Subsoil biochar application to vitalize coarse sandy soils

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The Interreg IVB North Sea Region Programme

The future of biochar

End conference of the Interreg IVB project Biochar: climate saving soils

Background

- To keep up with the growth in human population, more food will have to be produced worldwide over the next 50 years than has been during the past 10,000 years combined

- Lower productivity is observed as soil quality declines due to intensive soil cultivation and overuse of chemical fertilizers and pesticides

- Improved conservation of soil and restoration of degraded land are fundamental to future generations
  - quality of land for food production
  - water storage

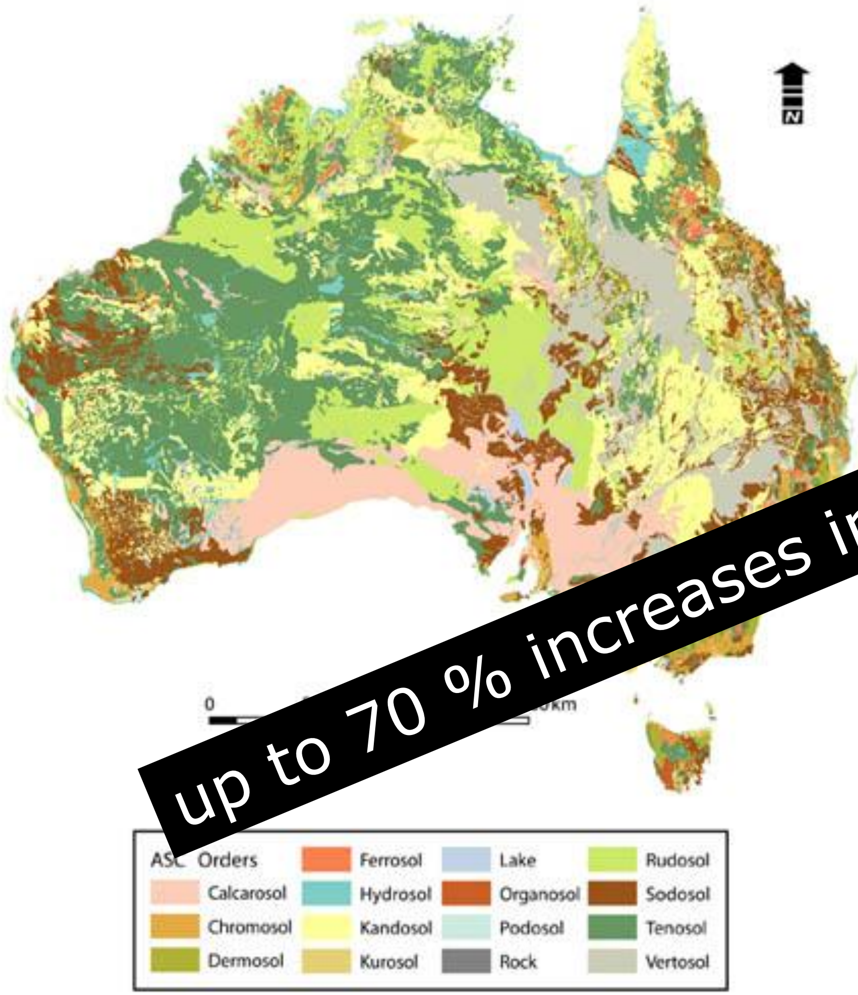
- Crop yields and yield potentials can be strongly limited due to restricted root growth and poor water and nutrient retention

- **Biochar subsoil application provide additional soil functions and services with promising potentials for the future**

Inspiration from colleagues DownUnder

DTU

Subsoil improvements in Australia



up to 70 % increases in wheat yields reported

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ELSEVIER

Changes in soil physical properties and crop root ... ense sodic subsoil following incorporation of organic amendm...

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... ARTICLE

Deep placement of organic amendments in dense sodic subsoil increases summer fallow efficiency and the use of deep soil water by crops

J. S. Gill · G. J. Clark · P. W. Sale · R. R. Peries · C. Tang

Amelioration of dense sodic subsoil using organic amendments increases wheat yield more than using gypsum in a high rainfall zone of southern Australia

