Nitrous oxide emissions from a grass arable rotation in NE Scotland

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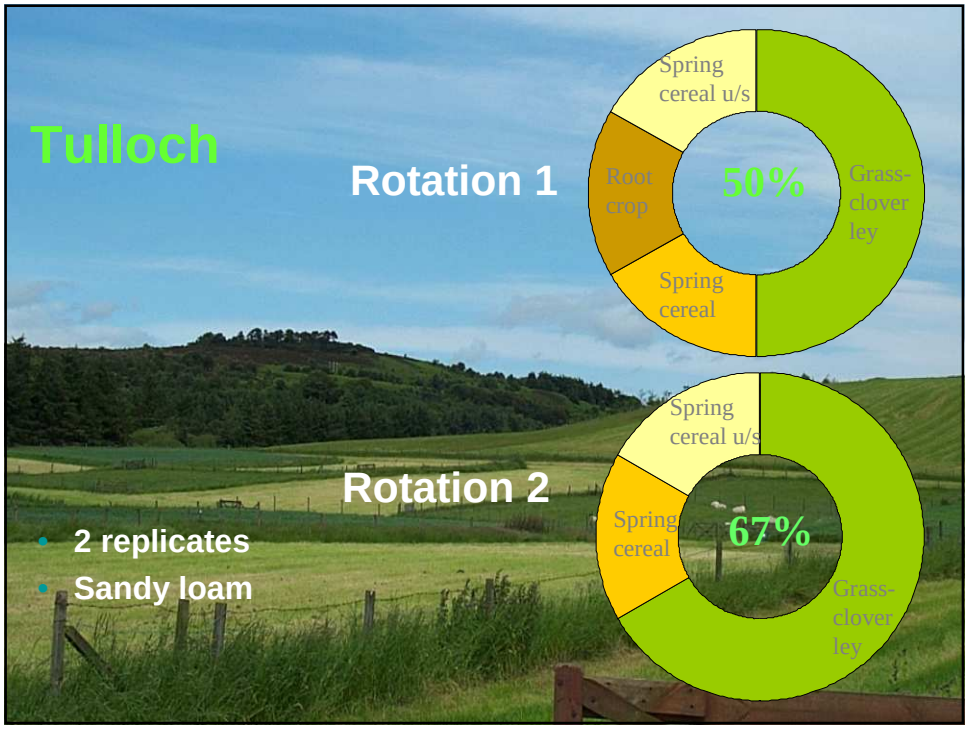
Greenhouse gas production in organic farming is not a concern?

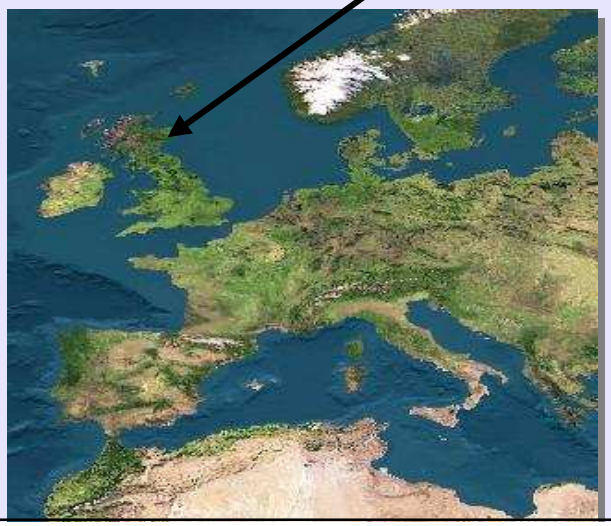
- Direct CO_2 emissions from organic rotations tend to be small or negative
- CH_4 emissions from soils are v. small
- N_2O emissions are thought to be low, but there is little information

Objectives

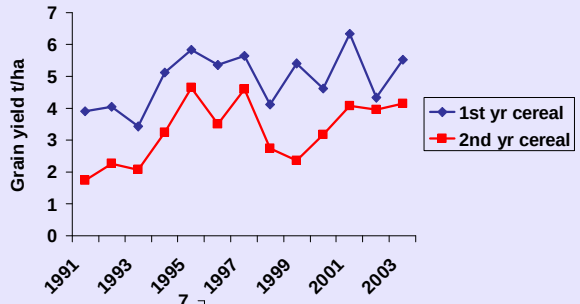
- To assess the effects of an organic rotation on nitrous oxide emissions
- To consider soil N_2O emissions with those from other sources
- To consider issues relating to energy efficiency



