Utilising hedgerows for landscape scale carbon sequestration

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Modelling hedgerow carbon sequestration

- UK field margins showed potential to sequester 0.1 to 2.4% of 1990 CO_2 emissions (Falloon *et al.* 2004)
  - Biomass + 1 t C ha^{-1} yr^{-1} for newly planted hedges for 5 years
  - Soil carbon + 1.23% yr^{-1} until equilibrium
- National/International GHG accounting
  - UK LULUCF GHG Inventory
    - Modelled changes to hedge length within grassland
    - 456 000 km of hedge in England and Wales (Carey *et al.* 2008)
- TWECOM - hedgerow management for wood-fuel (Crossland 2015)
- Local/Farmscale
  - Various Carbon accounting tools
    - Carbon neutral or calculated from model

Hedge management and Above Ground Biomass carbon lifecycle

Hedge management stage	1-2 Over-trimmed	3 Over-trimmed	4 Recently coppiced/ laid	5 Healthy	6a &6b Healthy	7 Healthy	8 Mature	9 Over-mature	10 Line of trees
Non-intervention	←Intense trimming $\uparrow CO_2$				Growth to next stage $\downarrow CO_2$				
Intervention	Coppice	Let up	Coppice or lay	Incremental trim	Trim or letup	Coppice or lay	Coppice or reduce	Coppice	
	$\uparrow CO_2$	$\downarrow CO_2$	$\uparrow CO_2$			$\uparrow CO_2$	$\uparrow CO_2$	$\uparrow CO_2$	

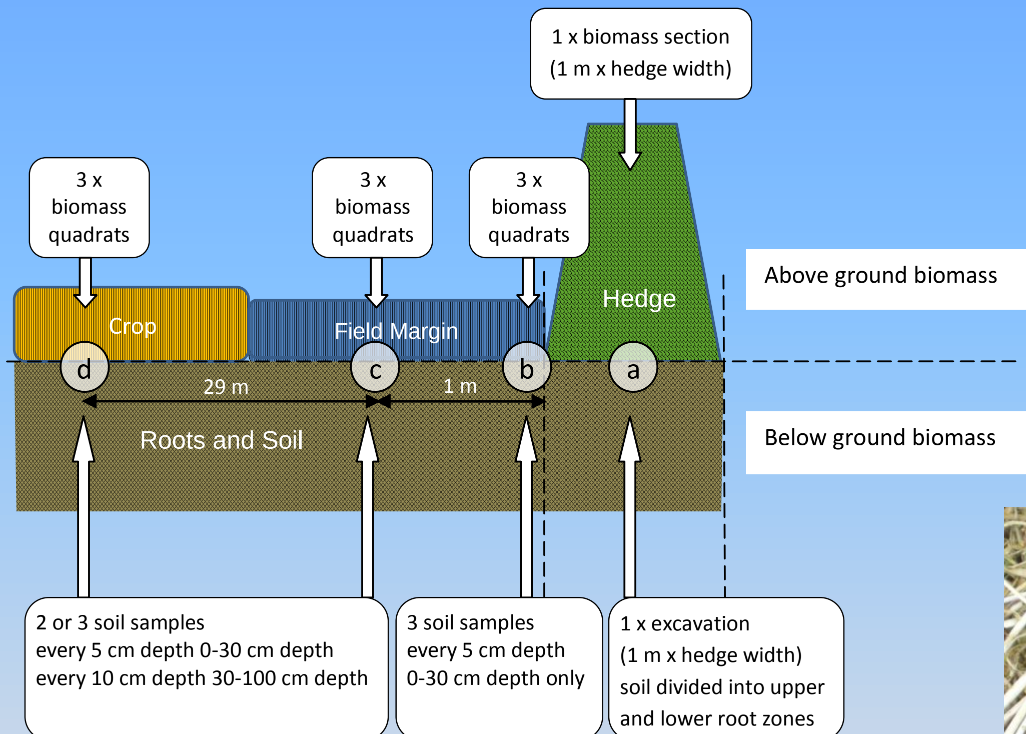
- If restorative management continues on same rotation – no change
- Alter the height distribution of hedges?
- Use for wood fuel?