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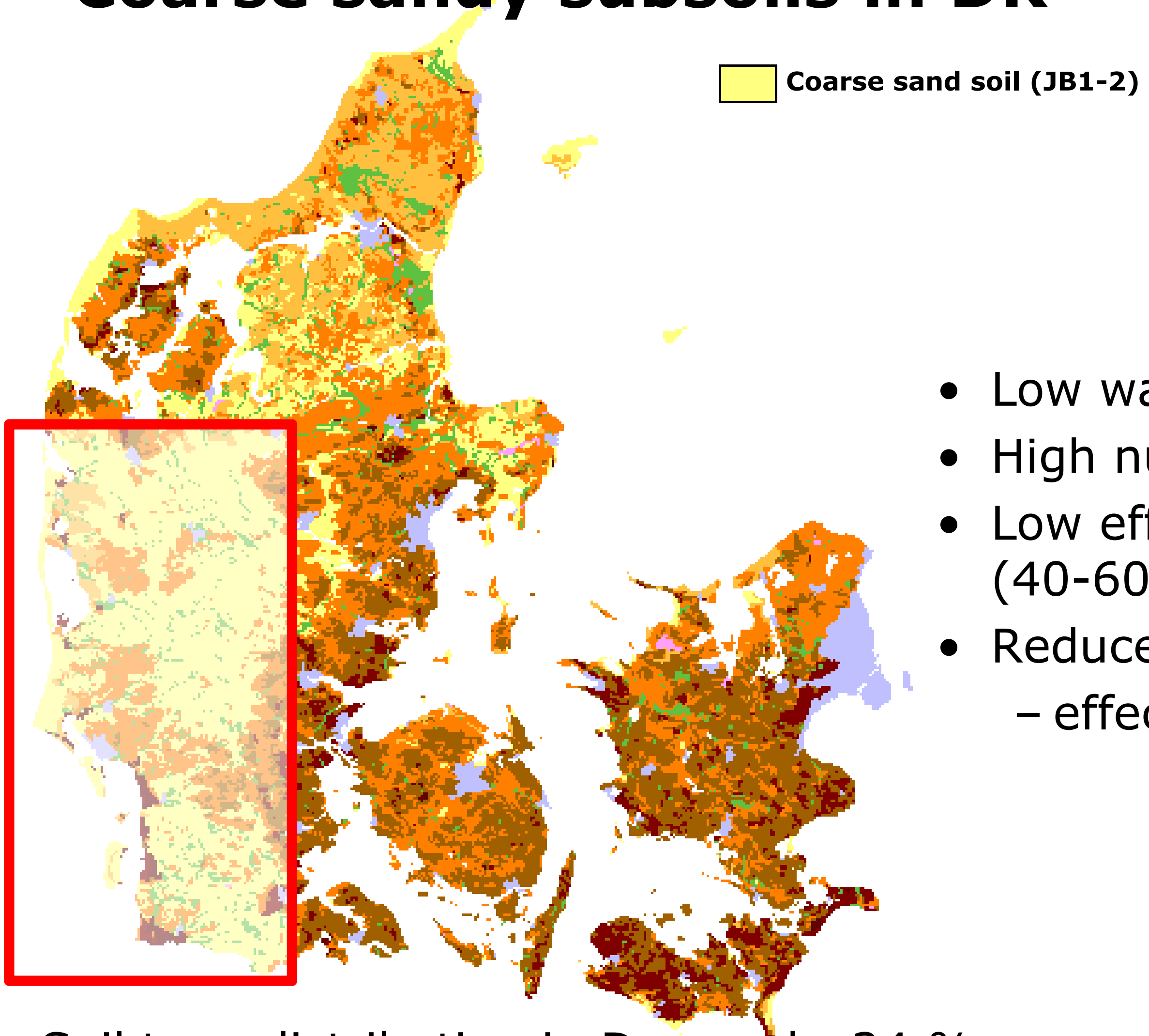
Coarse sandy subsoils in DK



- Low water rentention
- High nutrient leaching
- Low effective root depth (40-60 cm)
- Reduced yield potentials
  - effect on crop choice

Soil type distribution in Denmark: 24 % course sandy soil, 38 % sandy loam and 38 % loam soil (report DMU nr. 376)

Principal study: Root growth of common bean in a sandy subsoil with increasing biochar concentrations

Emilie M. Ø. Hansen, BSc project; KU Science 2010-11

% biochar

Hypothesis

"Biochar amendment to a coarse sandy subsoil increases the amount of plant available water, root density in the subsoil, and thereby aboveground yield; which means increased grain production"

Collaboration with DONG Energy

Low-temperature-Gasification (Pyroneer) straw biochar

52% C
PAH=5 mg kg^{-1}
pH (H_2O): 10.7
<100µm

Control

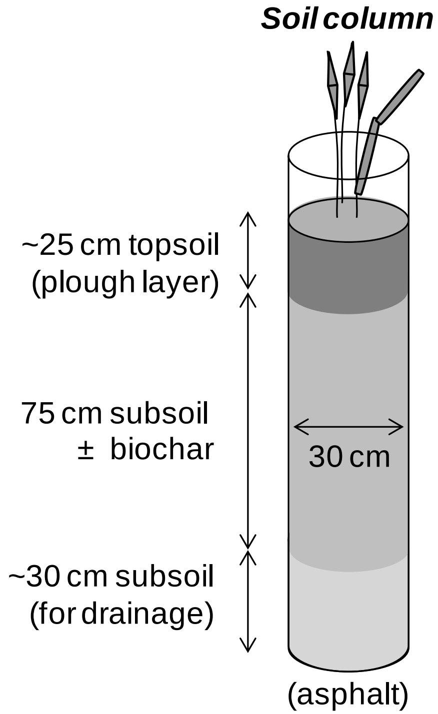
Wood-biochar

76% C
PAH<0.8 mg kg^{-1}
pH (H_2O): 9.1
0.5-1 mm

www.dongenergy.com/pyroneer

The experiment

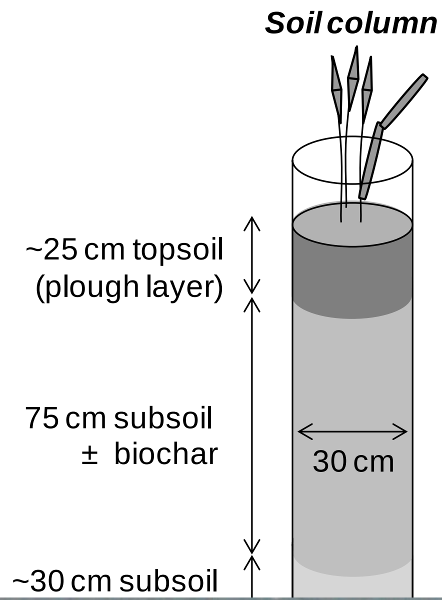
- Spring Barley, 18 columns, six subsoil treatments (n=3)
- Water and nutrient (~200 kg N ha^{-1}) supply in excess



