Best management practices for the sustainability of milk and beef industries in Finland

Catch the carbon project: Dairy and beef industries in Finland: Progressing pathways to carbon-neutrality by 2035 (NC-GRASS)

Narasinha J. Shurpali, Principal Scientist, Natural Resources Institute Finland (Luke)
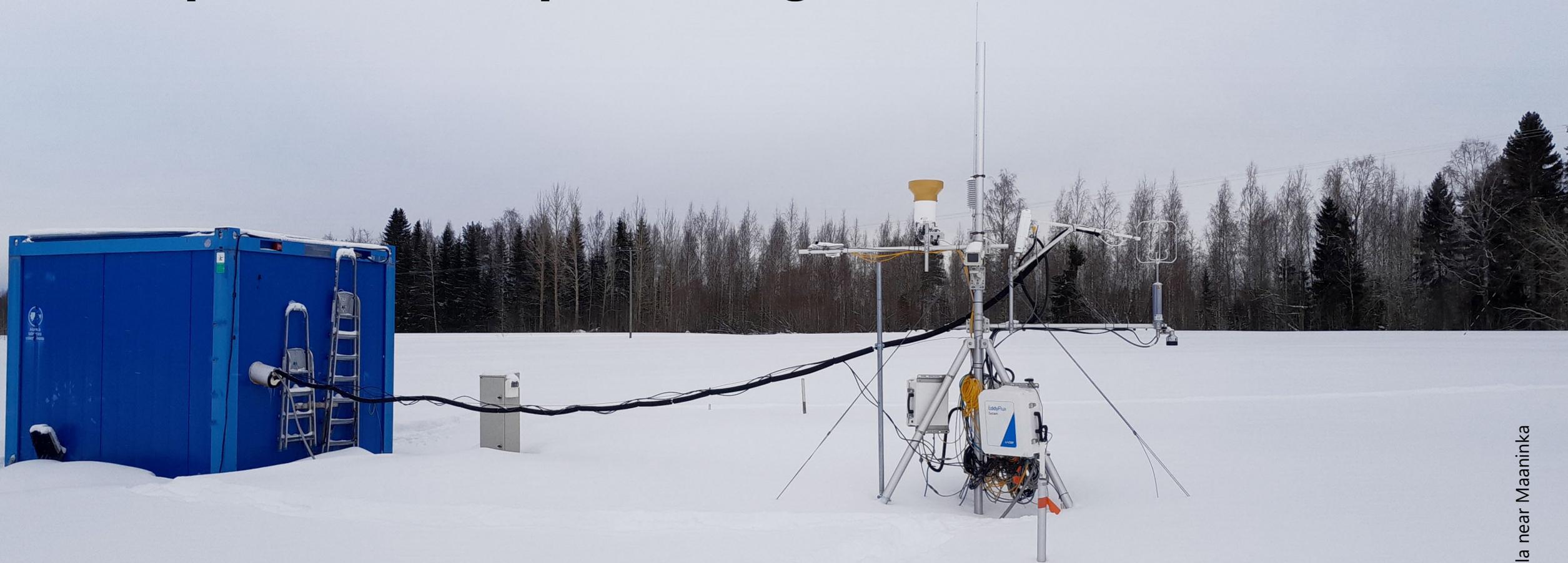
Luke

Integrated Milk and Beef production system is complex

- It involves several interacting processes that include crop and pasture production, crop harvest, feed storage, grazing, feeding, and manure handling.

- Profit margins for dairy industry are getting smaller while environmental constraints are higher.

