Assessing & recognising the soil carbon benefits of organic farming

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Soil Carbon - introduction

Soil carbon is a very important subject for this conference:

- one of the main drivers of climate change
- lower levels will exacerbate impacts of climate change
- a main & characteristic difference of organic farming
- probably **one of the main climate change benefits of organic farming**
- but … soil carbon is omitted from most assessments of the Global Warming Potential of organic farming.

Soil carbon losses - the causes?

- Agriculture has caused considerable historic soil carbon losses, and research indicates that losses are continuing
- together, the historic & current losses show the potential for soil carbon sequestration by farming
- these losses are being attributed to specific causes
- but we propose that: **the adoption of industrial farming practices, especially inorganic fertiliser, is actually a main cause.**

Soil carbon losses - historic

- attributed to the ploughing up of permanent grassland
- in UK, this occurred from the 1940s+ (King *et al*, 2005)
- but most dramatic losses were mid-1970s to mid-1980s
- traditional practices to maintain soil organic matter were abandoned: farmyard manure etc. (MAFF, 1970)
- these changes were all enabled by inorganic N fertiliser
- may have reduced micro-organisms that create humus
- so, **inorganic fertiliser may be a major cause.**

Soil carbon losses - current

- c.7.3% of UK's GHG emissions (Bellamy *et al*, 2005)
- attributed to rising temperatures, but **the effect of agriculture is being overlooked by researchers:**

(i) correlation of losses and intensity of farm management

(ii) grazed grassland being classified as 'non-agricultural'

(iii) studies are measuring to a limited depth (max. 30cm)

(iv) losses due to erosion excluded from some estimates

- so, modern farm practices may also be contributing.

What comparative evidence is there on soil carbon levels?

Evidence for comparative levels

Controlled long-term trials	Duration, years	Reference
Rodale Institute FST, US	21	Hepperly *et al*, 2006
FiBL DOK trial, Switzerland	21	Fließbach *et al*, 2007; Mäder *et al*, 2002
IBR Darmstadt, Germany	18	Raupp and Oltmanns, 2006
Michigan University, US	9	Robertson *et al*, 2000

Comparisons of organic & non-organic farms	
30 pairs org & non-org farms, England	Armstrong Brown *et al*, 2000
Org & non-org tomato production, US	Drinkwater *et al*, 1995
Org & non-org wheat field, US	Reganold *et al*, 1987

Evidence - the findings

- the two US trials: organic farming builds **from 80kg** (Michigan, 7.5cm) **to 981kgC/ha/year** (Rodale, 30cm). Ascribed to the use of winter cover crops.
- the European trials: **for same C & N rates, compost builds more SOM than inorganic fertiliser**.
- the three farm comparisons all found organic farming produces higher SOM, for horticulture and cereal crops.
- this evidence is in line with farmers' experiences

How much carbon can organic farming sequester in the soil?

Calculating sequestration potential

The carbon sequestration potential of organic farming varies considerably, depending on the scenario chosen:

- Example 1. If organic farming builds 320kgC/ha/year, on UK arable area of 5.9m ha ⇒ 1% UK annual GHGs
- Example 2. If 1tC/ha/year, on global cultivated land of 1.5bn ha ⇒ 47% of global annual net CO_2 emissions
- So, **if level is high (1t/ha/yr) on all cropped land**, organic farming could deliver most of the emissions targets … as long as the background losses stabilised.

Assumptions about C sequestration

Many negative assumptions are being used as reasons for not recognising the soil C benefits of organic farming:

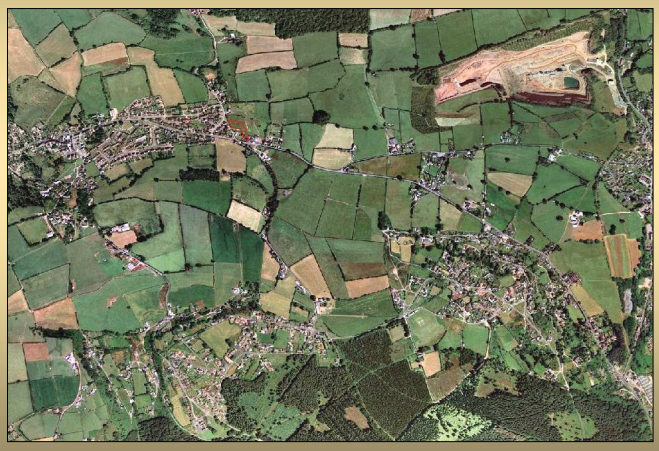
- the use of ploughing is a weakness of organic farming
- higher yielding systems can build up more soil carbon
- the higher microbial life of OF may be a disadvantage
- applying high levels of organic matter has little result
- sequestration is not continual but mainly in early years
- soil carbon sequestration is non-permanent, reversible

Assumptions - are they really true?

No, the evidence and analysis shows they are incorrect:

- higher crop yields means more organic matter is being *removed* from the farm. In FiBL trial, the non-organic system yielded more but did not build more soil carbon.
- **Below-ground biomass & soil micro-organisms are also factors**. In Rodale, despite similar above-ground C input, organic systems produced more SOM.
- ability to build soil C within 20 years is a real strength!

Role of agricultural policy



Policy approaches

The soil C benefit should be recognised by policymakers:

- **product of organic** system, no need specific practices
- benefit calculated **in relation to the target level**
- may not offset farm GHGs, but **other policy benefits**:

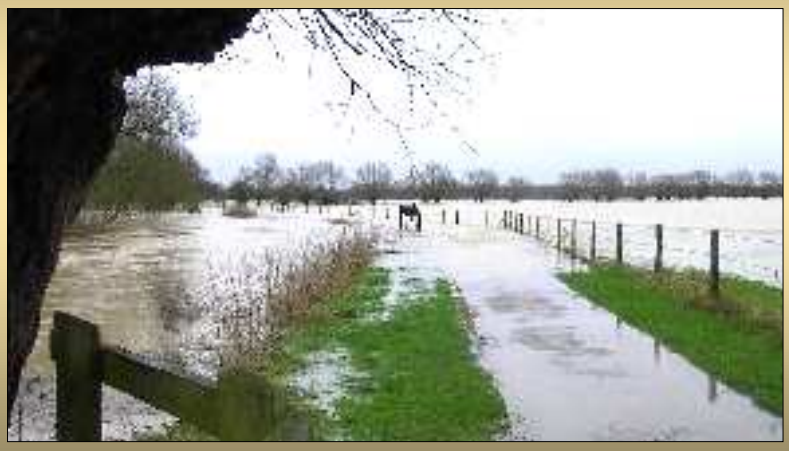
(i) reduces drought impact & irrigation need in agriculture

(ii) water-holding capacity reduces flood risk for society

(iii) humus promotes the dietary nutrient supply (minerals)

(iv) soil humus & microbes support biodiversity.

Surface water flooding is caused by soil saturation



Conclusion

- Organic farming produces higher soil carbon levels than non-organic farming, as a product of the system
- produces higher total biomass and soil microbial levels
- potentially a significant benefit for mitigating climate change and also delivers other major policy benefits
- soil carbon should be included in all GWP assessments of organic farming, and the expansion of organic farming should be promoted for its soil carbon benefits.

The End

[Thanks to those who provided the photographs]