GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

Norway- Country report

Ministry of Agriculture and Food: Evaluation 2015- February 2016:

Climate change and challenges for Agriculture- Knowledge status -need of new knowledge. Adaptation. Evaluate Norwegian climate policy related to new IPCC 5 report.

Norwegian Climate and Environment Directorate prepared for Government and Parliament, June 2015: Norway – Low emission society 2050. How to reduce emissions- cost…all sectors.

For agriculture different scenarios evaluated include:

- Reduced meat production, change diet from red meat to white meat, Change diet to more fish and vegetables
- Reduced food waste. Reduced peat cultivation
- Management practices also evaluated , Manure - biogas

Development of GHG emission calculator (April 2015) – emissions depending on food consumption, diet, need of agricultural land for production, national emission factors.

Calculator used in consultancy for the Climate and Environment Directorate

Reduced GHG emissions Norway. Calculations – Low emission society 2050

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	1000 tonn CO2-ekv		Compared to 2012	
	Without CO2	Incl. CO2	Without CO2	Incl CO2
Todays emissions	4 835	6 310	100 %	100 %
Emissions 2050 (6,7 mill inhabitants)				
Todays practice and efficiency	5 990	7 512	124 %	119 %
10 % increase in cereal and forage yields	5 864	7 369	121 %	117 %
Increased milk prodction /cow	5 497	6 999	114 %	111 %
Referencescenario 2015	5 083	6 207	105 %	98 %
Red to white meat	4 580	5 693	95 %	90 %
Stop in cultivation of peatsoil	5 051	6 021	104 %	95 %
Less food waste	4 984	6 102	103 %	97 %
Biogass from manure	4 922	6 056	102 %	96 %
From meat to vegetables	4 427	5 532	92 %	88 %
Low emission scenario	4 182	5 140	87 %	81 %

Need of agricultural area for the different measures mill daa (1 daa = 0.1 ha)

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	Total	Cereals	Other food crops	Harvested forage	grasland , meadow	Other agricultural area
Todays area	9,9	3,0	0,2	4,7	1,5	0,5
Emissions 2050 (6,7 mill inhabitants)						
Todays practice and efficiency	12,8	4,0	0,3	6,1	2,0	0,5
10 % increase in cereal and forage yiields	11,7	3,6	0,3	5,6	1,8	0,5
Increased milk prodction /cow	11,6	3,9	0,3	5,2	1,7	0,5
Referencescenario 2015	10,5	3,7	0,3	4,5	1,5	0,5
Red to white meat	9,9	3,8	0,3	4,0	1,3	0,5
Stop in cultivation of peatsoil	10,5	3,7	0,3	4,5	1,5	0,5
Less food waste	10,2	3,6	0,3	4,4	1,4	0,5
Biogass from manure	10,5	3,7	0,3	4,5	1,5	0,5
From meat to vegetables	9,4	3,3	0,3	4,0	1,3	0,5
Low emission scenario	9,1	3,2	0,3	3,9	1,3	0,5

Climate change – agricultural challenges: Effects of climate change. Adaptation to climate change. Reduction of GHG emissions.

Bioforsk

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Longer growing season (1- 3 months)- New possibillities: Higher yields, increased number of harvests, new varietes, new crops, crops for other purposes like energy , better quality.

Change in agricultural management recommendations like fertilisation, plant health (weed, diseases, fungi) , soil tillage, increased need of environmental measures








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Challenges – wetter climate

- **Adaptation to wetter climate:**





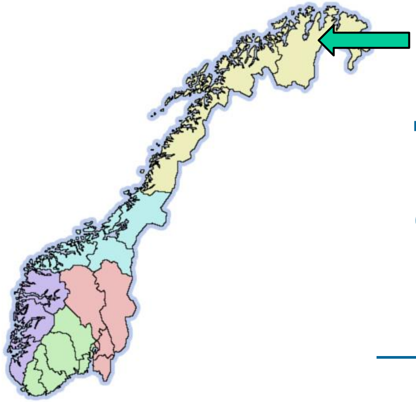

- **Harvesting:**



Wetter conditions-plant production

Robust plant materiale adapted to wet soil conditions and compacted soils

Unstable winter conditions.
Reduced winter survival.



