# The Place of Trees in the Agricultural Sector

**Presentation at "System Approaches for Sustainable Agriculture" workshop on 5 December 2016 within "Field to landscape: integration of the "Crop/ livestock/tree sub-systems" session**

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- Agriculture with trees as a land use
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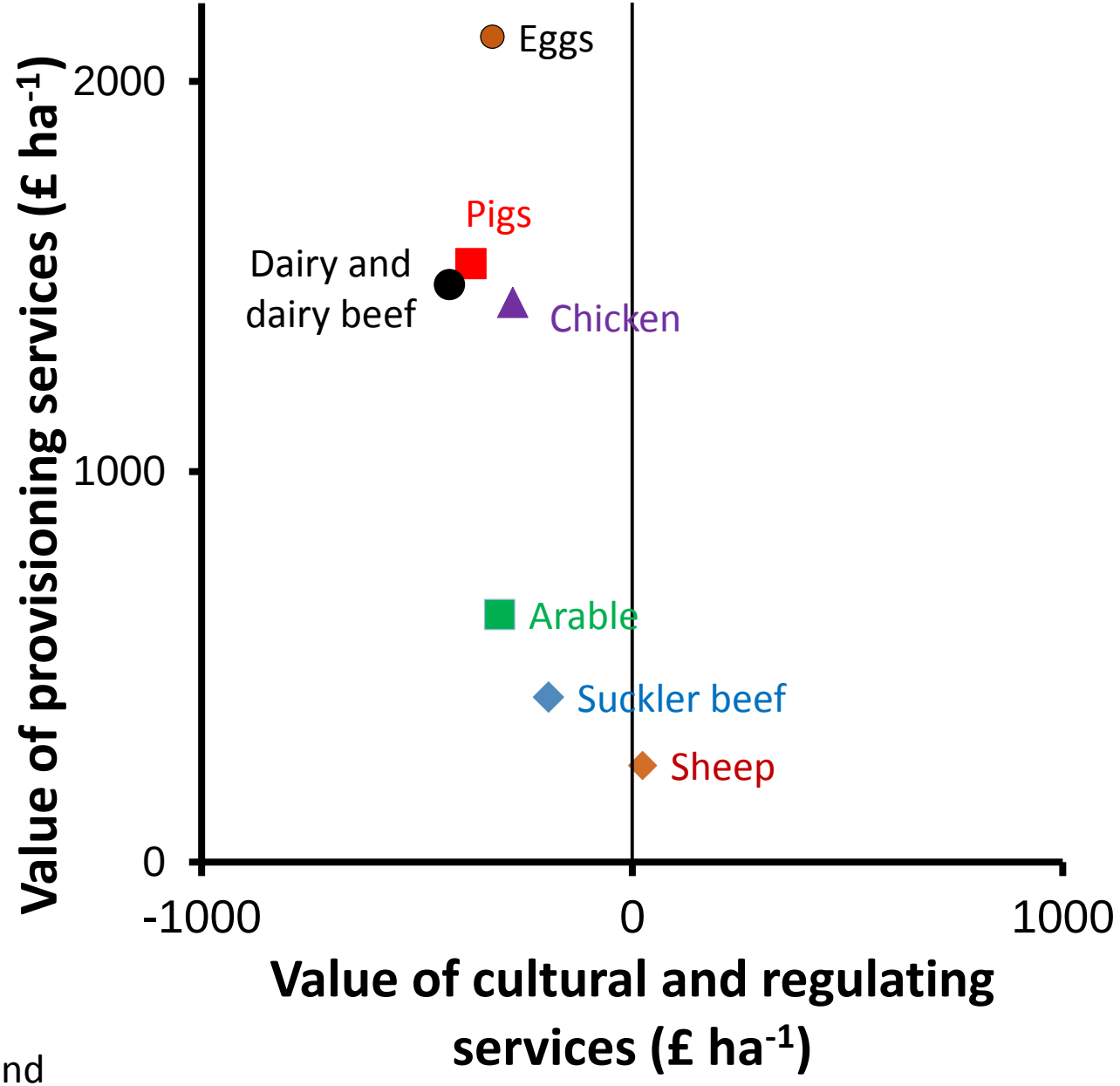
# Productive value and environmental cost of agriculture

# Annual value of provisioning services and cost of ecosystem services of UK agricultural systems
## (after Chatterton et al 2014)

| Agricultural system | Provisioning services (£ $ha^{-1}$) | Other ecosystem services (£ $ha^{-1}$) |
|---|---|---|
| Eggs | 2114 | -325 |
| Pigs | 1532 | -375 |
| Dairy and dairy beef | 1479 | -425 |
| Chicken | 1433 | -277 |
| Arable | 634 | -308 |
| Suckler beef | 422 | -194 |
| Sheep | 247 | 25 |