Harvest

Preservation

Crop

Grazing

Planting

Animal

Soil

Manure
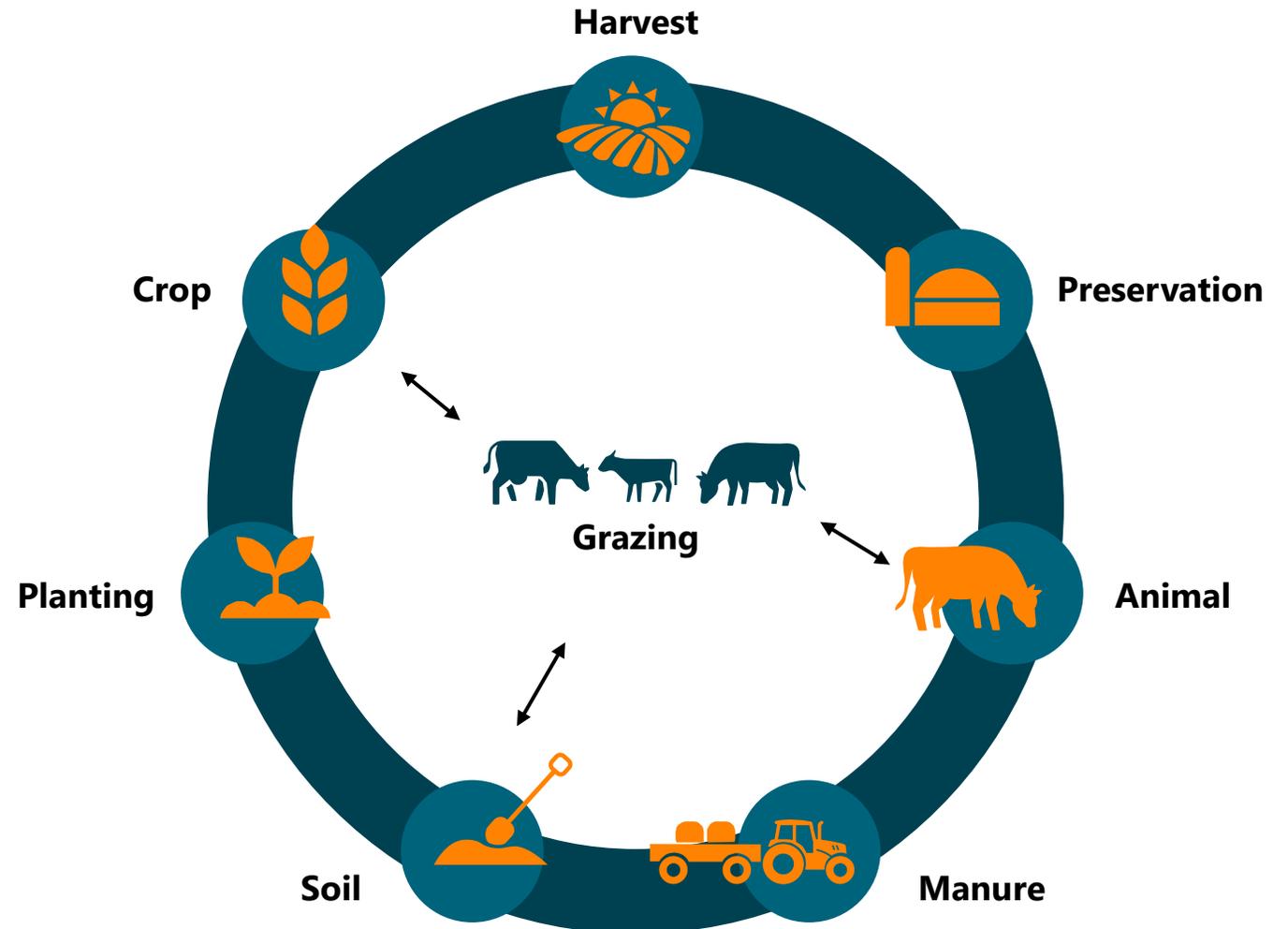
Milk production depends on grasslands

GHG Tower in Anttila near Maaninka

To support the sustainable milk production in Finland and to advise the farmers on the best grassland management practises.

We monitor year-round GHG emissions from grasslands, both on mineral and drained peat soils

Luke

Results from GHG measurements

- During winter months, Carbon is lost at low background rates

- During summer, Carbon uptake by the vegetation is higher than C loss

- On an annual basis, net Carbon gain or loss depends upon soil type, climate, and management practices (harvesting, tillage, fertilization)

