Can silvo-pastoral agroforestry systems contribute to Scotland’s emission reduction targets?

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Agroforestry in the UK

- The Scottish Government supports a policy to create 10,000 hectares of new woodland per year.
- It is recognised afforestation will provide a significant contribution to achieving Scotland’s long-term greenhouse gas (GHG) emission reduction targets.
- To date, the uptake of woodland expansion opportunities has not reached the target 10,000 hectares per year.
- Current perception for potential loss of productive (agricultural) land has led to reluctance among land owners to convert agricultural areas exclusively to woodlands or forests.
- It is important to identify integrated agroforestry (AF) systems for Scotland and in particular silvo-pastoral (SFS) options that have the potential to minimise land use conflicts.
The UK / Scottish Context

Glensaugh Farm
James Hutton Institute
Agroforestry Demonstration

Bolfracks Estate
Photography by Matthias Kremer for Soil Association

Newtown

Existing guidance
Published 2000
The importance of soil carbon

- Scotland contains high carbon upland soils (peats), organo-mineral soils (peaty soils) and mineral soils including productive agricultural land.
- Detailed data is available online to public

http://www.soils-scotland.gov.uk/data/soil-survey
Calculating carbon impacts

- Assessment of changes in carbon stocks and GHG emissions associated with land-use change from an improved grassland system to an integrated agro-forestry system was made using the information outlined in Equation 1.

\[ \Delta C_{tot} = Soil_{ST} - Soil_{DIST} + GHG_{Grass} + NPP_{Trees} \quad \text{Eq1.} \]

Where:

- \( \Delta C_{tot} \) is total emission or uptake of carbon (t C ha\(^{-1}\))
- \( Soil_{ST} \) is mean soil carbon stock to a depth on 100 cm
- \( Soil_{DIST} \) represents soil carbon loss due to disturbance
- \( GHG_{grass} \) represents net carbon (GHG) of managed grasslands
- \( NPP_{trees} \) represents the carbon sequestered in tree biomass
Conversion to ‘forestry’ at wide spacing (400 stems per hectare) is estimated to require between 12-20 years, depending on tree species yield class, for broadleaf silvo-pastoral agroforestry systems to recover the soil carbon lost during land conversion (example from managed grassland to silvo-pasture).
Managing tree components

- **Wood Biomass**
  Objective: optimize revenue from biomass production

- **Intensive even aged**
  Objective: optimize revenue from (saw-) timber production

- **Combined objective**
  Objective: multiple objectives (e.g. revenue, biodiversity, water protection, soil protection, recreation…)

- **Close-to-nature forestry**
  Objective: to produce wood by emulating natural processes and cycles

- **Forest nature reserve**
  Objective: unmanaged forest to allow development of natural processes without human intervention

- FMA’s focussed on multiple objectives (FMA3) and short rotation forestry (FMA5) are particularly well suited to agroforestry
Short Rotation Forestry can provide biomass and shelter, with additional benefit from substituting the use of fossil fuels.

Matthews & Broadmeadow 2009
The delivery of climate benefits is dependent on soil carbon, tree productivity and silvicultural system.
### Table 1. The combined benefits of agroforestry systems.

<table>
<thead>
<tr>
<th>Agroforestry benefits</th>
<th>Economic and environmental impacts</th>
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<tbody>
<tr>
<td>Diversification of farm income</td>
<td>Silvo-pastoral systems can provide additional income through thinning, timber production and farm subsidies.</td>
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<td>Shelter for livestock</td>
<td>Trees can provide shelter during extremes of temperature in both summer and winter. Livestock have been shown to prefer birthing in/close to woodland areas.</td>
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<td>Fuelwood supply</td>
<td>The residues from canopy management and thinning can provide additional fuelwood for combined heat and power generation.</td>
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<td>Carbon sequestration and GHG mitigation</td>
<td>Trees can significantly increase carbon sequestered in biomass while grassland productivity can be maintained with suitable planting densities. Some carbon will however be lost from the soil stocks due to disturbance during planting. Residual soil nitrogen will be utilised by the trees potentially reducing nitrous oxide emissions.</td>
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<td>Nutrient management</td>
<td>The utilisation of nitrogen fixing tree species such as Alder can reduce fertilisation requirements of the understorey grass canopy.</td>
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<td>Soil erosion and leaching</td>
<td>The presence of trees will aid soil stability and increase the interception and retain precipitation, reducing particulate erosion and diffuse pollution.</td>
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<td>Biodiversity</td>
<td>Integrated agroforestry systems can improve habitat fragmentation in rural and agricultural landscapes.</td>
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<td>Amenity value</td>
<td>The presence of woodlands and in particular broadleaf trees has been shown to improve the aesthetic and amenity value of rural landscapes.</td>
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Significant carbon and greenhouse gas emission savings can be made through silvo-pastoral agroforestry systems in which woodlands or forests are integrated with forage and livestock production systems.

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