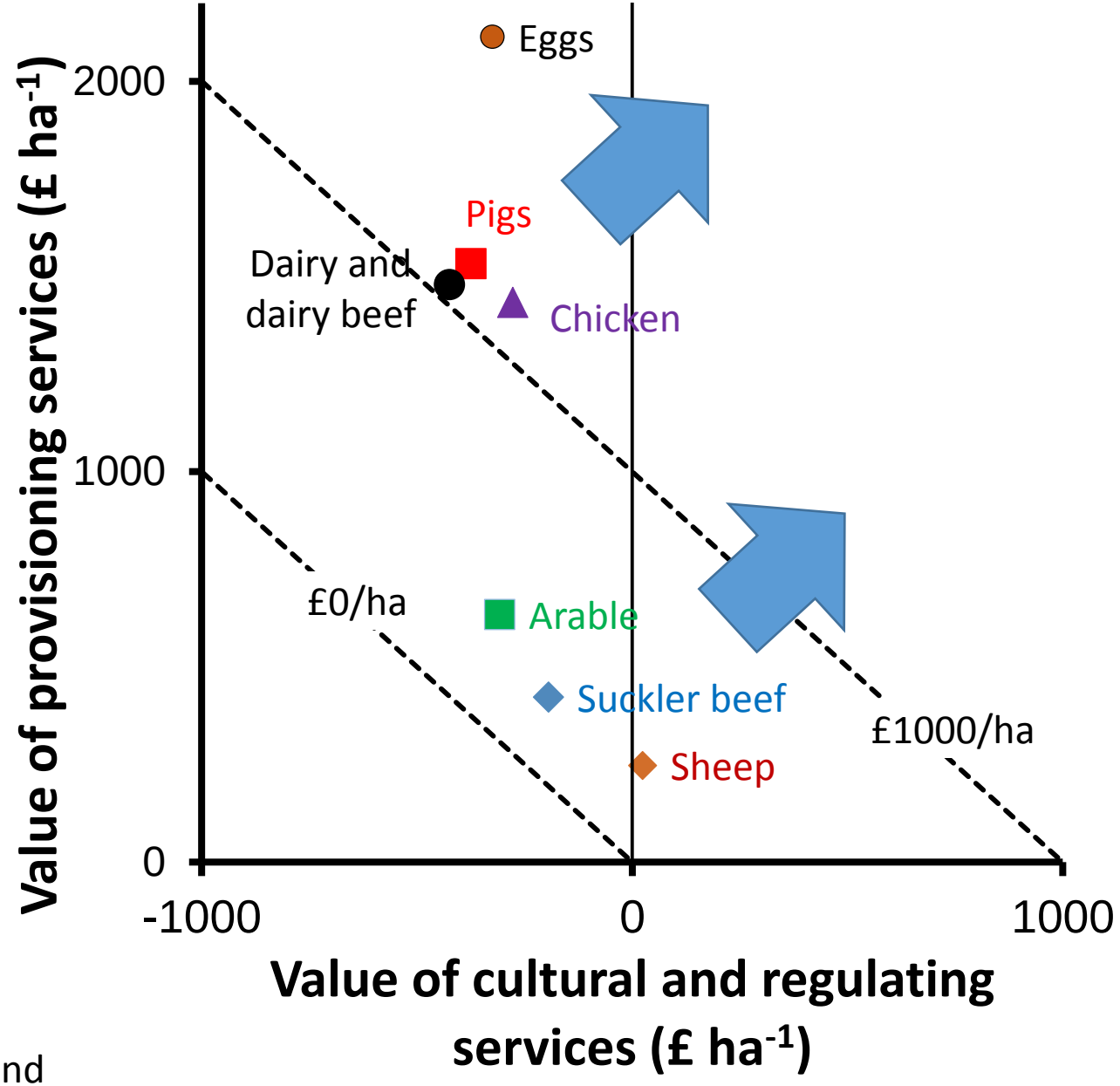
Current agricultural systems result in positive outputs of goods, but most systems result in ecosystem dis-services such as greenhouse gas emissions and reduced water quality

