

Field
Exchange

Agroforestry - trees on the farm

Jim McAdam



**Ulster
Wildlife**



**QUEEN'S
UNIVERSITY
BELFAST**



***Field Exchange* - is about bringing people together to support creativity, agriculture and address climate change....**

Agroforestry can do exactly this!

Overview

- Current problems facing livestock agriculture
- What do we mean by agroforestry
- What can silvopasture /agroforestry offer
 - *Farming and timber production*
 - *climate resilience*
 - *creativity*

Current issues facing farming and forestry in Ireland

From a sustainability perspective, Irish agriculture faces challenges in key areas:

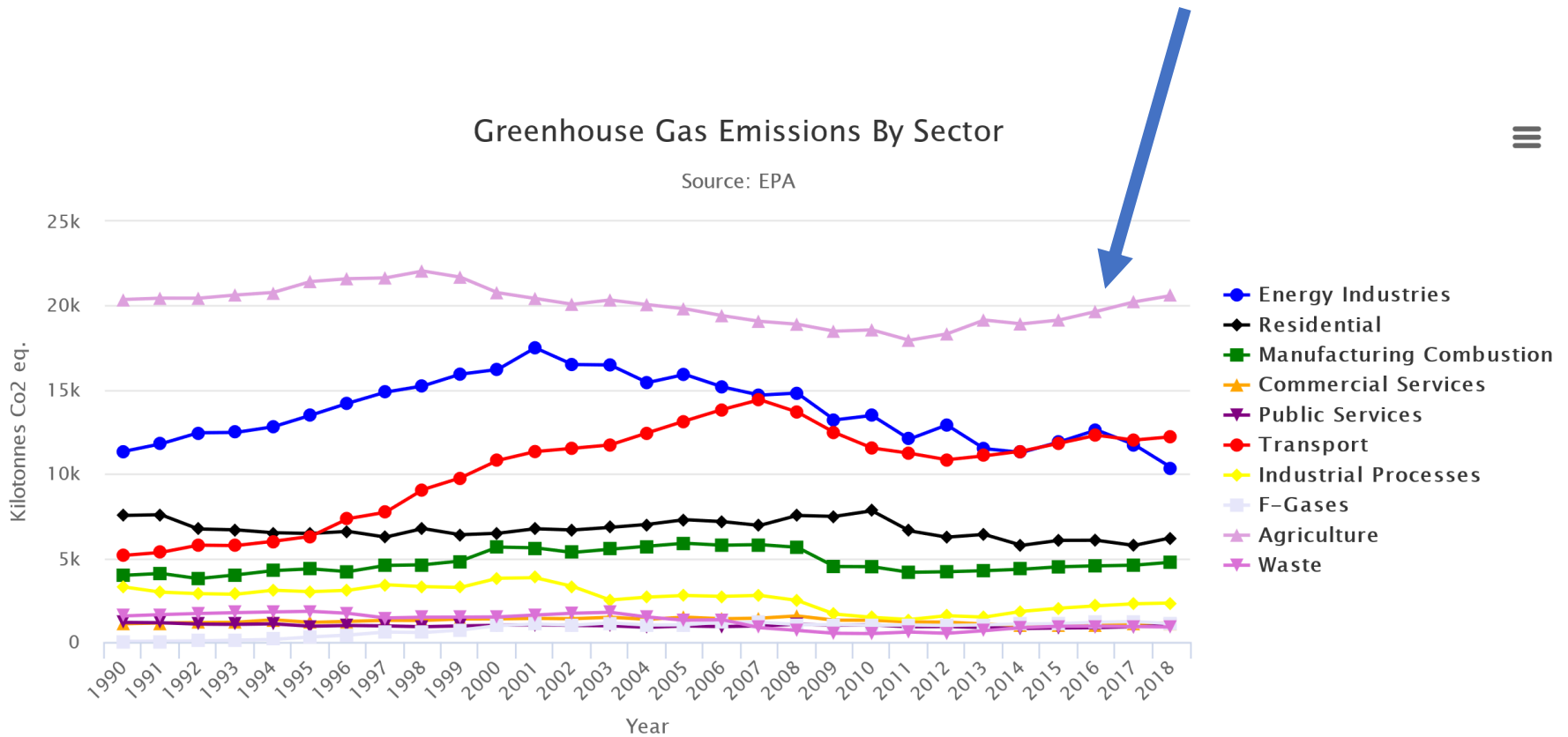
<i>water quality</i>	<i>tree cover & planting targets</i>	<i>air quality</i>
<i>biodiversity</i>	<i>soil health & degradation</i>	<i>ensuring family farm viability</i>
<i>GHG emissions</i>	<i>climate change mitigation obligations</i>	<i>access to markets</i>



...and preserving our rural cultural heritage

GGE by sector (Ireland)

The problem is not going away!



Challenge

How can we make farming more climate resilient and livestock production more carbon neutral

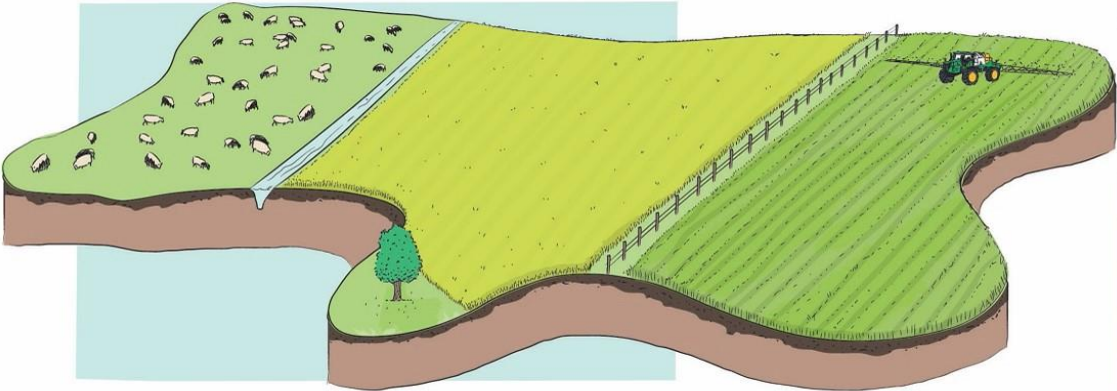
Two key strategies to meet this challenge

