

# Agroforestry: Complexity underpinning multiple benefits from the farm to the landscape

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# Content

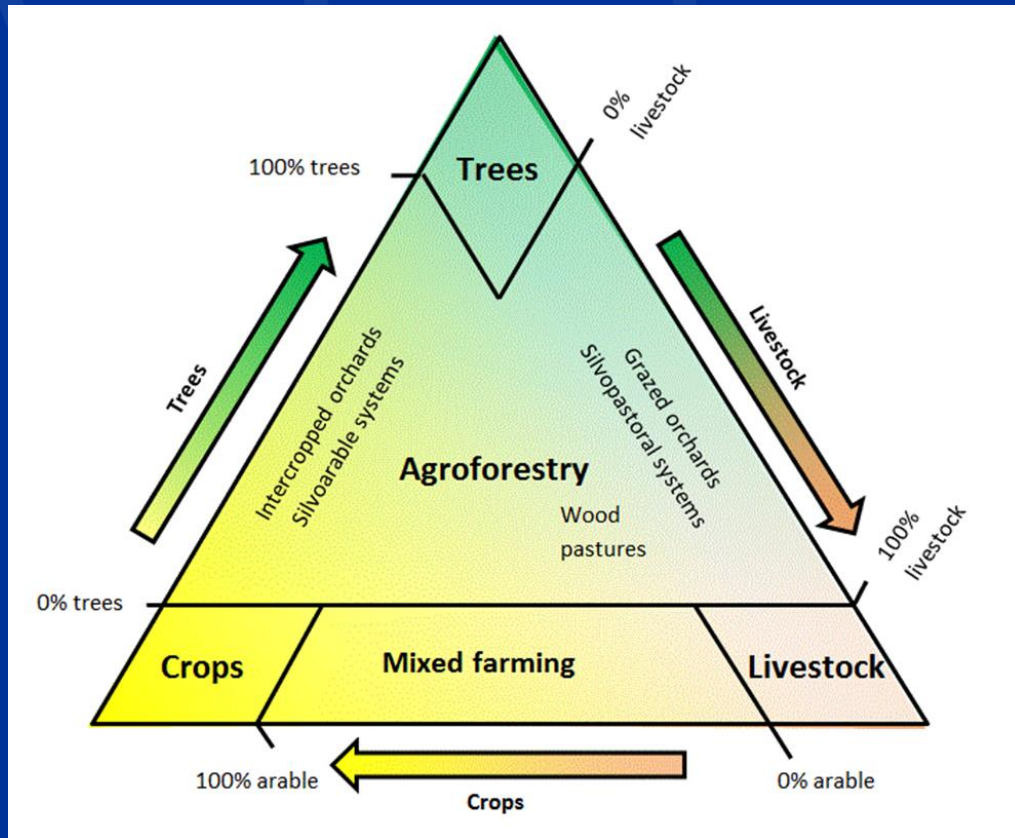
An aerial photograph of a rural landscape. The foreground is dominated by a dense, lush green forest. Beyond the forest, there are several large, brown plowed fields, likely cornfields, interspersed with green pastures and smaller fields. A small farmstead with several buildings is visible in the middle ground. The background shows rolling hills and valleys under a blue sky with light, wispy clouds. The overall scene depicts a diverse agricultural landscape.