- Their impact is well captured in our continuous, multi-year data
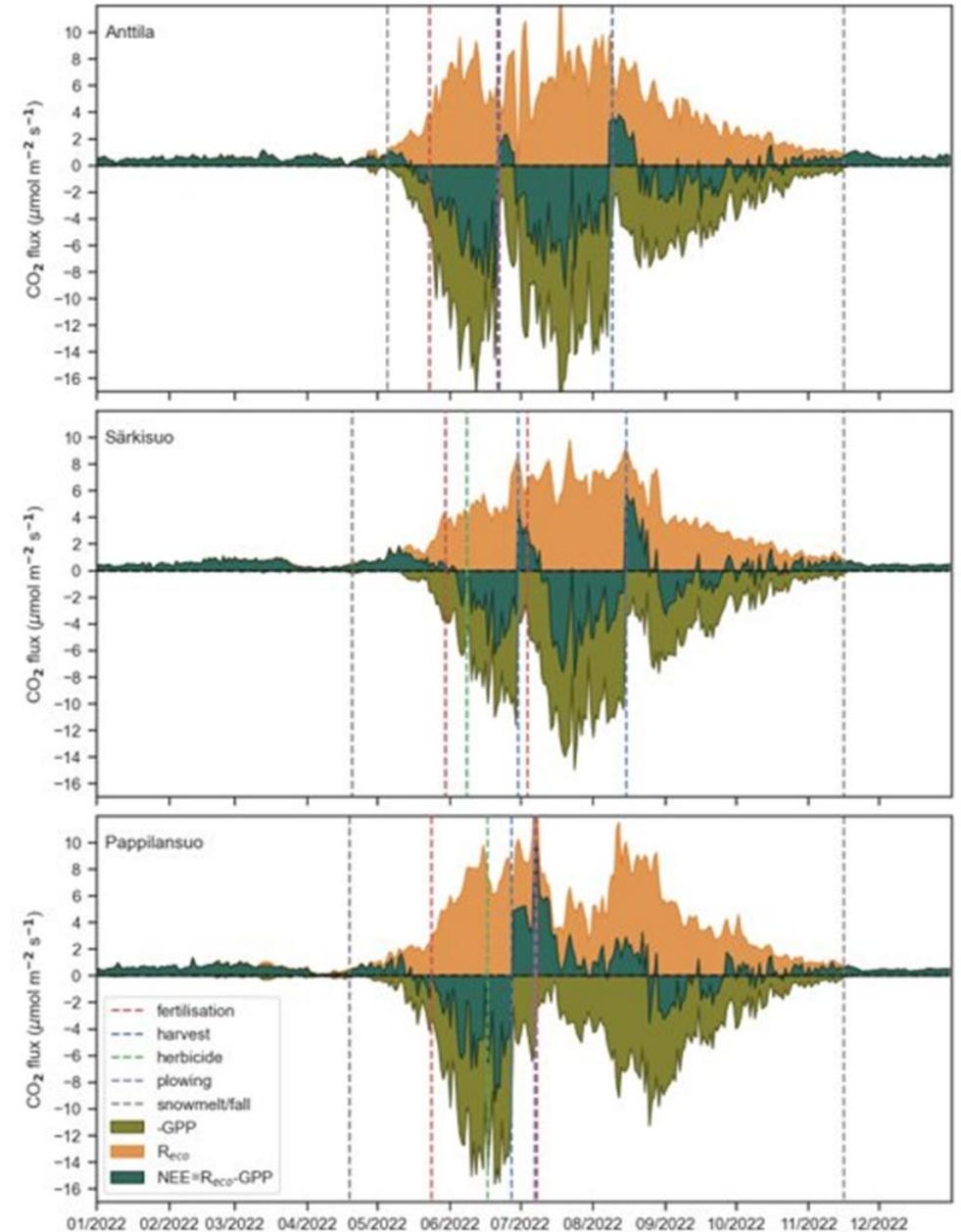
Finnish agricultural GHG mitigation opportunities

- Mineral soils are smaller net sources of GHGs, they emit less and produce more grass biomass than peat soils

- Among the drained peat soils, well drained soils emit less GHGs than poorly drained soils

- High N2O emissions after the first grass cut and second dose of fertilization can be reduced significantly by delaying the fertilizer application by a week to ten days
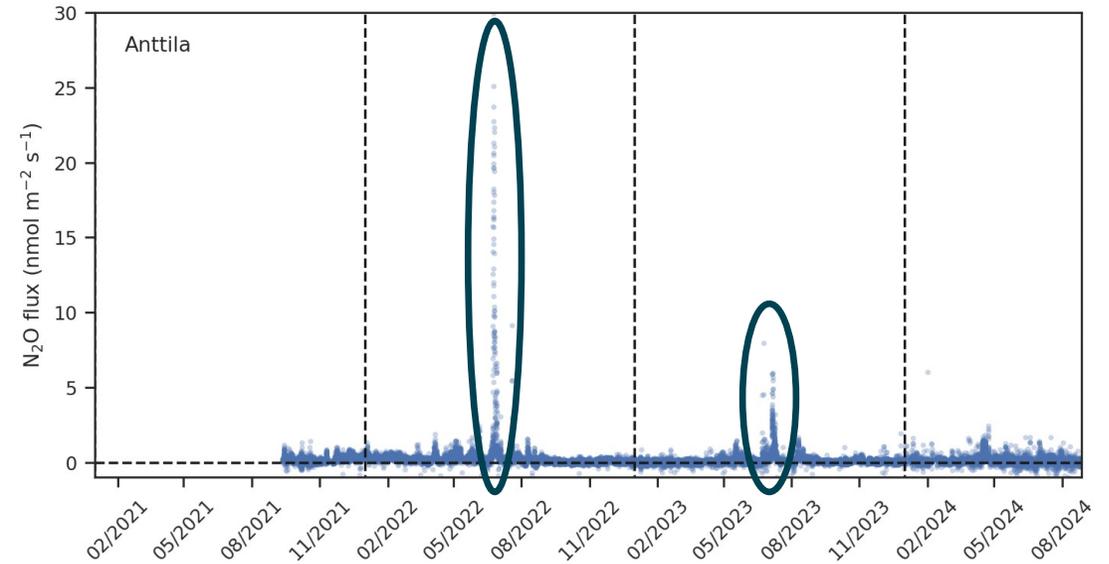