Photographs Hedgelink (2018a)
Management cycle adapted from Adams (2018) & Hedgelink (2018b)

Lowland Arable Hedgerows

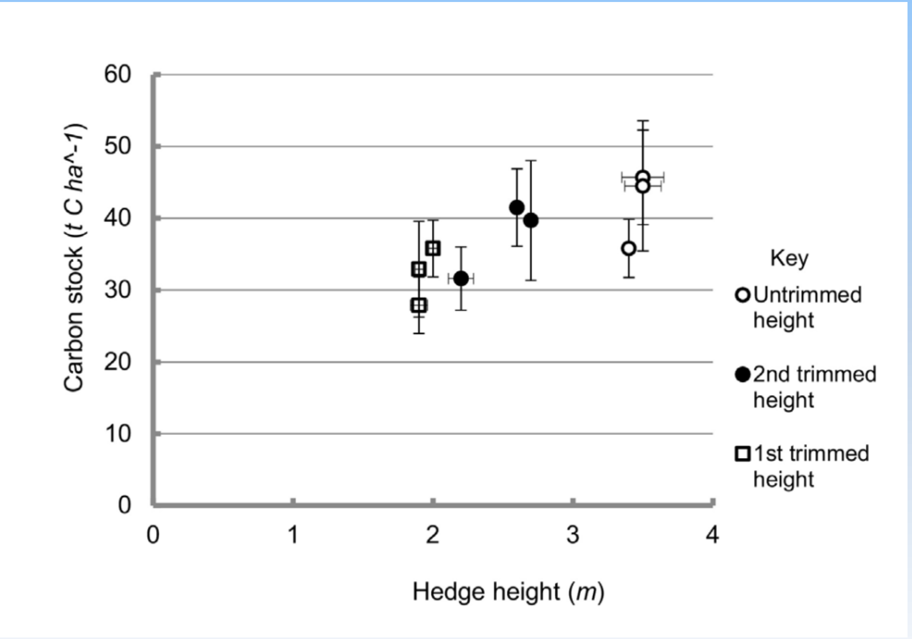
- Stratified random sampling from Harnhill Manor Farm (RAU)
- One annually flailed hedge
- A minimally managed ‘untrimmed’ hedge
- Three tri-annually trimmed hedges

Sampling Strategy

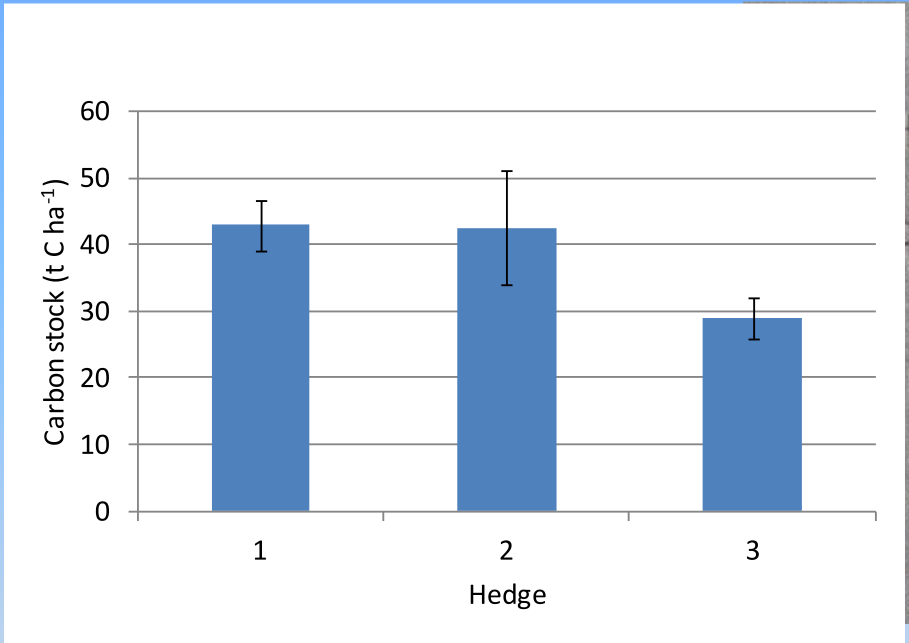


Above Ground Woody Biomass

- Measured 3 growth stages
  - 40.6 ± 4.47 t C ha^{-1} trimmed to 2.7 m high
  - + 6.2 t C ha^{-1} mean height increment of 0.7 m

