Agroforestry as a land use option to sequester carbon in a cool temperate climate

Large Park, Hillsborough
Northern Ireland
United Kingdom
Agroforestry in a Cool Temperate Climate
An Overview in the United Kingdom

The National Network Experiment

Experimental sites
4 treatments common to all sites
- Agricultural control (no trees)
- Sycamore (100 stems/ha)
- Sycamore (400 stems/ha)
- Forestry control (sycamore at 2500 ha)
All managed to agreed format

Macaulay Land Use Research Institute

<table>
<thead>
<tr>
<th>Glensaugh</th>
<th>Upland</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>✓</td>
</tr>
<tr>
<td>200</td>
<td>✓</td>
</tr>
<tr>
<td>400</td>
<td>✓</td>
</tr>
<tr>
<td>2500</td>
<td>✓</td>
</tr>
</tbody>
</table>

Contact: Alan Smith (phone 0131 662 5411)

Loughgall
Lowland
- Local treatments: Ash
- 100, 200, 400, 2500

Broughshane
Upland
- Local treatments: Indigenous swards
- Reseed - grass only
- Reseed - grass & clover
Contact: Jim McAdam (phone 01977 605805)

Anglesey
Lowland
- Local treatments: Ash, Hybrid larch
- 100, 200, 400, 2500

Institute for Grassland and Animal Production

Bronwyd Mawr
Upland
- Local treatments: Ash, Hybrid larch
- 100, 200, 400, 2500

Institute for Grassland and Animal Production

North Wyke
Lowland
- Local treatments: Ash
- 100, 200, 400, 2500

Contact: Nigel Talbot (phone 0853 710 520)
Agriculture is dominated by grassland production. 93% of the total farm area is devoted to either improved grassland or rough grazing. The intensive production sector is generally characterized by high production grass varieties coupled with high rotation rates. More extensive production systems tend to have mixed swards/low rotation rates or unimproved grassland.

Grassland production in Northern Ireland, at both intensive and extensive scales, takes place across a wide range of soil types, altitudes and climatic subtypes.
The UK Climate Change Act 2008, which extends to Northern Ireland, requires an 80% reduction in emissions across all sectors by 2050.

Agriculture accounts for 28% of GHG emissions in Northern Ireland or 5,780 tonnes of CO$_2$ equivalent.

The nature of GHG emissions and the economic importance of the sector in Northern Ireland, mean that agriculture is the largest source sector of GHG emissions.

It is thought that agroforestry can result in higher C storage than grassland through additional above and belowground biomass stocks.
Aim

This study investigated the potential of agroforestry, compared to the dominant land use (grassland), as a land use mitigation option to sequester carbon to assist with Northern Ireland’s GHG reduction targets.
Materials and Methods

Drawing upon measurements of soil CO\textsubscript{2} fluxes, biomass and SOC at an experimental site in Northern Ireland (UK National Network Silvopastoral Experiment), carbon sequestration rates of 24 year old agroforestry system planted with ash (Fraxinus excelsior) in 1989 at 400 trees/ha (5m x5m square pattern) and grassland plots both grazed by sheep were estimated and compared in 2014.

Overall density of each agroforestry plot was reduced with thinning regimes of trees in 2004 and 2011 (178 trees/ha). Sheep are grazed from April to November.

Fertiliser application (1989 -2000): 120kg Nha\textsuperscript{-1}yr\textsuperscript{-1}, thereafter reduced to 30kg Nha\textsuperscript{-1}yr\textsuperscript{-1}
Experimental site at AFBI Loughgall, Northern Ireland, UK.
Results

Carbon content of tree components growing in agroforestry

Grass yields and Carbon for both systems
Estimated carbon content and rate of fixation in three agroforestry ash plots assessed in 2014 in Northern Ireland. The estimated values presented here are for woody components only of the agroforestry system.

<table>
<thead>
<tr>
<th>Plot</th>
<th>Number of trees/plot</th>
<th>Estimated carbon content/plot (t C)</th>
<th>Estimated yearly rate of fixation (t C yr⁻¹)</th>
<th>Number of trees per hectare</th>
<th>Estimated carbon content per hectare (t C ha⁻¹)</th>
<th>Estimated yearly rate of fixation (t C ha⁻¹ yr⁻¹)</th>
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</thead>
<tbody>
<tr>
<td>AF1</td>
<td>111</td>
<td>31</td>
<td>1.29</td>
<td>202</td>
<td>56.5</td>
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<tr>
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<td>101</td>
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<td>AF3</td>
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<td>32</td>
<td>1.33</td>
<td>168</td>
<td>58.7</td>
<td>2.44</td>
</tr>
</tbody>
</table>
Soil respiration rates in agroforestry and grassland

The Li-8100 Soil CO\textsubscript{2} Flux system which was used to measure CO\textsubscript{2} concentration. Also shown is the Delta HH2 moisture probe and Ebro temperature probe.

Carbon respired (kg ha\textsuperscript{-1})

Mean CO\textsubscript{2} flux (kg ha\textsuperscript{-1} h\textsuperscript{-1})

Date of measurement

AF mean flux
GL mean flux
Soil Organic Carbon in agroforestry and grassland

Soil Organic Carbon (%)
Conclusions

- The results showed that on average grassland respires nearly double that of agroforestry.

- The results also suggest that agroforestry has greater potential than grassland as an option for sequestering carbon, $3.08 - 3.18 \text{ t C ha}^{-1} \text{ yr}^{-1}$ and $0.7 - 0.8 \text{ t C ha}^{-1} \text{ yr}^{-1}$ respectively.

- Trees in an agroforestry system could make an important contribution to carbon sequestration.
• Relatively low levels of forest cover in Northern Ireland suggest that there is scope to expand, subject to the limits of land availability and suitable locations being identified.

• Smaller scale planting through measures, such as this agroforestry system, can make an important contribution to the removal of carbon from the atmosphere.

• There is still uncertainty about the impacts of future climatic changes and elevated CO₂ levels on both land use options capacity to sequester carbon.
Acknowledgements

Thank you!
Any questions?