Soil type	CO_2	CH_4	N_2O	Total GHGB	Biomass Yield	Biomass C%	DBM CO_2-eq	NECB	Feed CO_2-eq
	CO_2-eq t ha^{-1}				t ha^{-1}	%	t ha^{-1}	t ha^{-1}	kg kg^{-1}
Mineral	-9.2	0.1	1.2	-7.9	7.5	0.42	11.7	3.8	0.5
Peat, well drained	-3.5	3.1	5.1	4.7	5.4	0.43	8.6	13.3	2.5
Peat, poorly drained	2.6	1.3	9.0	12.9	5.9	0.43	9.4	22.3	3.8

Forthcoming Policy Brief: Quantifying Greenhouse Gas Emission Potential from Organic Soils in Finnish Grass Production: A Satellite-Based Assessment of Cultivation Intensity

- Luke and Finnish Geospatial Research Institute

- Use of satellite images to identify the percentage of well and poorly drained agricultural soils across Finland

- Well drained sites – two grass cuts – Poorly drained sites – a single grass cut. Such vegetation structural changes are clearly distinguishable from remote sensing

- Using our measured, dynamic GHG emission factors, we assess the contribution of different organic soil types to agricultural GHG balances

Recommendation:
Farmers with unsustainable soil types (very high GHG emitters) should be encouraged with incentives and subsidies to give up environmentally costly agricultural production and adopt paludiculture or another less GHG emitting option
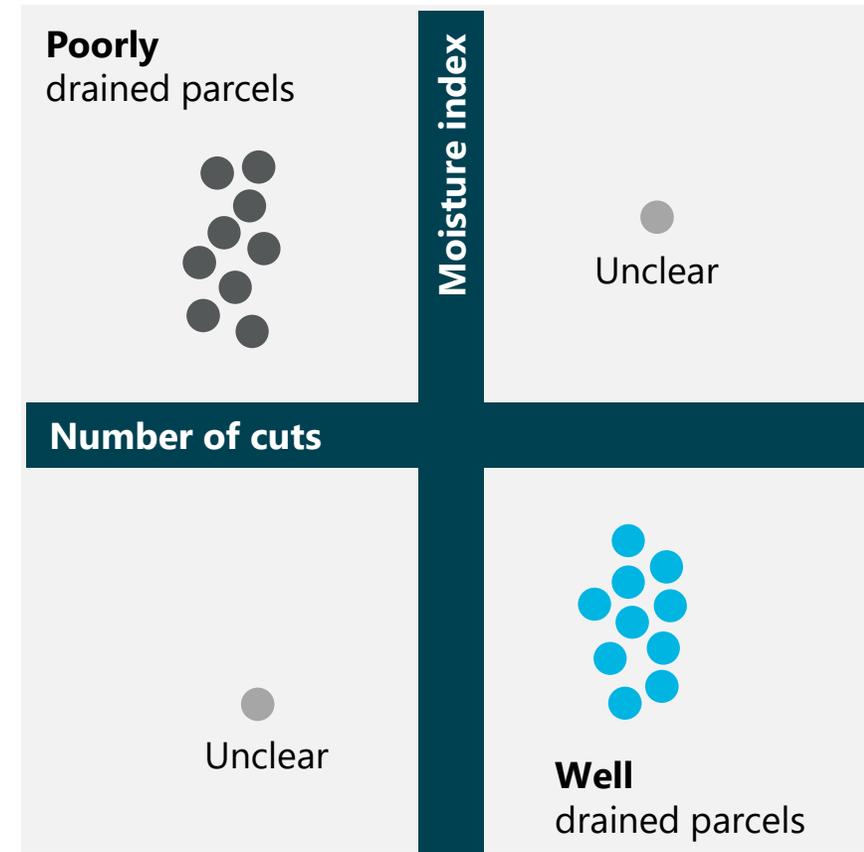
Thank you!

