

Evidence base for agroforestry and potential carbon-neutral livestock systems: a 30-years replicated trial comparing grassland, silvopastoral and woodland systems in Northern Ireland

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The European Agricultural
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Overview

- Rationale behind 30 years experience with agroforestry
- What measurements were taken and what climate benefits were shown
- Role of the CAP & EU
- Conclusions and next steps

Rationale

30 years ago our driver was to : Make grasslands in Northern Ireland more sustainable by increasing tree cover to improve biodiversity, nutrient capture and water quality & soil health.

Considerable investment went into establishing a replicated trial comparing grassland, silvopastoral and woodland systems.



Pasture with perennial ryegrass (*Lolium perenne*)



Silvopastoral system planted with ash (*Fraxinus*) trees (400 stems ha⁻¹)



Woodland planted with ash trees (2500 stems ha⁻¹)

This was a very typical site of the whole region-over (90% of farming in N Ireland is grassland) on a grassland research station

Sustainability benefits measured

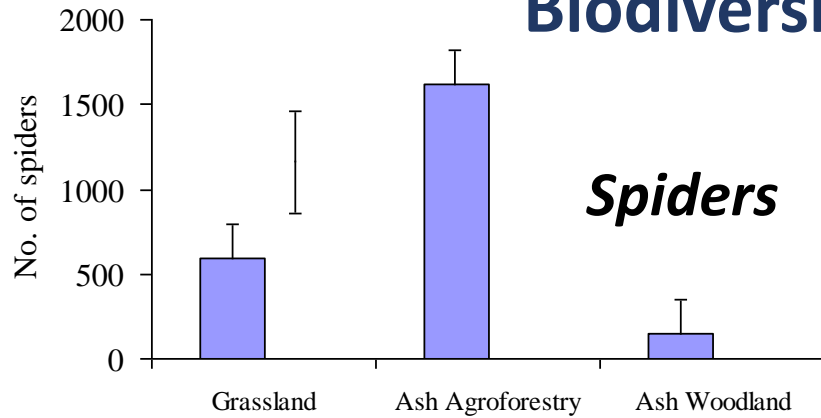
1. Economic performance

- outputs of all components of the system
- Basic payment throughout
- Full livestock output for 12 years then steady decline-decision time
- Year 13 removed 25% of trees –sold for €1048 ; allowed livestock production to creep up
- Year 17 removed more trees –now about 70% livestock potential with c 220 trees/ha
- Animals consumed tree foliage and had enhanced welfare environment

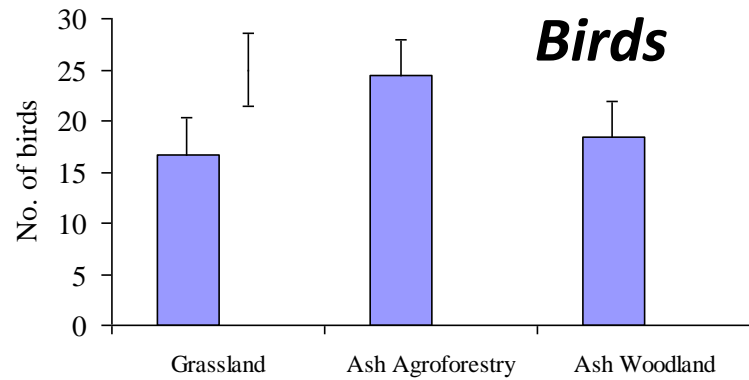
2. Environmental benefits

- Weather modifications-evapotranspiration reduced
- Biodiversity
- Soil nutrient status
- Soil carbon content
- Emissions
- Water permeability through soil profile

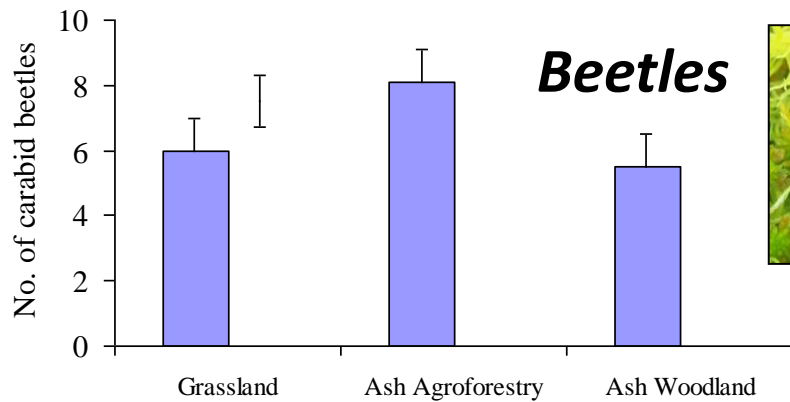
Biodiversity benefits



Earthworms



Flora



Pollinators

Carbon content

In the trees

From complete tree harvesting (24 years old), the total carbon in the woody biomass of agroforestry grown trees was **77.13 t C/ha**.
Annual carbon sequestration rates estimated **2.38 t C/ha/yr**