Svanhovd, Pasvik valley.7 km from Nickel,Russia

The Meadow warm experiment

Contact. Hanna Silvennoinen@nibio.no

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- Istallation of an experimental system to test; Increased temperature flux and show what the effects might be on food production for populations in the high north and measure changes in greenhouse gas emissions.
- Plots of meadow are heated up by three degrees Celsius and monitored by a complex system of sensors and imaging devices in the field, remote satellite imagery from above and laboratory tests of soil samples. Test of biochar stabilty under northern heated conditions- effect of biochar –ability to hold heavy metal in polluted soils.
- A collaboration of a dozen scientists across Norway will keep track of plant production, soil moisture, nutrients, microbial communities, heavy metal concentrations and greenhouse gas emissions in the soil and in the air above the heated sites.
- Will heated plots be a carbon sink or a carbon source?
- Effect on plant production? higher production

higher emissions - microbiology activity in soil

* Effect of biochar- warmer northern conditions






Biochar research

Climate and Environment Directorate: Biochar is calculated as one of the most efficient measures to store carbon and reduce GHG-emissions from agriculture . Biochar is not available for farmers. Effect on agricultural soils ?

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- Biochar and effect on C- storage and GHG emission in Norwegian soil. Contact: Adam O.Toole. Bioforsk
- Surface Properties and chemical composition of corncob and miscanthus biochars: effects of production temperature and method. Contact Alice Budai. Bioforsk
- Stability of Biochar Series in Soils and Induced Priming Effects. Contact: Daniel Rasse, Alice Budai, Bioforsk.daniel.rasse@nibio.no Adam.o.toole@nibio.no alice.budai@nibio.no

Field trial in Norway – 2010-14

- Biochar inverse ploughed in the fall of 2010. New application in 2012 and 2014.

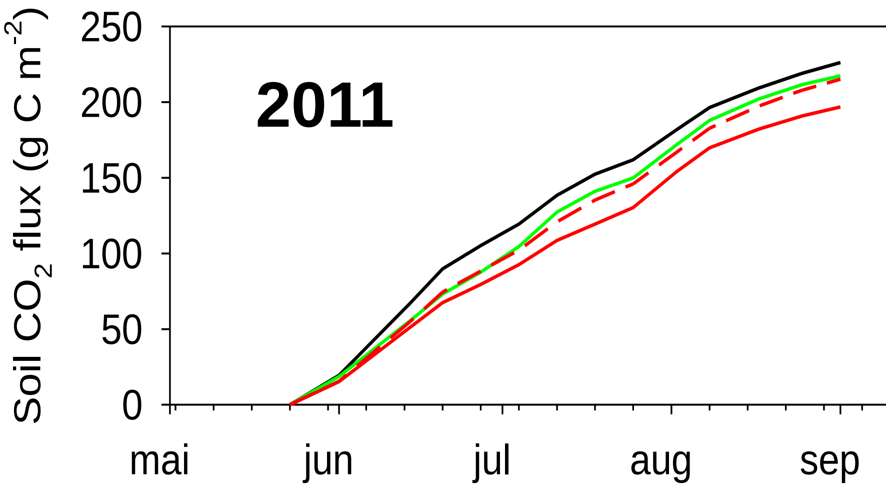
- Crops – 2011 Oats
  2012 Barley
  2013 Oats
  2014 Oats