1. Increase the dependence on grass or home-grown forage (imported feed substitution)
2. Absorb more carbon on our farms to reduce our **net** emissions-and enhance biodiversity and water quality

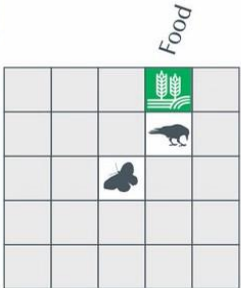
i.e. integrate more trees into our farming systems

Changes to Land Management:

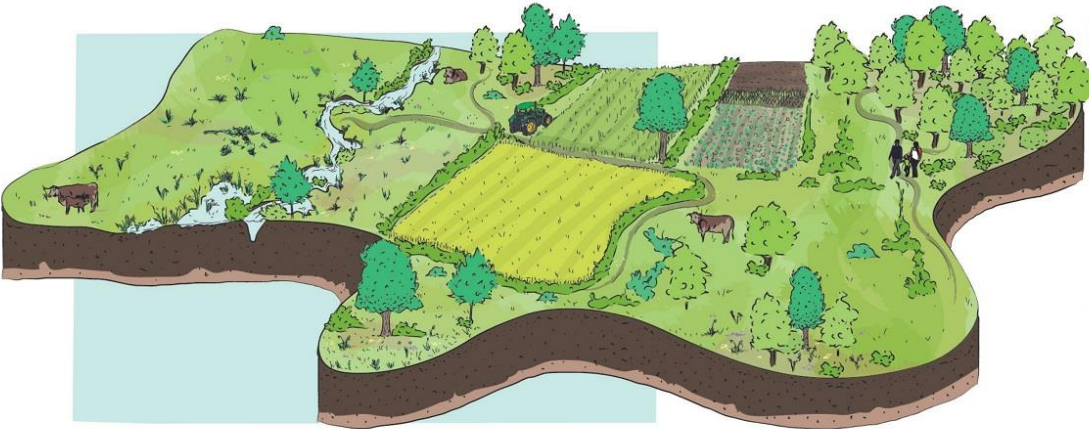
From this...



Low public goods



To this...



High public goods



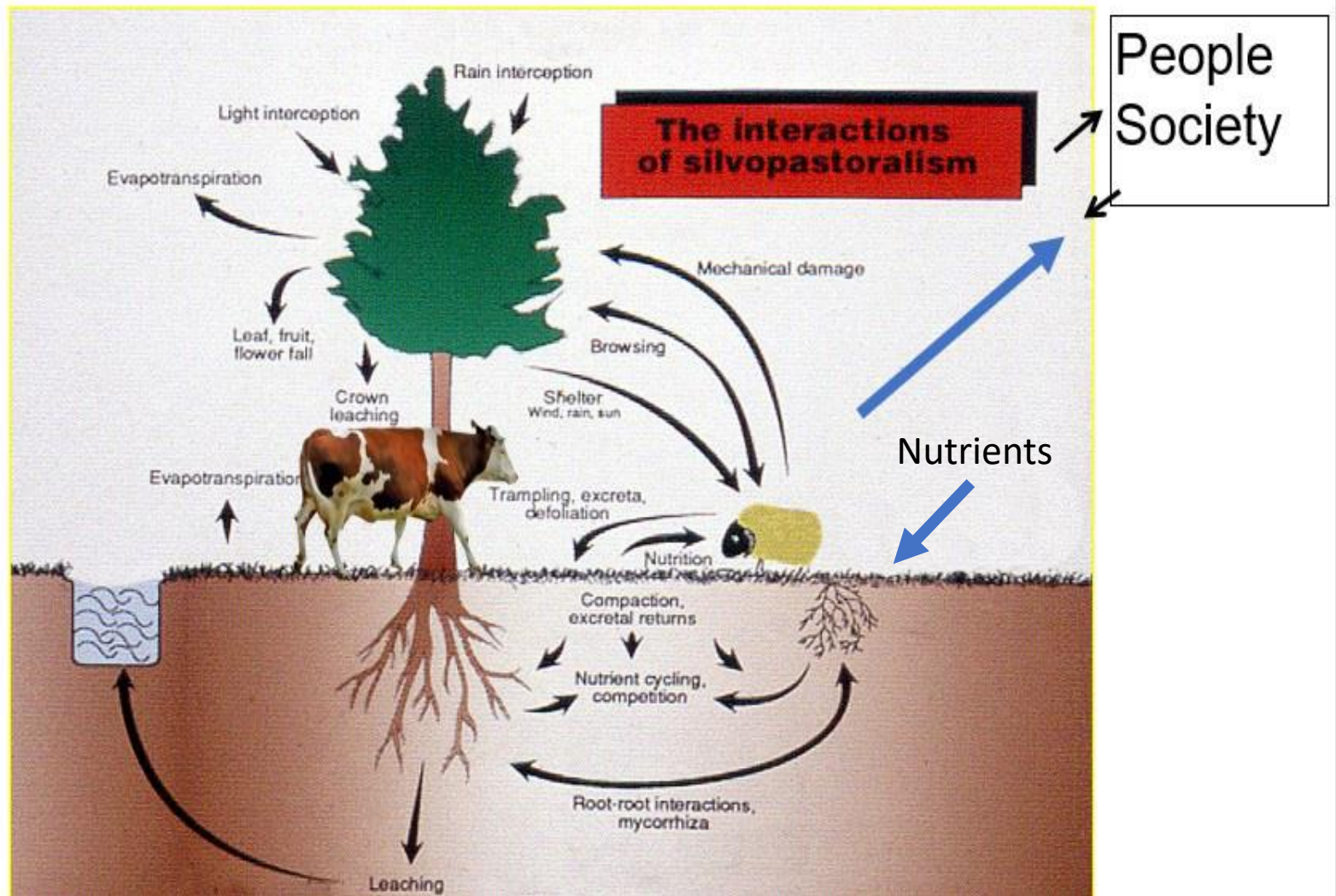
Agroforestry is one potential tool in our armoury

*Agroforestry is a collective name for land use practices where trees are combined with crops and/or animals on the same unit of land and where there are **significant ecological or economic interaction** between the tree and the agricultural components.*

Silvopasture – *where trees are grown in grazed pasture in a regular or varied pattern.*

Silvopasture

An integrated multifunctional land use option delivering a range of ecosystem services.