1. Agroforestry: what is it and where is it?

2. What is complexity?

3. Multiple benefits from diversity at farm and landscape scales

# What is agroforestry?

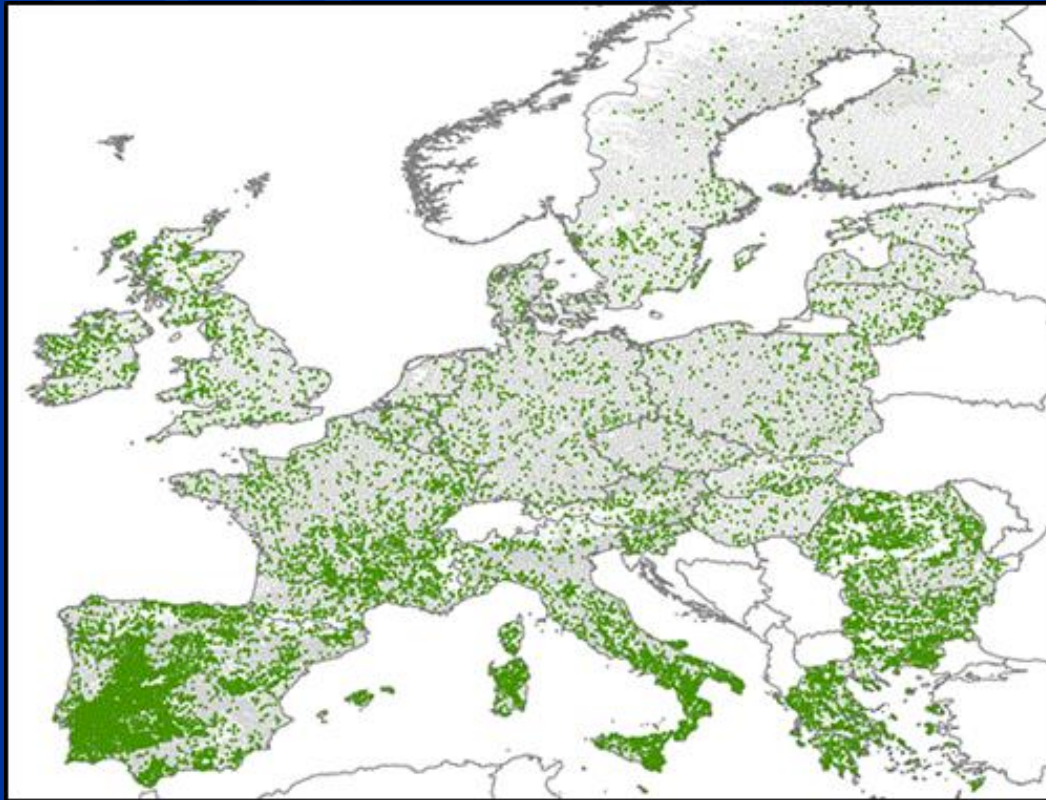


The practice of deliberately integrating woody vegetation (trees or shrubs) with crop and/or animal systems to benefit from the resulting ecological and economic interactions

The FP7 AGFORWARD project is promoting agroforestry: [www.agforward.eu](http://www.agforward.eu)

# Agroforestry as a multiple land use

The LUCAS dataset records not only land cover but land use (and the land use can be multiple)



Using LUCAS survey data, AGFORWARD has estimated that agroforestry is practiced on 23.4 million hectares (5% of the total area)  
(This is equivalent to the total area of wheat production)

Agroforestry is practiced throughout the EU27 with “hot-spots” in Bulgaria, France, Greece, Italy, Portugal, Romania, and Spain

# Agroforestry of high nature and cultural value



Dehesa, Spain and Montado, Portugal



Wood pasture, Romania



Agroforestry with reindeer, Sweden

## Other systems

- Bocage system, France
- Silvopastoral systems with oak, Greece
- Bocage agroforestier, Bretagne, France
- Oak wood pasture in Sardinia, Italy
- Wood pasture, UK
- Agroforestry in the Spreewald floodplain, Germany
- Wood pasture, Hungary

# Agroforestry with high value trees



Intercropping and grazing of olive systems in Italy



Intercropping oranges in Greece



Grazed orchards in England, Northern Ireland, and France

## Other systems

- Chestnut agroforestry, Galicia, Spain
- Intercropping and grazing of walnut plantations in Spain
- Intercropping of olives in Greece
- “Bordure” trees in France

# Integrating trees into arable systems



Switzerland



Mediterranean regions of France



Germany

## Other systems

- Alley cropping, Hungary
- Trees in arable systems in Greece
- Silvoarable agroforestry in S.W. France
- Silvoarable agroforestry in Western France
- Silvoarable agroforestry in Northern France
- Silvoarable agroforestry in UK
- Silvoarable agroforestry in Italy

