil quality in several ways. It increases soil organic matter, which improves soil structure and water holding capacity. It also reduces soil erosion and soil loss, which improves soil fertility and soil structure. It also reduces soil compaction and soil salinity, which improves soil fertility and soil structure. It also reduces soil acidity and soil alkalinity, which improves soil fertility and soil structure.

Read it here

Residue management

SmartSOIL FACTSHEET
RESIDUE MANAGEMENT: IMPROVING SOIL ORGANIC MATTER AND REDUCING SOIL EROSION

What is it?
This practice involves leaving crop residues on the soil surface after harvest. It can be used in conjunction with other practices such as cover crops and reduced tillage to increase soil organic matter and reduce soil erosion.

What are the benefits?
• Enhance soil fertility and soil structure
• Reduce soil erosion and soil loss
• Increase soil water capacity
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Read it here

Manure & compost

SmartSOIL FACTSHEET
RESIDUE MANAGEMENT: IMPROVING SOIL ORGANIC MATTER AND REDUCING SOIL EROSION

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Read it here

Cover & Catch crops

SmartSOIL FACTSHEET
BOOSTING ON-FARM SOIL ORGANIC MATTER WITH COVER/CATCH CROPS

What is it?
This practice involves growing cover crops or catch crops on the soil surface during the off-season. It can be used in conjunction with other practices such as reduced tillage and crop rotation to increase soil organic matter and reduce soil erosion.

What are the benefits?
• Enhance soil fertility and soil structure
• Reduce soil erosion and soil loss
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Read it here

Conservation Agriculture

SmartSOIL FACTSHEET
CONSERVATION AGRICULTURE: BUILDING SOIL ORGANIC MATTER AND REDUCING PRODUCTION INPUTS

What is it?
This practice involves a combination of reduced tillage, cover crops, and crop rotation. It can be used in conjunction with other practices such as reduced tillage and crop rotation to increase soil organic matter and reduce soil erosion.

What are the benefits?
• Enhance soil fertility and soil structure
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Read it here

The Toolbox – Real Life Case Studies

HUNGARY

Real Life Case, László Lévai, Kompolt, Hungary

Focus on adding manure, residue management and minimising tillage operations through subsoiling



Location of farm in Hungary



László Lévai who runs a 75ha arable farm in Kompolt

In Hungary SmartSOIL partner Andras Molnar spoke to László Lévai who runs a 75ha arable (winter wheat, rape, sunflowers) farm in Kompolt. The soil is loam with some sandy areas prone to drought and heat stress during summer. He applies manure and recycles crop residues in order to improve the soil structure. He also tries to minimise tillage operations to protect the soil, so when conditions he uses a subsoiler instead of a plough. These practices contribute to better soil functioning, which leads to better yields overall. For more details see below

Video - Demonstrating on farm SmartSOIL practices in Hungary



This video demonstrates SmartSOIL practices on a farm in northern Hungary. We take a look at how László, a farmer in Kompolt, engages in smart soil practices to improve his soil. He uses both reduced tillage and residue management to keep his soil healthy. Watch to find out more.

RLC - Hungary

SmartSOIL The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101019719.

FOCUS ON ADDING MANURE, RESIDUE MANAGEMENT AND MINIMISING TILLAGE OPERATIONS THROUGH SUBSOILING

Name: László Lévai
Region: Kompolt, Hungary
Farm type: Arable farming (winter wheat, rape, sunflowers)
Farm size: 75ha

Tell us about your farm
I have always (although I farmed with my father for many years and before that I worked at an agricultural research institute) farmed 75 ha arable land, of which half is leased. Most of my parents are on leasable soil, although I have a 10 ha sandy area which is prone to drought and heat stress during summer.

What do you do to protect your soil?
I apply manure and recycle crop residues in order to improve the soil structure. I also try to minimise tillage operations to protect the soil, so when conditions permit I use a subsoiler instead of a plough. These practices contribute to better soil functioning, which leads to better yields overall.

Why did you decide to implement that approach?
The soil was in poor health and there were negative effects on plant development, nutrient and water uptake, and on farm economics due to high fuel consumption for tillage and low yields.

How have you implemented the practices into your rotation?
The use of the subsoiler is not introduced as a substitute but rather as a complement to ploughing. My usual rotation includes rape winter wheat, sunflower-winter wheat (sometimes I have winter wheat for more than one year). Based on my experience, the most important issue for subsoiling is proper timing. I carefully assess each and every situation, mainly the soil conditions but also crop and machinery availability. I apply manure every 4-5 years, depending on availability and my financial situation. For residue management, the residue is spread evenly on the ground and partly ploughed in but this depends on the harvest.