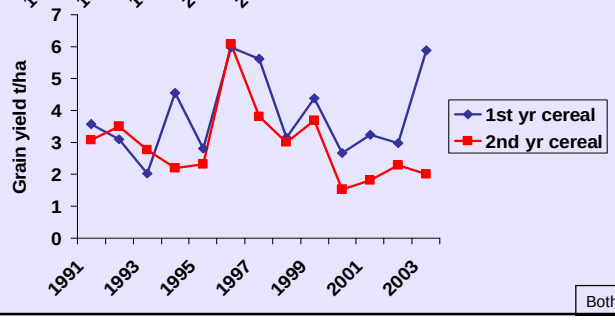
Tulloch



Grain Yields (Oats)



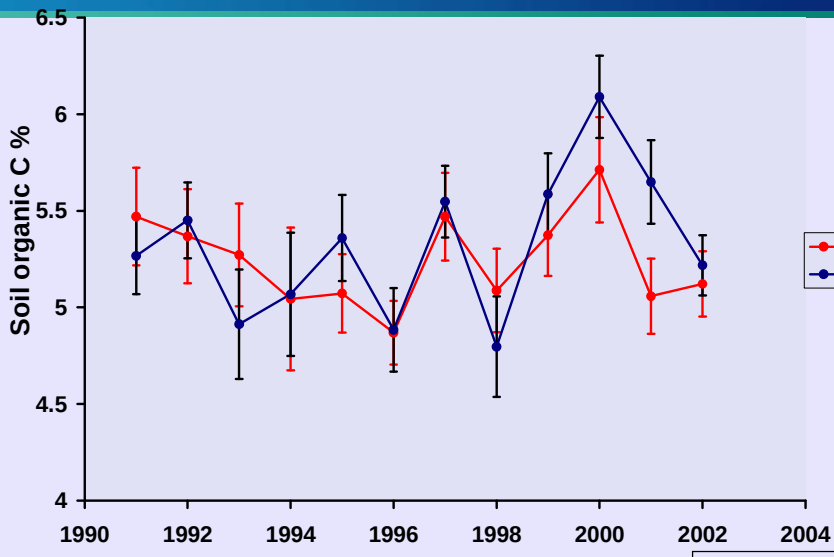
Tulloch



Woodside

Both rotations with 50% grass

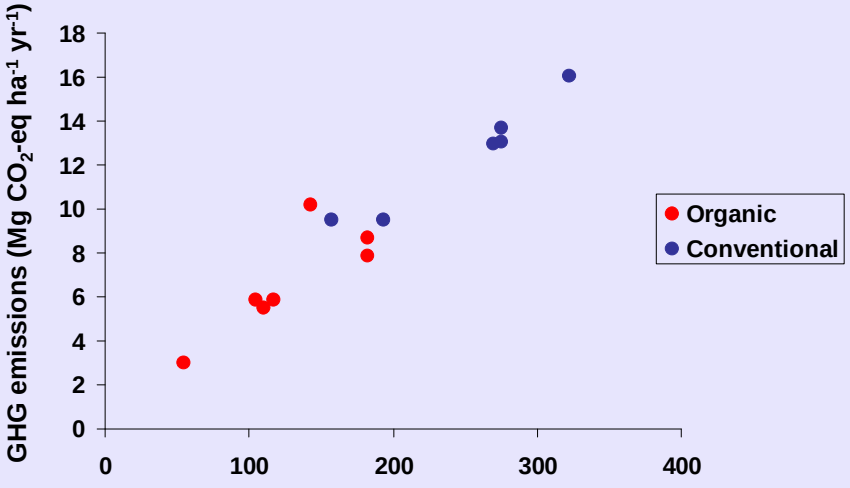
Soil Organic Carbon



Changes in SOC (0-15 cm) on the Tulloch rotation between 1990-2002

Rotation 1; 50% grass
Rotation 2; 67% grass

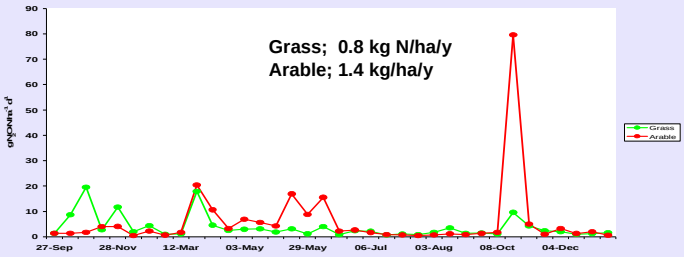