# Integrating trees into livestock systems



Agroforestry with Celta pigs in Spain



Poultry agroforestry in the UK



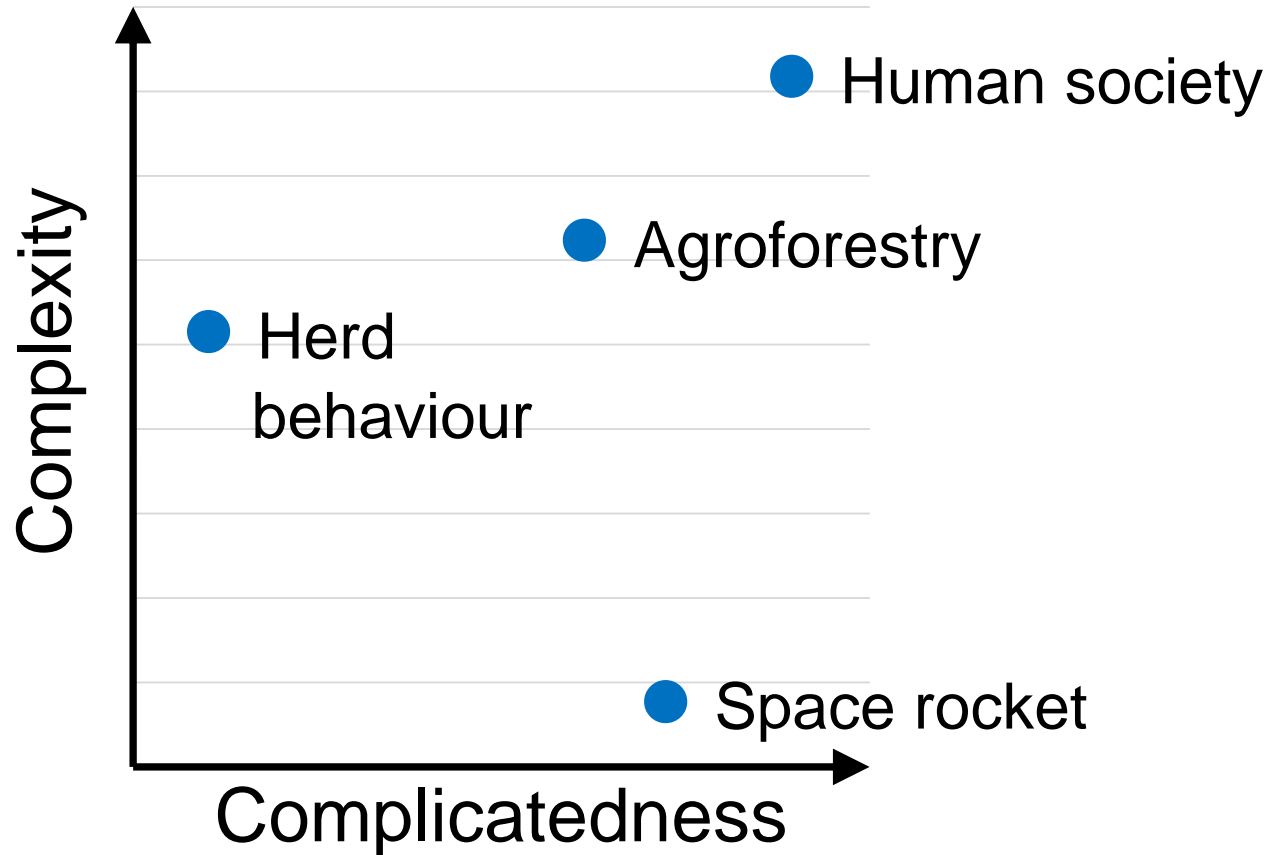
Agroforestry with ruminants, France

## Other systems

- Agroforestry for poultry in the Netherlands
- Agroforestry with organic poultry in Denmark
- Agroforestry with free-range pigs, Italy
- Agroforestry with free-range pigs, Denmark
- Fodder trees for goats and sheep in the Netherlands



# Agroforestry, like life, is complex and complicated



**Complexity:** large numbers of simultaneously interacting entities giving rise to **emergent** (often surprising) patterns

**Complicatedness** – systems, typically with some function, with an organisation that demands lengthy descriptions

# Seven characteristics derived from the complexity of agroforestry

- It is multi-functional: it addresses more than one objective
- Diversity of species can increase land productivity
- Diversity of habitats can improve animal welfare
- Diversity of habitats can increase wildlife
- Agroforestry can increase C storage and reduce runoff and nutrient loss
- Agroforestry can encourage farmers to work together at a landscape scale
- It requires new skills to administer and manage

These characteristics are shared with other agro-ecological systems (Altieri and Nicholls, 2005; Bonaudo et al 2014)

# Multiple benefits of agroforestry

Initial results from the AGFORWARD project asking 344 farmers and other stakeholders to identify the key positive aspects of agroforestry. Respondents generally perceived

