CAPTURE- Assessment of cover cropping as climate action in cereal production in Norway

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BACKGROUND AND AIMS

Recently, **the role of cover crops** in agriculture has broadened due to their ecosystem services and their potential **as a climate mitigation tool** via carbon sequestration. However, their net climate effect from carbon (C) sequestration may be offset by nitrate leaching and nitrous oxide (N2O) emissions when plant residues decompose in the soil. **In CAPTURE, we evaluate the net climate effect of different cover crops in the main cereal production areas in Norway (Fig.1)**.

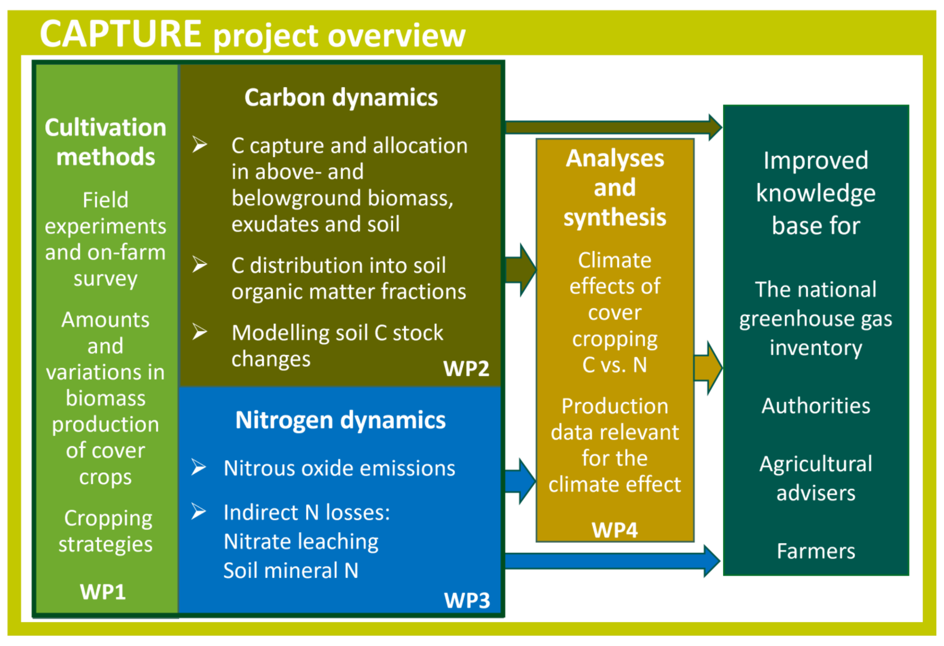


Fig.1. CAPTURE project structure and work packages.

Main hypothesis in WP2 and WP3:

WP2: 1) Cover crops significantly increase soil C in Norwegian cereal cropping systems on the short-term.; **2)** Cover crop species with low C:N ratio will promote more efficient accumulation of C in the mineral-associated organic matter (MAOM) fraction **3)** Cover crop species with higher root to shoot ratios, will increase the routing of C in MAOM

WP3: 1) Cover crop species with low C/N ratio and species with large above-ground biomass have a higher risk of off-season N losses; **2)** autumn fertilization accelerates cover crop growth and C capture, but induces additional N2O emissions shortly after fertilization; **3)** Species mixtures containing both annual and perennial plant species preserve N better than species mixtures containing only annuals

Experimental field

The main experimental field in CAPTURE is situated in Ås (59°39'49''N; 10°45'40''E) on the Southeast part of Norway where cereal production is more predominant. On this field dedicated plots for studying the contribution of cover crops to a) carbon sequestration and b) N_2O emissions were established side by side (Fig.1)

To study **carbon sequestration** potential, cover crops were planted in monoculture in spring 2021 to facilitate the labeling and tracing of each cover crop species separately.

Plots in which **N2O** was monitored were planted with barley in spring 2021 and cover crops were sawn in summer following common agricultural practices.