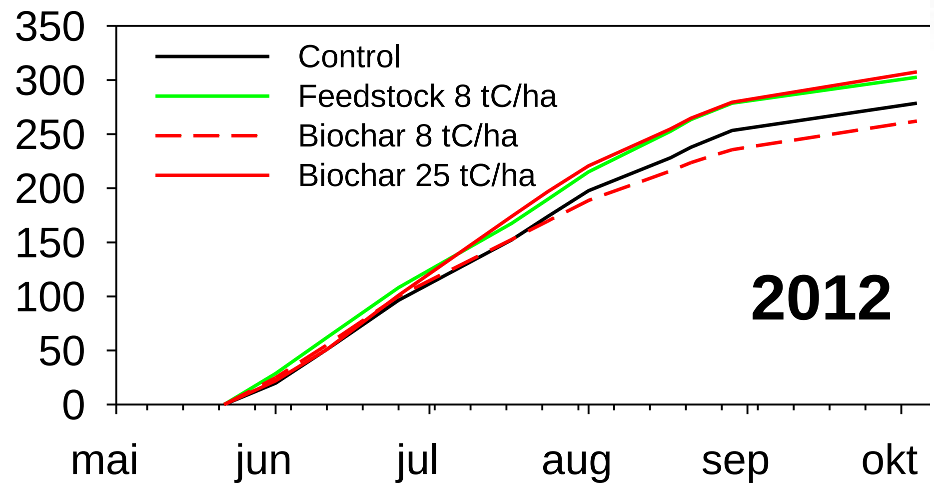
- Fertilizer: 150 kg N ha^{-1}

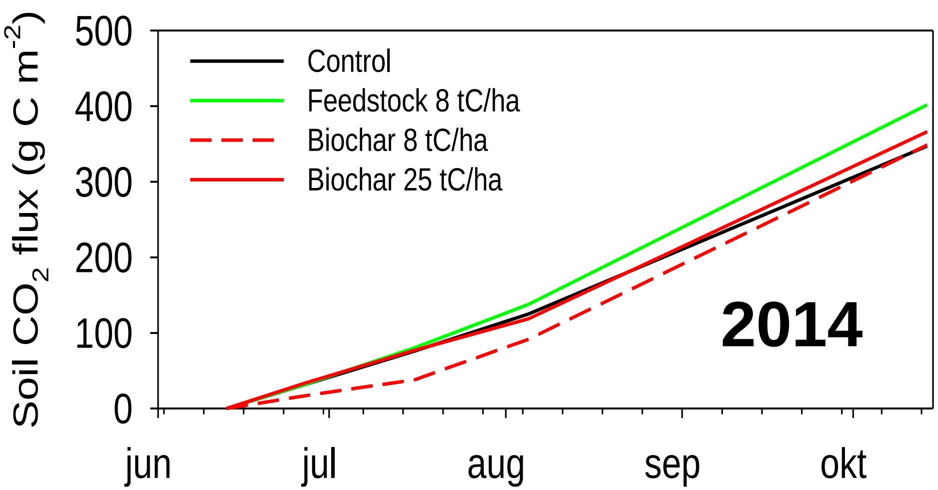
Measurments 2011 - 2014

- 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.
- N_2O fluxes: Larger closed chambers, measured via GC

Results - Soil respiration







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

Cumulative C losses – 2012

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Growing season 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		279	-	-
Straw	8 t C ha^{-1}	303	63.4	7.9%
Biochar	8 t C ha^{-1}	262	2.2	0.7%
Biochar	25 t C daa^{-1}	307	2.4	0.3%

In the field, Pyreg miscanthus biochar appeared to decompose at about 0.5% per growing season (June – October).

