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Norwegian Institute for Agricultural and Environmental Research

Presented at the TERRA PRETA kick-off meeting by :

Daniel Rasse,
Department head, Soil Quality and Climate

Norway - at the northern fringe of Europe

Large contrasts and gradients in nature

Norwegian Institute for Agricultural and Environmental Research

A geographically distributed institute

Organisational Structure

Ministry of Agriculture and Food

Board

Director General

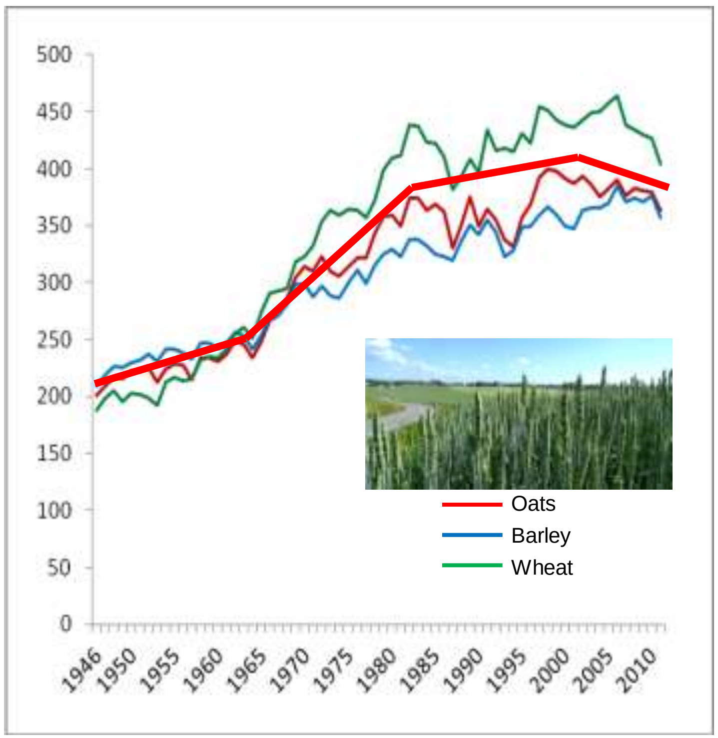
- **Environment and Natural Resources**
- **Plant Science and Plant Health**
- **Agriculture and Rural Development**

Bioforsk's multiple roles in Agriculture and environmental R&D

- Applied research
  - End-user orientation and demand-driven research
  - About 65 % of the budget from short-medium term contracts and "competitive" research activities
- Policy and management support
- Strategic research with long-term perspectives
- Innovation and rural development
- Information and transfer of knowledge

A long-lasting increase in crop productivity levels off

Cereals in Norway



Breaking the current trend

- Uncover the causes
- Understand the driving forces
- Design measures

More yield per land area

Sustainable intensifications

An increasing challenge:

Fungal diseases and mycotoxins

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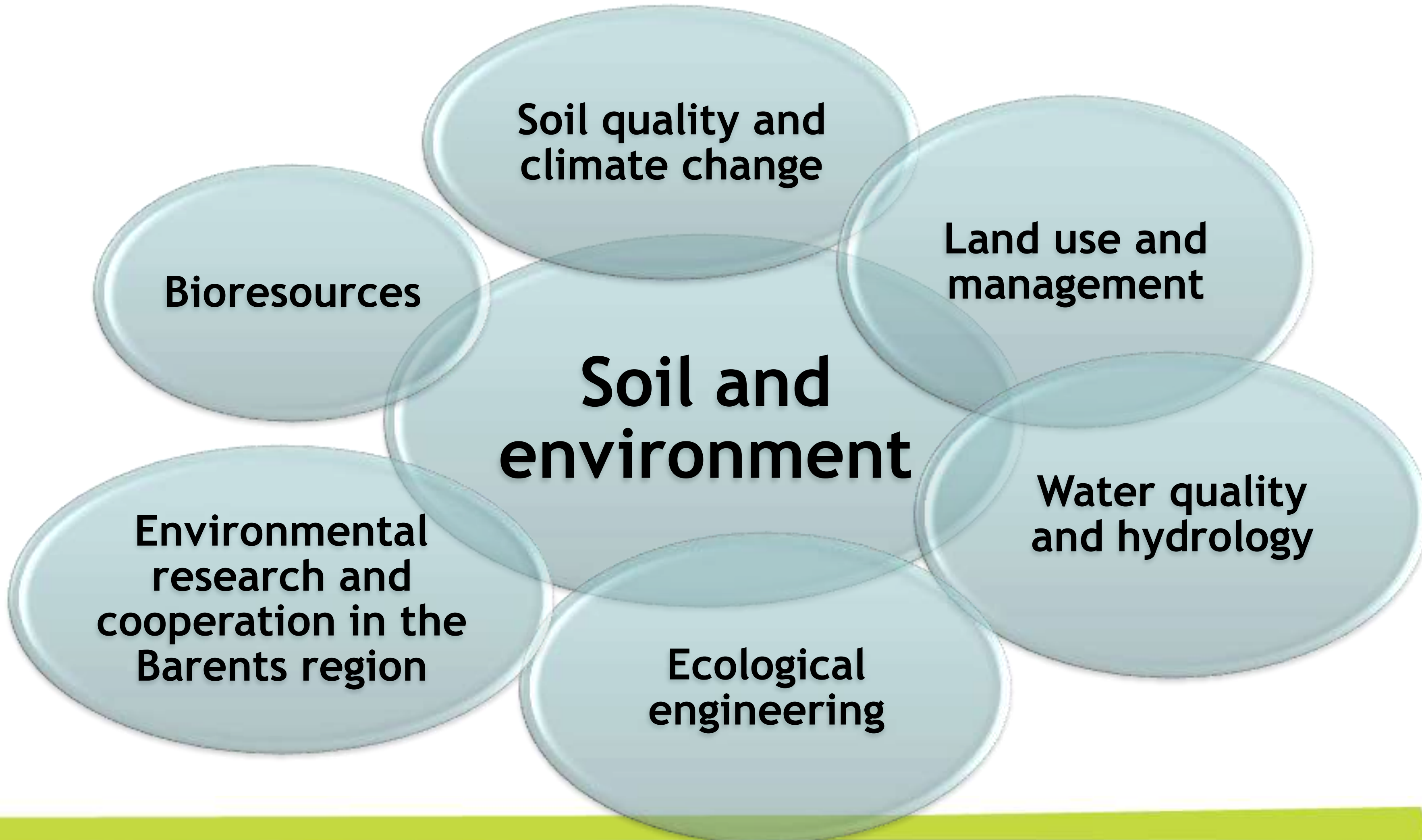
Soil and Environmental Division
- an overview

Bioforsk Soil and Environment Division

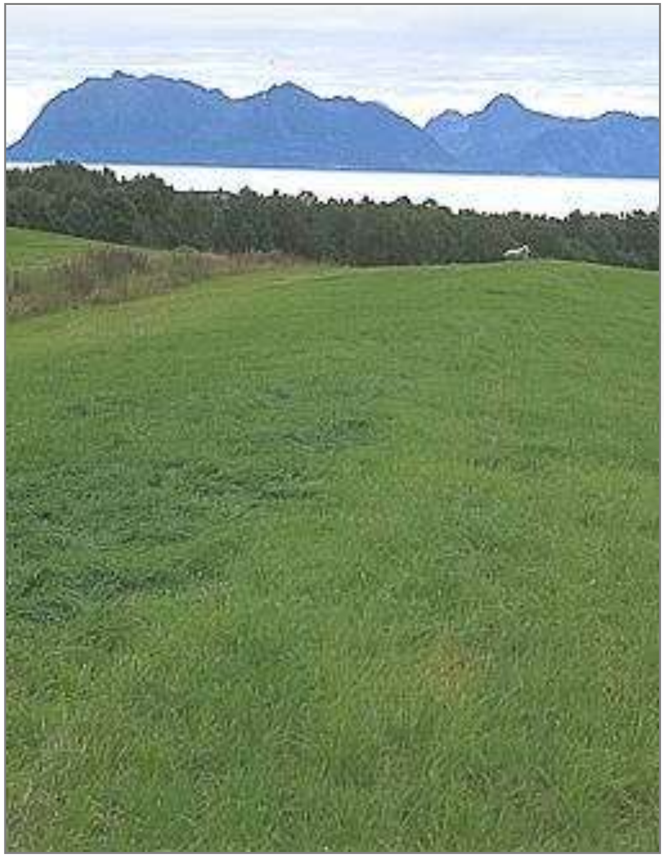
Research on soil, water, environment and natural resources