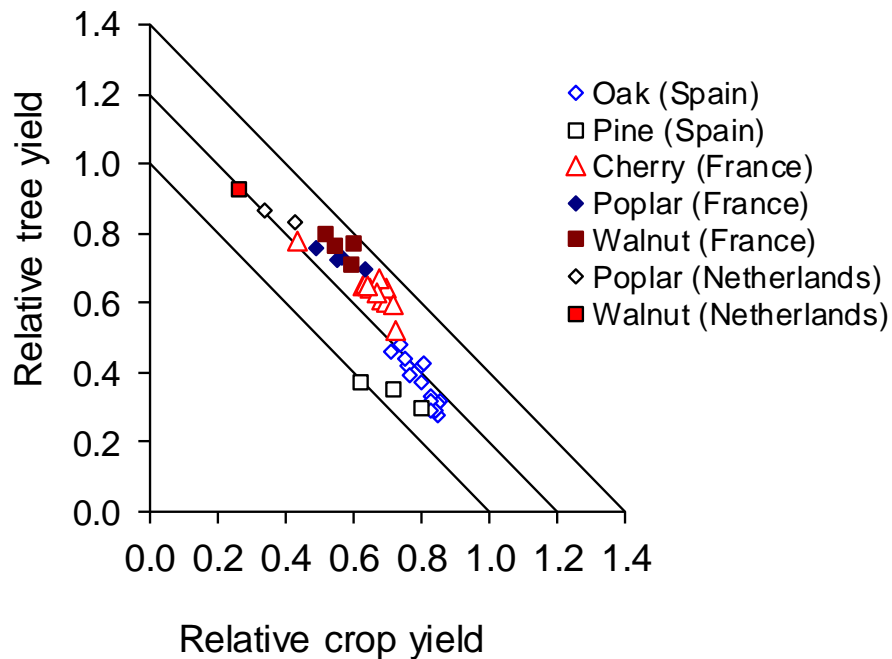
**production,** **animal welfare/ economic** and **environmental benefits**

	Top rank	Second rank	Third rank
Denmark	Animal health & welfare	Biodiversity and wildlife	Landscape aesthetics
France	Biodiversity and wildlife	Output of tree products	Animal health & welfare
Germany	Crop/pasture production	Soil conservation	Biodiversity and wildlife
Greece	Animal health & welfare	Diversity of products	Quality of tree products
Hungary	Disease and weed control	Climate moderation	Crop/pasture production
Italy	Diversity of products	Animal health & welfare	Quality of tree products
Netherlands	Animal health & welfare	Landscape aesthetics	Biodiversity and wildlife
Portugal	Income diversity	Biodiversity and wildlife	Diversity of products
Spain	General environment	Biodiversity and wildlife	Landscape aesthetics
Sweden	Rural employment	Business opportunities	General environment
UK	Biodiversity and wildlife	Animal health & welfare	Landscape aesthetics

# Production: complementary use of resources



Biophysical hypothesis: agroforestry increases land productivity when the trees acquire resources of water, light and nutrients unavailable to the crops (after Cannell et al. 1996)



Modelled relationship between relative crop and tree yields for walnut, poplar (France and the Netherlands), cherry (France), oak and pine silvoarable systems (Spain) at 113 trees ha<sup>-1</sup> (Graves et al., 2007)

# Animal welfare and profitability



## Woodland eggs



### Providing woodland cover can provide animal welfare and production benefits

Reduced injurious feather pecking by laying hens in a woodland environment (Bright and Joret, 2012)

Proportion of eggs with poor quality shells fell by 1% when hens were given access to a woodland (Bright and Joret, 2012)

### Some UK consumers are willing to pay 20% premium for woodland eggs

Price (£ per six eggs) of free range and woodland eggs (source: retailers' websites, April 2014; Burgess et al., 2014)

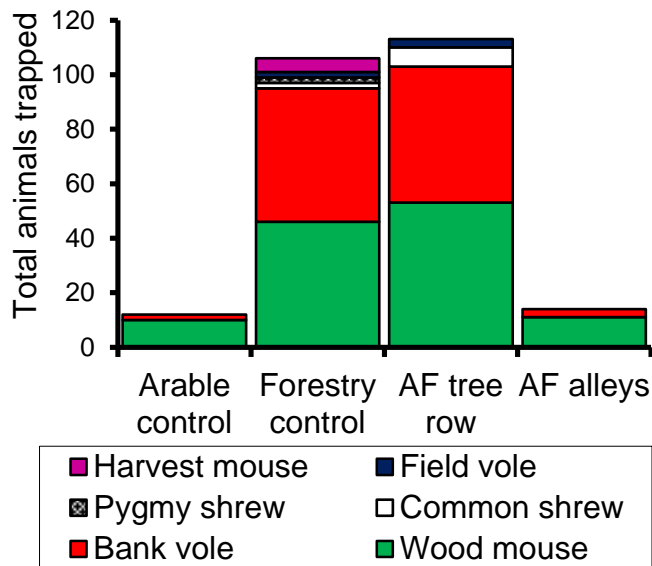
Supermarket	Free-range	Woodland
A	1.00	1.19
B	1.39	1.59

