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# EFFECTS OF CROP RESIDUE ON CARBON DIOXIDE, METHANE AND NITROUS OXIDE EMISSIONS ON CULTIVATED PEAT SOILS

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**SAMUEL MUSARIKA[1,2]**

**SMUSARIKA@CEH.AC.UK**

**UK CENTRE FOR ECOLOGY AND HYDROLOGY / BANGOR UNIVERSITY**

**Co-authors:**

**Chris Evans[1], Davey Jones[2], Niall McNamara[3], Dave Chadwick[2]**

1 UK Centre for Ecology and Hydrology, Environment Centre Wales, Bangor, LL57 2UW
2 School of Natural Sciences, Bangor University, Bangor, LL57 2UW
3 UK Centre for Ecology and Hydrology, Lancaster Environment Centre, Lancaster, LA1 4AP


UK Centre for Ecology & Hydrology | Prifysgol Bangor University | STARS Soils Training And Research Studentships | UKRI Natural Environment Research Council

# INTRODUCTION

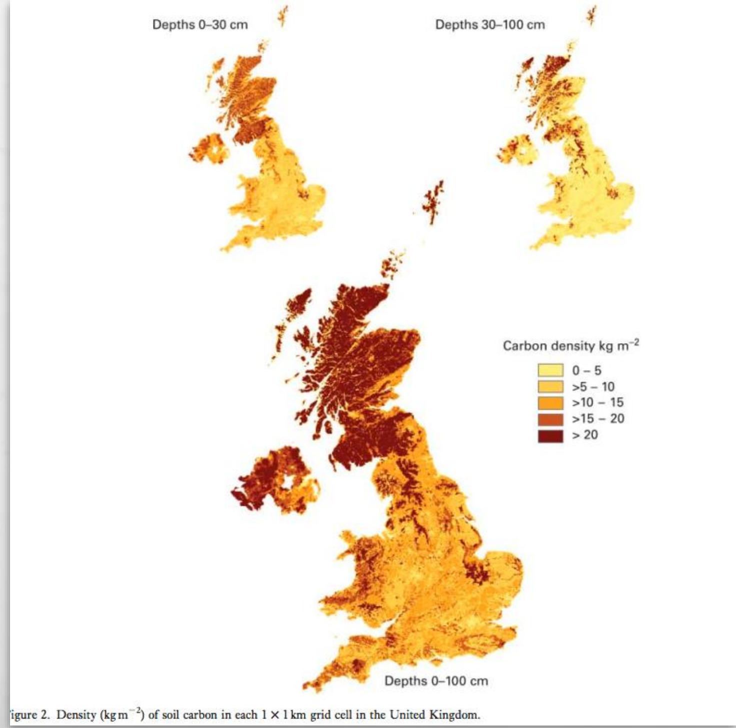



**Image source: Bradley et al. 2005**


**Location of The Fens in the east of England [image source: (Morris *et al.,* 2000)]**

- Global peatland coverage is about 3% (400 Mha)
  - Account for 30% of the global soil carbon storage
- (14%) of the UK's land is peatland
  - Approximately 3.3 million ha, 40% of which is modified for anthropogenic activity
  - Only 20% is considered near natural
  - e.g. The fens – 5000km$^2$ but 3370km$^2$ under anthropogenic use (nearly 70%)
- UK soil carbon loss is estimated to be an average rate of 0.6% yr$^{-1}$, in extreme cases 2% yr$^{-1}$
- UK soil degradation costs over £1 billion per year

(EEA 2016:Foresight, 2011; Gilbert, 2012)