Soil Quality and Climate Change- Focus areas

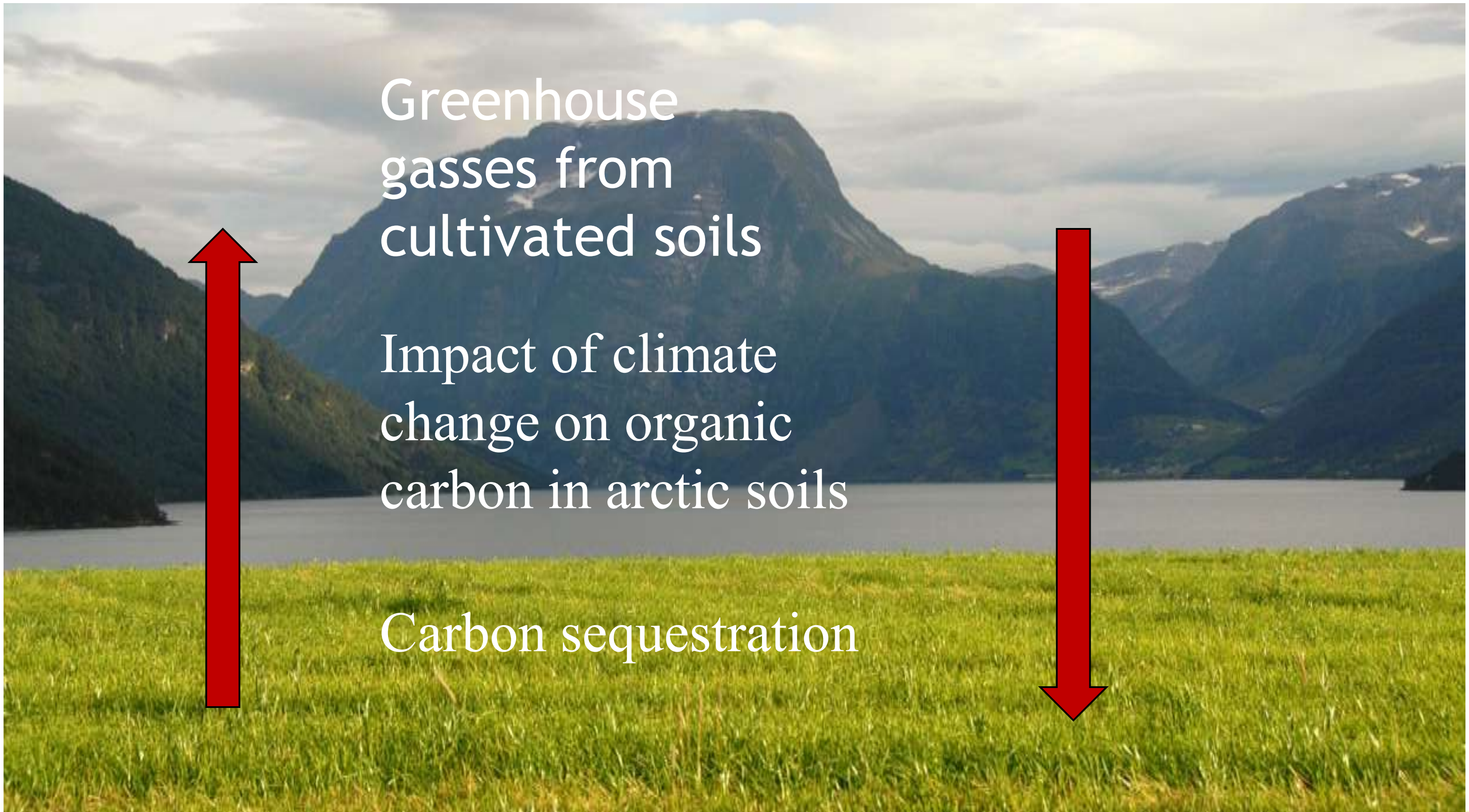
- Soil and climate change
  C-dynamics and greenhouse gas emissions, C sequestration, biochar

- Contaminated soils and sediments
  Environmental contaminants -
  sources, transport, bioavailability,
  toxicity, transformation, remediation



Cultivation GHG fluxes

Soil, carbon and climate



Soil ecotoxicology

- Acute and chronic toxicity tests on three trophical levels (microorganisms, plants, invertebrates)
- Multi-generation tests with soil invertebrates:
  - Effects studies where several generations of an organism are subsequently exposed to a chemical
- Effects of chemical mixtures on soil organisms
  - Bioassay directed fractionation for identification of key contaminants in complex mixtures
  - Effects of mixtures in single species tests, multi-species systems and field studies

Land Use and Management - headlines

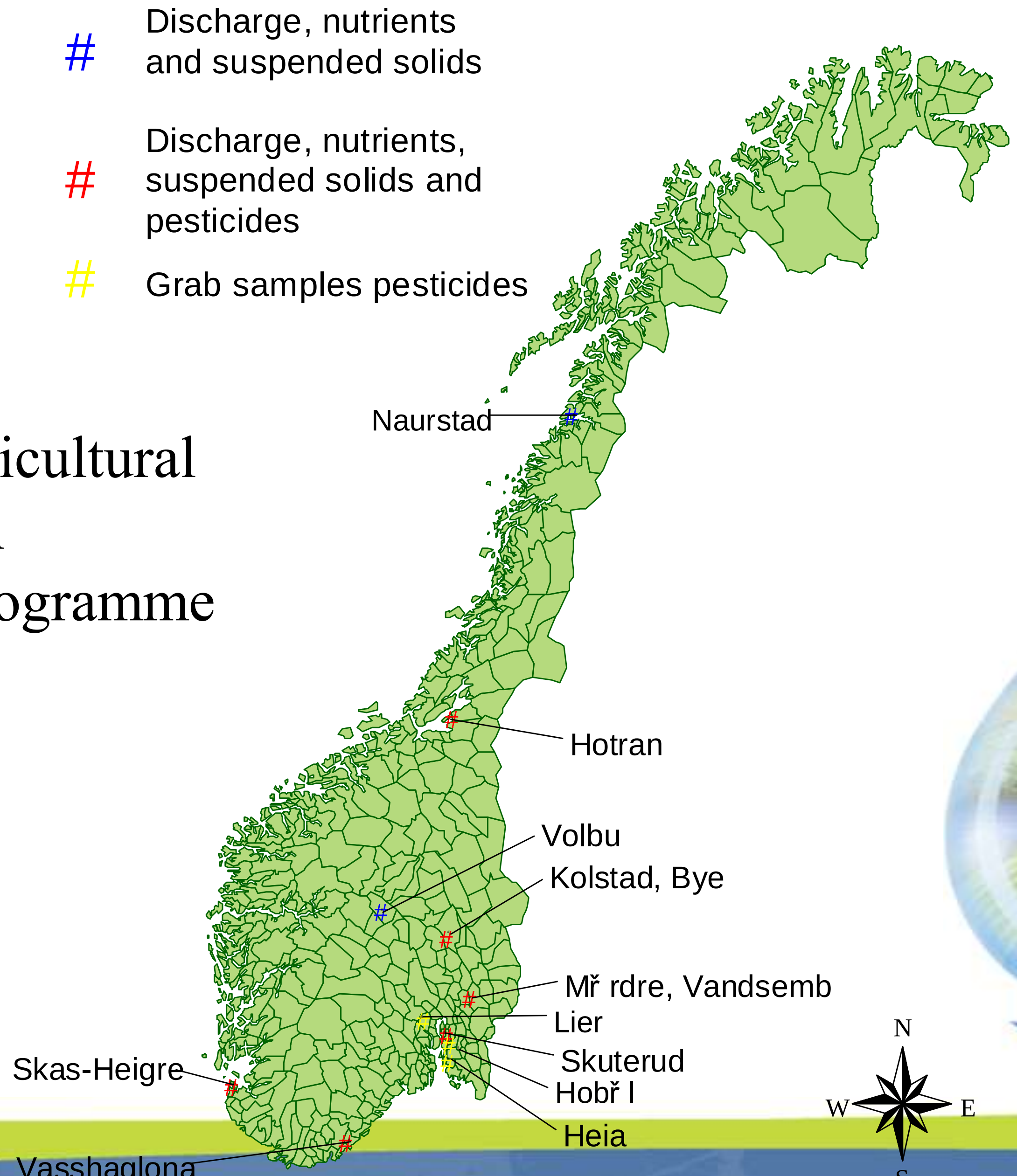
Focus research areas:

- **Runoff from agricultural areas**
- **Erosion, losses of nitrogen, phosphorus and pesticides**
- ➢ **Methods to mitigate environmental pollution**
  - **Reduced tillage**
  - **Balanced fertiliser application**
  - **Vegetated buffer sones**
  - **Constructed wetlands**

- **Agricultural environmental monitoring**
- Research and development on processes in the agricultural landscape
- Watershed management and mitigation plans




JOVA - The agricultural environmental monitoring programme in Norway



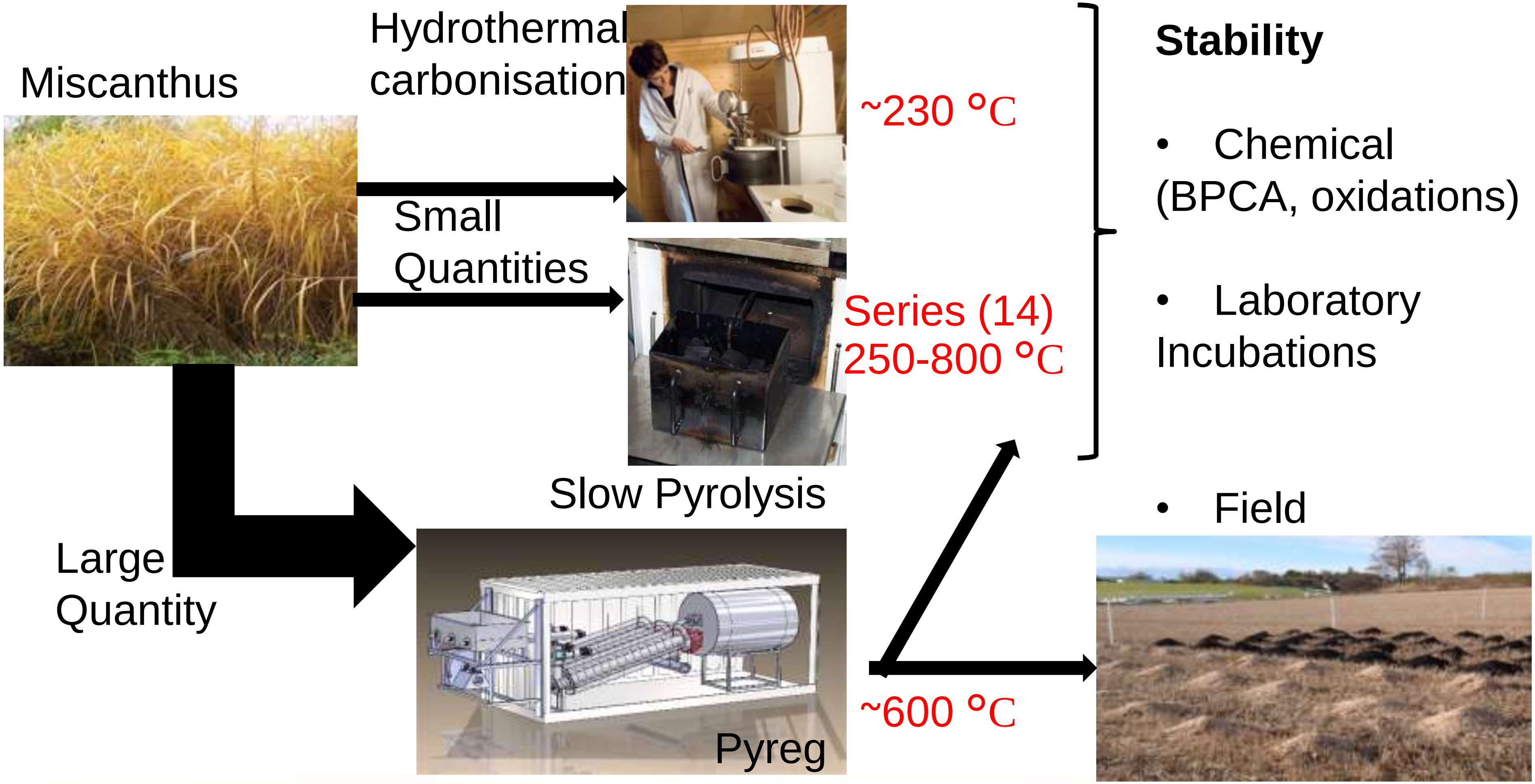
BIOCHAR RESEARCH IN NORWAY

D.P. Rasse, A. Budai, A. O'Toole
Bioforsk Soil and Environment, Ås, Norway.

Charcoal: the key to increasing soil organic matter content and soil fertility?

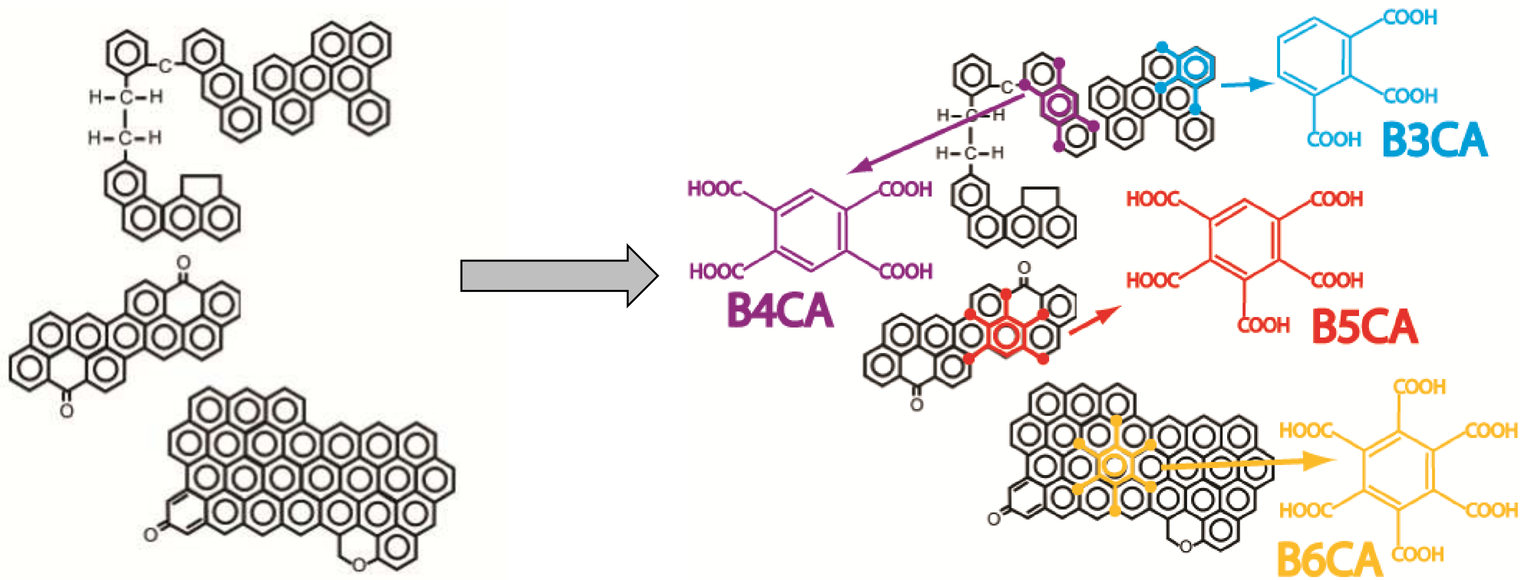
- Carbonizing biomass renders plant-C more resistant to biological breakdown – a feature making it attractive for increasing soil C stocks.