	Coarse sand (>2mm)	Fine sand	Silt	Clay
	gram per kg			
Topsoil	66.3 ±1.2	28.5 ±0.6	3.7 ±0.8	1.5 ±0.4
Subsoil	77.9 ±1.8	18.9 ±2.0	0.9 ±1.0	2.3 ±0.2

The experiment

- Spring Barley, 18 columns, six subsoil treatments (n=3)
- Water and nutrient (~200 kg N ha^{-1}) supply in excess



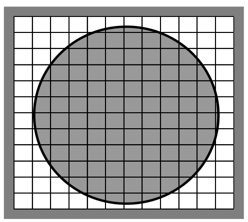
Subsoil treatments :
(25-100 cm, n=3)

0 % (Control) | **½ %** | **1 %** | **2 %** | **4 %** | **2 %** (Wood-biochar)

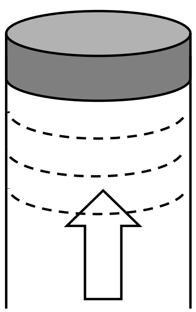
Straw-biochar incorporation

Parameters: subsoil root coverage, soil water content, and bulk density

Root determination



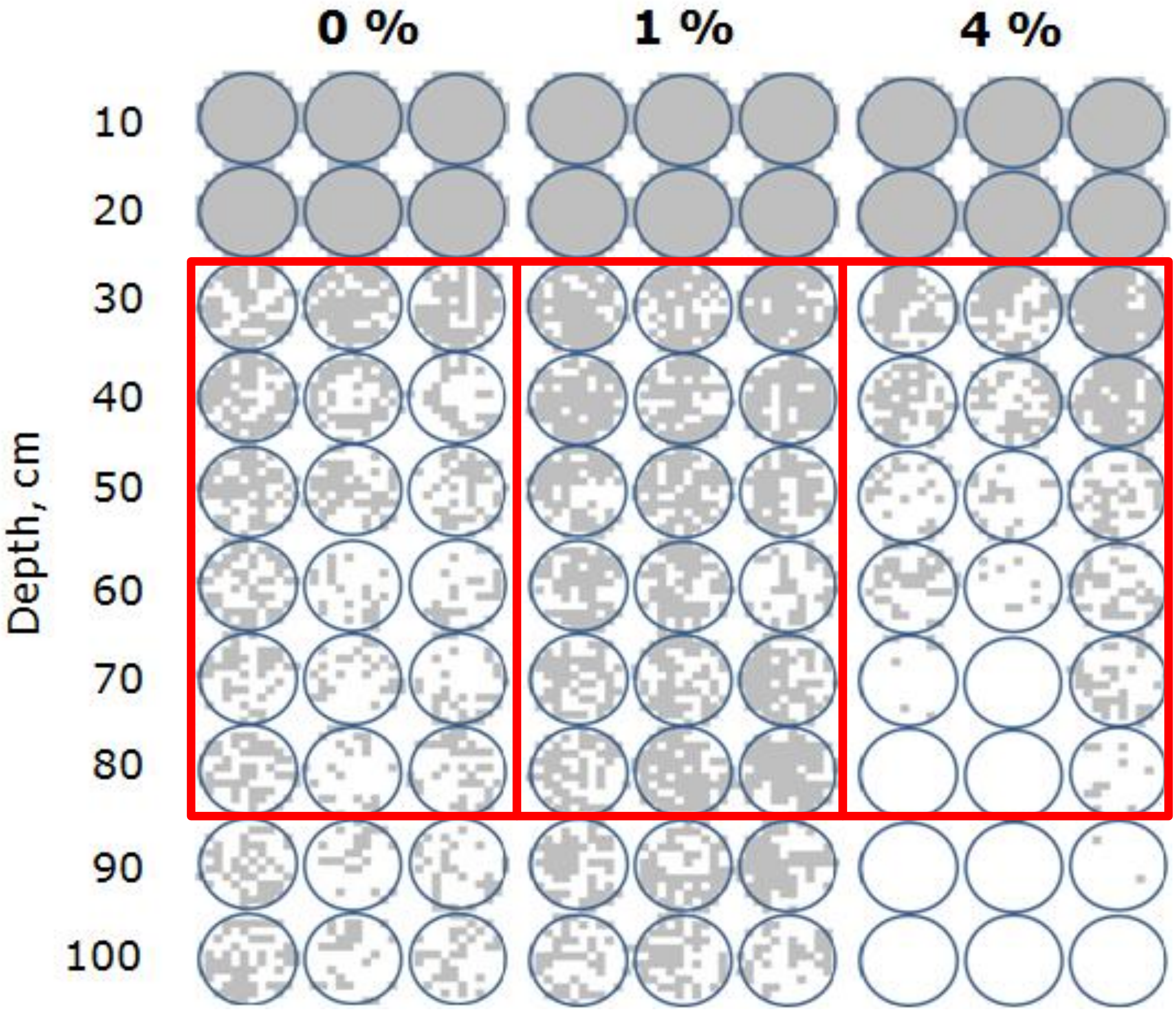
Root coverage determined in grid at end section



Soil is extruded through the tube and cut of every 5 cm (subsoil) or 10 cm (topsoil)