# Increased biodiversity



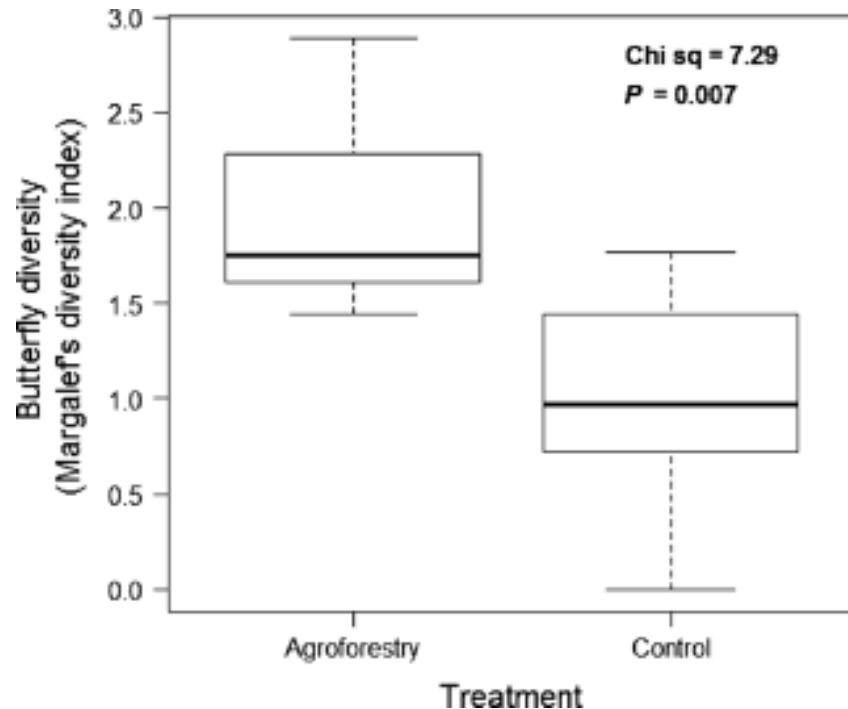
## Small mammals

Silvoarable agroforestry (AF) in the UK with a grass understorey increased the number of small mammals compared to an arable control (Wright, 1994, reported by Burgess, 1999)