Examples of agroforestry systems



The evidence base...

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)

Establishing silvopasture

3 yr old



6 yr old



8 yr old



8 yr old



16 yr old



19 yr old

8 yr old



Performance



- **Basic Payment unaffected**
- **Full sheep output for 12 yrs**

Year 13 (ash) at 400 stems/ha – 7.21m³ hurley quality ash butts sold @ €272/m³ from 1.87ha.

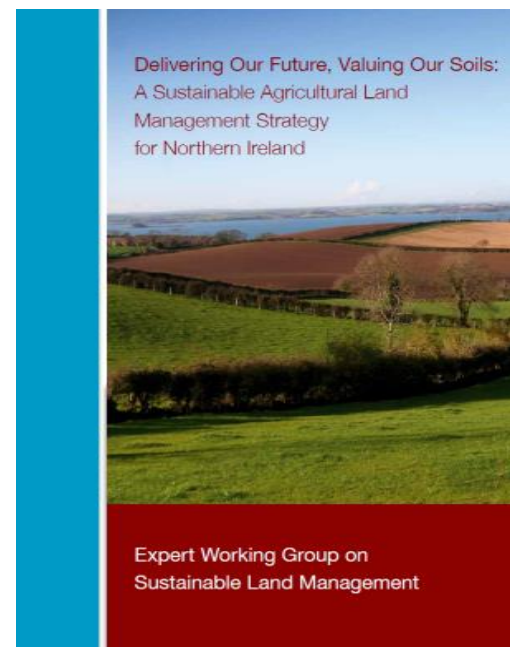
i.e. €1048/ha (£786)

26 yr old



From a farming perspective-

- We showed that the system could work for all components
- From an evidence-base perspective, we had sufficient proof from this trial (and the network) for the Department to move forward and support the system through an Agri-environment scheme option
- Inclusion in the Sustainable Agriculture Land Management Strategy in 2017 was a major leap forward



The Details – Delivering Change

- **Pasture Agri Forestry**, used to extend grazing season to help higher grass utilisation & give resilience to grazing during extreme rainfall, while increasing biodiversity, carbon sequestration, reducing water run off and providing renewable fuel.
“Mine” P from greater volume of soil.



- **Woody Bio Security Corridors** to reduce spread of diseases such as BVD, while delivering the benefits above.

Ecosystem Services

Scenery

Pollination

Renewable Energy

Flood Control

Biodiversity

Crops

Fodder



Meat



Wool

Carbon storage

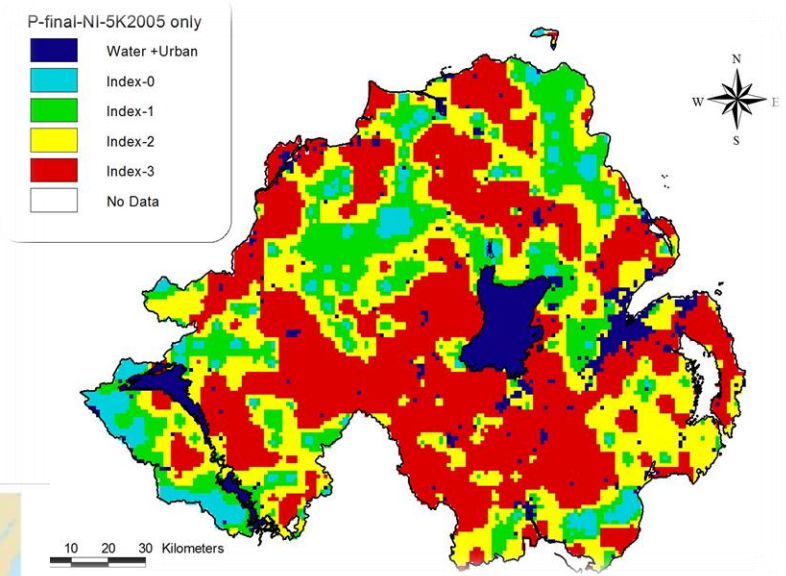
Healthy soil

Water purification



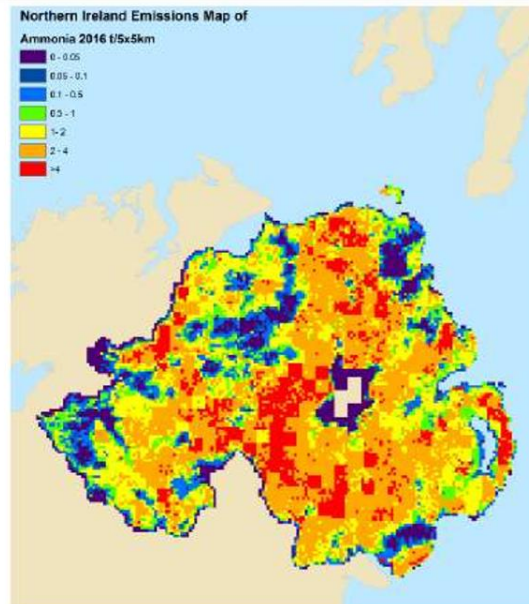
Silvopastoral systems are **environmentally sustainable** and deliver a range of **ecosystem services**

- Improved nutrient cycling
- Reduced nutrient leakage
- Carbon sequestration
- Opportunity for nutrient sustainability