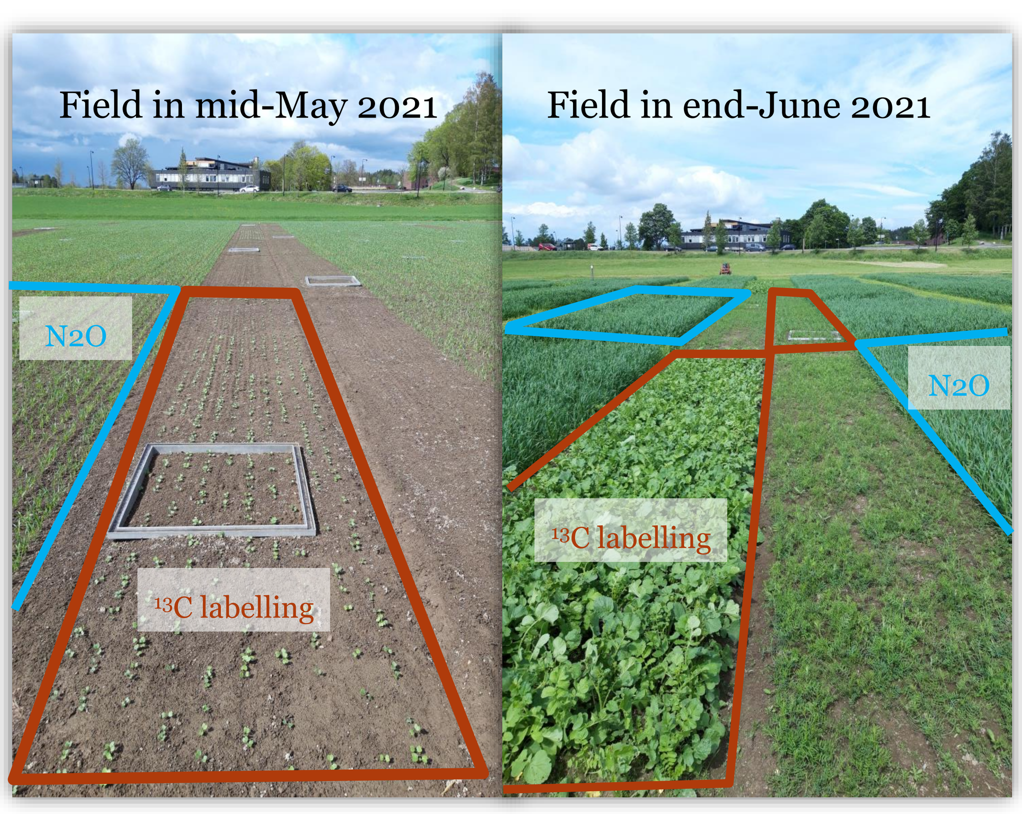


Fig.2. Examples of field plots for pulse labelling with ^{13}C and N_2O measurements.

METHODS AND PRELIMINARY RESULTS

^{13}C Pulse labelling of cover crops

The study of soil carbon sequestration potential focuses on four species (Italian ryegrass, phacelia, oilseed radish and summer vetch) planted in monoculture (in 4 replicates, which were pulse labelled (5-6 pulses) with $^{13}CO_2$ during the growing season.

Fig.3. Examples of ^{13}C-pulse labelling events during summer 2021 with 1 m^3 transparent chambers

Sampling, processing and analysis

Shortly after the last pulses, samples were harvested from ^{13}C-labelled and natural abundance plots. The soil carbon derived from cover crops will be assessed by analyzing the ^{13}C found in bulk soil, particulate organic matter (POM) and MAOM. Consecutive samplings of soil are carried out this year (spring and autumn).

Fig.5. Pictures of harvesting of biomass (a), soil (b) and root samples after separation and washing (c)

Aboveground biomass

δ13C (‰) in shoots (avg ± SEM, n=4)	
Summer Vetch	877 (50)
Phaselia	735 (59)
Oilseed radish	423 (30)
Italian ryegrass	367 (28)

Soil

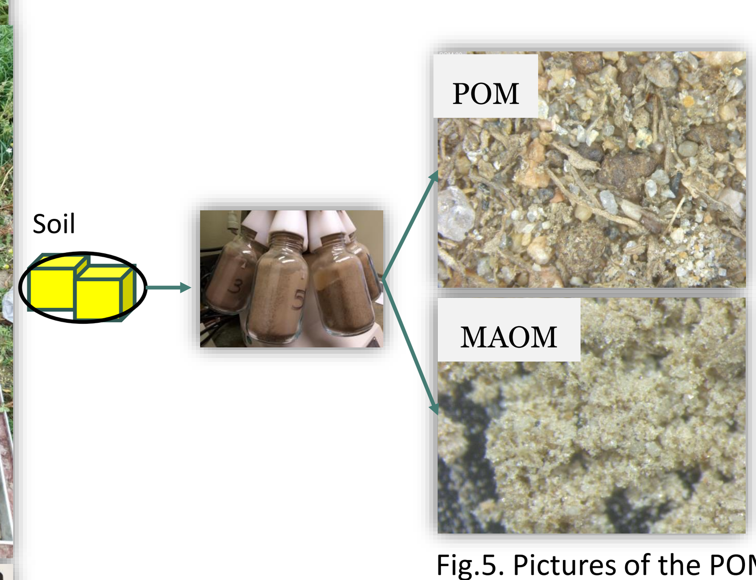


Fig.5. Pictures of the POM and MAOM fractions

Standing root biomass (2mm)