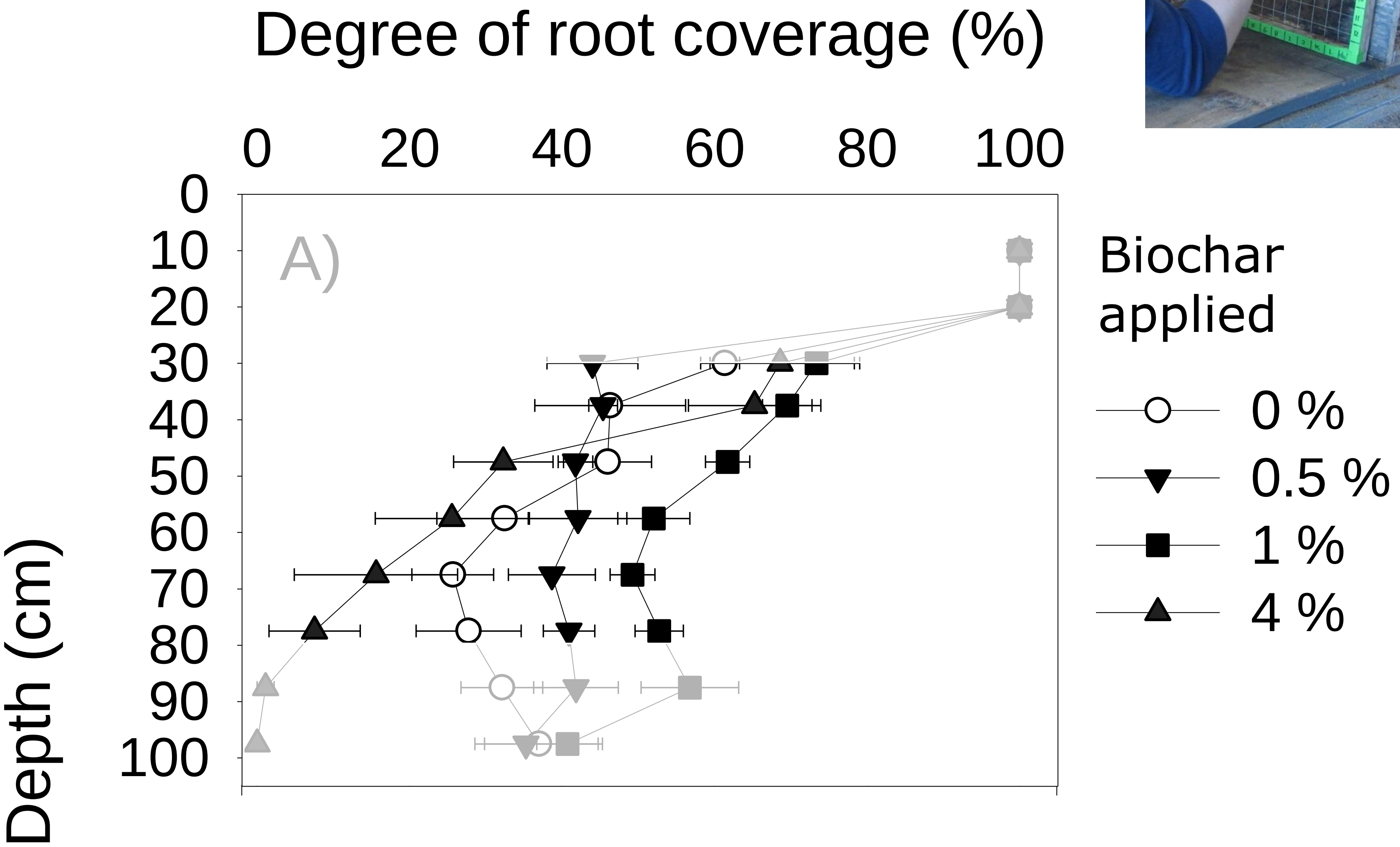
2.5 x 2.5 cm each

144 cells in total

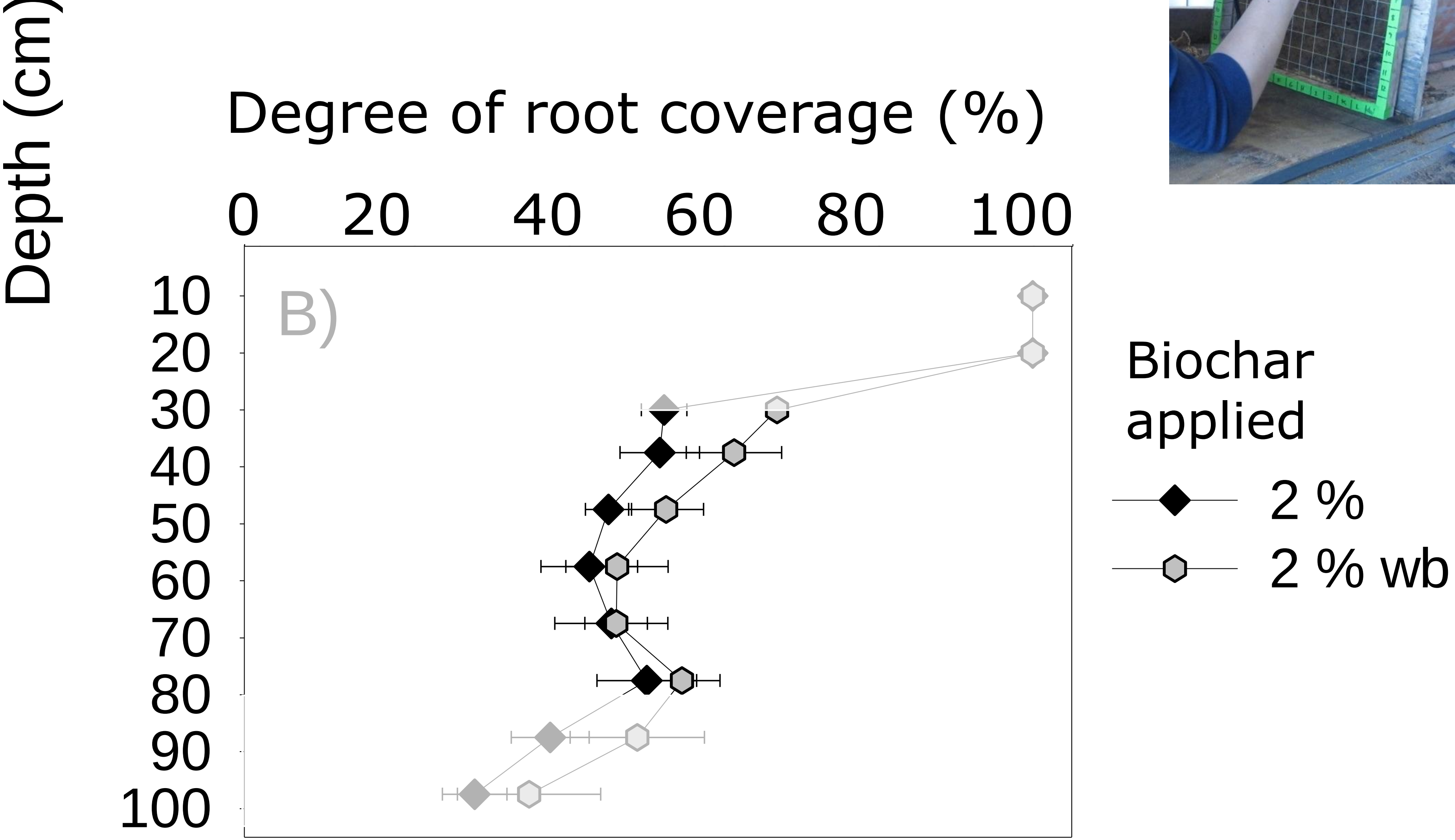