# Value of provisioning and other ecosystem services of seven UK farm systems (after Chatterton et al 2014)




Includes use of non-UK land

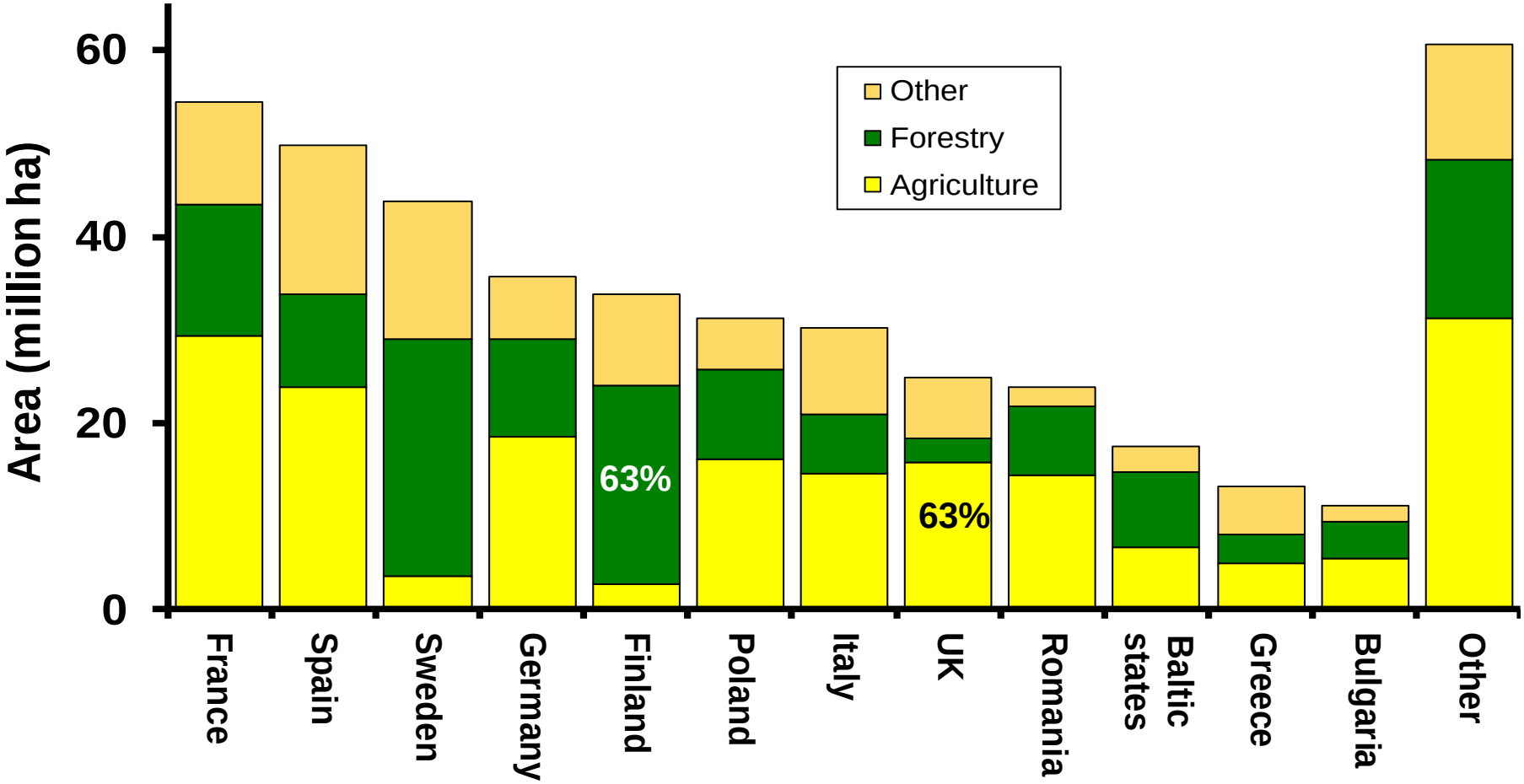
# Value of provisioning and other ecosystem services of seven UK farm systems (after Chatterton et al 2014)