Biochar and experiments



Results: stability - chemical tests

Condensation degree of aromatic rings: biomarkers (BPCA)

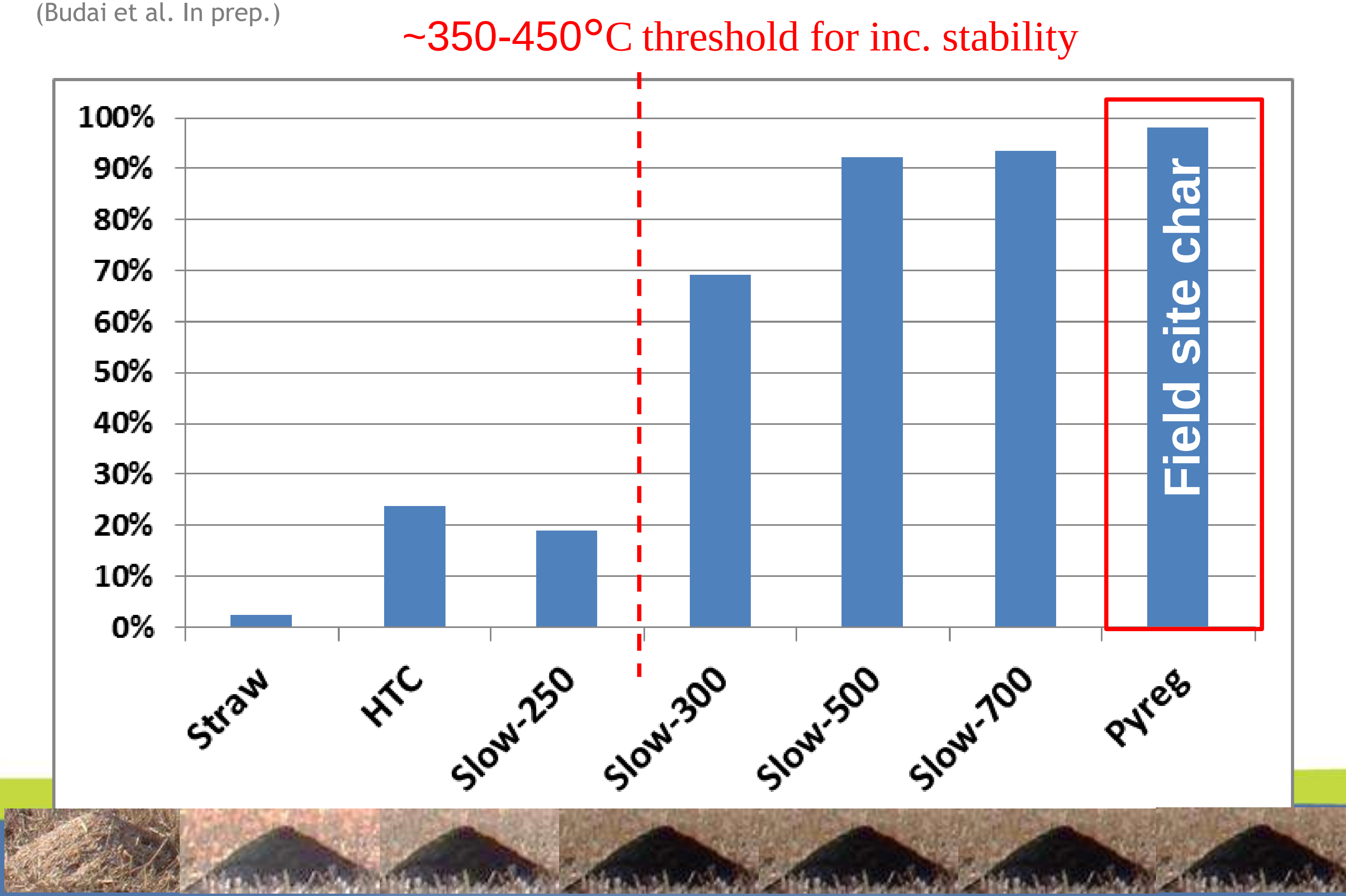


- Total BPCA is indicative of the amount of black carbon (aromaticity)
- B6CA / $_{total}$BPCA is indicative of degree of condensation

Straw and Biochar-C stability

after Potassium Dichromate ($K_2Cr_2O_7$) oxidation

(Budai et al. In prep.)



Results, stability : laboratory incubations

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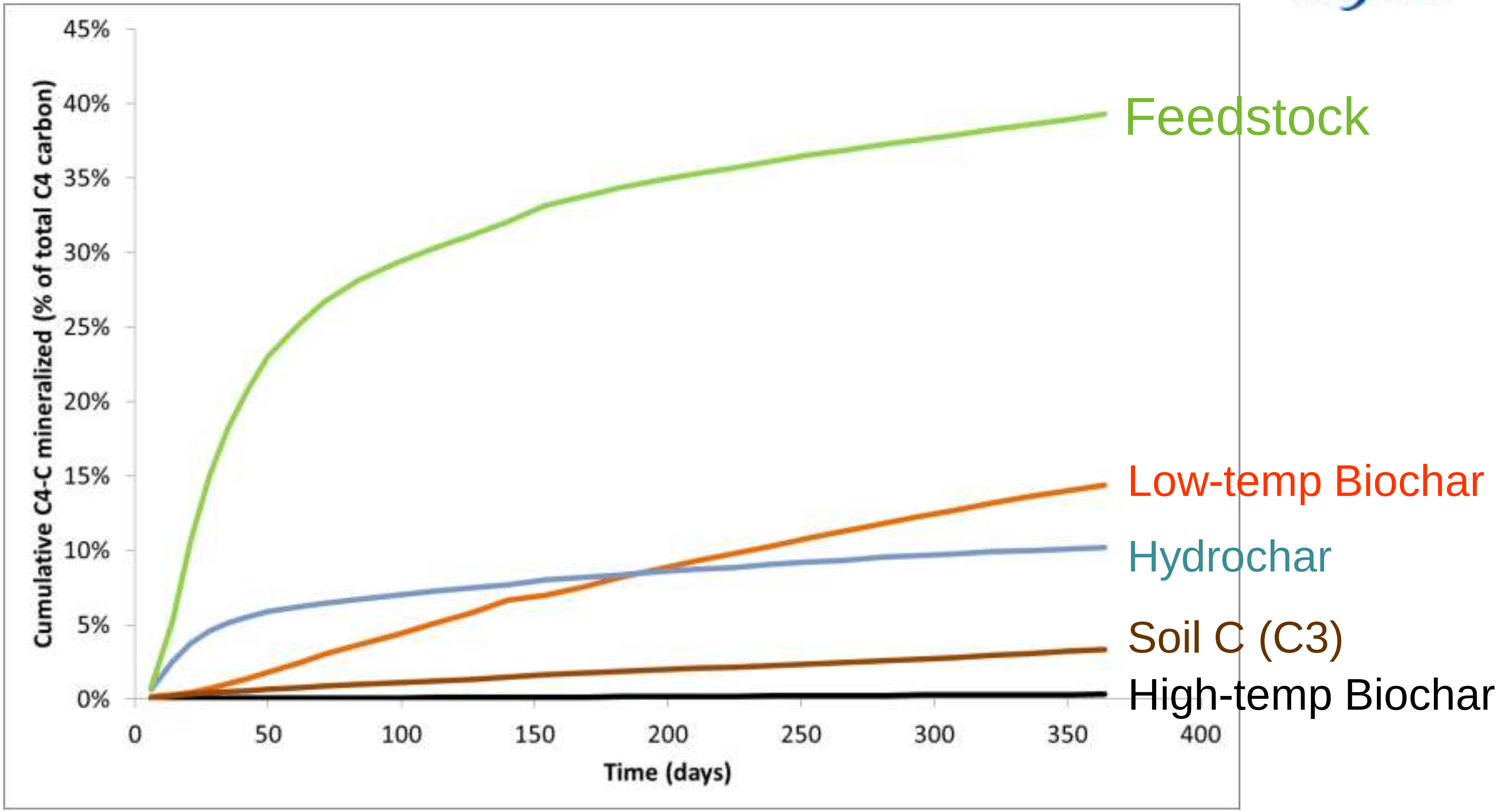