N surplus and N loss



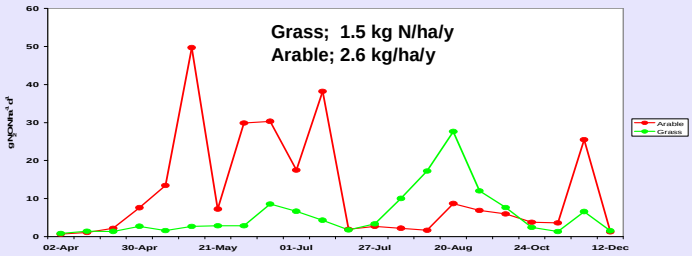
Olesen *et al*. 2004
Midair Conf Proc

N_2O losses from arable and grass phases of the rotation 2006-07

2006

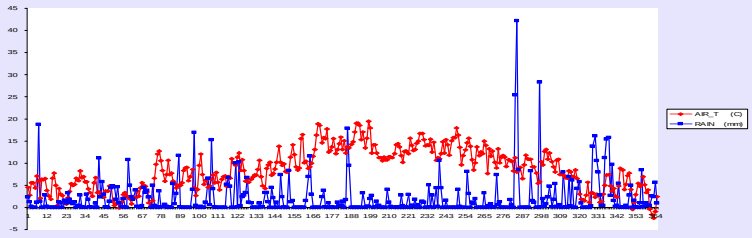


2007



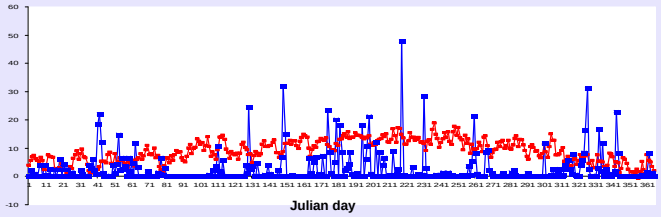
Rainfall and temp

2006



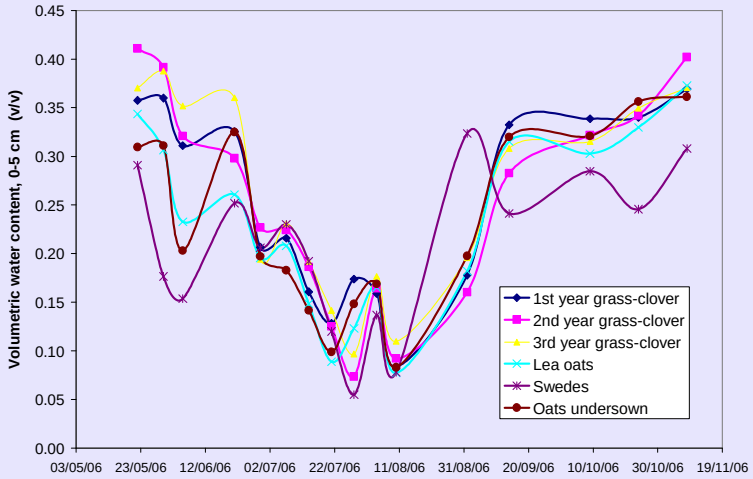
Annual Av temp 8.7 °C; Total rainfall 731 mm