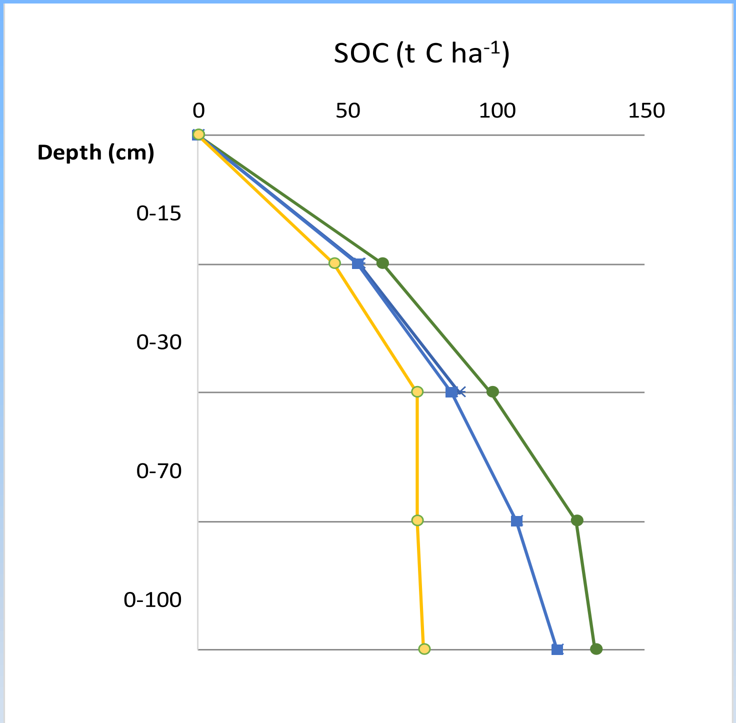


Below Ground Woody Biomass



- BGB C stock higher than expected 38.2 ± 3.66 t C ha^{-1}
- BGB:AGB 0.94:1
- Large quantity of C in stump/root crown (43% of BGB C; 16.3 t C ha^{-1})