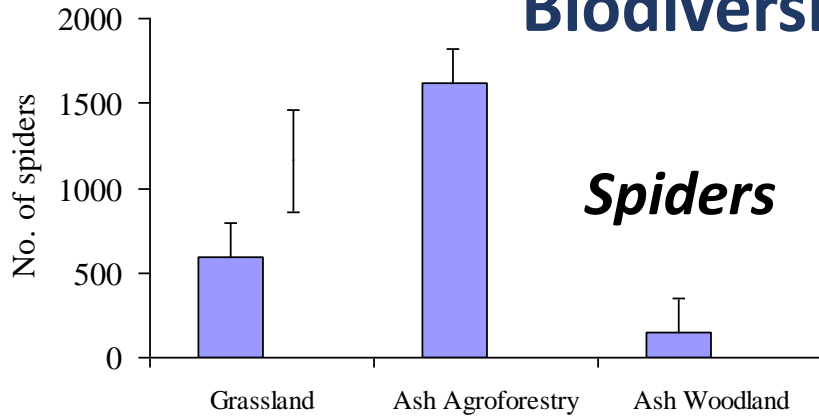
Soil Phosphate levels

NI Ammonia emissions 2016

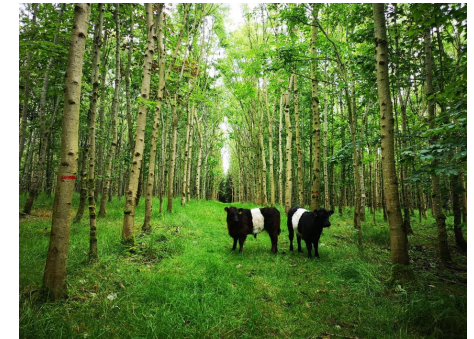
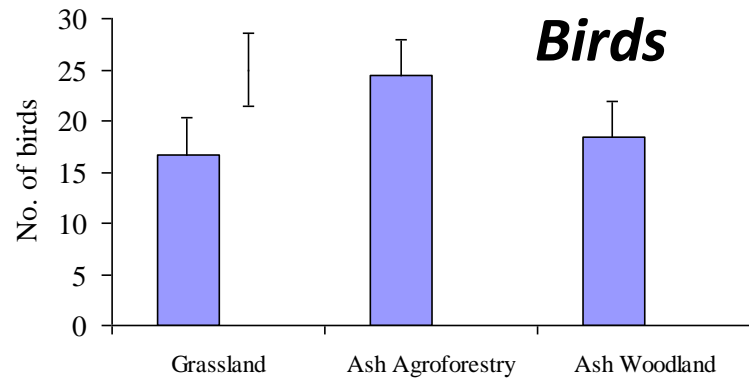


National Atmospheric Pollution Inventory: Air Pollutant Inventories for England, Scotland, Wales, and Northern Ireland: 1990-2016