Biochar (>300C) has negligible decomposition rate as compared to feedstock

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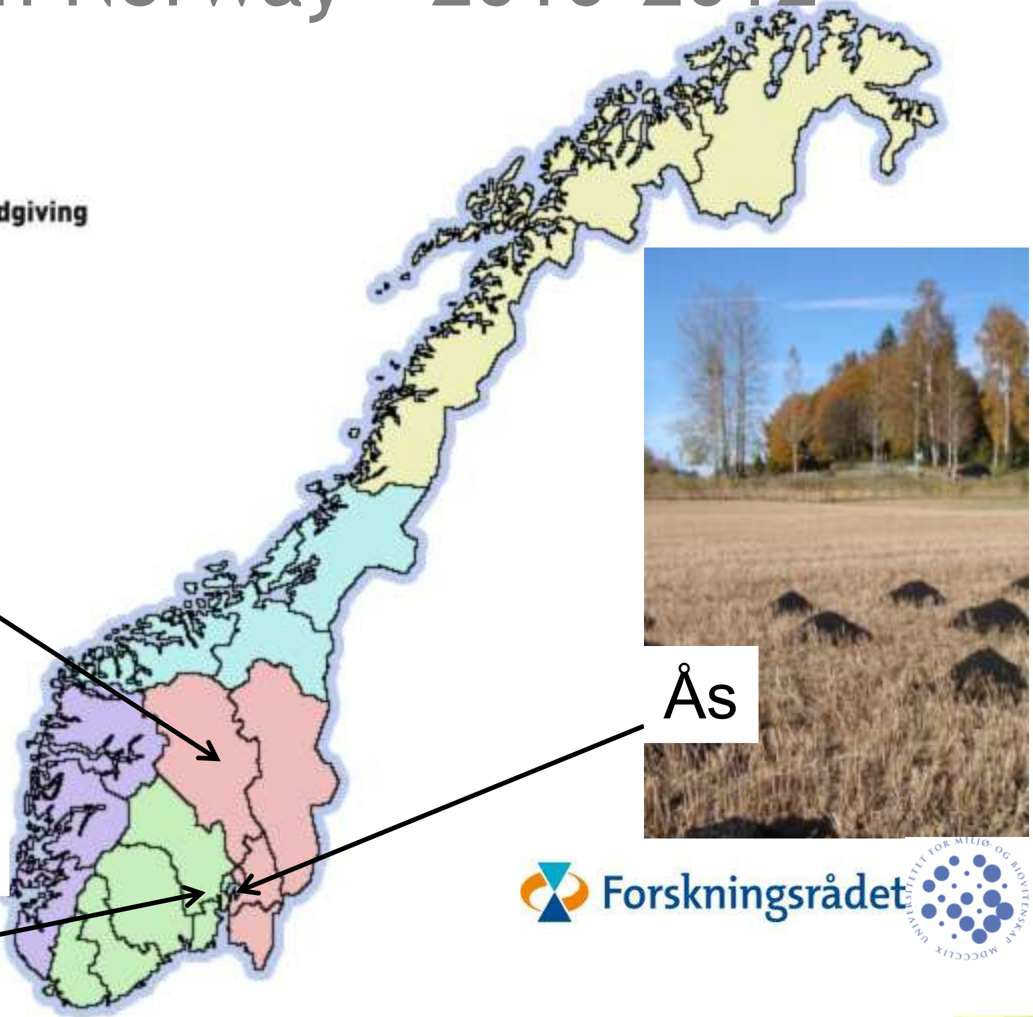
Field trials in Norway – 2010-2012

The Interreg IVB North Sea Region Programme

Investing in the future by working together for a sustainable and competitive region

Norsk Landbruksrådgiving



NORGESVEL

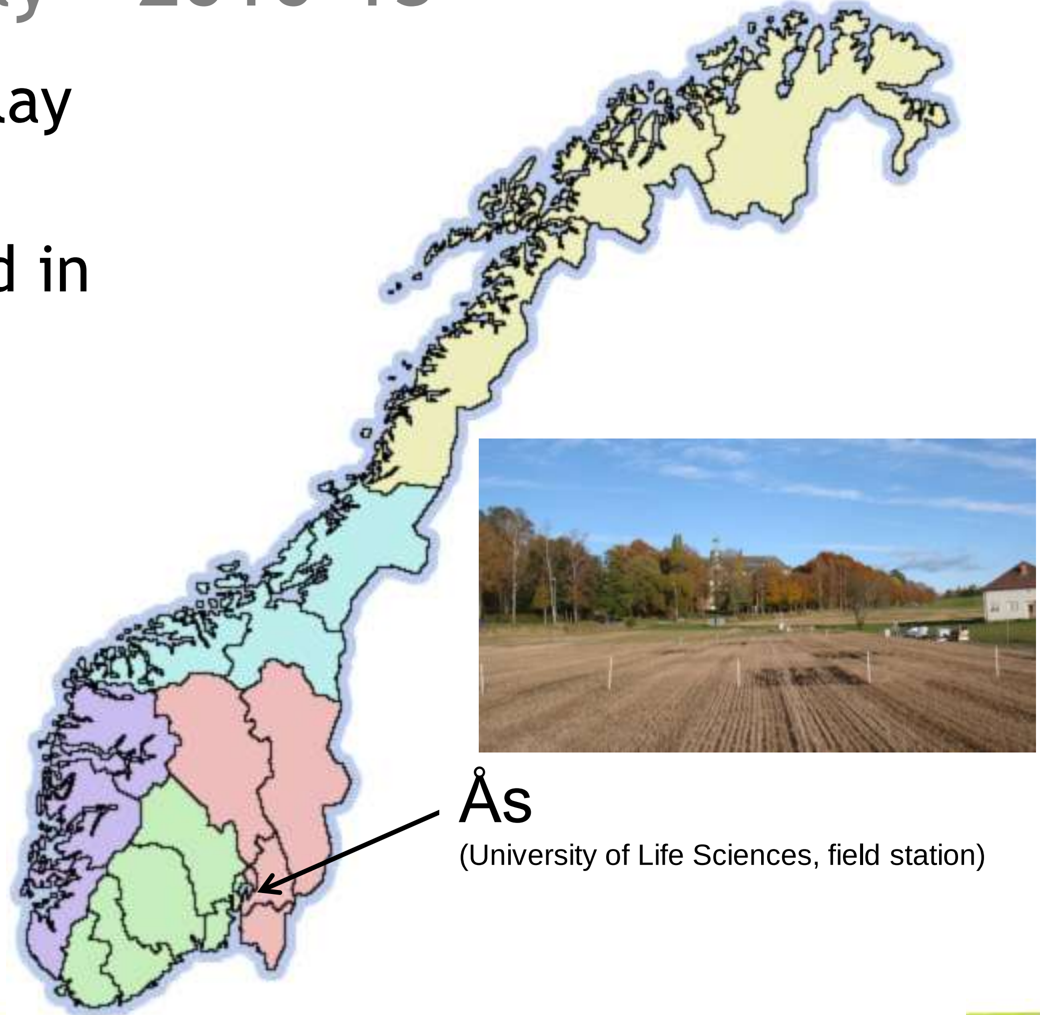
Statens landbruksforvaltning
Norwegian Agricultural Authority