Soil Organic Carbon

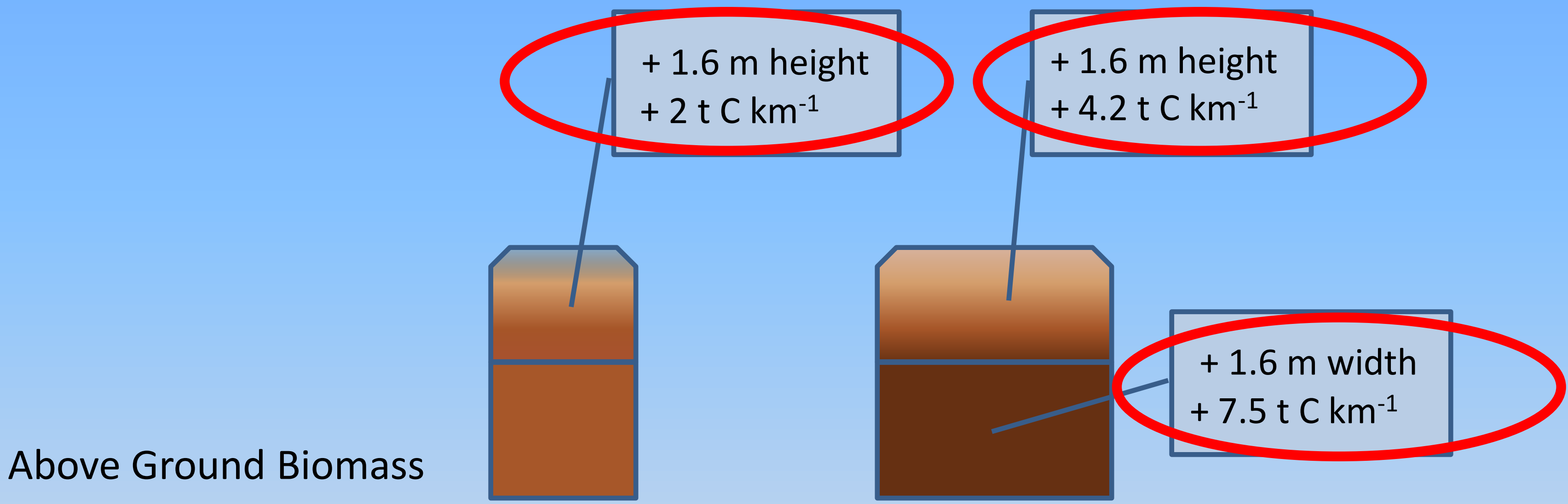


- Land use effect at 0-15 cm depth very highly significant ($H = 21.26$, $p<0.001$)
- Hedge SOC = 133.5 t C ha^{-1} at 100 cm depth
- Complex – site effect significant from 25 cm depth ($H = 6.04$, $p<0.05$)

  - Site 2 and 3 stones became abundant (>36%) at significantly less depth in Arable (28.2 cm), compared to Hedge (43.3 cm) ($F= 13.89$, $p <0.05$)

  - Soil lost from arable area?

Utilising the hedge for carbon sequestration



- **Wider hedges were more efficacious at storing C than taller ones**
- Typical hedges: Flailed, narrow (77% hedges < 2 m wide), 90% contain Hawthorn, 50% contain Blackthorn (Barr *et al.* 2000; Britt *et al.* 2011).
- Lateral outgrowth of Blackthorn - response to competition (Küppers 1985).
- BGB/SOC is not all lost with coppicing/laying

National scale

-	SOC			Below ground biomass			Above ground biomass			Total		
Management type	Mt C	Mt CO_2e	% of GHG reduction target of 236 Mt CO_2e	Mt C	Mt CO_2e	% of GHG reduction target of 236 Mt CO_2e	Mt C	Mt CO_2e	% of GHG reduction target of 236 Mt CO_2e	Mt C	Mt CO_2e	% of GHG reduction target of 236 Mt CO_2e
Hedge height distribution unaltered												
Width increased to 2.5 m	0.7	2.6	1.1	1.7	6.2	2.6	1.3	4.8	2.0	3.6	13.2	5.6
Width increased to 2.5 m and gapped up	0.7	2.6	1.1	1.7	6.2	2.6	1.4	5.1	2.2	3.7	13.6	5.7
Width increased to 3.5 m	1.2	4.4	1.9	3.3	12.1	5.1	2.5	9.2	3.9	7.1	26.0	11.0
Width increased to 3.5 m and gapped up	1.2	4.4	1.9	3.3	12.1	5.1	2.7	9.9	4.2	7.3	26.8	11.3
Hedge height altered - no hedge below 2.5 m high												
Width increased to 2.5 m	0.7	2.6	1.1	1.7	6.2	2.6	1.6	5.9	2.5	3.9	14.3	6.1
Width increased to 2.5 m and gapped up	0.7	2.6	1.1	1.7	6.2	2.6	1.8	6.6	2.8	4.1	15.0	6.4
Width increased to 3.5 m	1.2	4.4	1.9	3.3	12.1	5.1	3.2	11.7	5.0	7.8	28.6	12.1
Width increased to 3.5 m and gapped up	1.2	4.4	1.9	3.3	12.1	5.1	3.5	12.8	5.4	8.1	29.7	12.6

Agricultural industry's ambition - reduce GHG emissions by 3 Mt C by 2020 (DEFRA 2014)

Carbon sequestration from hedgerows on a landscape scale

- Changes in distribution of the different stages of hedge growth will be needed in ***a landscape area*** to achieve long term Carbon sequestration
  - -Incremental raising of trimmed height could contribute to this

- Increasing *width* of hedgerows is an efficacious method to increase biomass C / SOC pools
  - This would depend on *landscape area* capacity

    e.g. In arable areas with neglected hedges → wide low hedges
  - Utilise the 2 m uncultivated land either side of centre of hedge

- Priority order for hedge management woody waste
  1) Discard on site (flail or chip)
  2) Use for wood-fuel
  3) Burn on site

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Questions?