# INTRODUCTION

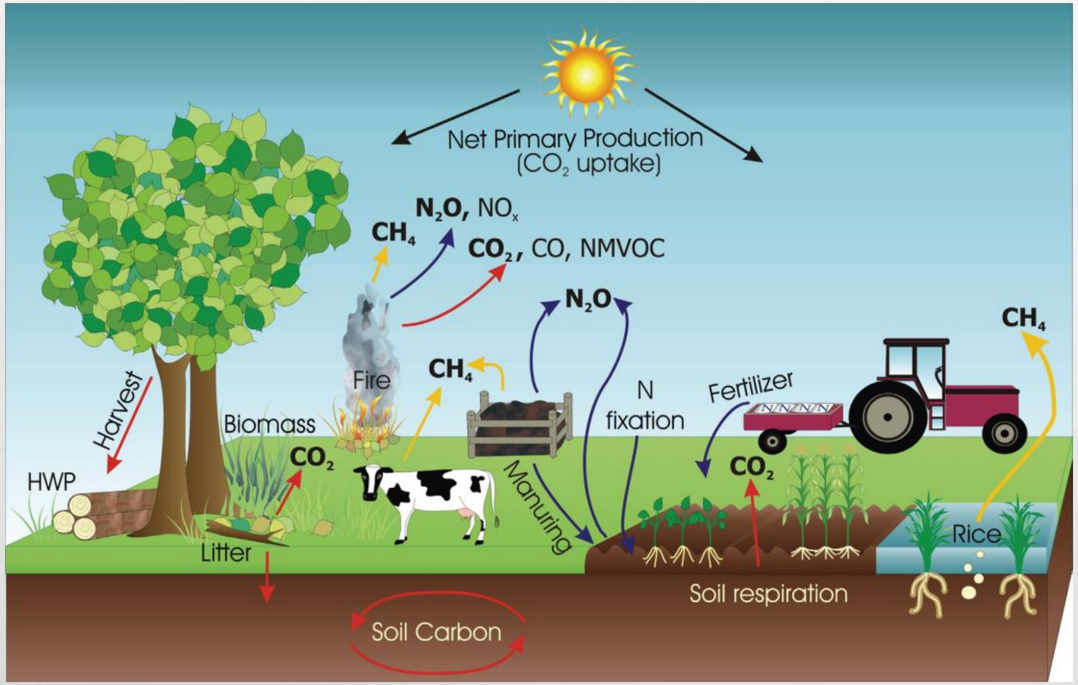



**Image source: IPCC**

- Globally, agriculture produces a third of anthropogenic greenhouse gas (GHG)
  - In Europe, agriculture is the second largest contributor of greenhouse gas (GHG)
- Horticulture alone on drained peatlands produces 6 times more $CO_2$ than restored deep peatland
- We are fast losing productive peatlands,
  - A third will be lost by 2050

(EEA 2016:Foresight, 2011; Gilbert, 2012)

# PRESERVING PEATLANDS


**Figure 1.** Subsidence on one field at Rosedene Farm showing the field is now lower than the road which used to be same level circa 50 years ago.

- Water table manipulation (usually -50 cm) can reduce peat loss but it is insufficient as soil compaction and oxidation is persistent. Rosedene Farm utilizes water table manipulation, but subsidence and peat loss continues (Figure 1.)
- Water table closer to the ground (e.g. -30 cm) possible for some crops but has some challenges (see Musarika *et al.,* 2017)
- Can peatlands be saved by importing Fresh Organic Matter (FOM)?

# STUDY AIMS

**Figure 2.** Barley straw used as a fresh organic matter amendment (left) and when the barley straw was applied to the mesocosms.

- Fresh organic matter changes the decomposition rate of existing soil organic carbon (SOC). There is little evidence showing its effect on UK cultivated peat soils
- The aim is to assess the effects of crop residue, on the release of $CO_2$, $CH_4$ and $N_2O$ in cultivated peat soils

# METHODS


- 16 peat soil cores were collected from Rosedene Farm for the experiment **(a,b)**
- The cores were set up into mesocosms that were buried into the ground **(a,b,c,d)**
- FOM residue used was barley straw (10g per core) **[Figure 2]** and the experiment ran for 27 weeks
- The emissions in the experiment were measured using Licor Autochambers (8100-104), a Licor IRGA (LI8100) and a Picarro (G2301) connected in series for CH4 and N2O **(e,f,g,h,i)**