2007

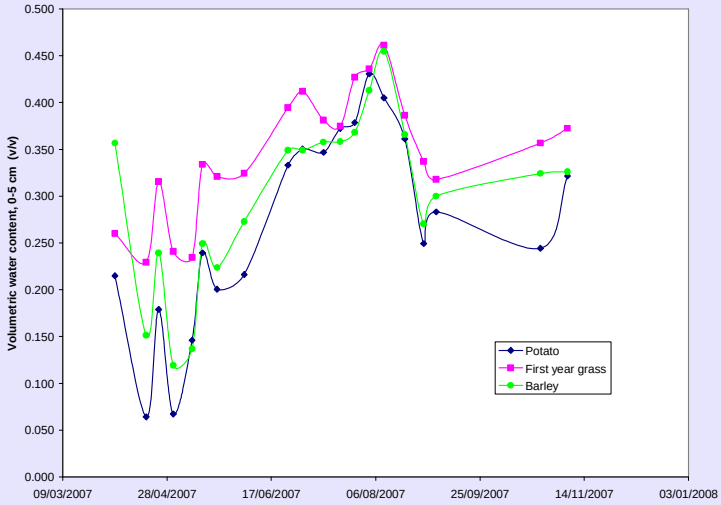


Annual Av temp 8.9 °C; Total rainfall 940 mm

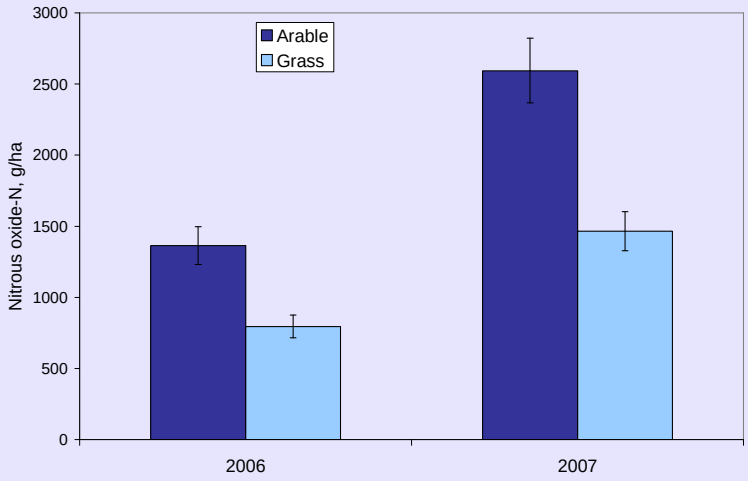
Soil water content 2006



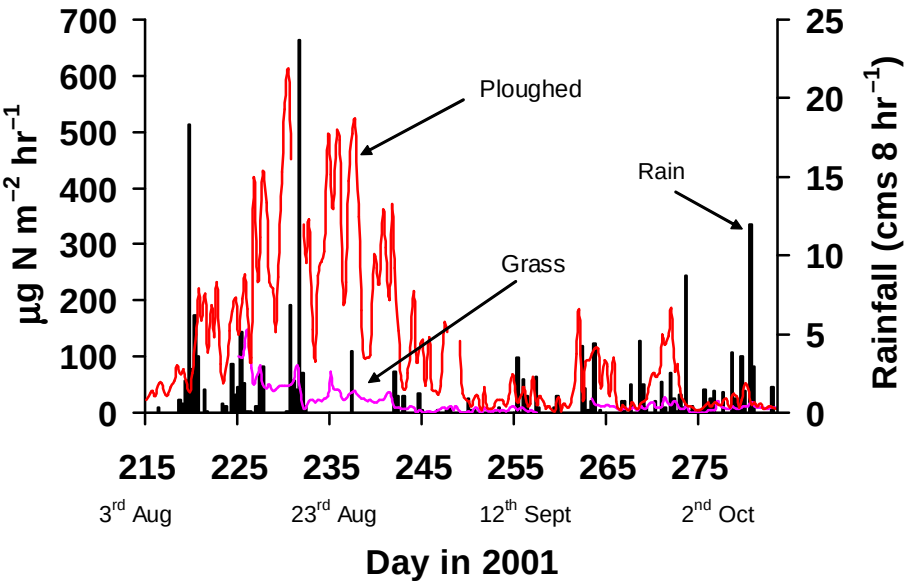
Soil water content 2007



Cumulative total annual emissions from the grassland and arable phases of the rotation



N_2O emissions after ploughing at Bush



Carbon emissions saved by avoidance of fertiliser N use

Assume N fixation rate of 105 kg ha/y[a]

