Farm Woodlands Information Sheet

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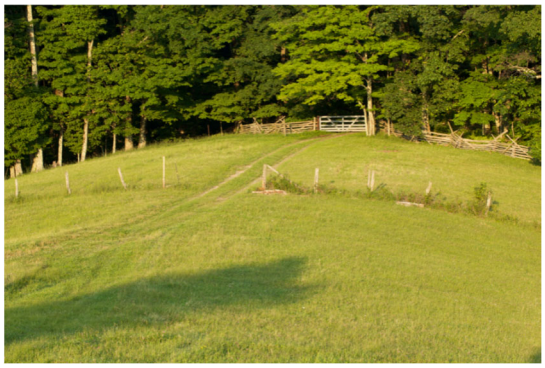
Trees and Carbon Capture

Carbon emissions are dominating headlines due to the recent release of the Intergovernmental Panel on Climate Change 6th assessment report and the evident effects of climate change, which have contributed to major environmental impacts such as windthrow of forests, forest wildfires and flooding .

Within Scotland's land use sector emissions from agriculture are directly responsible for 21% of total greenhouse gas ($CO2_e$) emissions, whilst forestry is the primary land sink, mopping up 12% of total greenhouse gas ($CO2_e$) emissions. This makes agriculture, which only accounts for <1% of GDP, the third highest emitter of carbon after transport and business, although it is likely to overtake business in the near future as this sector continues to decarbonise. Therefore steps to improve the land use sector 'carbon balance' need to focus upon emissions reduction and activities to lock-up CO_2, primarily through afforestation and peatland restoration.



Carbon on the farm

All plants capture CO_2 from the atmosphere through photosynthesis and store this as carbon. However, during the process of these plants being used as food, products or fuel, carbon is returned to the atmosphere through respiration, decomposition or burning. Extra carbon emissions are also generated in the growing and processing of these plants through the use of of machinery , fertiliser etc. To counter these losses and emissions, we can look to increase the amount of carbon stored by plants or reduce the input emissions. One way to increase net carbon storage on land is to increase forest cover, the carbon stored in agricultural (mineral) soils and lock up carbon in long life timber products. Emissions can be reduced by, amongst other things, being more efficient with diesel, reducing food waste, reducing nitrate/fertiliser use, managing slurry, cleaner burning, stock reductions and peatland restoration.

Reducing carbon on the farm through reduction in emissions and by offsetting with greater carbon storage carries several potential benefits:

- Lower input costs
- Access to new markets (as supermarkets decarbonise supply chains, zero carbon food may become more desirable)
- New products, e.g. biomass & timber
- Compliance
- Carbon offsets

As with any change there may be potential downsides too:

- Lower yields
- Higher input costs
- Capital expenditure
- Risk (although there is also a risk of not making changes)

The webinar on which this publication is based can be viewed here

Capturing and storing carbon in trees

Agricultural land use is primarily a net emitter of greenhouse gases whilst woodland has the potential to reduce emissions by acting as a carbon sink (Table 1).

How do we assess the CO2 benefit of forests? Detailed Forest Research experimental sites, in Sitka spruce and oak dominated woodlands, show maturing commercial spruce captures ~25t CO_2 per hectare per year and the Oak-mixed deciduous woodland captures approximately 18t CO_2 per hectare per year (Figure 1).

Such estimates underpin national scale modelling which demonstrates that UK woodlands contribute a substantial net uptake of 17 Mt CO_2 per year.

Table 1. Breakdown of emissions from agriculture, forestry and other land use.