Includes use of non-UK land

# Agriculture with trees as a land use

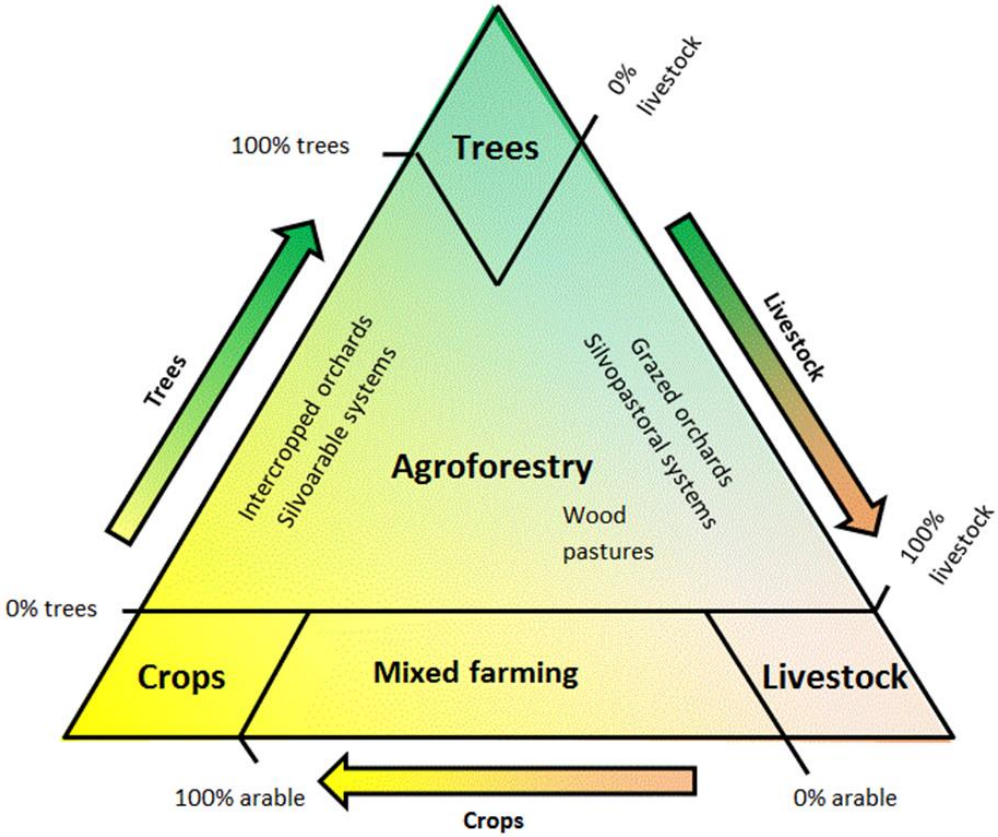
# Simplified understanding of land use



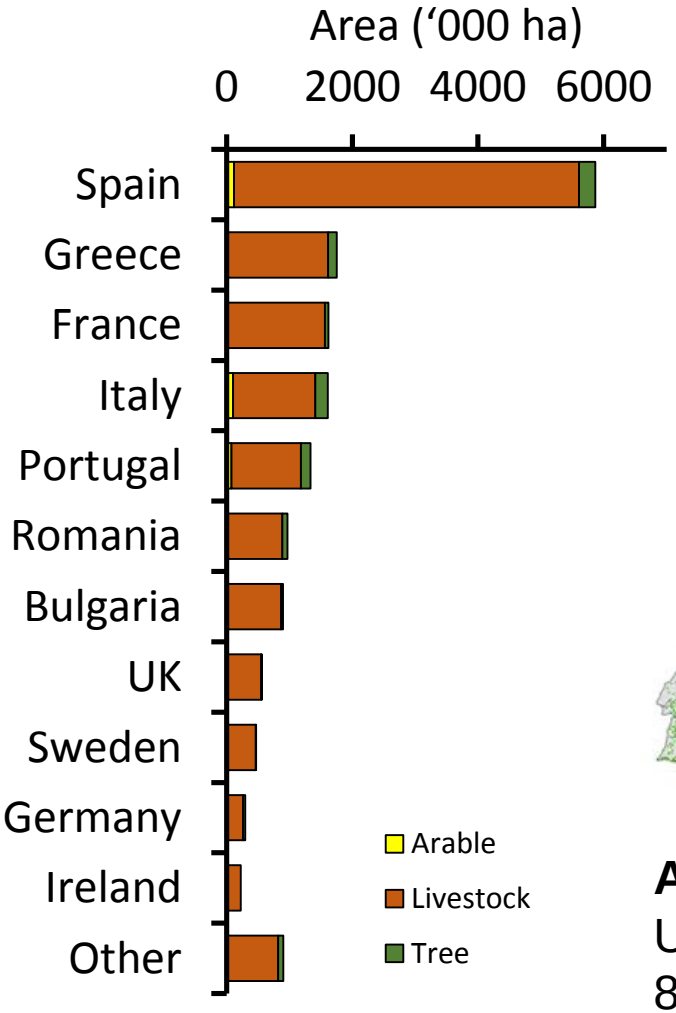

Land use across the EU27 (Eurostat 2016 based on LUCAS 2012)
Other land uses includes hunting and fishing, heavy environmental impact, services and residential, and unused and abandoned land