Root coverage at different depths

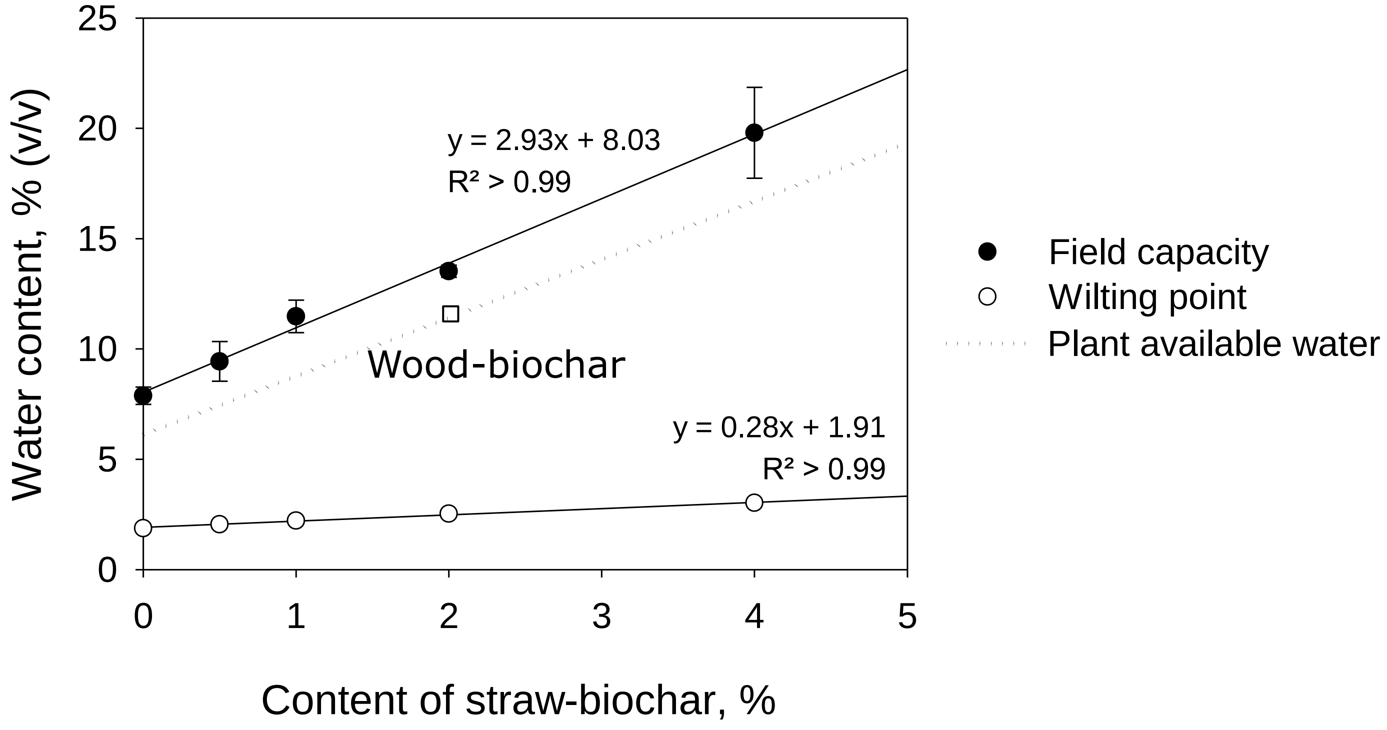
Root coverage in single cells out of a total of 144 (2.5 x 2.5 cm each)