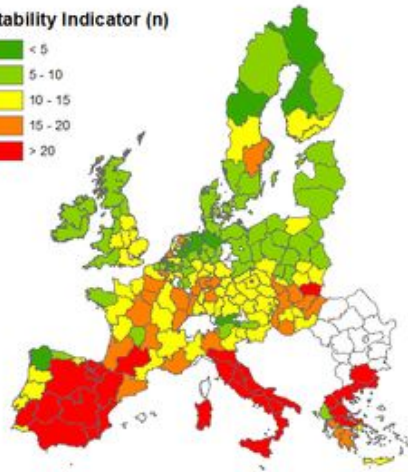
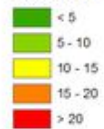
What has been the biggest challenge? And how have you overcome it?
The most difficult challenge was the timing of subsoiling operations, that needs constant learning and adaptation. Moreover, having access to a wider range of tools is not easy for my farm size due to financial barriers. I overcome this by buying used machinery (or sometimes build my own) or using contractors. For manure spreading I use contractors.

- [Click here for English version](#)
- [Click here for Hungarian version](#)

The Toolbox – Soil risk maps

Soil risk maps

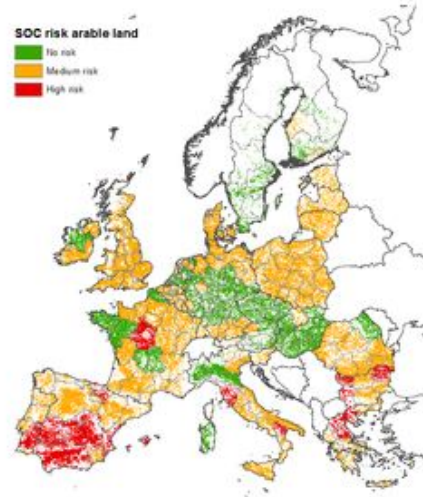
Stability Indicator (n)



Click on the map to enlarge

Soil potential stability map (Figure 4 from D2.4)

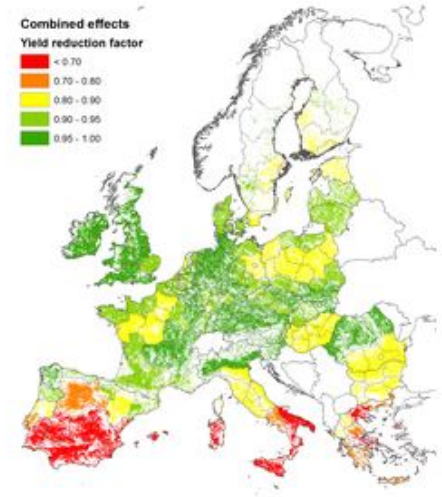
SOC risk arable land



Click on the map to enlarge

SOC risk map

Combined effects
Yield reduction factor



Click on the map to enlarge

Yield reducing factors

The Toolbox – Farmer videos

SmartSOIL partners own videos

SmartSOIL practices in Hungary



This video demonstrates SmartSOIL practices on a farm in northern Hungary. We take a look at how László, a farmer in Kompolt, engages in SmartSOIL soil practices to improve his soil. He uses both reduced tillage and residue management to keep his soil healthy. Watch to find out more.

SmartSOIL practices in Italy



This video explores the farming practices of Andrea and Nunzio De Angeli. They run a 300ha mixed farm producing apples, peaches, potatoes and maize in Tuscany with both sandy and heavier clay soils, which are managed differently. Using the SmartSOIL practices of cover crops and no-till seeding within their rotations, Andrea and Nunzio aim to improve their soil organic matter. Check out the video for more details.

Links to relevant videos from other sources

Visualising carbon - no mean feat!



This animated film demonstrates the need to protect the long term carbon stored in soils and vegetation as well as reduce carbon emissions. It quite neatly gives you a sense of the quantities of carbon in our atmosphere and soils. [Read more...](#)

3 min.

Carbon Accounting for farmers



Farming Futures has created this short film to explain the benefits of using carbon calculators on your farm. Henry Aubrey Fletcher, CLA president and dairy farmer, takes us through his journey using the CLA CALM Calculator and how it helped him identify areas for improvement and efficiency savings on his farm. [Read more...](#)

5 min.

SmartSOIL partnere

www.smartsoil.eu



SmartSOIL Team



Aarhus University, Denmark (Project Coordinator)
Lead: Jørgen E. Olesen



University of Aberdeen, UK (Scotland)
Lead: Pete Smith



University of Copenhagen, Denmark
Lead: John R. Porter



Alterra, Netherlands
Lead: Peter Kuikman



University of Florence, Italy
Lead: Marco Bindi



Ecologic Institute, Germany
Lead: Ana Frelih-Larsen



Universidad Politécnica de Madrid, Spain
Lead: Ana Iglesias



Scottish Agricultural College, UK (Scotland)
Lead: Dominic Moran



Countryside & Community Research Institute, UK
Lead: Julie Ingram



Warsaw University of Life Sciences (SGGW), Poland
Lead: Zbigniew Karaczun



Le Groupe-conseil baastel spri, Belgium
Lead: Olivier Beucher



Research Institute for Agricultural Economics, Hungary
Lead: András Molnár