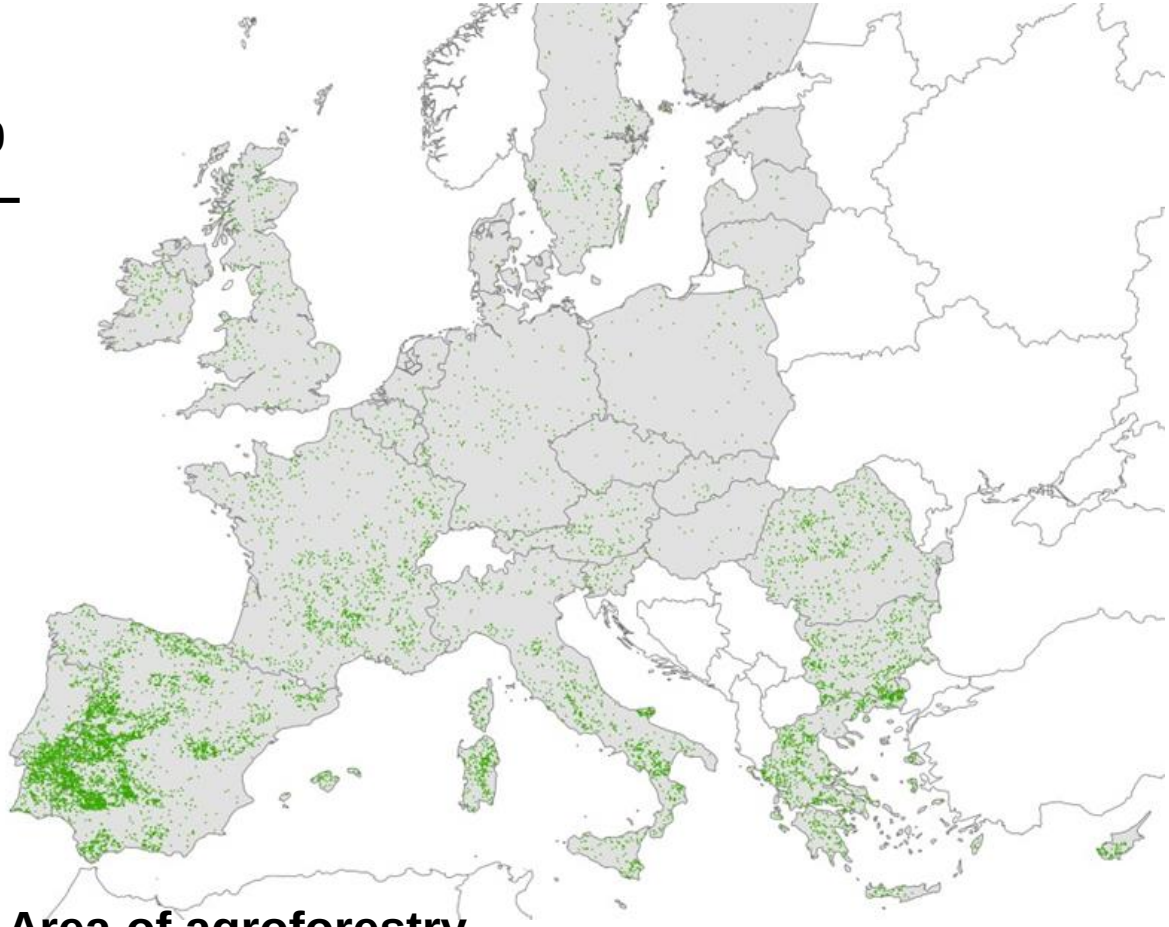
# What do we see?

# Agroforestry: integrating trees and farming (www.agforward.eu)



# Extent of agroforestry in Europe



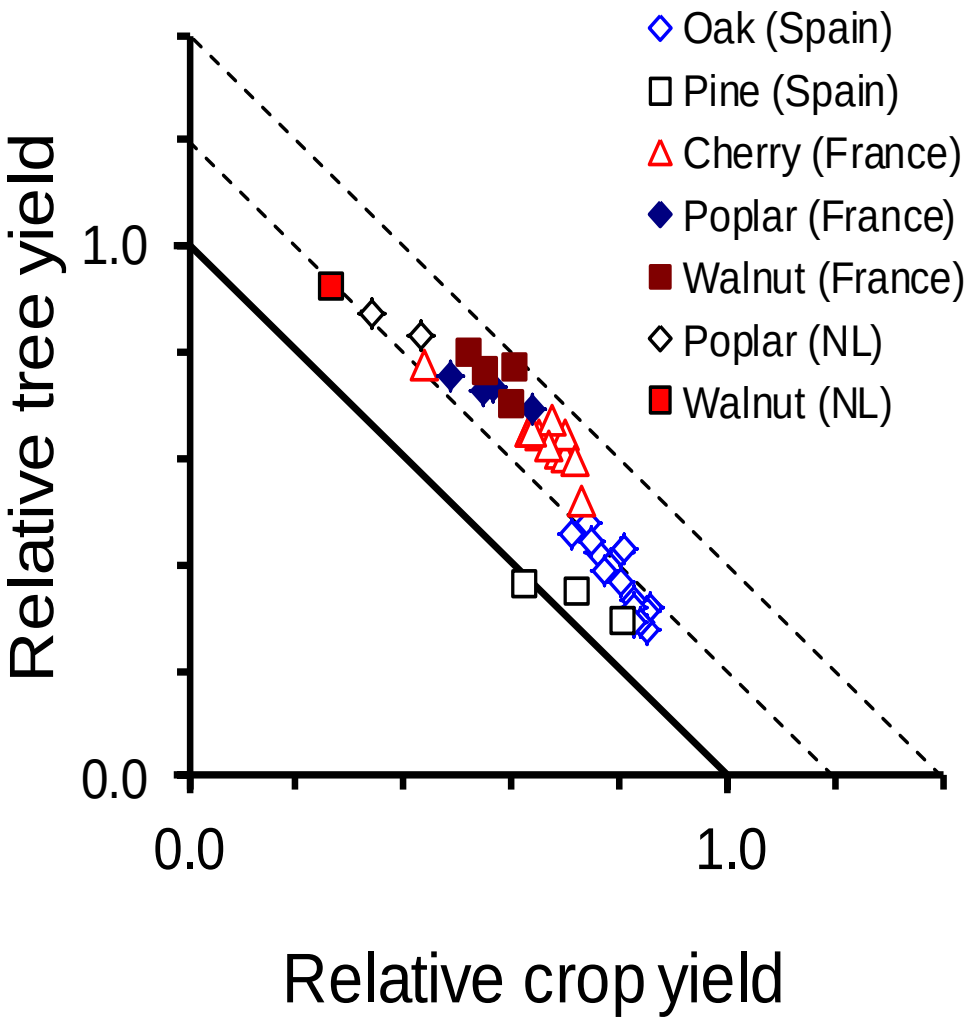



**Area of agroforestry**

Using LUCAS data:15.4 Mha (3.6% of total area and 8.8% of agricultural area) (den Herder et al. 2016).