Straw versus wood biochar

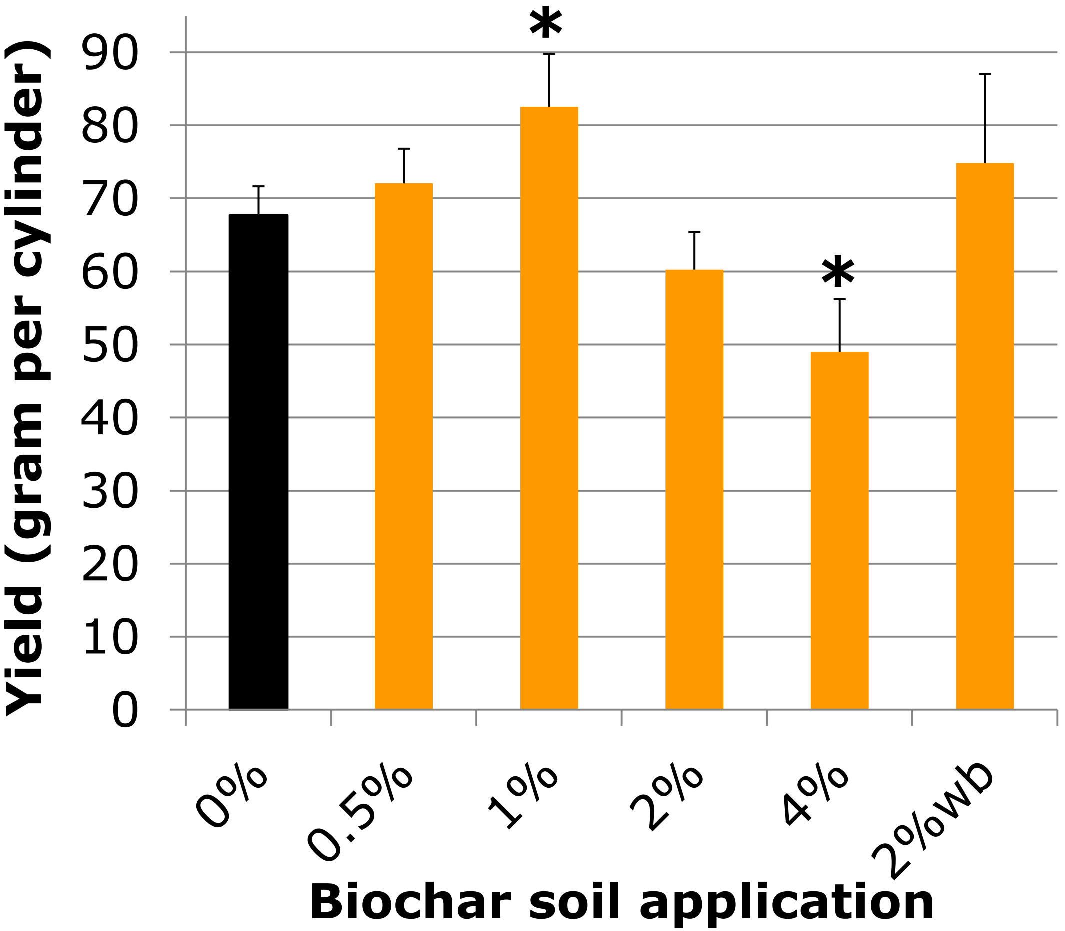


Biochar effect on subsoil's water retention



Volumetric water contents at 30-80 cm depth: in-situ values after drainage, values at the wilting point, and difference between the two. Average values and standard errors (n=3).

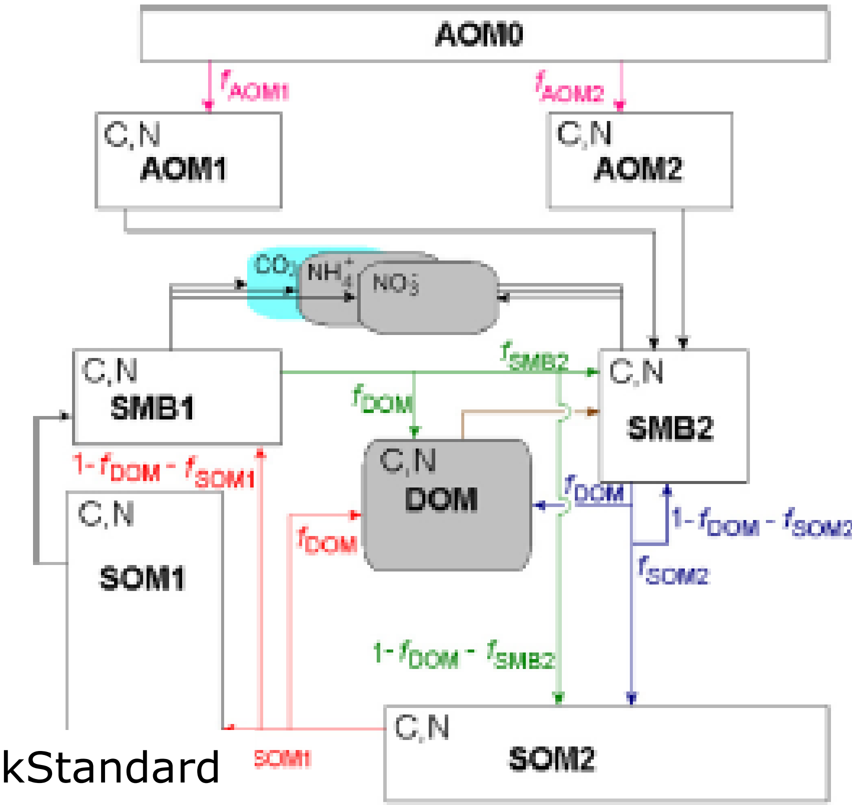
Grain yield per cylinder



'*' significantly different from the control ($p<0.05$)