N_2O flux 2012

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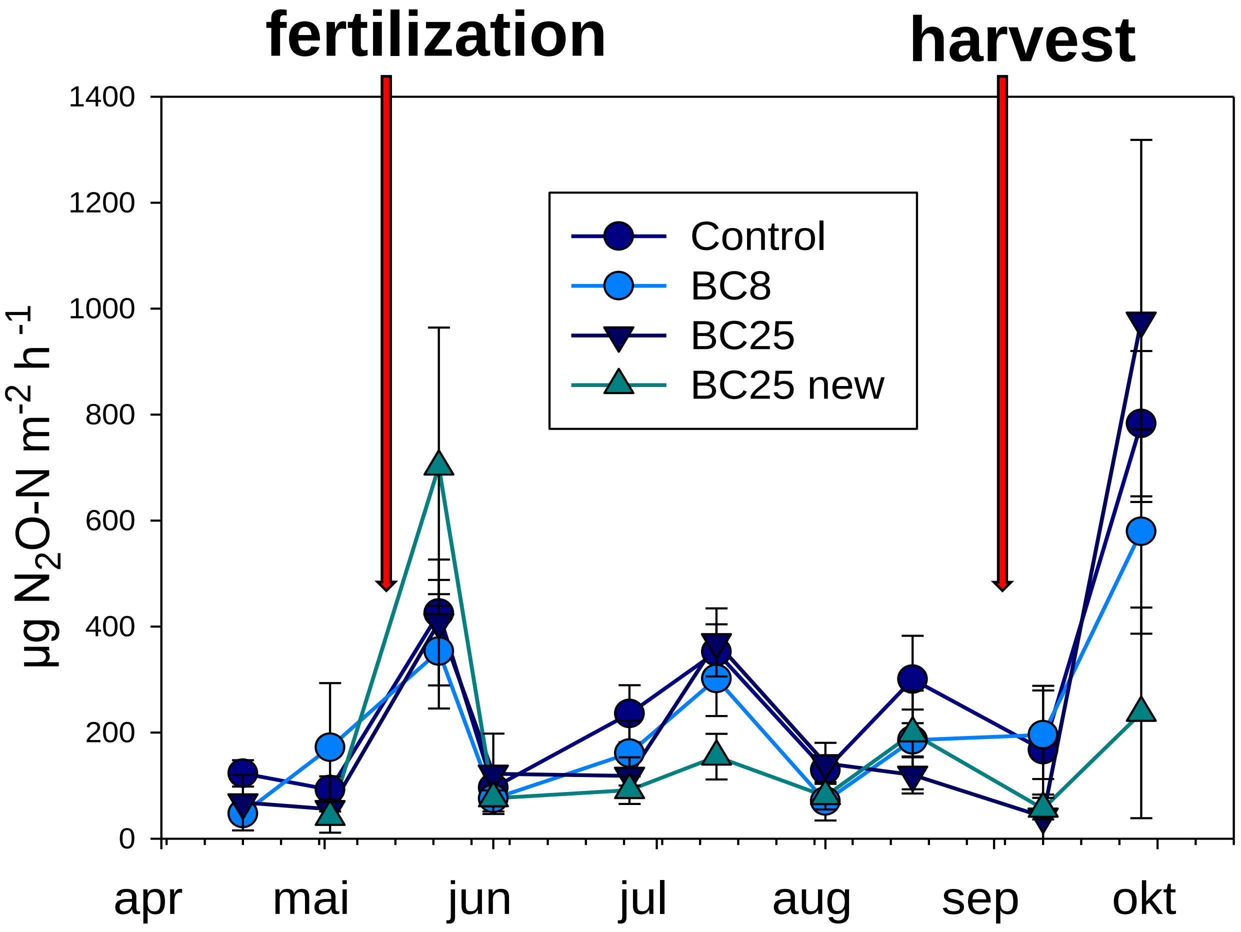
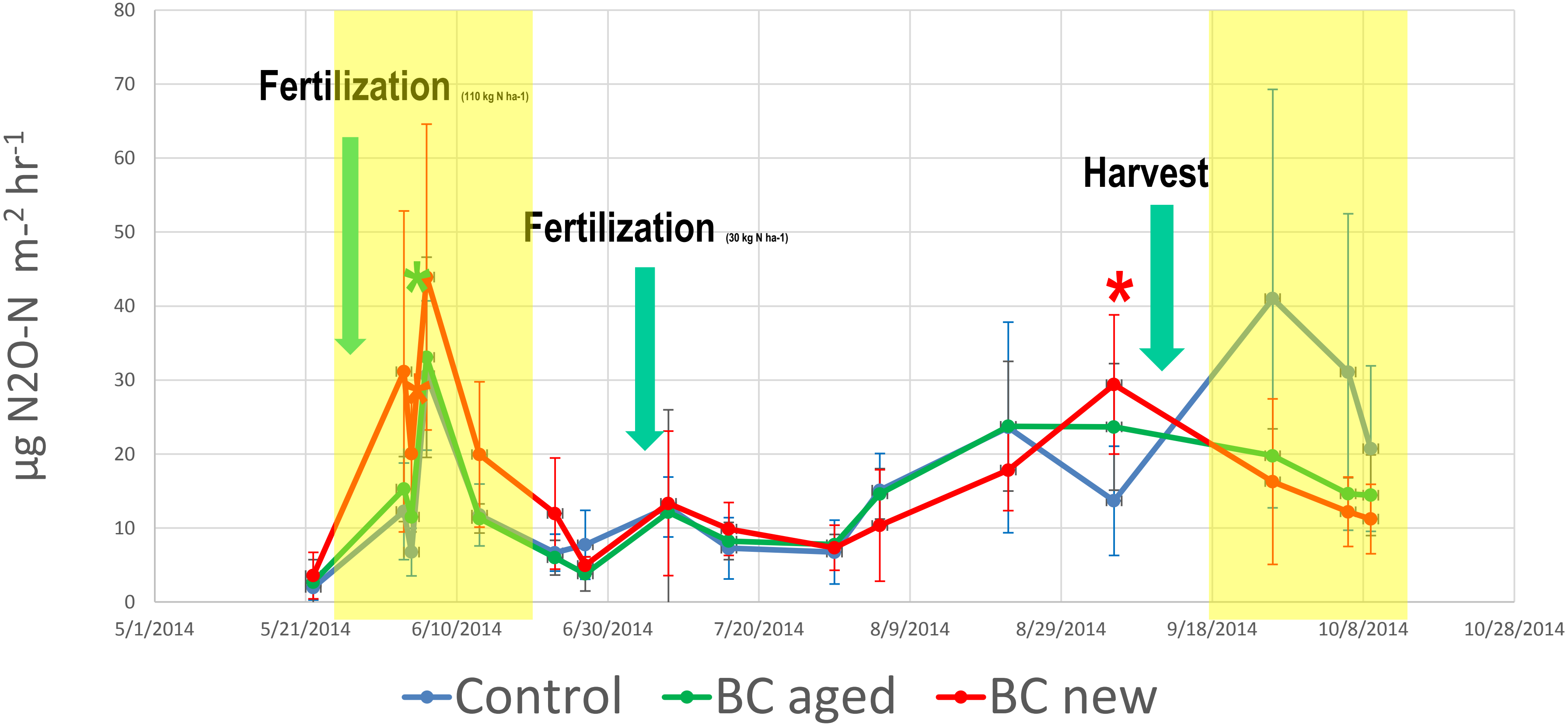