# Benefits of integrating farming and trees

# Improved resource use




Models indicate that increased capture of solar radiation and water allow integrated trees and arable crops to produce more  per unit land than growing them separately
(Graves et al. 2007).

However, need to be careful to choose appropriate “controls”

# Increased carbon sequestration
## (Aertsens et al. 2013)

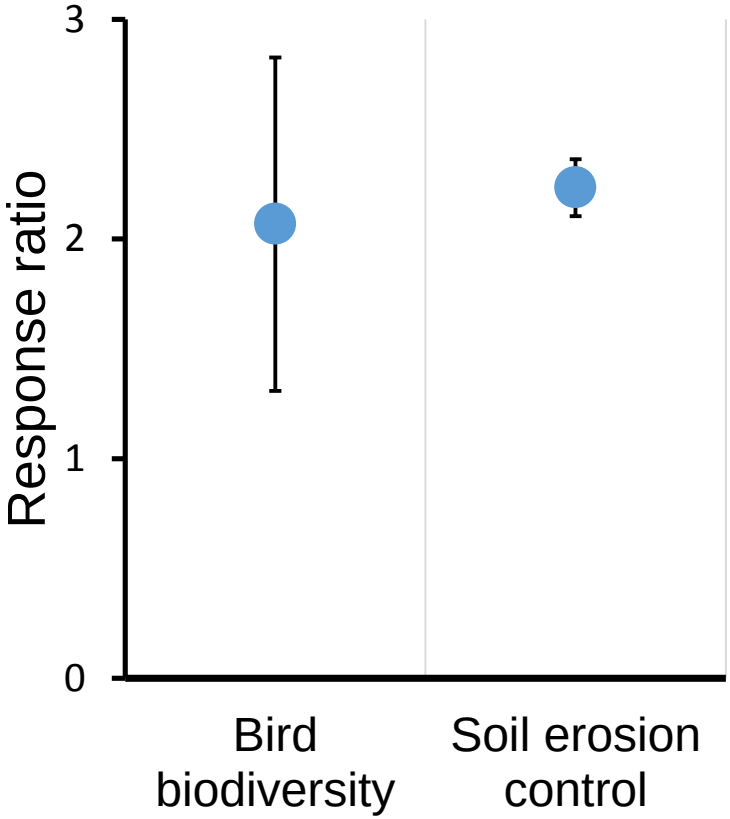
| Measure | Potential area EU-27 (million ha) | Potential per hectare per year (tonnes C) | Potential EU-27 (million tonnes $CO_2$-eq per year) |
|---|---|---|---|
| Agroforestry on arable land | 90 | 2.75[a] | 906 |
| Agroforestry on pastures | 50 | 2.75[b] | 503 |
| Hedgerows | 178 | 0.10 | 65 |
| Cover crops | 119 | 0.16 | 70 |
| Low/no tillage | 60 | 0.10 | 22 |
| All | | | 1566 |

EU emissions were equivalent to 5564 million tonnes $CO_2$-eq per year in 1990

[a]Aertsens et al. (2013) predicts high levels of carbon sequestration, but values of 2.7 t C per hectare of a silvoarable system per year in the UK resulted in loss of cropping after about 10 years (Upson, 2013).

[b]Upson et al. (2016) describe how incorporating 4% tree cover on pasture accumulated about 0.3 t C per hectare in the first 14 years.

# Biodiversity and soil conservation




Mean effect size (response ratios) of European agroforestry on bird biodiversity (n =16) and soil erosion control (n = 65) (relative to forestry or agriculture (error bars show 95% confidence intervals) (Torralba et al. 2016)