Emission Type	Reason	Amount of Emissions
Farm carbon dioxide	Burning diesel	1 $MtCO_2e$
Farm methane	Ruminant livestock	4$MtCO_2e$
Farm nitrous oxide	Fertiliser use	3$MtCO_2e$
Soil carbon dioxide	Degraded peatland	8$MtCO_2e$
Soil methane	Degraded peatland	3$MtCO_2e$
Tree carbon dioxide	Carbon capture	-9.5$MtCO_2e$

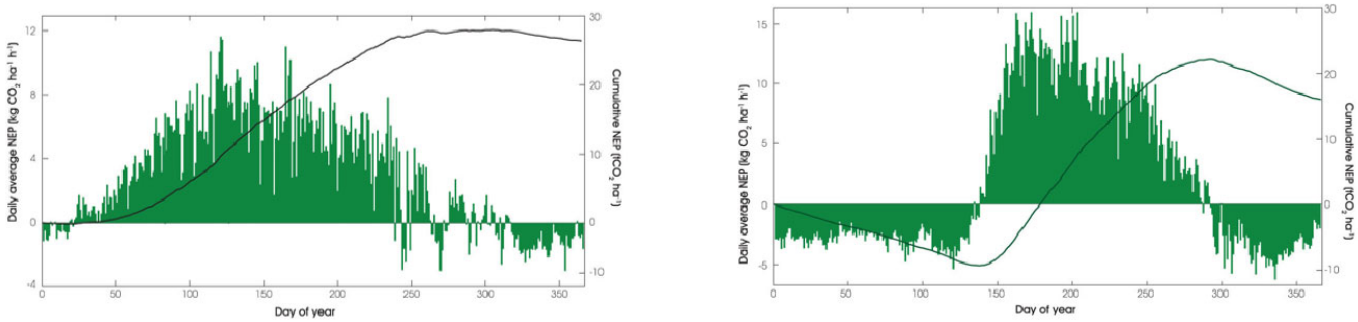


Figure 1. Carbon capture/loss measured for two contrasting forest types.
Figures under the zero line are losses due to respiration. Figures above the zero are gains where photosynthesis exceeds respiration at the stand level, measured as Net Ecosystem Productivity of the forest stand. Solid line is cumulative capture. (Left panel: Sitka Spruce; Right panel: Oak dominated mixed deciduous woodland.)

What about soil disturbance when planting trees?

The planting of trees requires some form of soil preparation to ensure that establishment is successful. Ground preparation leads to some carbon release which can vary depending on the type of ground preparation used and the organic content of the soils. The type of trees planted and the way they are managed will determine how much carbon is captured. Carbon captured by tree growth is offset against soil carbon losses during establishment to give a net figure.

These net figures differ in value depending upon the carbon content of the soil and the management regimes, with native conifers giving the lowest net value and productive Douglas fir the greatest.

All types of new woodland, over time, do provide net climate mitigation benefits, with the major influence upon the rate of delivery being the balance between growth rate and soil carbon content and loss due to soil disturbance at establishment.

When woodlands are thinned or harvested the use of wood products provide an additional substitution benefit which also helps mitigate climate change

Maximising carbon capture through trees

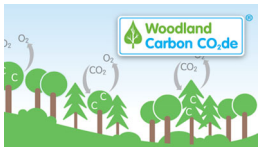
The Scottish Government's ambition for Net Zero by 2045 assumes that forestry should deliver a net capture of carbon of >1.05 t/ha/year over 20 years. To achieve this ambition there will be a requirement to plant a significant amount of productive species on better quality mineral soils to achieve a higher net carbon capture over a shorter period of time whilst minimising soil carbon loss. The Scottish government recognises forestry as a reliable and cost-effective way to lock away carbon. To that end they support the creation of multiple types of woodland on multiple land capability classes.

Additional Forest Benefits

Standing trees sequestering carbon are beneficial in their own right. However, when this stored carbon, in the form of wood products, is used as a substitute for more carbon intensive materials such as concrete, steel and plastics the benefit in reduced emissions is multiplied.

