



**Centre for  
Ecology & Hydrology**

NATURAL ENVIRONMENT RESEARCH COUNCIL

# The Impacts Of Bioenergy Systems On Soil Carbon

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# The In's & Out's of Perennial Bioenergy Crops & Soil C Stocks



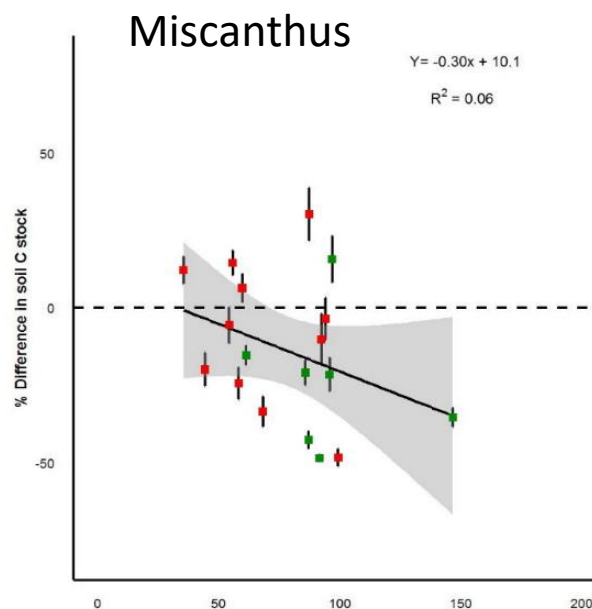
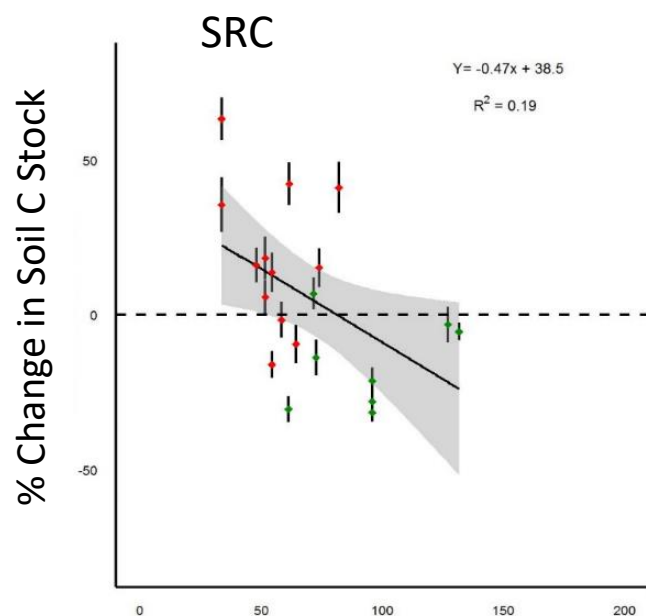
- Impacts on soil C stocks of LUC to the perennial bioenergy crop SRC willow and Miscanthus (Elum 2011 – 2015)
- Impacts of soil C stock of perennial bioenergy crop removal (MAGLUE 2015-2018)



# Impacts on soil C stock of LUC to Bioenergy cropping

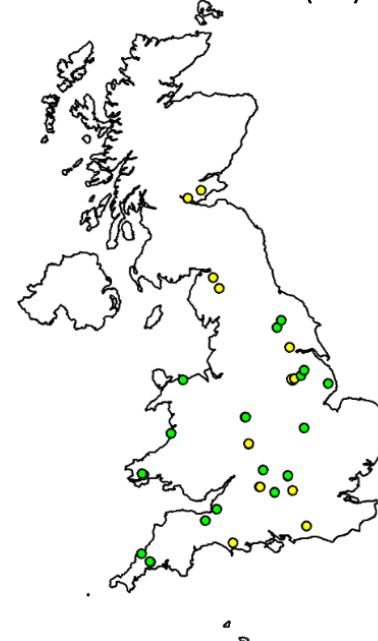
- Surface soil C stocks (0-30 cm) were negatively correlated with carbon stocks in the reference /paired sites
- No impact on soil C stock over 0-1m soil profile

Rowe et al., 2016, doi.org/10.1111/gcbb.12311



Reference soil C stock (t C ha<sup>-1</sup>)

- *Miscanthus* (20)
- SRC – Willow (21)



Based on ESM reference mass of 3 Gg ha<sup>-1</sup> ( $\chi^2(1) = 8.70$ ,  $p = 0.003$ )