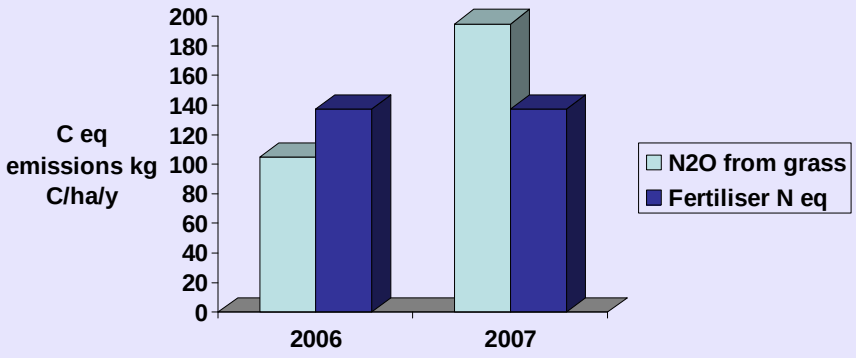
Assume C emissions associated with equivalent N fertiliser Production of 1.3 kg C /kg N[b]

Saved C emissions therefore 137 kg C/ha/y

[a] REES,R.M., WATSON,C.A., TOPP,C.F.E. & SANDERS,I. Nitrogen fixation by white clover in organic rotations in Scotland. COST 852. 2004. Conference Proceeding

[b] LAL,R. 2004. Carbon emissions from farm operations. *Environment International* 30, 981-990.

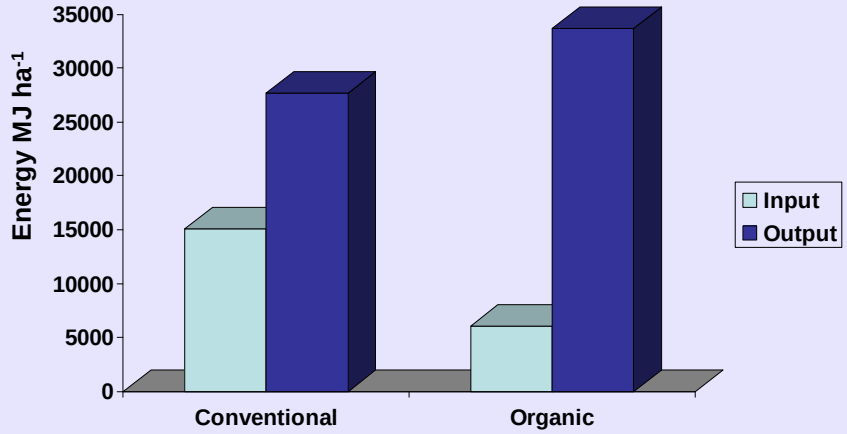
Comparison of emissions from soils and fertilisers



Assume 105 kg biologically fixed N replaced by synthetic fertiliser

Energy budget: for a cut grassland

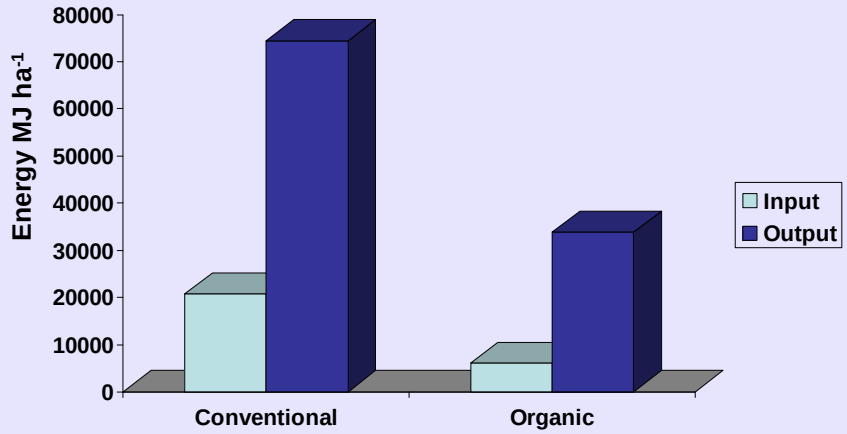
Output/input ratio **1.8** **5.5**



Topp *et al.* 2006
J Sci Food and Ag, In press

Energy budget: mainly arable

Output/Input ratio **3.8** **5.5**



McCormack. DEFRA, 2000

Conclusions

- Emissions of N_2O from this experiment were generally within the range of values observed at Scottish farmland sites
- Emissions N_2O expressed as C equivalents are higher and more variable than those from energy production
- Energy use efficiency in organic rotations is high due to reliance on N fixation
- There is a need to develop management systems that deliver further improvements in N use efficiency