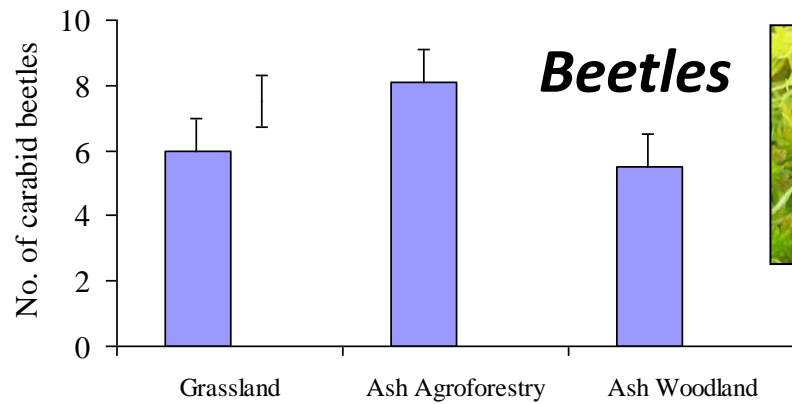
Biodiversity benefits



Earthworms

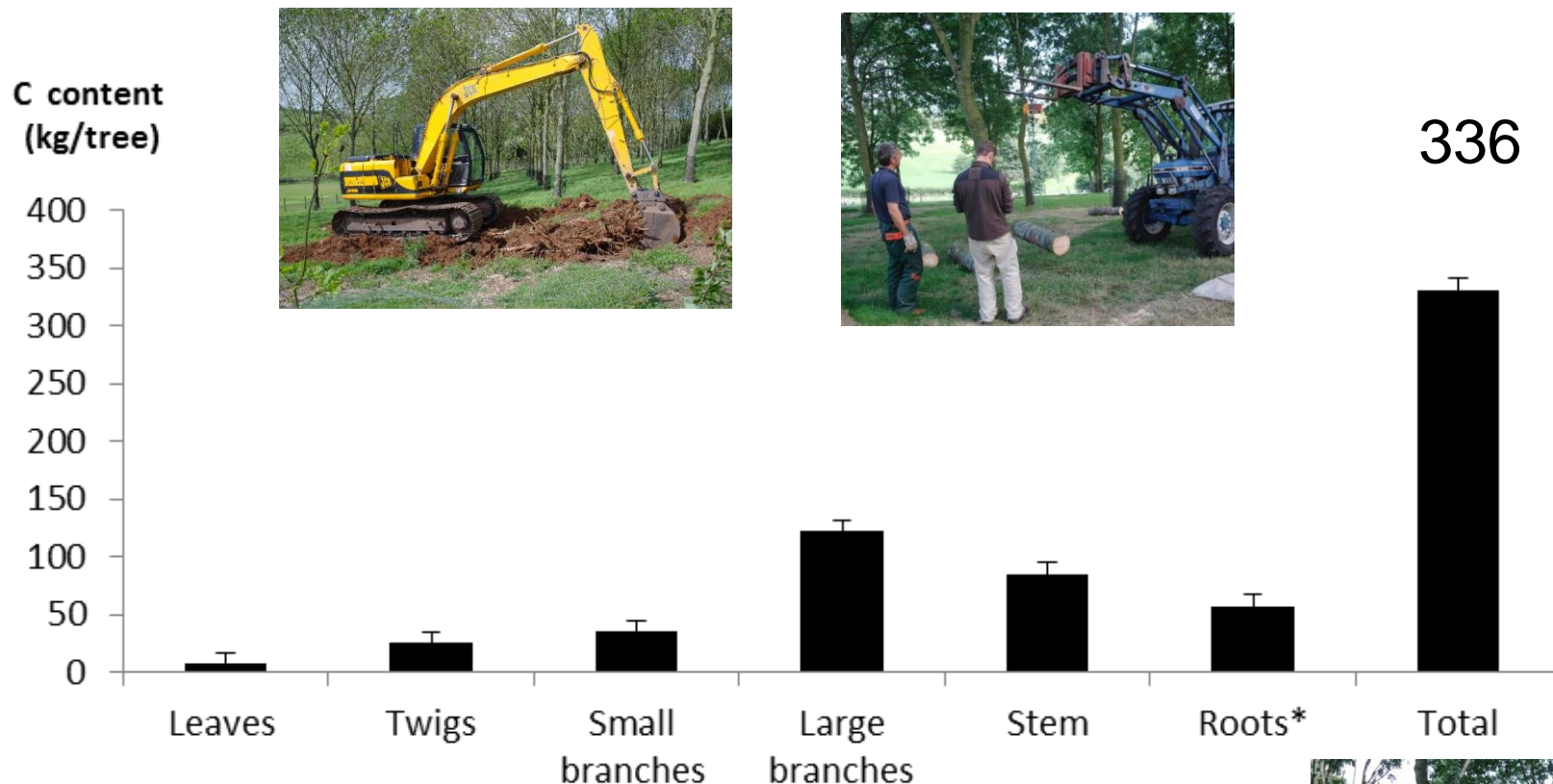


Flora



Pollinators

Carbon stored in ash trees (dry weight) growing in agroforestry (21 years old)



Tree components of ash trees

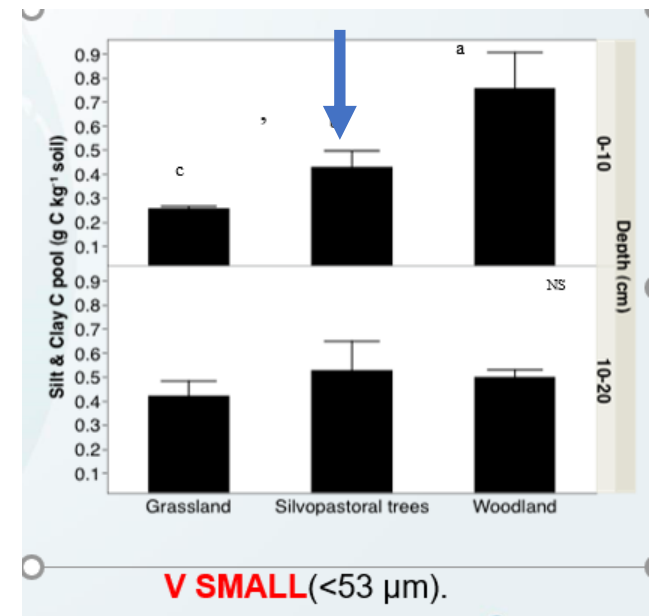
Total C in woody biomass- **77.28 t/ha**

Source: Olave, R., Higgins, A., Sherry, E., Fornara, D., McAdam, J (2016). Agroforestry as a land use option to sequester carbon in a cool temperate climate. World Congress Silvopastoral Systems 2016. University of Évora, Portugal. 27-30 September 2016. 32-33.



Soil carbon

There is more 'stable' carbon stored in the ash silvopasture than the grassland.



- When the carbon stored in the wood is added in, these systems have the potential to store "long term" and "short term" carbon

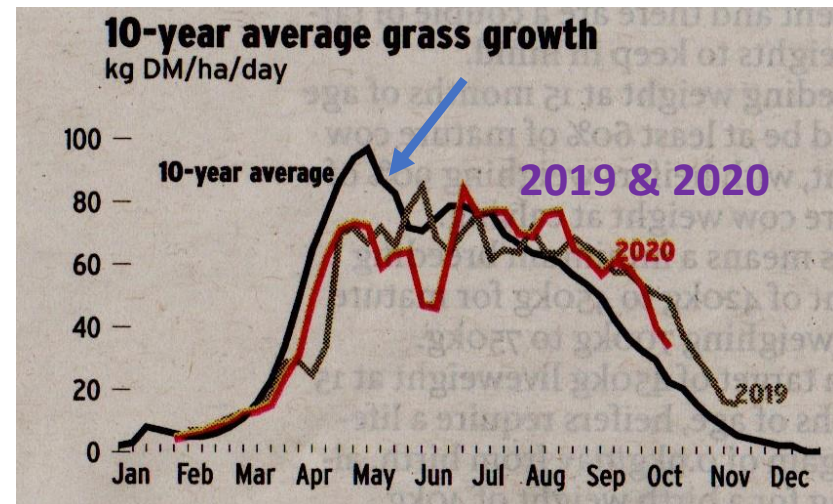
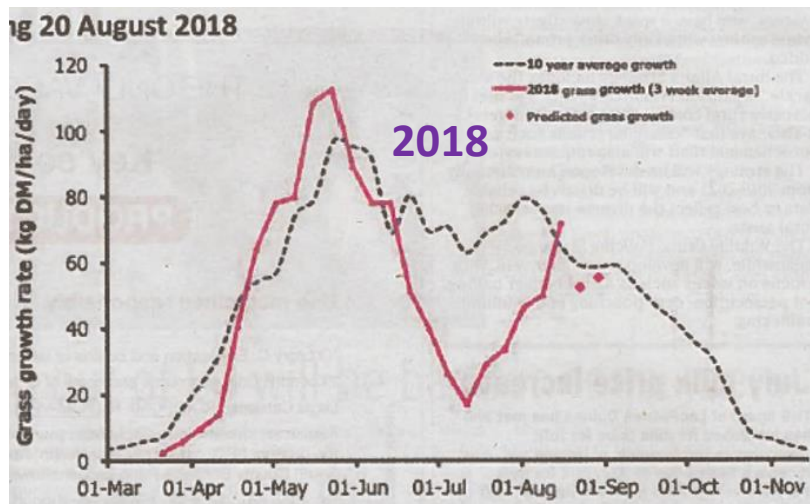
Carbon sequestration

Land Use Practice	Species	tC/ha/yr
Silvopasture	Ash /Mixed Species	2.4
Pasture	Perennial ryegrass	0.6-1.0
Forest plantation	Sitka Spruce	3.8

Resilience to weather extremes-

- **Drought**

GRASS GROWTH IN IRELAND



AFBI & Irish Farmers Journal

Wide spaced trees reduce windspeed and evapotranspiration

- **Storminess**

Densely planted trees with interlocked roots are more vulnerable to large-scale windthrow on Poor soils