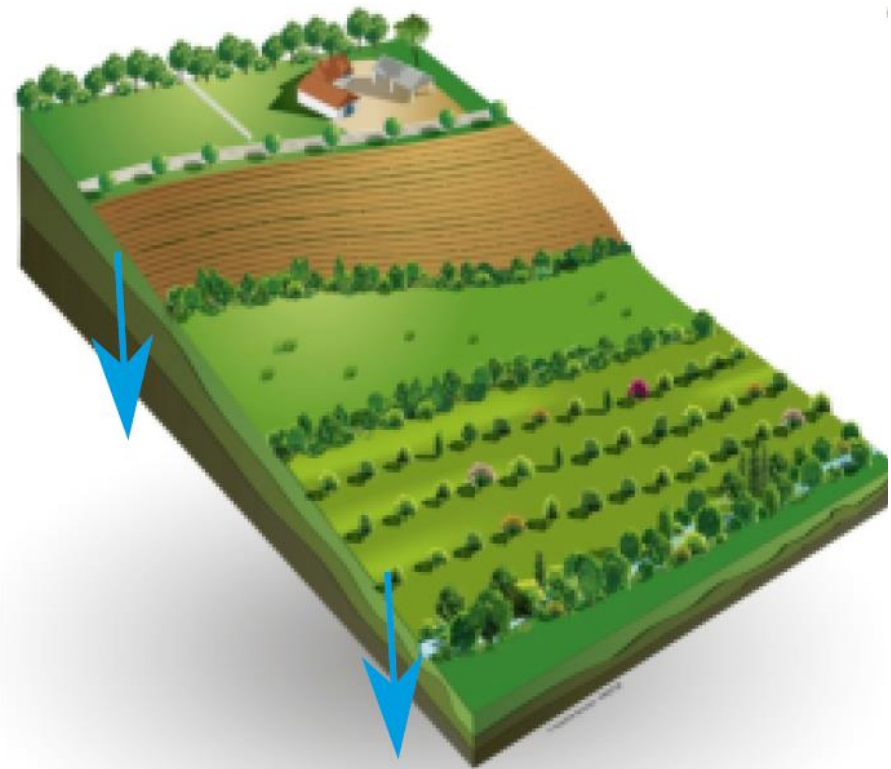
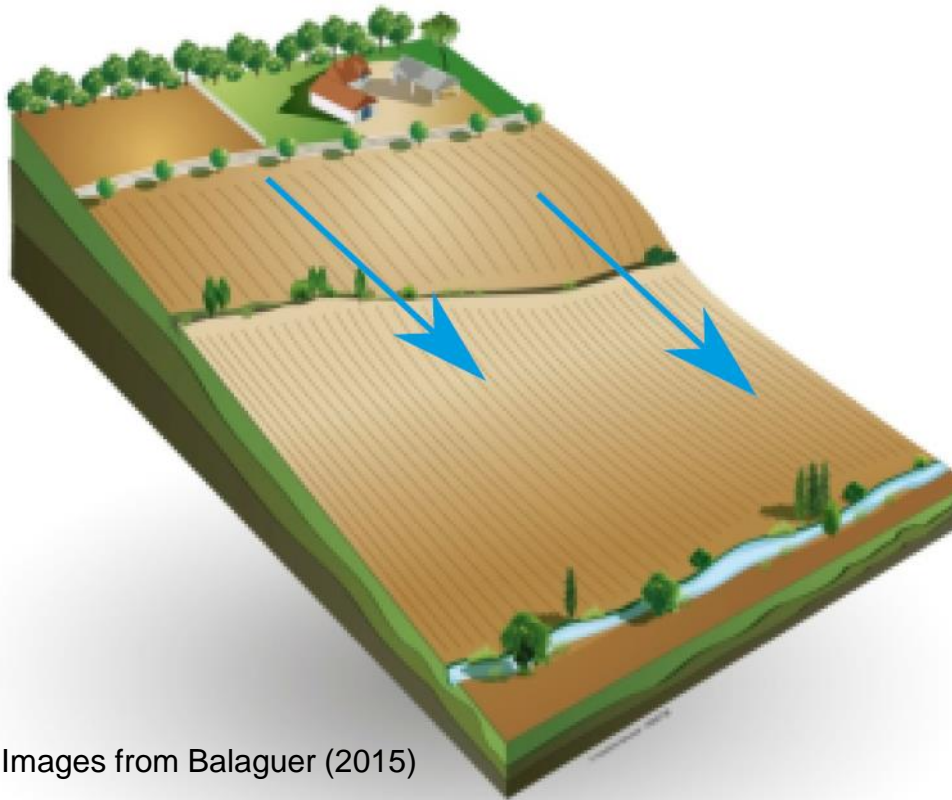


## Pollinators

Butterfly diversity (shown), abundance of hoverflies, and species richness of *Bombus* species was higher in agroforestry treatments than pasture and arable controls (Varah et al. 2013)



# Maximising biomass storage Minimising runoff and loss of nutrients



Images from Balaguer (2015)

Appropriate use of trees can maintain food production, increase carbon storage, and reduce runoff and nutrient loss

# Developing collective management at a landscape scale

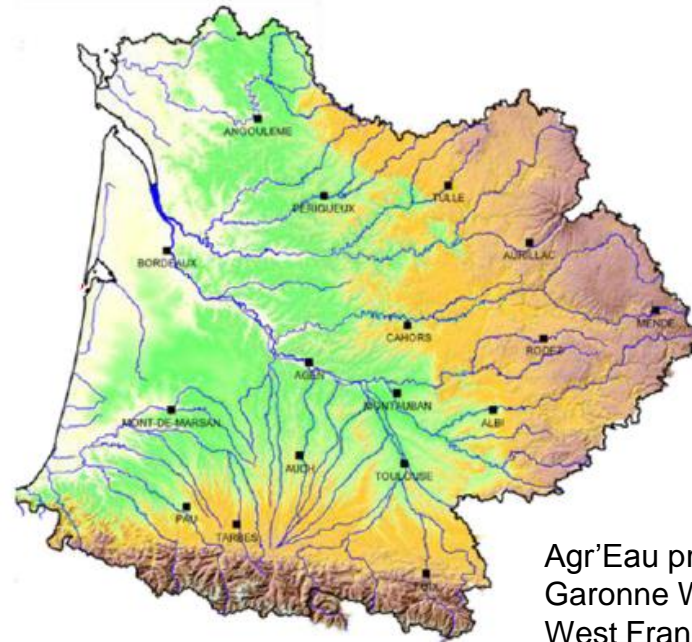


Agroforestry, the integration of trees with farming, has been used to develop collective management of water catchments