Woodlands can provide a screen which captures ammonia pollution and can reduce diffuse pollution (run-off) through riparian tree planting to reduce nitrate leaching. Shelterbelts are also known to improve upland animal welfare

Woodland carbon code



In addition to the grant aid for woodland creation, revenue can be generated through the issuance of carbon credits for the carbon that the woodland will capture. Amongst the requirements to be able to apply and be successful for the WCC scheme is the concept of 'additionality'. The is, there is no legal requirement to plant the trees and the woodland creation would not be able to go ahead with out the financial contribution from the carbon credits. Find out more at https://woodlandcarboncode.org.uk

Integration not replacement

To meet the goal of >1.05 t/ha/year net carbon over 20 years tree planting will need to move 'down the hill'. This will produce faster growing trees and reduce soil carbon release by avoiding high carbon soils. However, land is a valuable commodity and these trees will need to be integrated into the productive agricultural landscape.

Forestry can be integrated with farming through planting trees on those areas of the farm which are of low or limited value to agriculture thereby forming various types of agroforestry.

This might involve planting areas of the farm of low or limited value to agriculture to create new woodlands, the planting of shelterbelts or along riverbanks and dens, trees managed at wide spacing to allow grazing or even crop production below, and small groups of trees in agricultural landscapes.

The addition of trees to a farm has multiple benefits which include, but are not limited to, livestock shelter, reduced feed costs, reduced risk of flooding, increased animal welfare, reduced soil erosion, management of runoff, reduced ammonia emissions and an alternative source of income. At its best, agroforestry enables the sum of production from both trees and agriculture to be greater than either one or the other, although a fully functioning system may take some decades to develop. Currently grant support for agroforestry is limited by area and the Land Capability for Agriculture Class (3.1 to 4.2 inclusive). The better quality of the land the greater the potential for carbon sequestration and financial return (Table 2).

Table 2. Typical Agroforestry Management Alternatives that could be deployed with key Land Capability for Agriculture classes. The AFMAs (AMA) are not exclusive as some species and management types will be suitable for more than one LCA class but are indicative. (Adapted from Perks et al 2018 "CxC Agroforestry")

Land yield and productivity	Agricultural land type Agroforestry option [LCA CLASS]	Predominant agroforestry management option	Land potential Tree productivity	Carbon sequestration potential (C Stock @ Year 40) [t C ha^{-1}]
LOW	Lowest Quality Rough Grazing *"Sheep & Trees"* [LCA 7.0]	**Upland wood pasture** Native Scots pine woodland & Low productivity native broadleaf (AMA 1) (AMA2)	Extensive upland *Poor Do not plant peat>50cm deep*	Negative to Moderate [-6.2 to 45.6] *Negative C stocks possible with organo-mineral soils.*
	Poor Quality Upland Rough Grazing *"Sheep & Trees"* [LCA 6.1 – 6.3]	**Lowland wood pasture** Multipurpose Broadleaf & Multipurpose Conifer (AMA 3) (AMA4/5/7)	Extensive upland *Moderate-Good*	Negative to Moderate [-6.2 to 51.5] *Negative C stocks possible with organo-mineral soils*
	Improved Grassland *"Livestock & Trees"* [LCA 5.1 – 5.3]	**Shelter Belts for Livestock** Multipurpose Broadleaf & Productive Conifer (AMA 3) (AMA 7/8)	Intensive upland *Moderate-Very Good*	Low to Moderate [1.1 to 62.5]
	Mixed agriculture *"Livestock & Trees"* [LCA 3.2 – 4.2]	**Buffer Strips or Shelter Belts for Livestock** Productive Broadleaf & Productive Conifer (AMA 3/9) (AMA 6/7)	Lowland *Very Good – Excellent*	Good [12.8 to 77.5]
HIGH	Arable agriculture *"Arable & Trees"* [LCA 2.0 – 3.1]	**Buffer strips for Arable** Short Rotation Forestry, Productive conifer & broadleaves, silvo-arable (AMA 9) (AMA 7)	Lowland *Very Good - Excellent*	Good [12.8 to 77.5]