Forskningsrådet

Field trials within international networks

Field trial in Norway – 2010-13

- Soil: Inceptisol, Sandy Clay Loam, TOC: 2.5 %
- Biochar inverse ploughed in the fall of 2010.
- Crops – 2011 Oats
  2012 Barley
  2013 Oats
  2014 Oats
- Fertilizer: NPK 22-3-10, 150 kg ha^{-1}



Experimental Design

- 16 plots (6 x 4 m), 4 reps

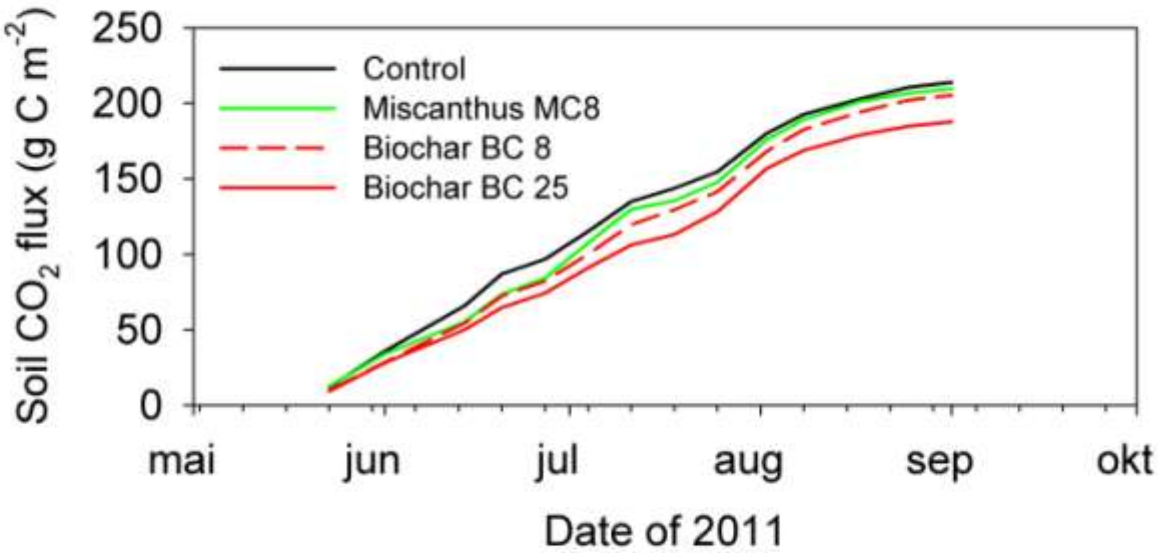
1. Control – no amendments
2. Straw 8t C ha^{-1}
3. Biochar 8 t C ha^{-1}
4. Biochar 25 t C ha^{-1}

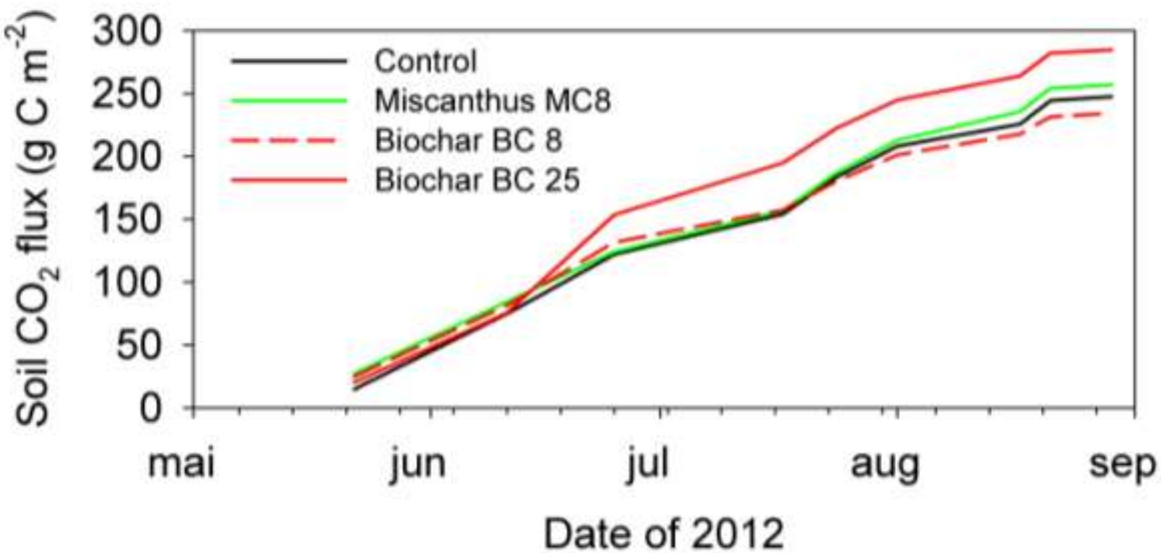
Methods: Experiment 1

- CO_2-flux measurement: Closed static chambers, Infrared gas analyzer (IRGA)

- CO_2 from biochar: repeated $\delta^{13}C$ measurements with Piccaro G1101-i, and keeling plot method.

Results – Soil respiration



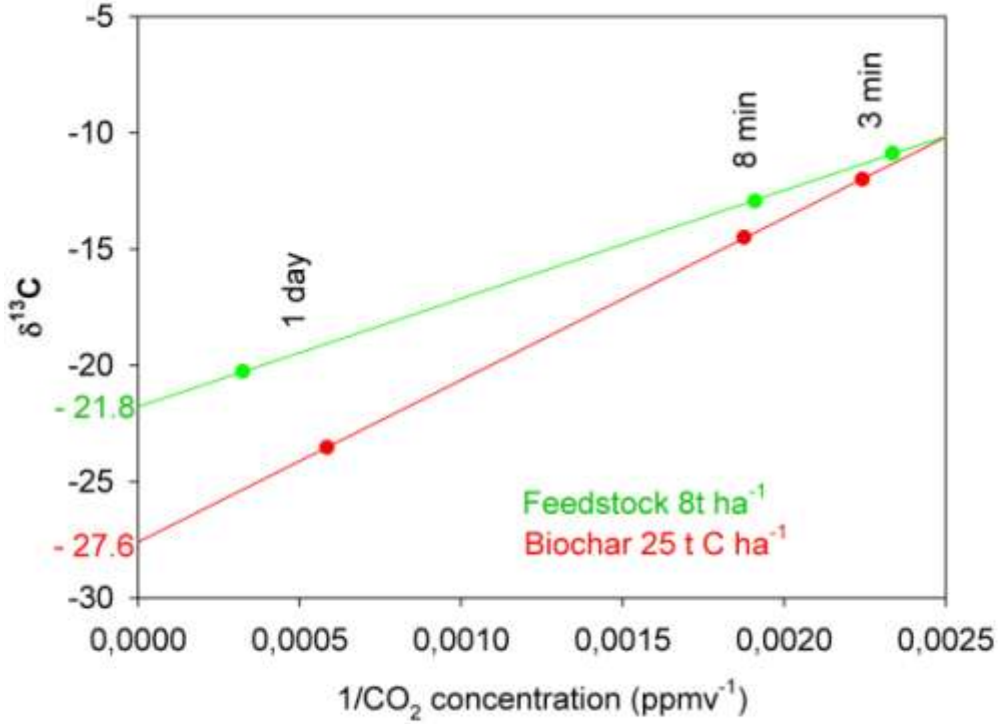


Pyreg miscanthus biochar at 8 and 25 t per ha does not significantly increase soil CO_2 efflux.