Trees planted at wider spacing are more windfirm

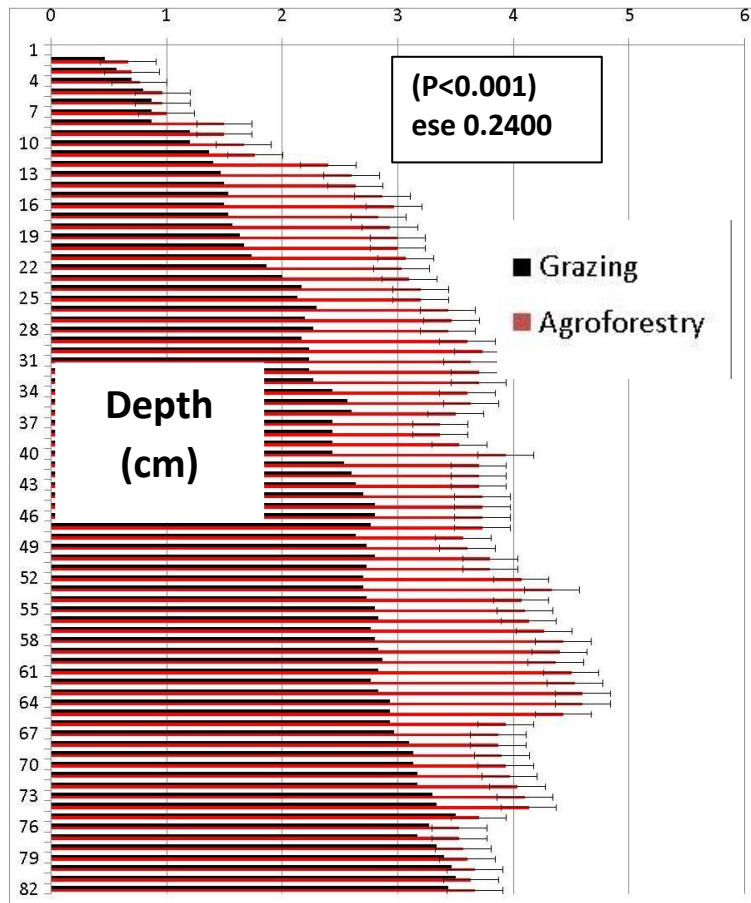
Silvopastoral systems are more resilient to weather extremes

This will impact positively on animal welfare and crop performance

Resilience to extremes of weather

- **Rainfall** is expected to become more intense. Silvopasture increases soil permeability
- **infiltration potential was greater in the silvopasture than the grassland treatment down to 76cm (Sept-Nov)**

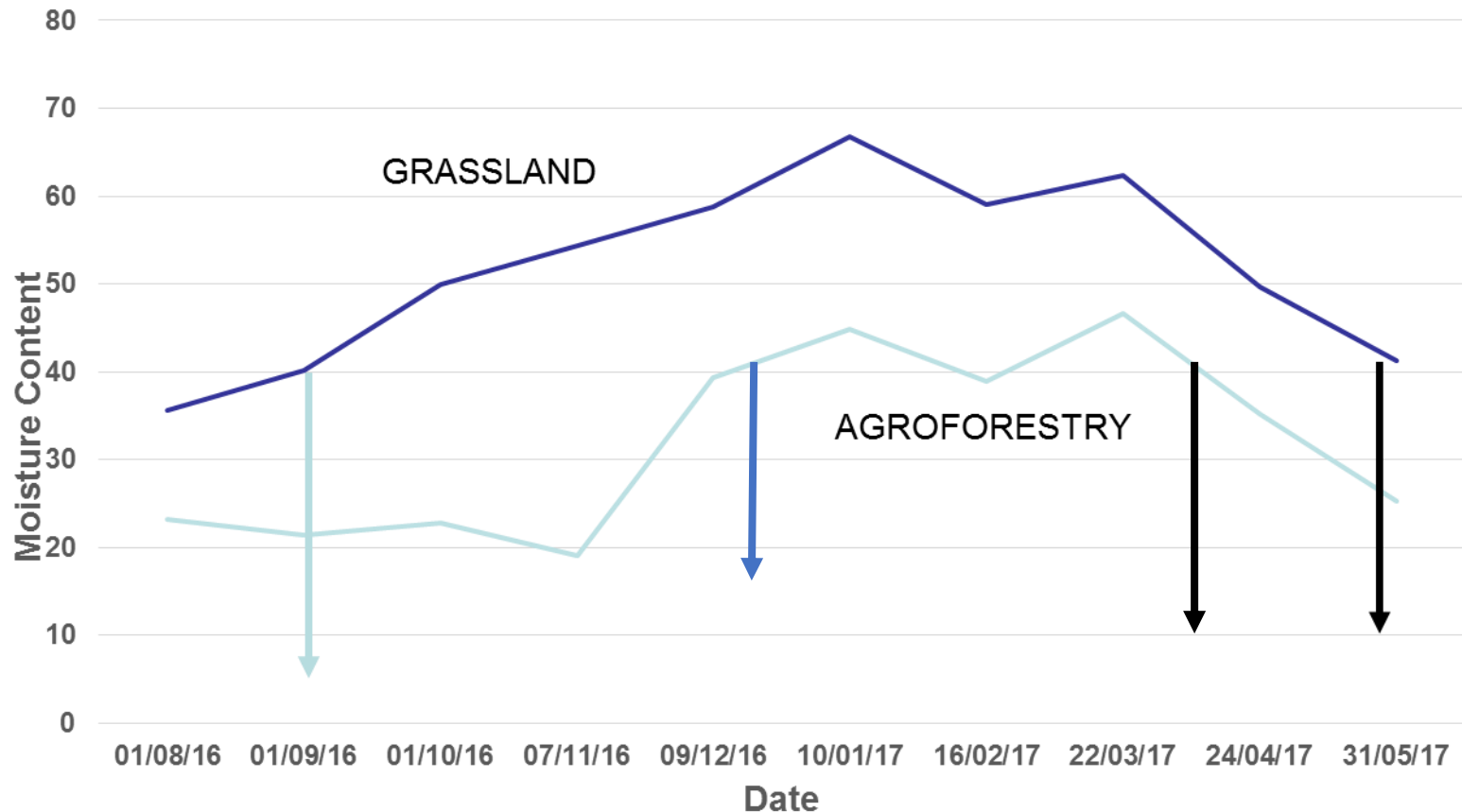
Results in-



- Extended grazing season under agroforestry (we measured 13-17 weeks)
- Greater levels of grass utilisation
- Reduced ammonia emissions from livestock
- Reduced N₂O emissions
- Improved animal health
- Increased resilience to flash flooding
- Improved biological soil health

Ability to sustain grazing-soil trafficability

Extended grazing season under agroforestry



Assume 40% soil moisture content as a cut off, we have 17 weeks longer “season” under agroforestry-5 in spring, 12 in autumn.