**UK:** farmer-led sustainable land management at Pontbren in Wales (Woodland Trust, Wales, 2013)



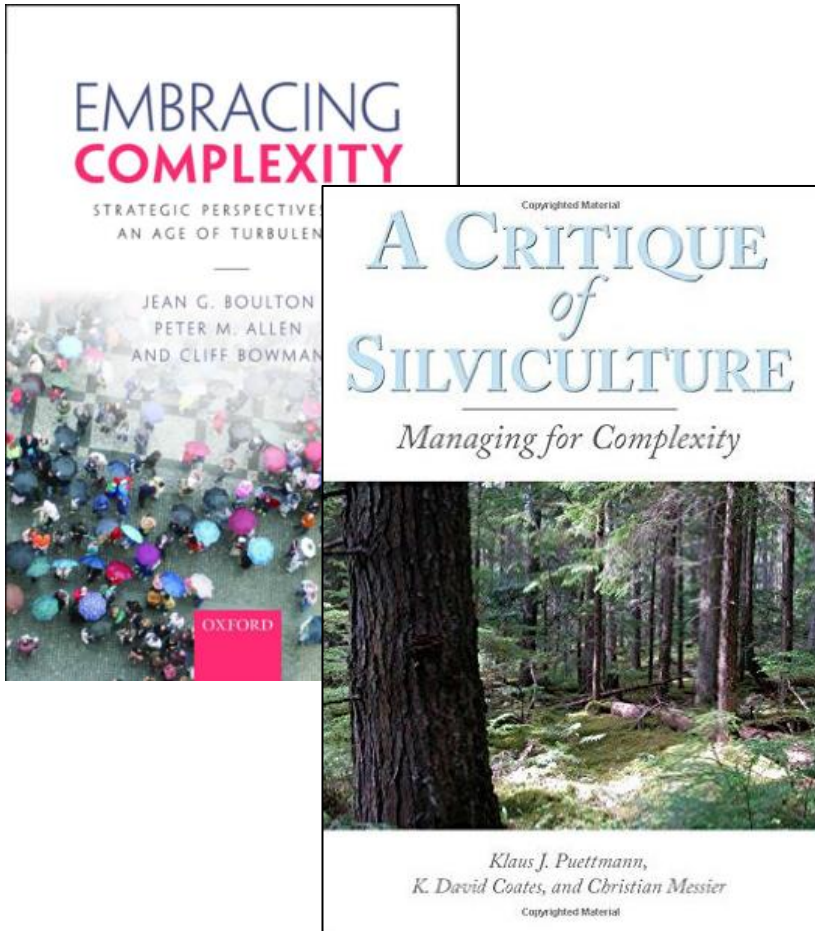
**France:** the Agr'eau project is working with over 300 farmers to develop farming practices that produce more whilst reducing negative impacts on soil and water management (Balaguer 2015)



Agr'Eau project in the Adour-Garonne Watershed in South West France



# Managing complexity



There are few uniform prescriptions when managing complex systems

The appropriate management will depend on the people, the history, geography, and ecology of the field, farm, and landscape.

Our survey suggested that the administrative burden and managerial complexity of agroforestry can be important constraints

Importance of education and training

# Conclusions

1. Trees are a common feature of European agriculture. It is, therefore, essential that they are recognised in production, planning, policy development, and agricultural research and innovation.
2. Integrating trees and farming is complex, but it can provide multiple benefits
3. The benefits from diversity can include increased land productivity, improved animal welfare, higher value products, and increased wildlife
4. Integrating trees with farming can increase carbon storage and decrease runoff and nutrient loss
5. Agroforestry is being used to develop collective management at a landscape scale
6. How do we efficiently administer complex systems such as agroforestry?
7. Getting agroforestry right will help us get European rural land use right

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