In the soil

The soil carbon pool stored in the ash silvopasture is on smaller soil particles than in the other systems- this carbon pool is said to be more resilient to environmental change than in pasture alone

In the pasture

Fixation rates in this type of soil/pasture **0.8 t C/ha/yr**

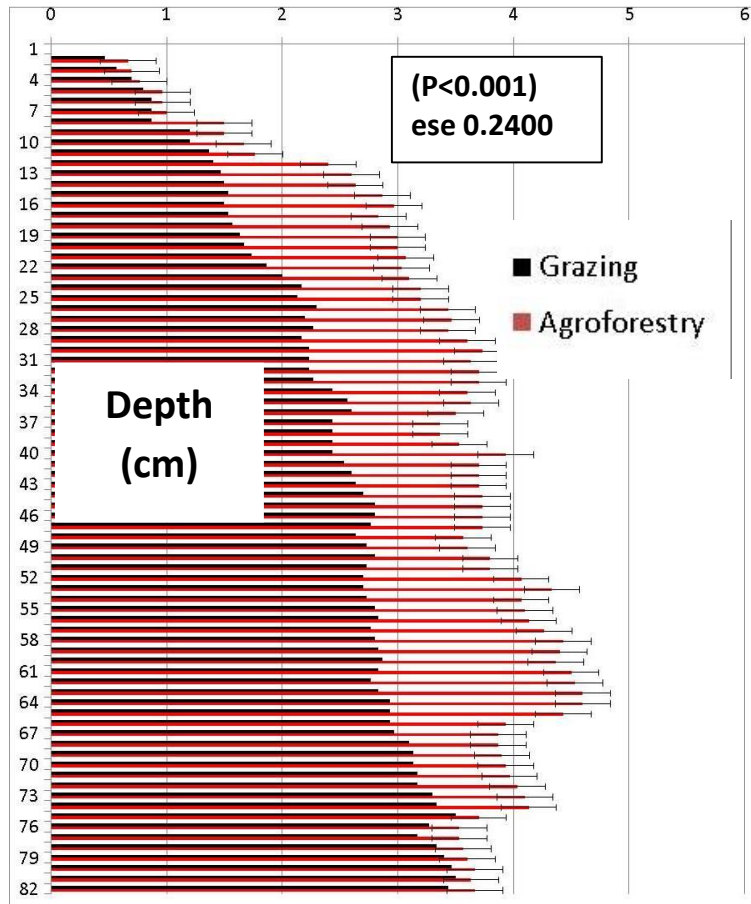
Land Use Practice	Species	tC/ha/yr
Silvopasture (tree component only)	Ash	2.4
Pasture	Perennial ryegrass	0.8

Silvopasture –the trees plus the understory sward –is sequestering around 3.2 tC /ha/yr

Water in agroforestry

Penetrometer measurements through the soil profile

infiltration potential was greater in the agroforestry than the grassland treatment down to 76cm (Sept-Nov)



Results in-

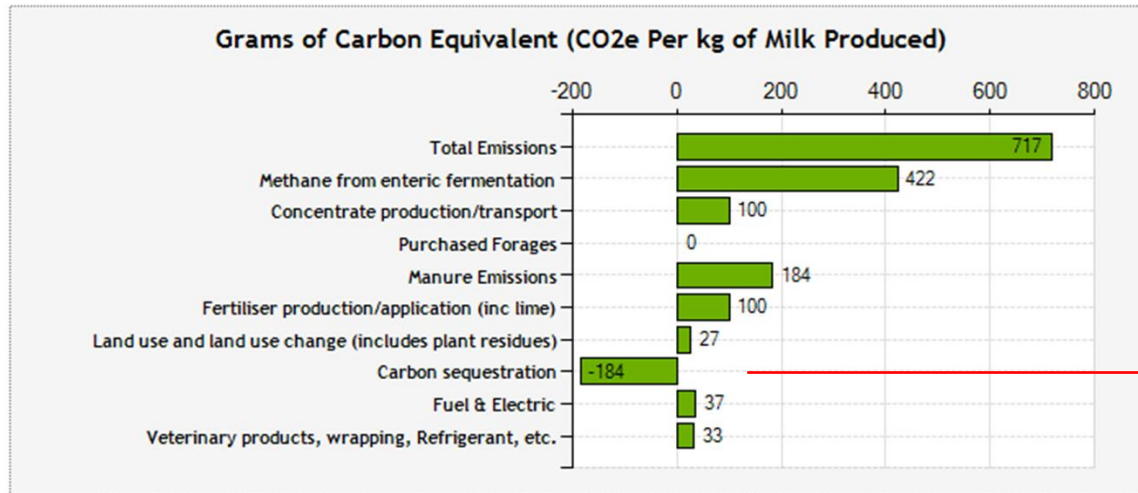
- Extended grazing season under agroforestry (we measured 13-17 weeks)
- Reduced ammonia emissions from livestock
- Improved animal health
- Increased resilience to flash flooding
- Greater levels of grass utilisation
- Improved biological soil health