- No statistically difference between treatments.
- Large variations.
- Peak after fertilization
- High peak in September after harvest and no plant growth.

O'Toole et al. in prep

Soil N_2O flux 2014



Modeling approach Christophe Moni, GRA:cross-cutting C- N modelling

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Weather data from 2011 to 2014
Air temperature
Soil temperature at 6 depth
Air humidity and pressure
Wind speed and direction
Solar radiation
PAR
Precipitation

Parameterization

Soil and plant properties
Agricultural management
Plant parameters
Soil bulk density
Soil hydraulic properties
Soil texture
Soil OC content

COUP Model

Calibration

Validation

Crop yield and height from 2011 to 2014

Recorded	Year	From	To	Frequency	Treatments (number of replicates)					
Parameters					Control	MC8	BC8	BC25	BC25new	Depth
Soil moisture	2011	June	October	24 h	4	4	4	4		4
NO_3^-/NH_4^+	2012	April	September	x7	4	4	4	4	4	1
Heat fluxes	2012	April	June	30 min	8			8		1
Soil moisture	2012	June	September	4 h	3	3	3	6		1
Soil moisture	2012	September	October	1 h	3-10		1-5	2-5		1
Temperature	2012	September	October	1 h	2		2	2		1
N_2O fluxes	2012	April	September	x10	4			4	4	
Soil moisture	2014	June	November	15 min	3-4			3-4	2-3	2
Temperature	2014	June	November	15 min	3-4			3-4	2-4	2
CO_2 fluxes	2014	June	October	x5	4	4	4	4	4	
$\delta^{13}C$ CO_2 fluxes	2014	June	October	x5	4	4	4	4	4	
N_2O fluxes	2012	May	October	x15	4			4	4	