δ13C (‰) in roots (avg ± SEM, n=4)	
Summer Vetch	122 (54)
Phaselia	444 (47)
Oilseed radish	211 (19)
Italian ryegrass	214 (27)

N_2O emissions

N_2O emissions were measured at least weekly by manual chambers and by a field flux robot after the harvest of barley.

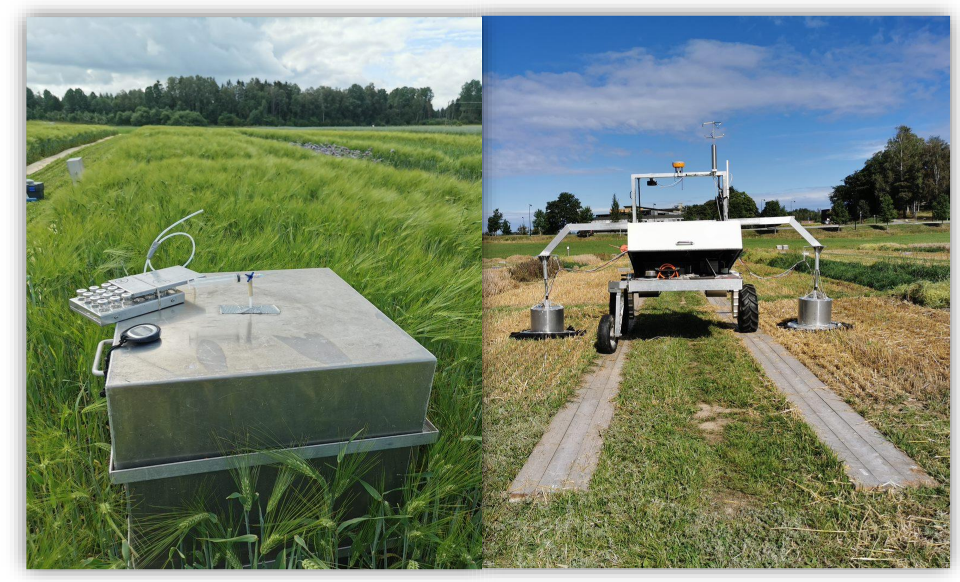
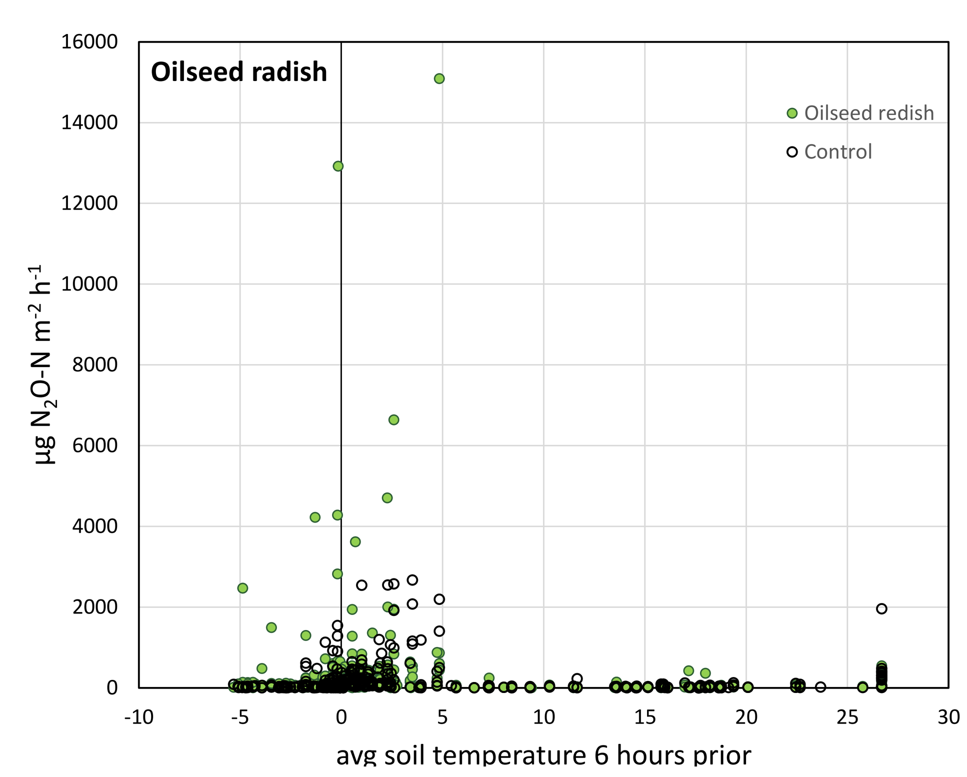