Preliminary DAISY modelling

- When applying 1% straw-biochar
  - 8 years' climatic data from the area where the subsoil was collected
    - 30 % increase of barley grain yield per year
    - nitrate leaching reduction of 30 kg N per ha per year



www.code.google.com/p/daisy-model/wiki/DanskStandard

Conclusions

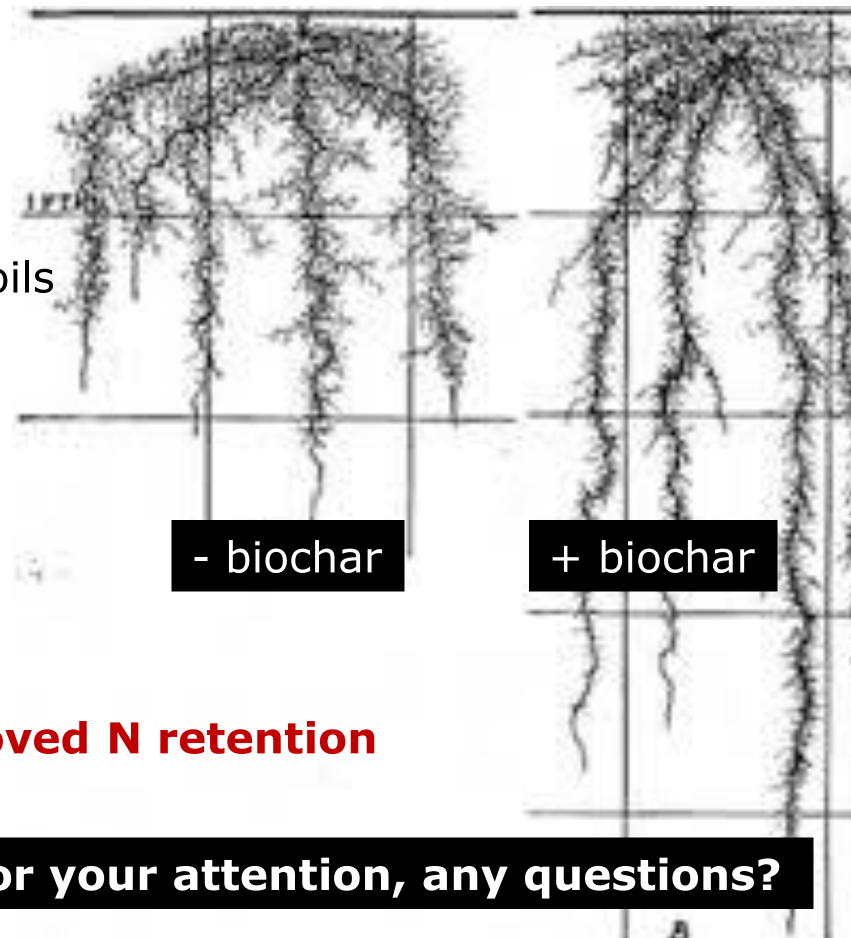
- Biochar up to 2% increases root growth, 4 % decreases it
- Increased water retention
- 1% biochar is most beneficial for root growth and grain yields

Perspectives

- Subsoil transformation of low-productive soils
  - New crop choices
    - Cash crops versus pastures