Benefits to the animals

- Welfare-shelter and shade – diversity of surroundings



Trees and eggs do mix

BY RICHARD HALLERON

MODERN laying hens can trace their genealogy back to ancestors who preferred a woodland environment. The trees gave the birds improved levels of shelter from the elements.



David Richmond, Premier Woodlands' Stephen Warren and Donaghmore producer Raymond Watt show that eggs and trees really do mix.

Indoors are maintained in a systematic manner throughout the 2000 planting season. The design of each site reflects the emphasis on using native trees. Species planted out include Ash, Rowan, Oak and Birch.

He continued: "Prior to planting we mound the site with the trees planted into the raised soil. This provides the young trees with better drainage and a better micro-site to compete against the surrounding vegetation, which can grow very quickly at this time of the year."

"Hens are very prone to pecking, so each young tree is protected by a tree guard. Mulch mats are also placed at the base of each tree to provide improved weed control."

Stephen went on to explain that a tree spacing of 3 by 3 metres was selected for all of the sites planted out this year.

"This allows for easier vegetation control," he stressed.

"Between 100 and 1,000 trees will be planted out on each of the Sheela sites. It will take up to five years before the woodlands established will provide full ground cover."

Raymond Watt confirmed that a certain amount of vegetation control is required in year one in order to give the trees the best possible start.

"But it doesn't take the birds long to get used to their surroundings, after which they are more than capable of keeping the grass around the trees under control," he added.

Harold Richwood believes that the growing consumer demand for welfare friendly production systems will encourage egg companies to further invest in the concept of habitat enrichment.

"Eggs are the cheapest source of high quality protein available in the shops today," he concluded.

"They constitute a unique food as they can be included in starters, main courses and desserts. Consumers are willing with their foot at the present time and buying more eggs than ever before. So it's incumbent on egg companies like Sheela to give their exactly what they want. Habitat enrichment is good for the hens and is proving a winner with shoppers."



Tree fodder ...









Figure 1: (a) Harvesting and bundling tree fodder from an ash tree, June 2016 (b) feeding air-dried tree fodder to cattle, March 2017.

There is evidence that eating twigs and leaves from trees can reduce methane emissions from ruminants

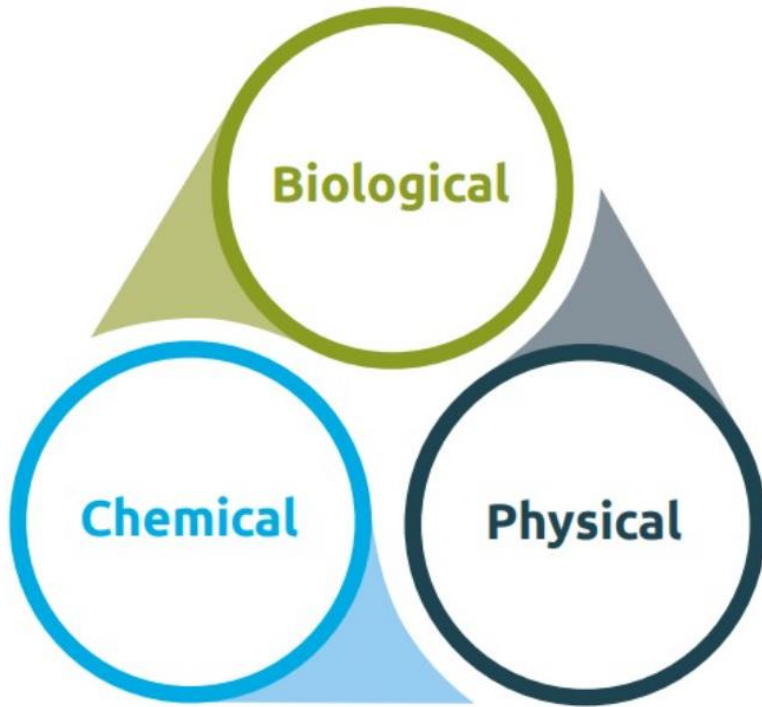


Table 2: Macro-elements of tree leaves.

Latin name	Date sampled	Ca (g/kg DM)	P (g/kg DM)	N (% w/w)	Mg (g/kg DM)	S (g/kg DM)	K (g/kg DM)
Willow	Aug-15	18.8	3	2.23	1.8	4.1	10.4
Alder	Aug-15	13.3	2.2	3.16	2.5	1.9	9.1
Fresh ash	Jun-16	12.8	3.1	1.78	2.2	1.8	14.1
Dried ash	Jun-16	16	3.7	2.21	2.7	2.3	20
Goat willow	Jun-16	10.2	4.2	2.66	1.9	2.1	13.9
GW-dried	Jun-16	14.5	5.5	2.16	2.7	2.6	19.0
Elm	Jun-16	11	2.3	2.23	1.9	1.3	14.7
Elm-dried	Jun-16	16.8	2.4	2.31	2.8	1.7	20.9

GRASS	2.8 - 3.5
SILAGE	2.0 - 4.0
HAY	1.5 - 3.5

Managing for soil health



Well-maintained soils provide good structure, water retention and nutrient availability to crops. The physical, chemical and biological properties of soil interact to deliver these functions.