# Animal welfare benefits

## Woodland Eggs

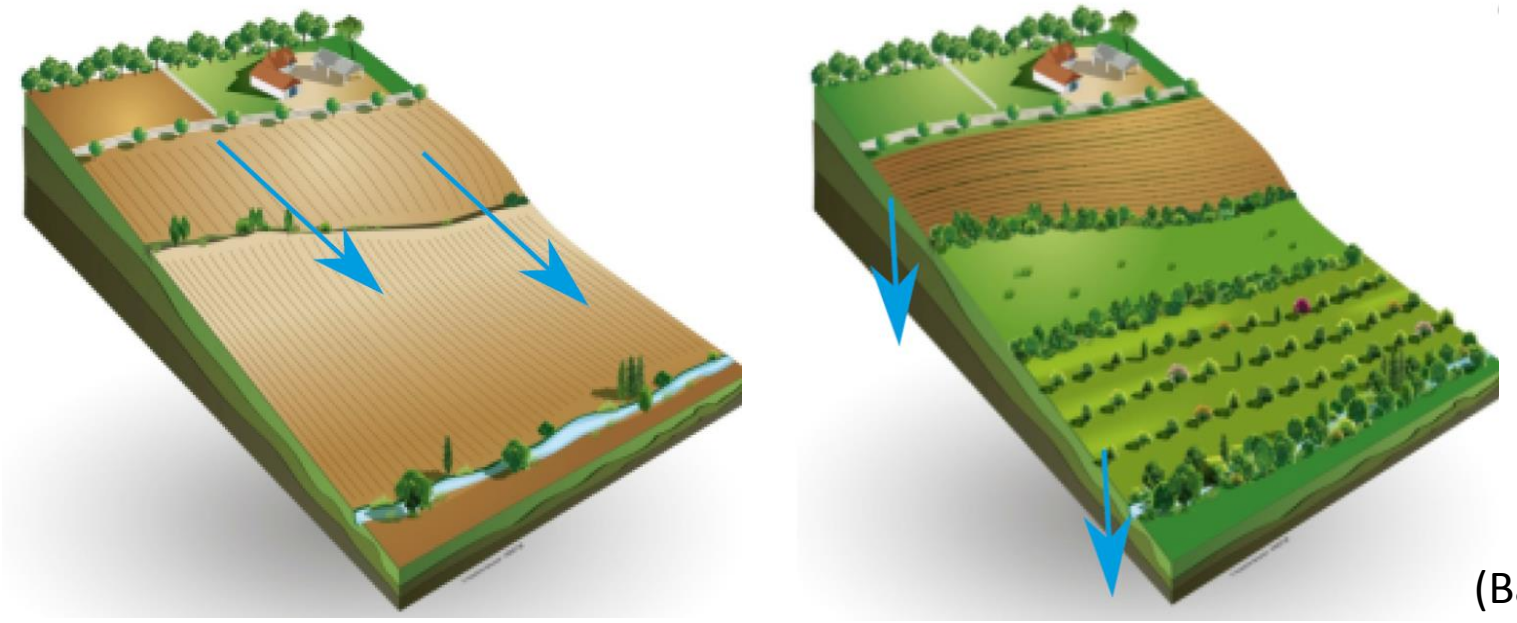
**Reduced injurious feather pecking in a woodland environment** (Bright and Joret, 2012). They also report that the proportion of eggs with poor quality shells fell by 1% when hens were given access to a woodland.

UK consumers were **paying a premium** of **£0.20** for six woodland eggs compared to free-range eggs in two supermarkets (Burgess et al. 2014).
UK egg packers are willing to give a price premium of **£0.01** for six woodland eggs compared to “free-range” (IGD, 2008)

# Reducing downstream flooding

Photo of Pontbren in Wales, where farmers have worked together to integrate trees into farm systems, maintaining production whilst improving the environment (Woodland Trust, 2012)