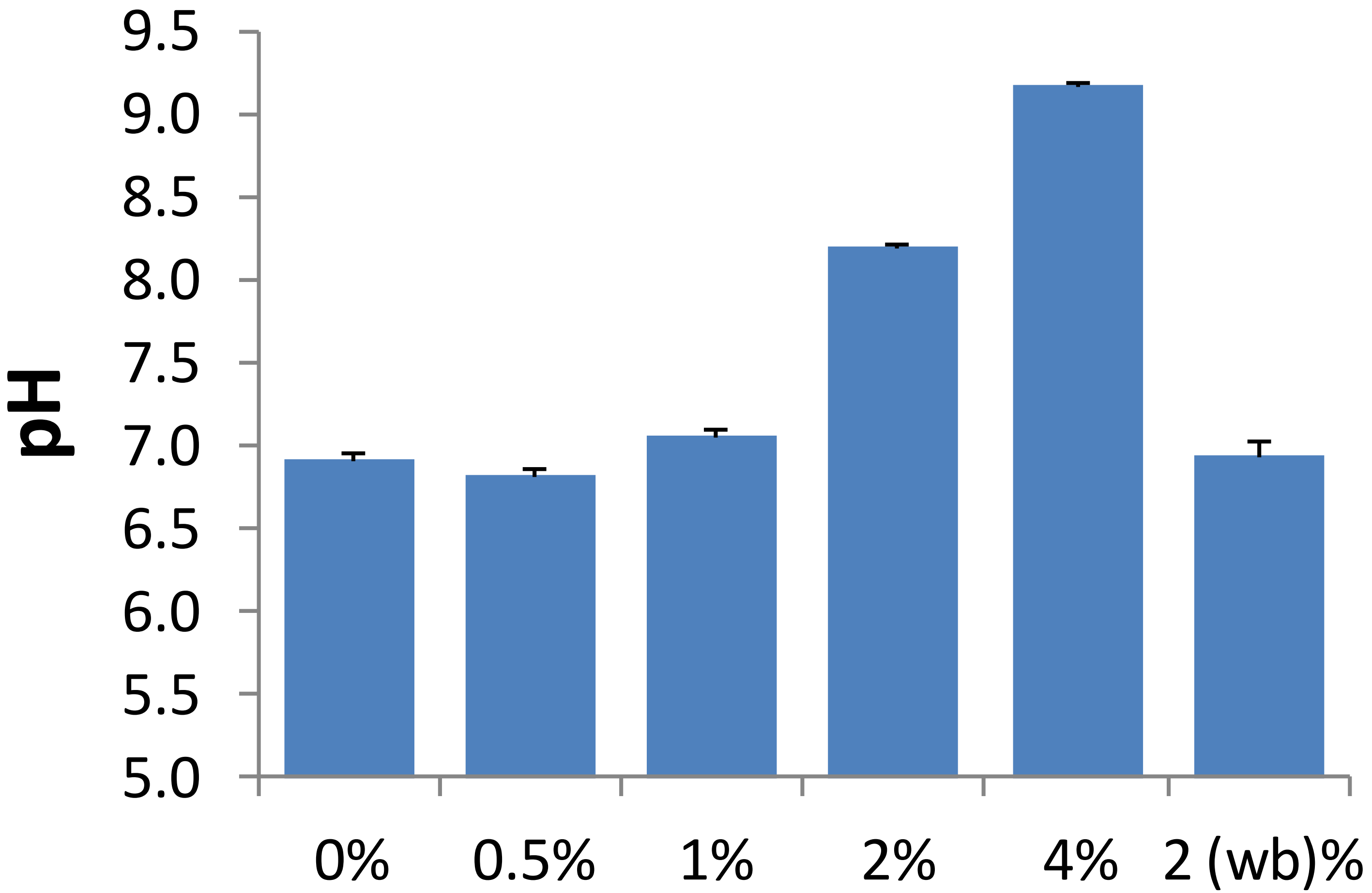
However,

- **How to incorporate biochar?**
- **Is it feasible for the farmer?**
  - **Level of yield increases and improved N retention**
  - **Costs of application**

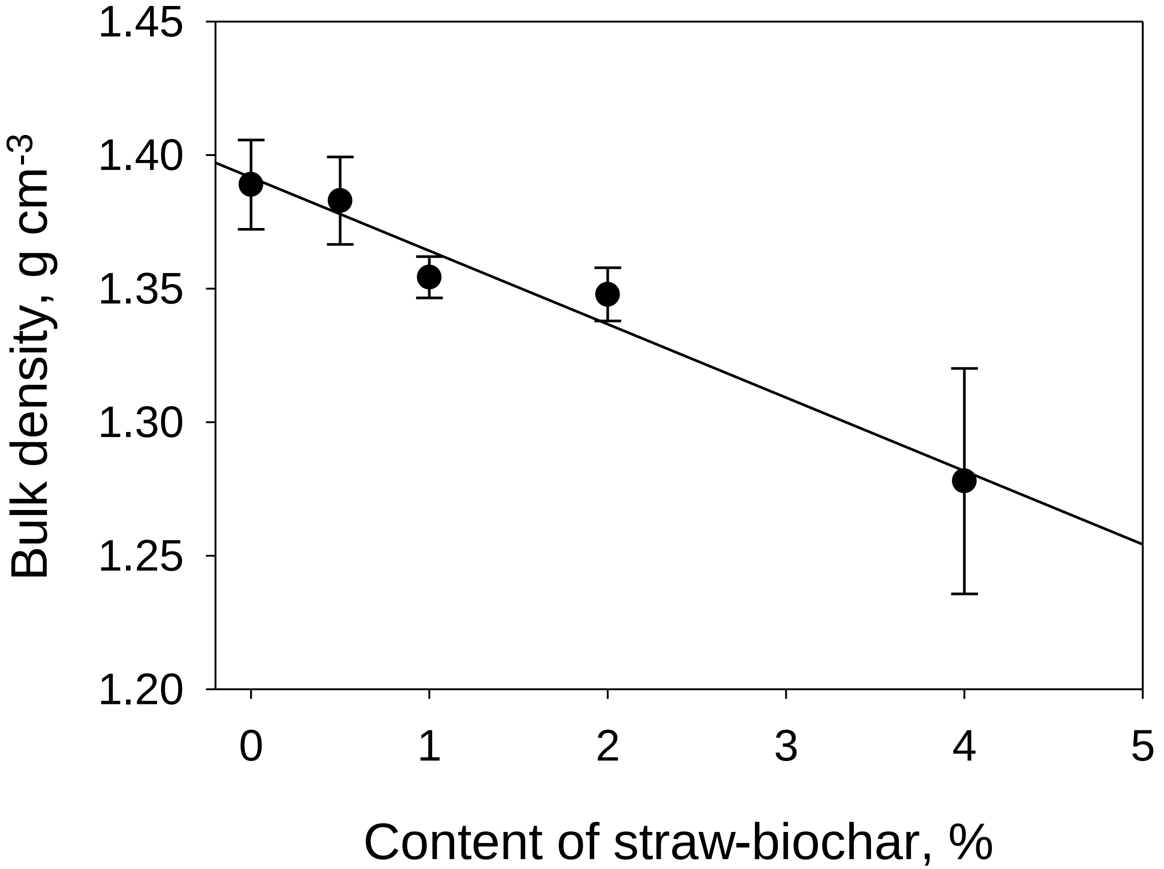


Thank you for your attention, any questions?

Subsoil pH (n=2)



Bulk density



Typical bulk density for JB1 subsoils (1.49 ± 0.05 g cm^{-3})(Hansen et al., 1986).

Clear advantages for the farmer needs documentation

"I grew the 2 official heaviest pumpkins in the state of Illinois this year in a very wet hot disease filled season for many. I believe **biochar** helps protect and build the structure of my soil especially when you water as much as I do.**"**

Jeff Joliet,

Illinois, 2010