Members of the Luke NUMA research group & **Luke INFRA Unit** &

Refereed *Journal articles* during the project period

1. Optimizing irrigation and nitrogen addition to balance grassland biomass production with greenhouse gas emissions: A mesocosm study, J Sang, Y Zhao, Y Shen, NJ Shurpali, Y Li **Environmental Research** 249, 118387 2024

2. Optical assessment of the spatial variation in total soil carbon using laser-induced breakdown spectroscopy V Dwivedi, J Ahokas, J Viljanen, P Ryczkowski, NJ Shurpali, HR Bhattarai, … **Geoderma** 436, 116550 2023

3. Management practices during the Renewal year affect the carbon balance of a Boreal legume grassland Y Li, P Korhonen, S Kykkänen, M Maljanen, P Virkajärvi, NJ Shurpali **Frontiers in Sustainable Food Systems** 7, 1158250 2023

4. Sustainable intensification with irrigation raises farm profit despite climate emergency A Muleke, MT Harrison, R Eisner, P de Voil, M Yanotti, K Liu, … **Plants, People, Planet** 5 (3), 368-385 2023

5. Clarifying confusions over carbon conclusions: antecedent soil carbon drives gains realized following intervention A Muleke, MT Harrison, R Eisner, M Yanotti, P de Voil, S Fahad, W Fei, … **Global Environmental Change Advances** 1, 100001 2023

6. The challenges fraught opportunity of agriculture expansion into Boreal and Arctic regions T Klöffel, EH Young, N Borchard, JD Vallotton, E Nurmi, NJ Shurpali, … **Agricultural Systems** 203, 103507 2022

7. Simulating soil-plant-climate interactions and greenhouse gas exchange in Boreal grasslands using the DNDC model D Forster, J Deng, MT Harrison, N Shurpali **Land** 11 (11), 1947 2022

8. Peatland heterogeneity impacts on regional carbon flux and its radiative effect within a Boreal landscape D Kou, T Virtanen, CC Treat, JP Tuovinen, A Räsänen, S Juutinen, … **Journal of Geophysical Research: Biogeosciences** 127 (9), e2021JG006774, 2022

9. Nitrogen addition affects nitrous oxide emissions of rainfed Lucerne grassland Y Li, G Wang, NJ Shurpali, Y Shen **International Journal of Environmental Research and Public Health** 19 (13), 7789 2022

10. Use, calibration and verification of agroecological models for Boreal environments: A review D Forster, S Helama, MT Harrison, CA Rotz, J Chang, P Ciais, E Pattey, **… Grassland Research** 1 (1), 14-30 2022

11. A strong mitigation scenario maintains climate neutrality of northern peatlands C Qiu, P Ciais, D Zhu, B Guenet, J Chang, N Chaudhary, T Kleinen, XY Li, … **One Earth** 5 (1), 86-97 2022

12. Substantial hysteresis in emergent temperature sensitivity of global Wetland CH 4 emissions KY Chang, WJ Riley, SH Knox, RB Jackson, G McNicol, B Poulter, … **Nature Communications** 12(1), 2266 2021

Conference presentations during the project period

13. Accurate Simulation of greenhouse gas emissions across fertilizer scenarios with DNDC T Thentu, D Forster, P Virkajärvi, MT Harrison, N Shurpali EGU General Assembly Conference Abstracts, 7642 2024

14. Impact of management and Boreal climate on GHG exchange from Finnish grasslands on Mineral and peat soils N Shurpali, O Peltola, T Thentu, P Virkajärvi EGU24 2024

15. Peatlands have the potential to emerge as significant contributors to future climate warming N Chaudhary, JP Tuovinen, D Kou, PKD Burman, A Lodh, S Lamba, 2023

16. Nitrous oxide emissions from pan-Arctic terrestrial ecosystems: A process-based biogeochemistry model analysis from 1969 to 2019 Y Yuan, Q Zhuang, B Zhao, N Shurpali EGUsphere 2023, 1-37 2023

17. Current research view about nitrous oxide uptake in agricultural soils HR Bhattarai, P Manninen, S Lind, P Virkajärvi, H Ruhanen, W Wanek, … Grassland at the heart of circular and sustainable food systems, 104 2022

18. Modeling studies of beef and dairy farming in Boreal environments: a review. D Forster, S Helama, P Virkajarvi, NJ Shurpali 2022

19. GHG mitigation potential of agricultural management practices on Mineral and organic soils S Lind, M Maljanen, M Myllys, M Räty, S Kykkänen, P Korhonen, … EGU General Assembly Conference Abstracts, EGU21-5567