O'Toole et al. in prep

Isotopic signatures

Keeling Plots



Season average

Control	-27,6 (±0.4)
Misc. Feedstock 8 t C ha-1	-24,1 (±1.0)
Misc. Biochar 8 t C ha-1	-27.3 (±0.3)
Misc. Biochar 25 t C ha-1	-27.3 (±0.7)

Reliable keeling plots obtained with Picarro ^{13}C analyzer

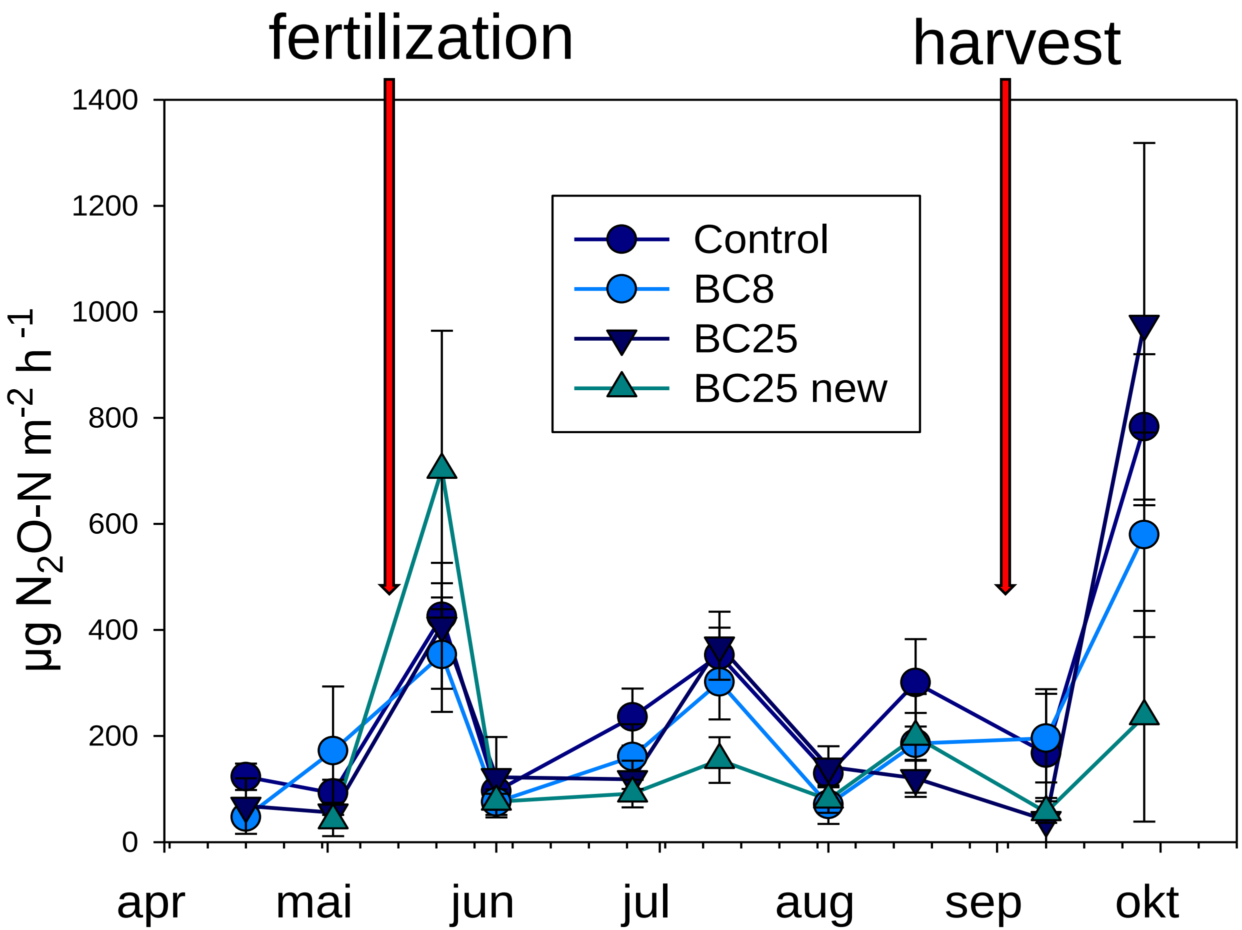
Cumulative C loss – 2011-2012

Summer 2011 and 2012 (initial fall and spring periods not captured)

			C4 plant-C loss	
		CO_2-C loss	Contribution to CO_2	C loss from straw and biochar
		g m^{-2}	g m^{-2}	%
Control		461	-	-
Straw	8 t C ha^{-1}	467	76	9.5%
Biochar	8 t C ha^{-1}	439	5	0.6%
Biochar	25 t C daa^{-1}	472	9	0.4%

In the field, Pyreg miscanthus biochar appeared to decompose at less than 1% over two growing seasons.