Balanced soils reduce requirements for mechanical intervention

Soil health

- There is a lot of evidence worldwide for the benefits agroforestry brings to soil health
- Soil physical structure-improved porosity, earthworms
- Organic matter-carbon in particulate matter,
- Mycorrhizal fungi
- The understorey component can be a multi-species sward to deliver more nutritious, carbon sequestering fodder.



- **Healthy soils are more climate - resilient**

Can beef production be made more carbon neutral by incorporating trees

On an RTE Climate Change programme (Science week 2019) one of the “changes required to fight climate change” was an example between:-

- Beef production from a low – input, multispecies sward integrated into a silvopastoral system and
- High- input, intensive beef farm following latest Teagasc best practice advice



On Jane Shackleton’s organic farm (the low input unit) **her profit per animal was the same as the high output farm which emitted twice the amount of carbon per hectare**

There were many issues involved-

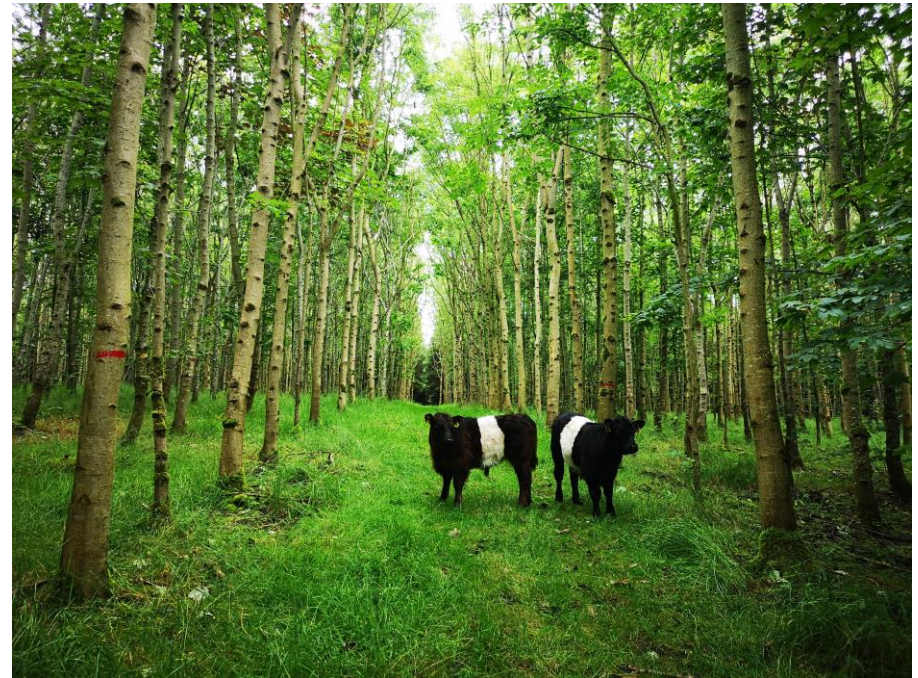
Breed selection

Sward composition (understorey and as wider forage source)

Presence of the trees

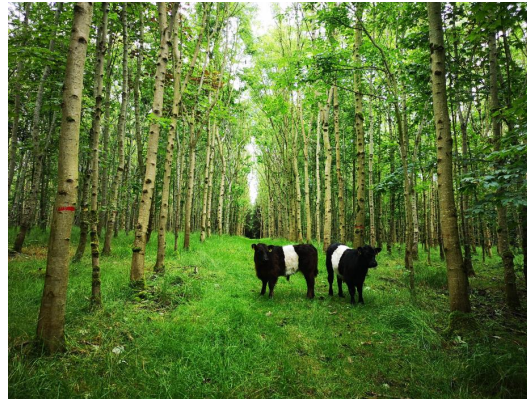
Carrying capacity (winter)

Soil health



Establishing agroforestry

- Can be established by respacing an existing forest/woodland/scrubland



- Or by planting directly into grassland





Tree protection



“Cactus” guards



Establishing agroforestry (2)

- Plant a mixture of species to suit the site, deliver a range of environmental benefits and give resilience to disease etc
- Plant in a configuration to suit your farming system. Eg contour planting, rows, clumps
- Consider mixing systems-e.g. if using cattle



Silvoarable

Silvopasture

- Remember the forage value of the foliage. Animals eat twigs and leaves= reduced methane emissions. Research by ORC , England (Smith, Westaway & Whistance 2018)

Trees can be incorporated into farms in a range of scenarios



- Silvopasture
- Hedgerows contain large quantities of stored carbon and sequester large amounts of CO₂ from the atmosphere annually





Trees in the farmed landscape-AFBI Loughgall



Management of some of our iconic landscapes is dependent on the interaction of livestock and trees

BurrenLIFE

BurrenLIFE: delivering for farming and wildlife.



How can we promote silvopasture on farms?

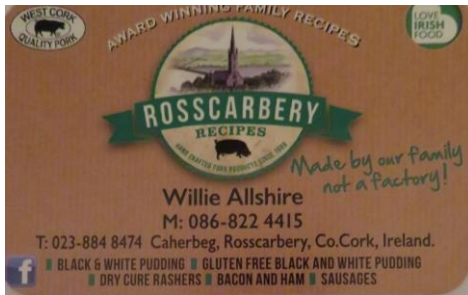
Two pronged attack

1. As a tree-production system whereby a form of forestry, using high-value trees, can be of great value to the beleaguered farming and forestry industry,
2. As a grassland system to produce nutritious wholesome food where farms can be made more sustainable and carbon friendly by incorporating trees at a range of levels.

Variation and Innovation



Elms with Shropshire sheep
(Eugene Curran, DAFM)



Think outside
the box

Conclusions

- Agroforestry gives increased climate resilience to farming and forestry systems
- Fits well into proposed **Ecoschemes**-and **carbon farming projects**-we now have a strong environmental evidence base.
- Agroforestry lends itself very well to organic and low-input systems
- Agroforestry can sequester rates of carbon which approach those of equivalent afforestation
- 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***

We need to promote agroforestry across the island-even if not everyone might want to hear the message!



Support..



- Act as a coordinated voice-very dispersed interest
- Educate
- Disseminate research
- Train practitioners
- Advise policy-a largely unknown area
- Promote



www.irishagroforestry.ie



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