Restoration of cultivated peatlands

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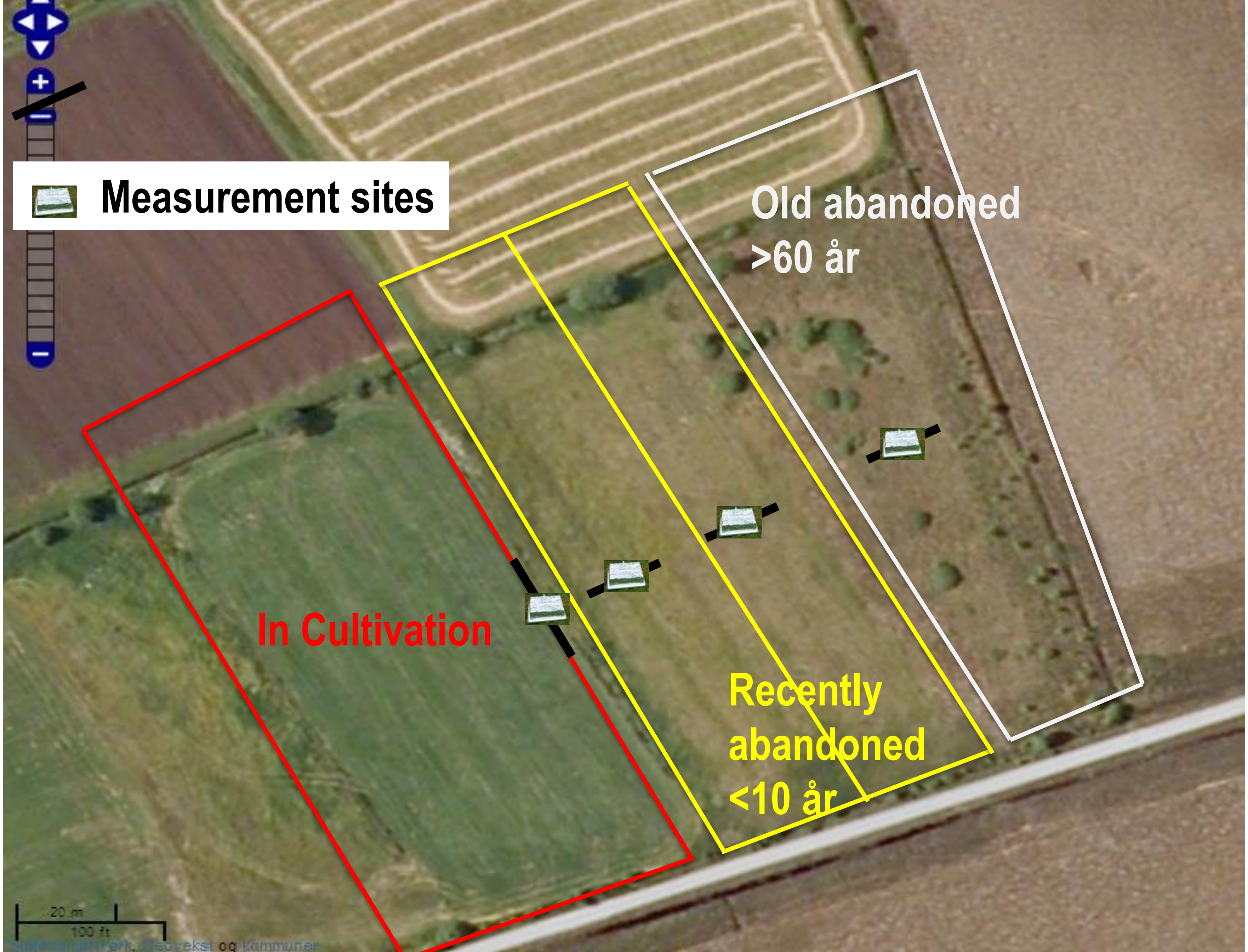
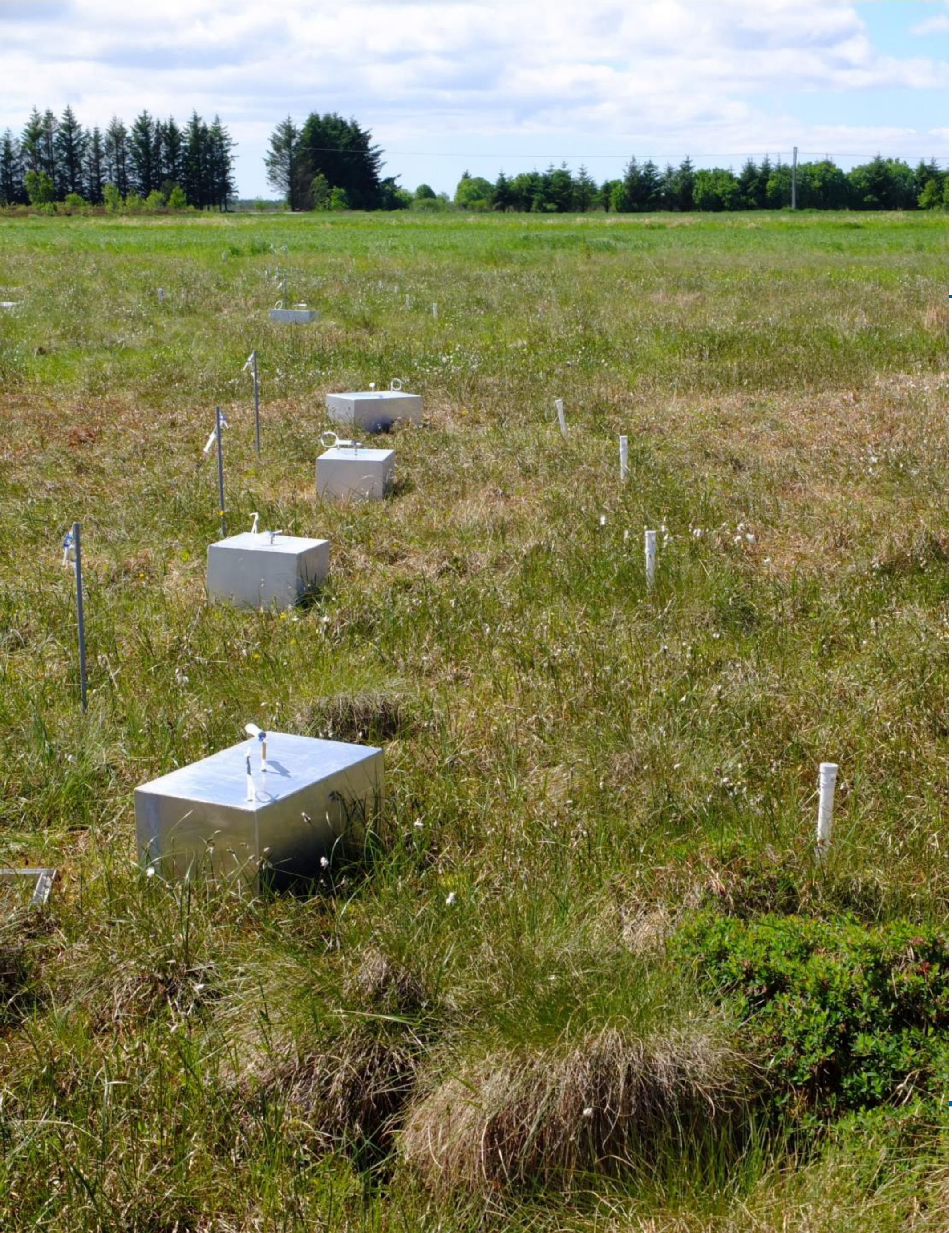
- Measurements over the last 3 years.
- Examined the effect of drain blocking on GHG fluxes.
- Measured:
  - Ecosystem Respiration with dark chambers
  - Water table
  - Plant species composition

- Blocked the drains at the start of year 3.
- Measured the response of ecosystem respiration to drain blocking.
- Post drain blocking in year 3.
- Single campaign with high frequency measurements to compare currently cultivated with the abandoned plots.
- Contact: Simon Weldon.nibio.no , Arne Grønlund, Nibio


Measurement sites
Old abandoned
>60 år
In Cultivation
Recently
abandoned
<10 år
20 m
100 ft



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High emissions of CO2- years after abandoned

Low losses of N20 (no fertilization).