# The In's & Out's of Perennial Bioenergy Crops & Soil C Stocks



- Impacts on soil C stocks of LUC to the perennial bioenergy crop SRC willow and Miscanthus (Elum project 2011 – 2015)
- **Impacts of soil C stock of perennial bioenergy crop removal (Maglue 2015-2018)**



# Impacts on soil C stock of Bioenergy crop removal and reversion

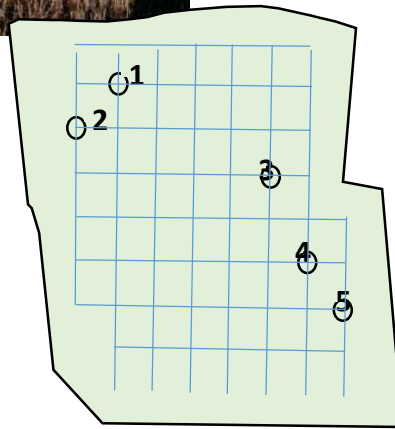
- *Miscanthus* reversion (2)
- SRC willow reversion (2)
- *Miscanthus* tillage (1)



Commercial Paired  
fields

**9 x Deep (0-1 m)  
cores per field**

15 x Surface soil  
(0-30 cm) Per field



Soil C stock calculated on  
equivalent soil mass (ESM)  
bases to account differences in  
bulk density

# Impacts on soil C stock of Bioenergy crop removal and reversion



Ideally each site would have 2 paired counterfactuals

- Retained bioenergy crop
- Arable control

SRC sites x 2

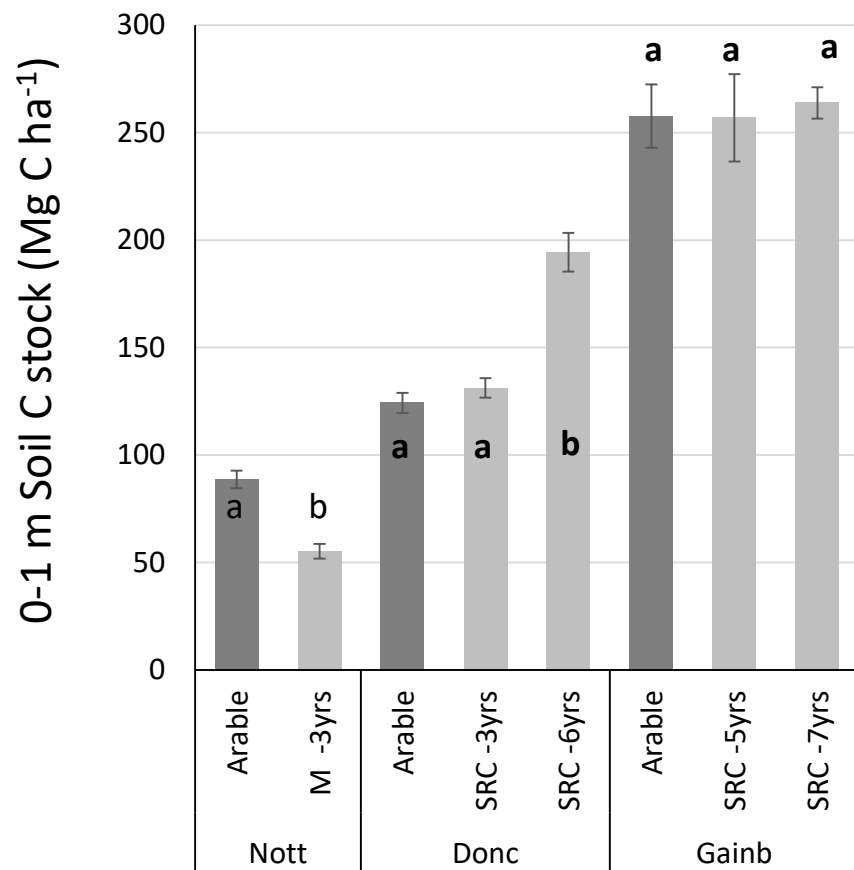
- All bioenergy crop removed only arable controls