Contribution to Climate Balance

emissions By Source (Including Sequestration)

Carbon Emissions per kg of Milk Produced: 717 g CO₂e per kg of milk

Carbon Emissions per kg of Meat Produced: 11.27 kg CO₂e per kg of meat (14.82% of total CO₂e emissions)



Grassland system,
0.6 to 0.8 t C/ha/yr
Agroforestry system - AFB1
2.3 to 2.5 t C/ha/yr

- Currently only 25% of emissions are sequestered in grass-based milk production –with agroforestry this could be 64% **PLUS**
- Ammonia removal in the canopy - leads to (small but important) reduction in N₂O in atmosphere
- N₂O emission reduction from drier soils
- Stock consuming twigs and leaves reduces methane emissions
- Excess nitrate application to soils is “mopped up” by the tree roots
- Reduced fire risk by removal of combustibles in trees

Summary of farm climate performance

- Our farm is **119 ha** with **25.3 km** of hedges storing **273.3 tC/ha** (**measured**) and sequestering **359.4 tC/ yr** (**calculated**-all from PhD study, 2020)
- Add this to (**measured**) **0.8 tC/ha/yr** sequestered by the pasture, our farm sequesters **455 tC/yr** – **3.82 tC/ha/yr**-*the mean emissions from beef production in Ireland is 4 tC/ha/yr*
- we also have silvopasture storing **77 tC/ha** and SEQUESTERING **3.4 tC/ha/yr** (**measured**)
- if we incorporated 20% silvopasture on the farm we would be sequestering an additional **81 tC/yr** ie whole farm performance of **4.5 tC/ha/yr** (**extrapolation**)
- **This is the equivalent to forestry production-yet we have all the ecosystem services delivered by the agroforestry**
- These are all based on hard data - A CLIMATE WIN-WIN !

Meets these criteria for a carbon-farming project -

PERMANENCE	Outputs are: sports sticks (long-lasting) and construction timber (small amount of firewood) ; regular supply of grass-fed meat production; permanent deep-soil impacts; management and attitudinal changes are all permanent.
LEAKAGE	C is sequestered, N2O and Ammonia reduced and animals can stay longer outdoors-no leakage.
ADDITIONALITY	The agroforestry would not have been planted –and the benefits over grassland shown-without the project. The farm has high profile, it's findings incorporated into a local agri-environment measure (EFS), and the benefits are being widened to a landscape level.

Role of the CAP

- In the early days agroforestry was not supported as a land use system-we did receive some support under Pillar 2 as a Farm Woodland special project with pro-rata grant aid.
- However, under IACS, eligible for Basic Payment
- Over its lifetime the project was supported by:-
 - The Department of Agriculture and Rural Development (now DAERA) in Northern Ireland
 - Queens University Belfast (student projects) & EURAF
 - The EU –we were part of 3 research consortia –projects in FP2 and FP7. These were vital.
- Future research focus should be on enhancing C sequestration, soil health and barriers to system uptake.
- But there is plenty of evidence to support agroforestry
- Important to assure the future for the site



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Conclusions

- Agroforestry can be part of a farm support measure and a forestry support measure- the climate objectives are the same
- Fits well into UK proposed [Ecoschemes](#)-and [carbon farming projects](#)-we now have a strong environmental evidence base.
- It gives increased climate resilience to farming and forestry systems
- Agroforestry lends itself very well to an organic system
- Agroforestry can sequester rates of carbon which approach those of equivalent afforestation
- It can give support for grazing on forest land as a fire control measure
- By integrating trees into farms in a range of spatial options we can deliver carbon neutral livestock systems and reduce GHG emissions, improve soil health, carbon storage capacity, biodiversity enhancement, flood mitigation and cleaner water-***all climate positive***