Rewetting 1 year. No effect/reduction on CO2 losses or increase in CH4- emissions.

Dry year- need longer measurement period.

Nitrous oxide emissions from clover rich leys during the long northern winter

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Materials and methods

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110 kg N ha^{-1}

cattle slurry

Undisturbed
Removed

Conclusions

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Clower in grasslands promotes off-season N_2O emissions under northern winter conditions

Removal of foliage did not reduce gasseous losses under the conditions encountared at our sites
More than70 % of N2O was lost during winter.
N content in clower leaves reduced by 82 %.
Increased N- content in straw and roots .
Highest emission during thawing soil.

Contact;ievina.sturite@nibio.no; peter.doerch@nmbu.no

Cropping systems- environmental effects- (emissions og GHG and nutrient loss to surface and drainage water.
Contact - Peter Dörsch, Audun Korsæth

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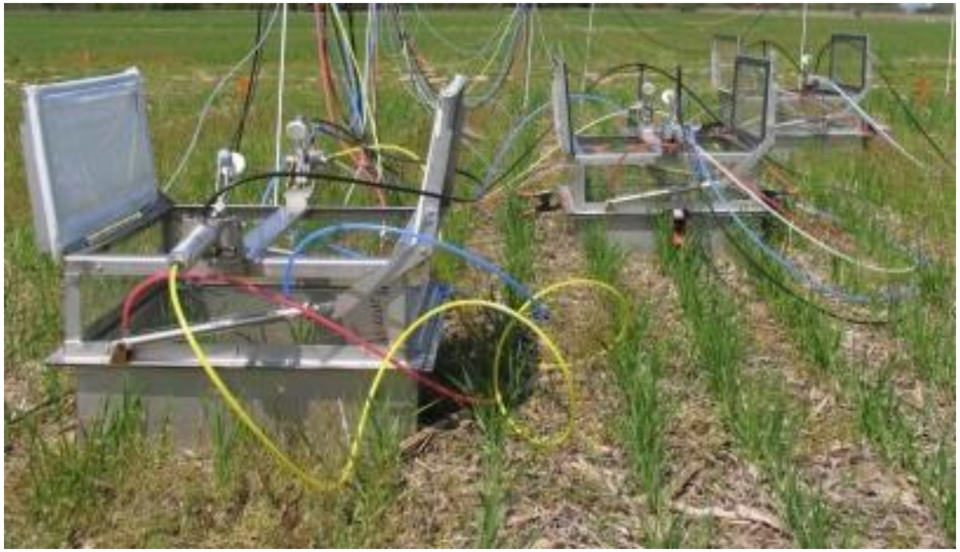

* Measurement of N_2O i lang term field trials (NMBU and NIBIO, Apelsvoll) . 20 year of measurements cropping systems, crops, fertilizer, soil tillage. Yield, runoff losses surface and drainage water.
* Development of equipment for automatic measurements of N_2O in field.

Project DRAINIMP: Effect of drainage status on N_2O emissions. Peter Dörsch

Project; Mitigation of Greenhouse gas emission from cropped soils by mafic Mineral applications (MIGMIN)".

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- Purpose : Innovative strategies for pH regulation in acid soils – field research– increased yield with less GHG emissions.
- Dolomite, Olivine a.o for regulating pH.
- Peter Dörsch, Lars Bakken (NMBU Nitrogen Group), Nina Simon (Ife) and Pål Tore Mørkved (UiB)

Automatic N_2O emission measurements in cooperation with EU prosjekt (NORA – N_2O Research Alliance, Marie Curie ITN, 2013-2016) lead by NMBU Nitrogen group.

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NMBU = Norwegian University of Life Sciences

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Norway Country update

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