Miscanthus sites

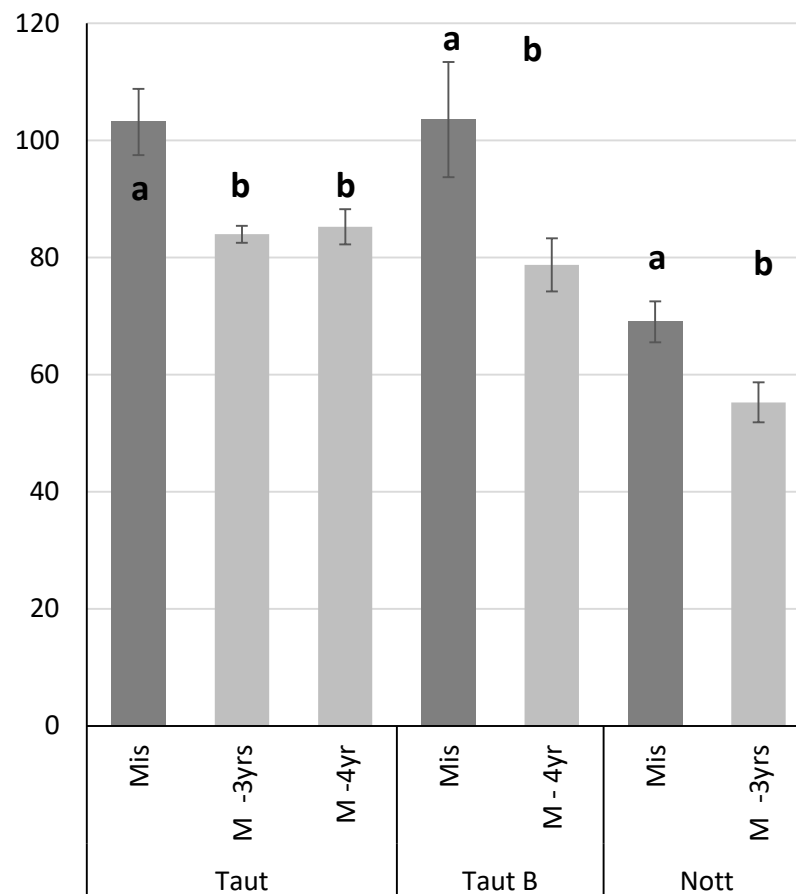
- 1x Retained bioenergy crop & arable control
- 1x Retained bioenergy control

# Impacts on soil C stock of Bioenergy crop **removal and reversion**

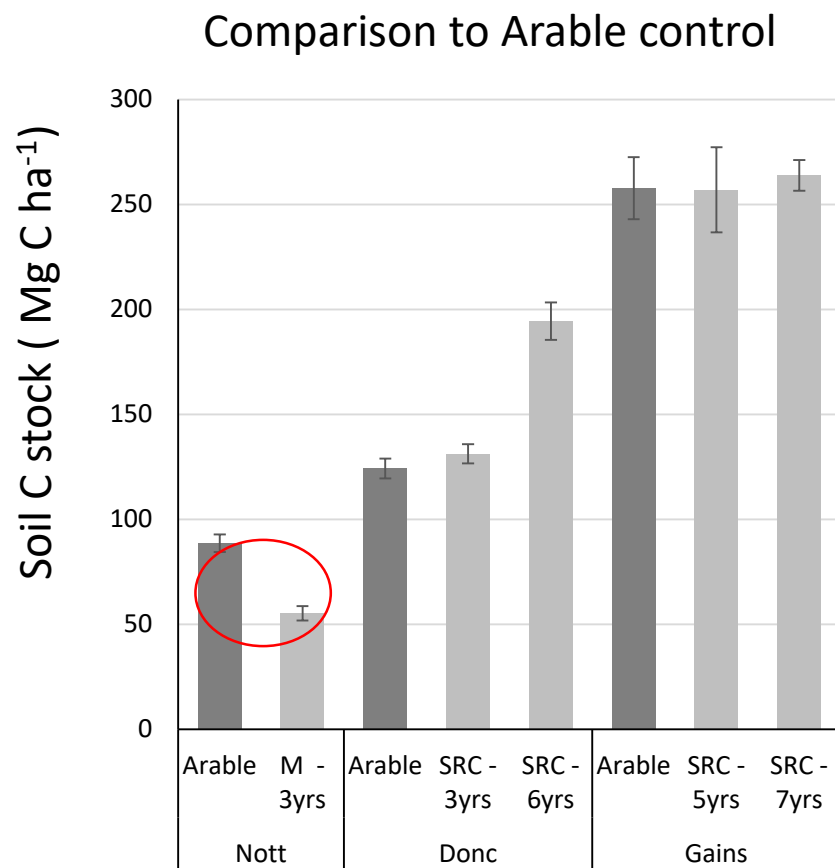
Comparison to Arable control



Comparison to retained bioenergy



# Impacts on soil C stock of Bioenergy crop removal and reversion



## Carbon Balance Impacts

Changes in soil C stock compared to arable.