# METHODS

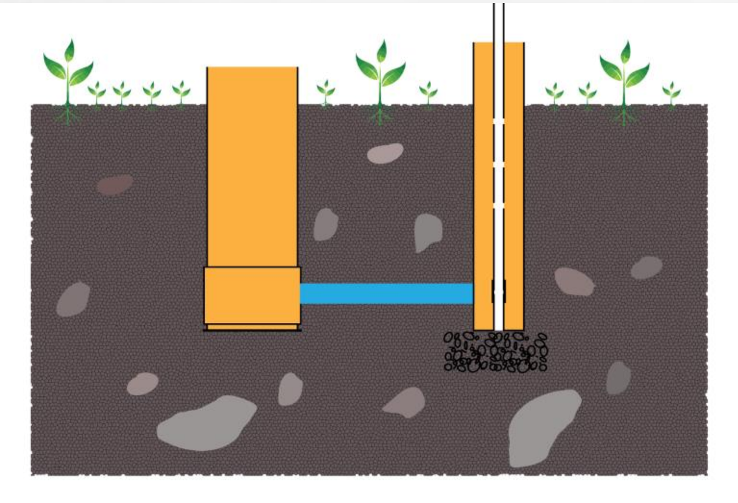


**Figure 3.** A single core (left) connected to the water table management pipe/reservoir on the right

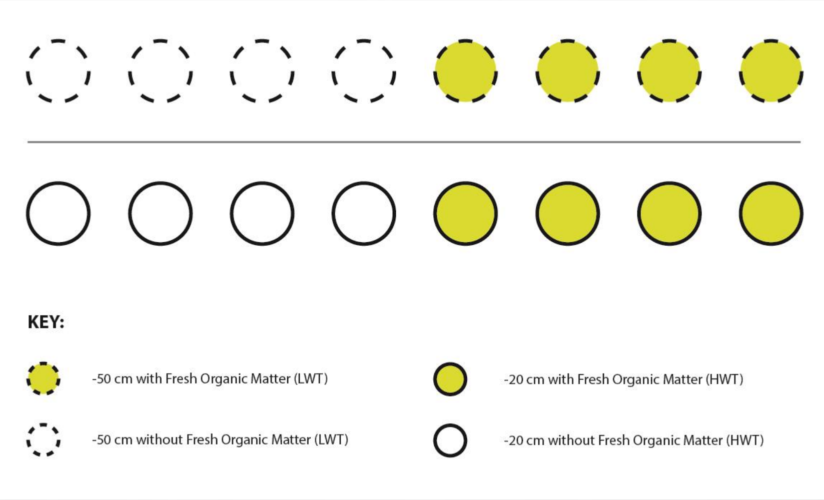


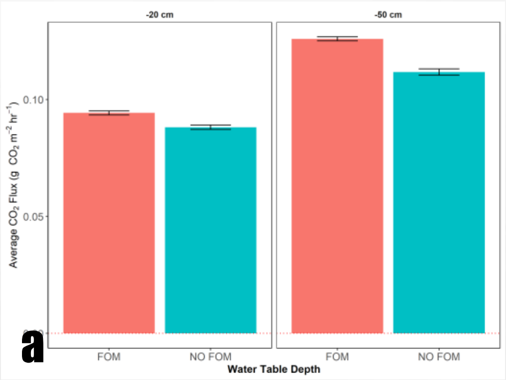

**Figure 4.** The cores were divided into two water tables (WT), half -50 cm (LWT) and half -20 cm (HWT). Half (4) from each WT had FOM added in week 6

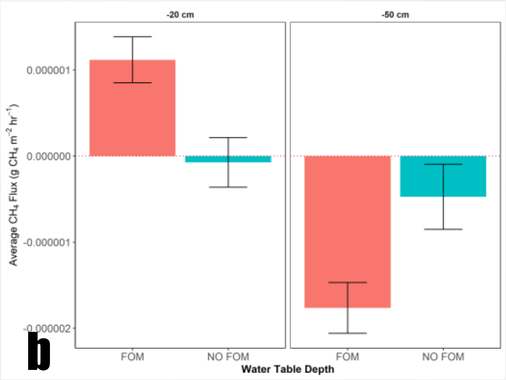
# RESULTS

The data in **Figure 3.** shows that there is an effect of both water table manipulation and FOM on fluxes

The -50 cm cores had significantly higher $CO_2$ fluxes than the -20 cm ($p<0.05$). The effect of FOM on $CO_2$ was higher in -50 cm ($P<0.05$). The -20 cm cores became $CH_4$ sources whilst the -50 cm cores became sinks of $CH_4$

FOM led to increased $N_2O$, which was significant in -20 cm ($p<0.05$ )



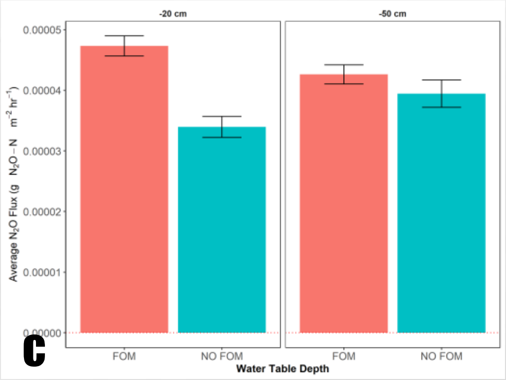




**Figure 3.** The cumulative emissions over 27 weeks of a) $CO_2$, b) $CH_4$ and c) $N_2O$

# CONCLUSION

Fresh organic matter in peatlands may be an unwise practice which can lead to increased $CO_2$ and $N_2O$ emissions (Figure 3a & Figure 3c)

Fresh organic matter can also lead to increased CH4 fluxes under a high water table (- 20 cm)

However, the addition of fresh organic matter under a low water table (-50 in this study) could help $CH_4$ sequestration (Figure 3b)

# REFERENCES


1. Frolking, S. et al., 2011. Peatlands in the Earth's 21st century climate system. *Environmental Reviews,* Volume 19, pp. 371-396.
2. Joosten, H. & Couwenberg, J., 2009. *Are emission reductions from peatlands MRV-able? ,* Wageningen: Wetlands International, Ede.
3. Berglund, Ö. & Berglund, K., 2010. Distribution and cultivation intensity of agricultural peat and gyttja soils in Sweden and estimation of greenhouse gas emissions from cultivated peat soils. *Geoderma*, 154, pp.173-80.
4. Strack, M., 2008. *Peatlands and Climate Change.* Jyväskylä: International Peat Society.
5. Musarika, S., Atherton, C.E., Gomersall, T., Wells, M.J., Kaduk, J., Cumming, A.M.S., Page, S.E., Oechel, W.C. & Zona, D., 2017. Effect of water table management and elevated CO2 on radish productivity and on CH4 and CO2 fluxes from peatlands converted to agriculture. Science of The Total Environment, 584-672, pp.665-72.