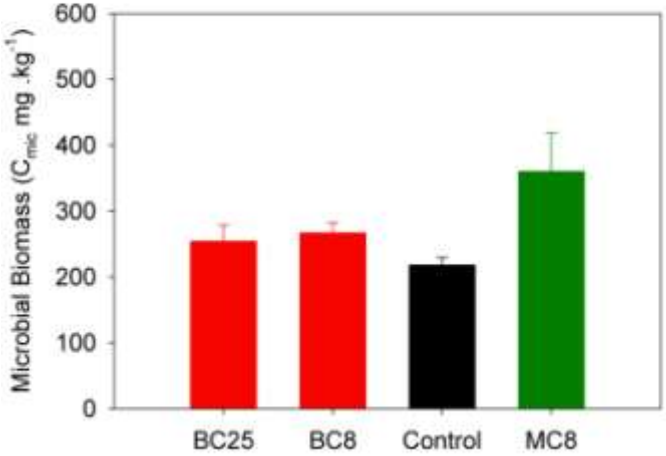
N_2O flux 2012



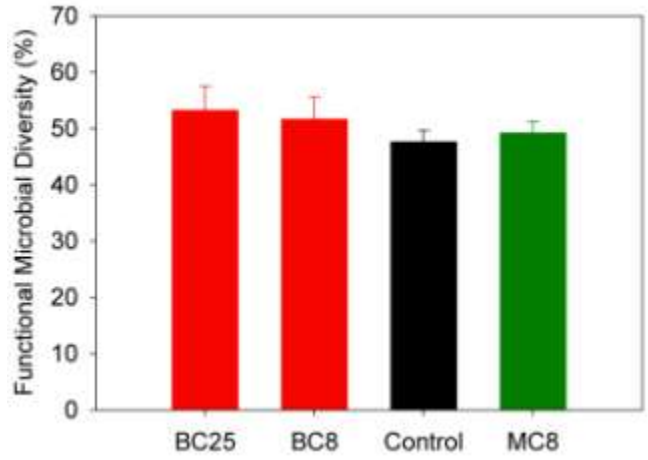
O'Toole et al. in prep

Microbial Indicators

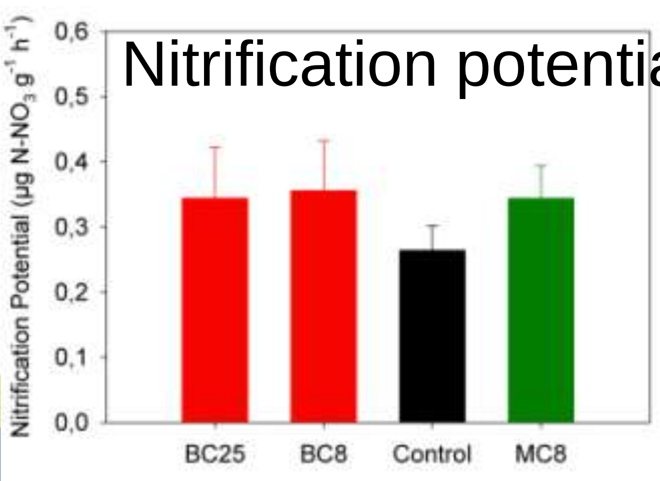
Microbial Biomass



Functional Diversity

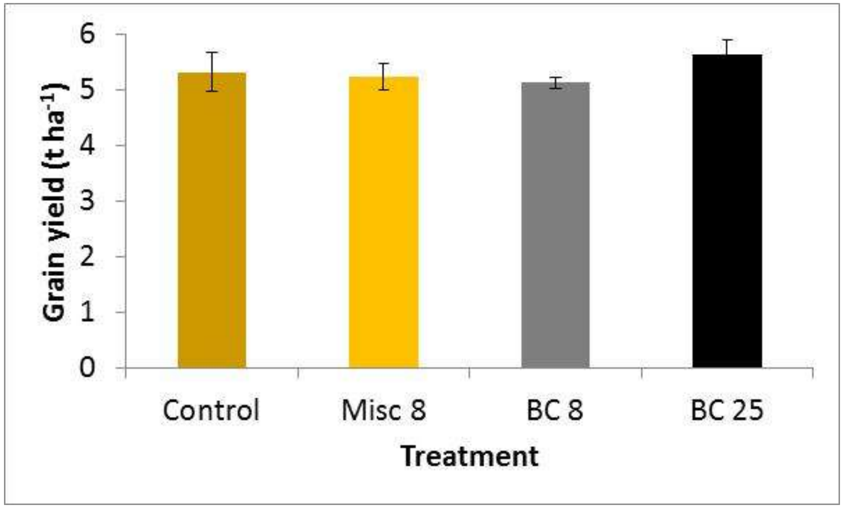


Nitrification potential

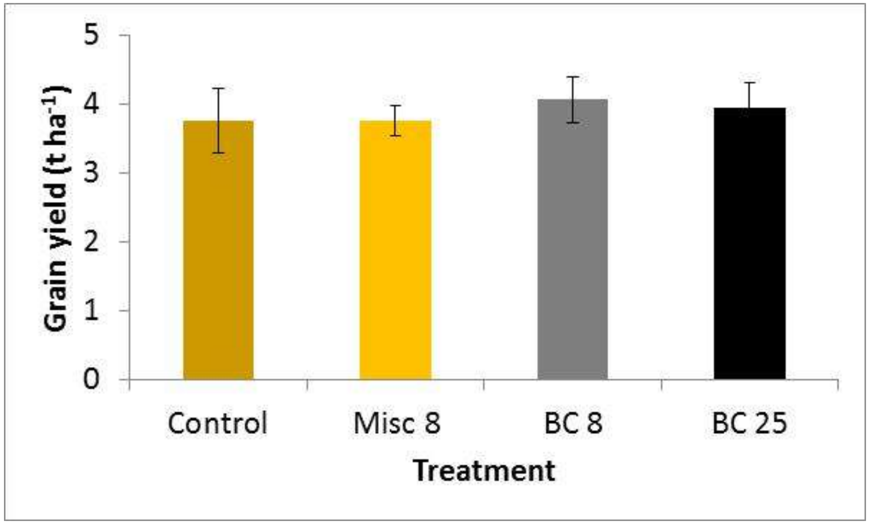


Grain yield

2011 Oats

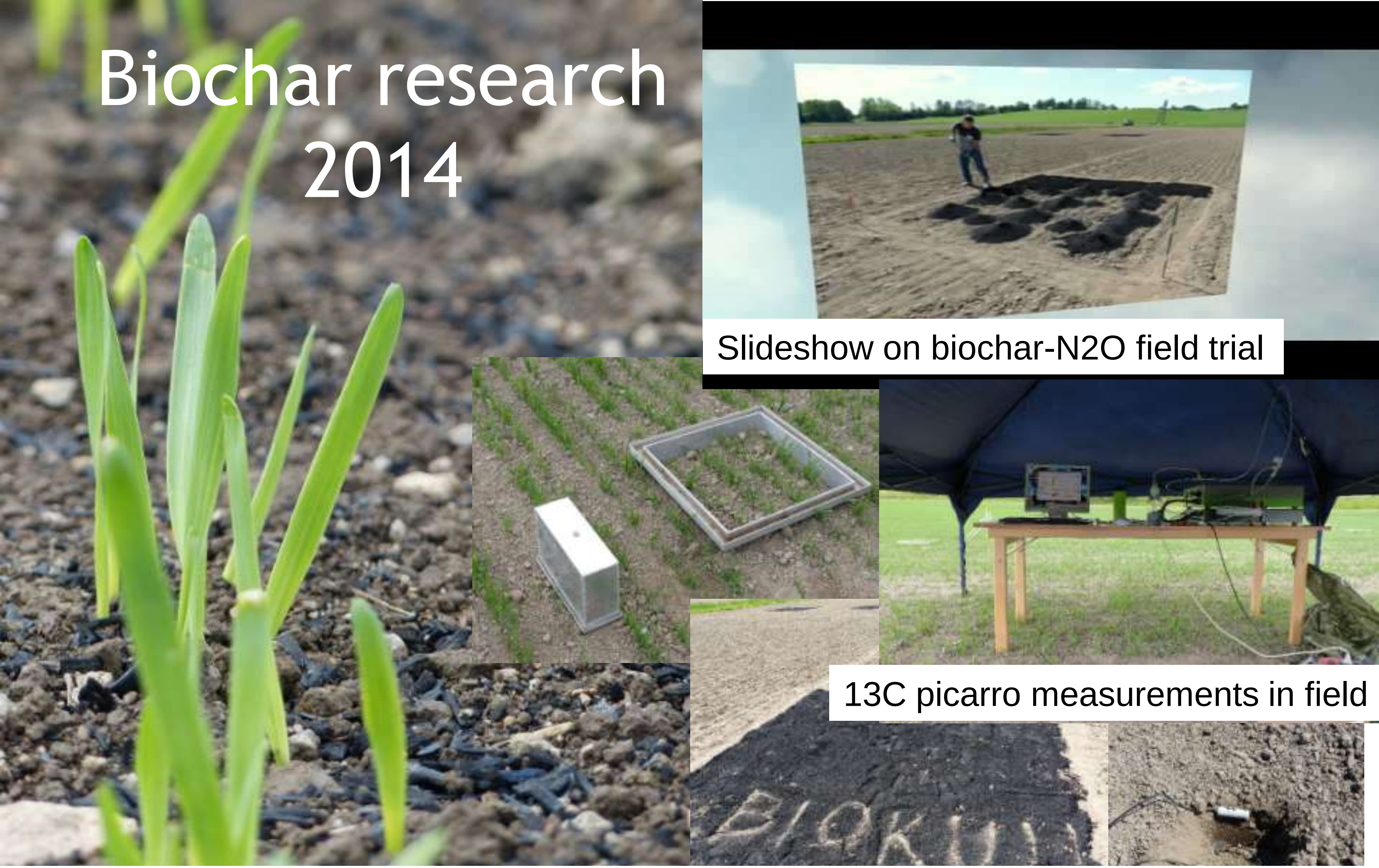


2012 Barley



No significant diff. between treatments

Biochar research 2014



Slideshow on biochar-N2O field trial

13C picarro measurements in field

Agronomic measurements: Yield, crop height soil moisture and potential, EC, soil temp. pH, avail. N, fate of biochar in profile, aggregate stability, soil penetration.

Conclusions (field)

- Stability under Norwegian field conditions is confirmed.
- N_2O emissions measured 2 years after biochar application were not significantly reduced.
- Biochar applications at 8 and 25 t C ha^{-1} had little impact on microbial biomass and functional diversity in the field.

Thank you for your attention

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Statens landbruksforvaltning
Norwegian Agricultural Authority

The Interreg IVB North Sea Region Programme
Investing in the future by working together for a sustainable and competitive region

Forskningsrådet

Our website: www.bioforsk.no/biochar