- $-33.38 \pm 5.33 \text{ Mg C ha}^{-1}$

Life time carbon offset provided for Miscanthus

- $35\text{-}137 \text{ Mg C}_{\text{offset}} \text{ per ha}^{-1}$

# Impacts on soil C stock of Bioenergy crop ~~removal~~ and reversion regeneration



Image: FWC Fish and Wildlife research Institute, <https://www.flickr.com/photos/myfwc/4949117702/in/photostream/lightbox/>

# Impacts on soil C stock of Bioenergy crop ~~removal and reversion~~ regeneration



Lincolnshire commercial  
Miscanthus planting.

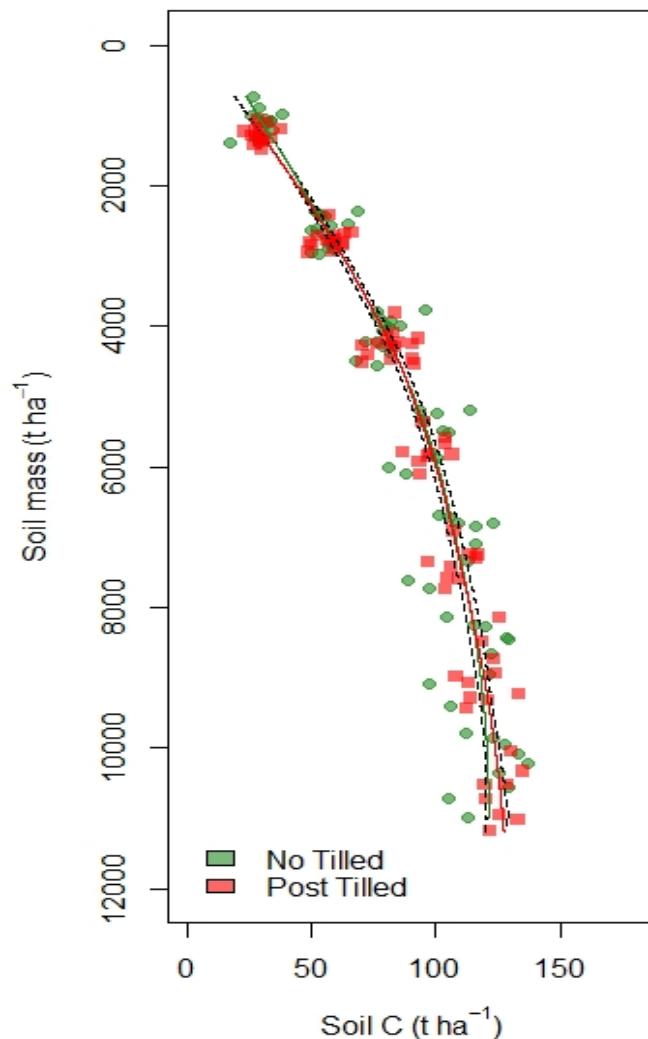
Two fields Planted 2006

Mis-D was disked in 2013

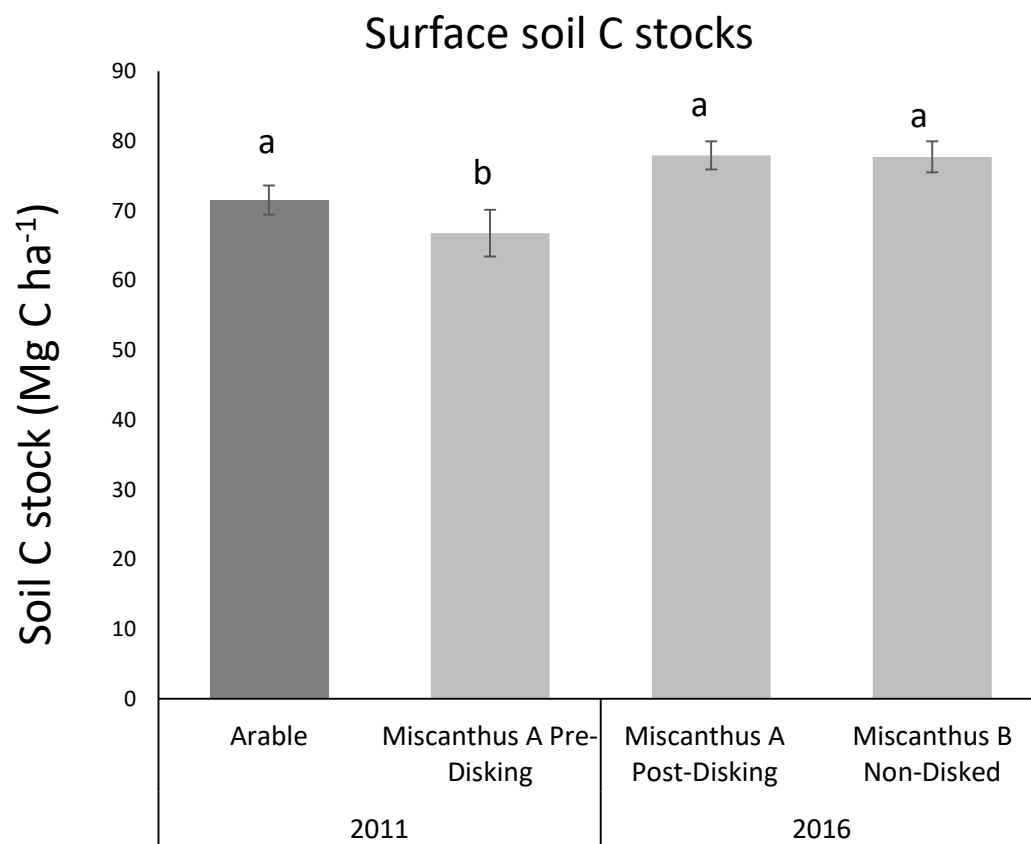
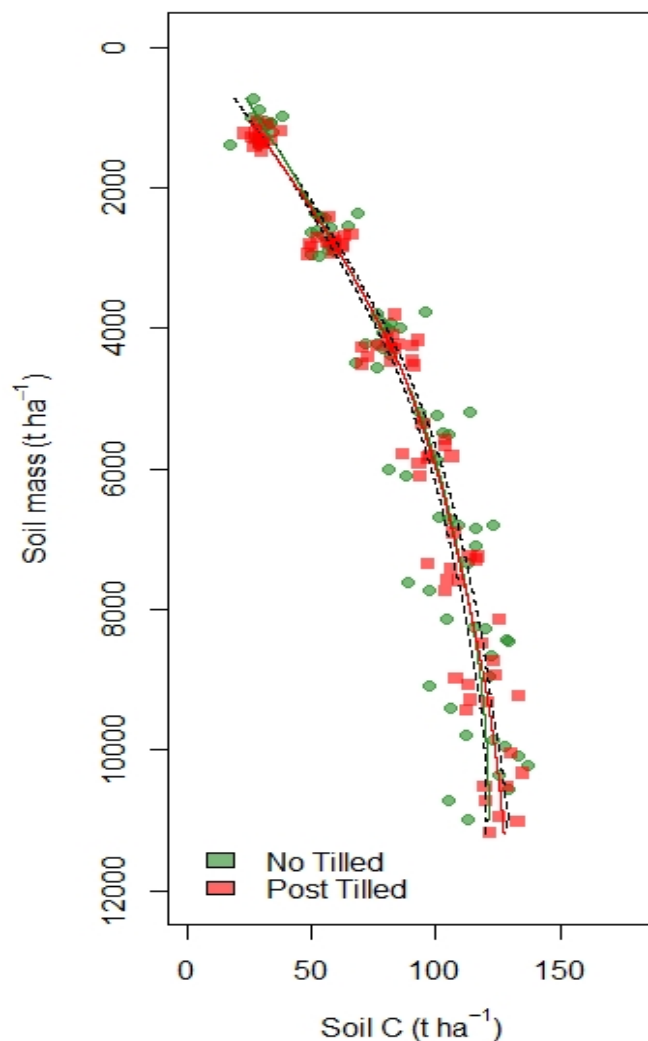
Soil sampling conducted in  
2016

Archived soil samples from  
2011

# Impacts on soil C stock of Bioenergy crop ~~removal and reversion~~ regeneration



# Impacts on soil C stock of Bioenergy crop ~~removal and reversion~~ regeneration



# Conclusions & Next Steps

- IN's
  - Planting bioenergy crops on low C soil and maximising the life span of the crops offer the greatest potential to increase soil C storage.
- Out's
  - Soil C stock can be impacted by crop removal but overall carbon balance will depend on full life cycle and following management
  - In regards to soil C conservation, regenerative tillage of Miscanthus may offer better option than removal and replanting.
- Next
  - Scenario based temporal landscape scale modelling is required to predict long term impacts for regional/national soil C storage of bioenergy crop rotations – beyond the field.



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# Questions

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