Fig.6. N_2O measurements (e.g. with manual chambers (left) or robot(right))

N_2O emissions strongly driven by freezing-thawing during off-season, with clear effects of cover crop type (Fig.4).



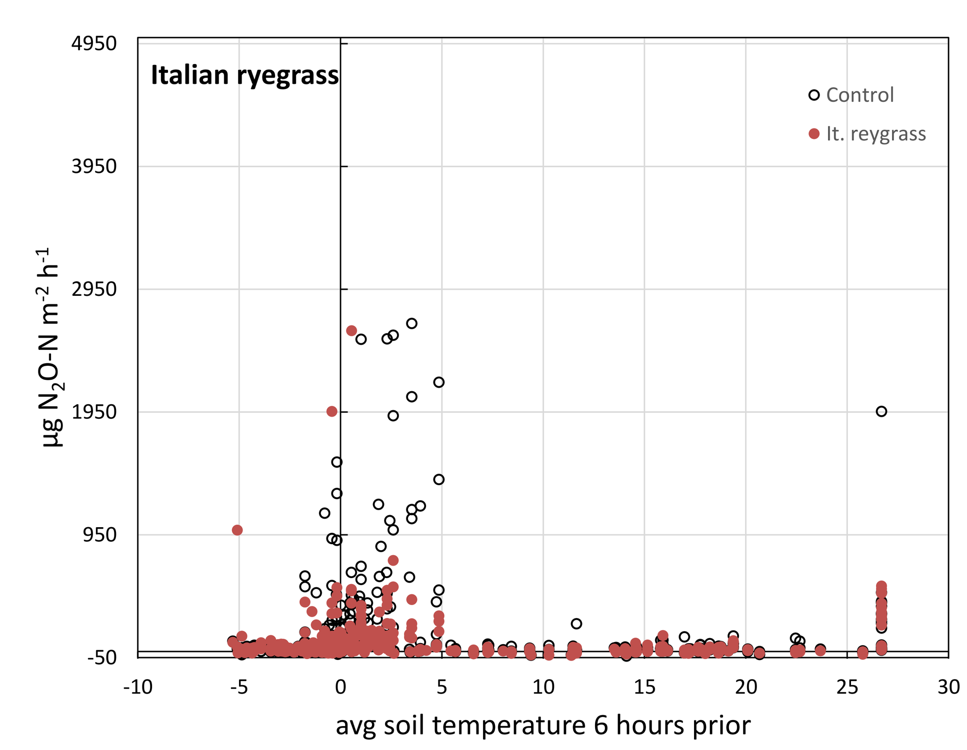


Fig.7. Examples of N_2O fluxes as a function of preceding soil temperature. Plots including cover crops (oilseed radish/Italian ryegrass) are compared to controls with no cover crop.

FACTS ABOUT THE CAPTURE PROJECT AND COVER CROPPING IN NORWAY

In Norway, cover crops were introduced in the 1990's to prevent loss of nitrogen and phosphorous from fields to waterways. The total area of cover crops has changed in line with the level of the subsidies. At most, in 2002, it amounted to 35 000 ha. Currently, it is only 1/10 of this. The potential is estimated to 80 000 ha.

Traditionally, ryegrass undersown in spring cereals has been the main cover crop. Currently, mixtures of different cover crops species are more common, sown after harvest of the main crop. There is a growing interest in using cover crops as they contribute with several ecosystem services and are considered an applicable climate action. Cover crops are currently not accounted for in the national greenhouse gas inventory because of insufficient documentation of its effect under Norwegian conditions. The CAPTURE project, 2021-2025, aims to improve this knowledge base and provide recommendations on cover crops that have the best climate mitigation potential.

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