# Reducing downstream flooding

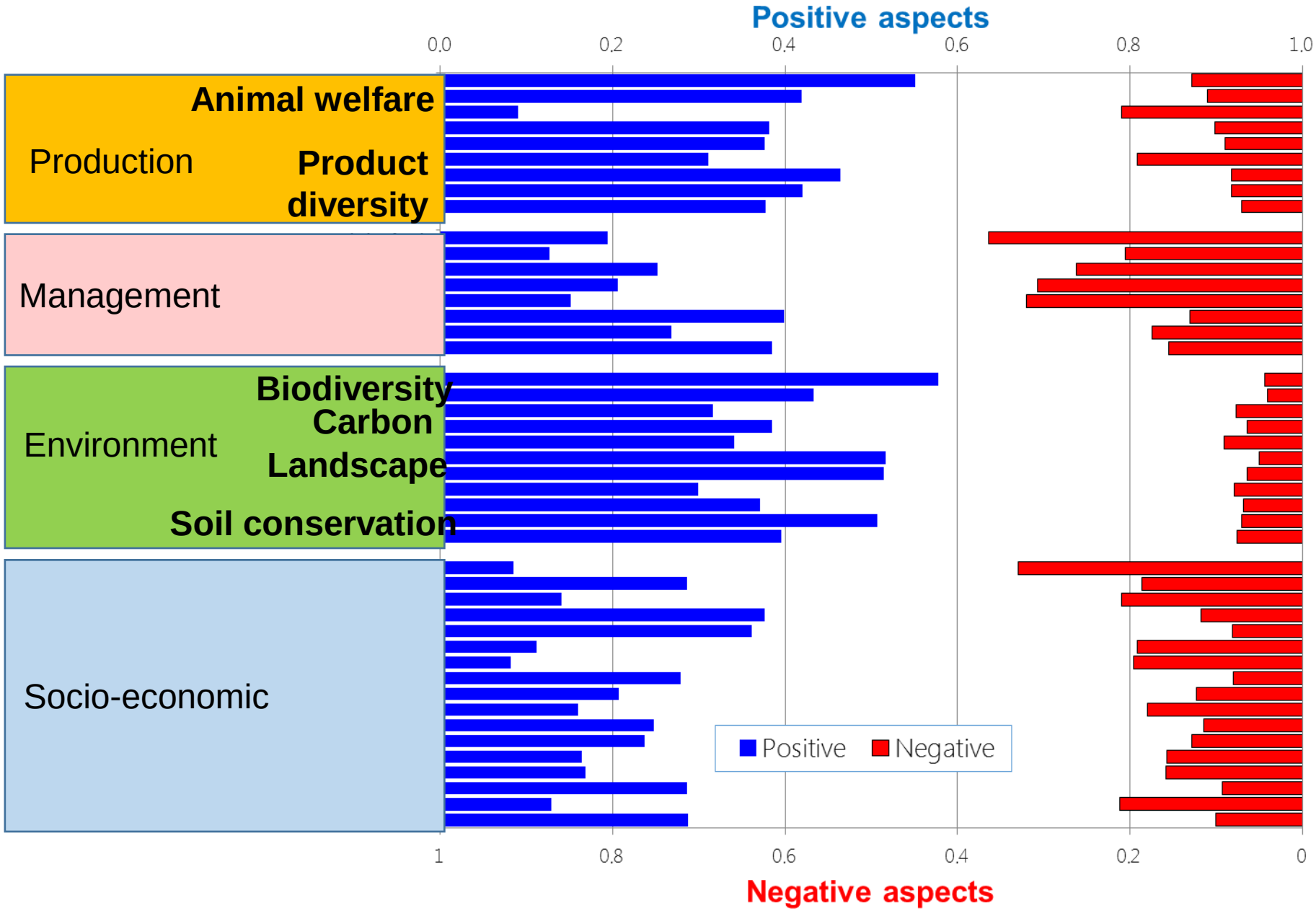


(Balaguer 2015)

Modelled effect of trees in the 4 km$^2$ Pontbren sub-catchment, Wales (Wheater et al., 2012)

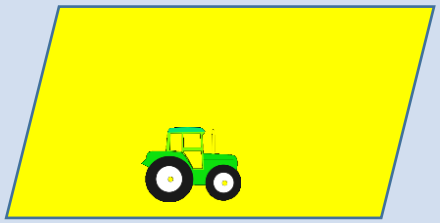
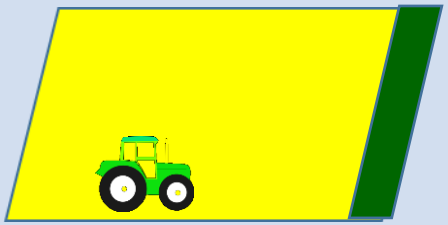
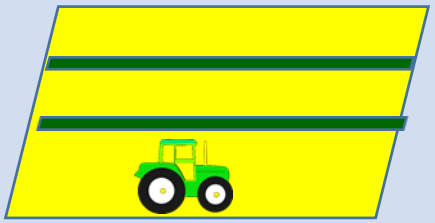
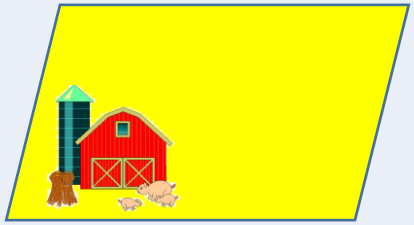
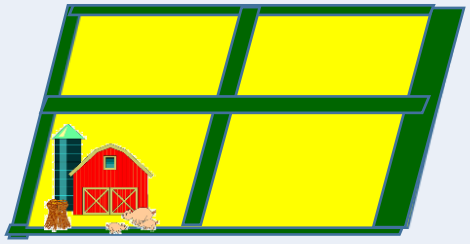
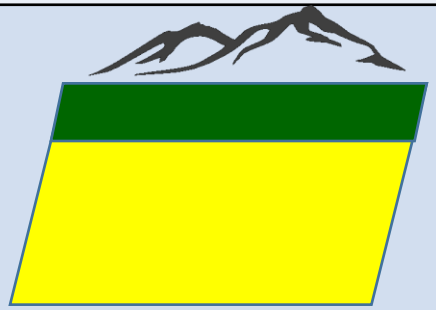
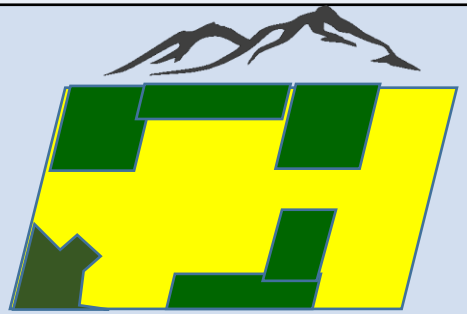
| Management choice | Change in flood peaks |
|---|---|
| Remove all trees | +20% |
| Baseline situation | |
| Add tree shelterbelts | -20% |
| Afforestation | -60% |

**Initial results from the AGFORWARD project asking 344 farmers and other stakeholders in the EU to identify the key positive and negative aspects of agroforestry against 45 criteria.**

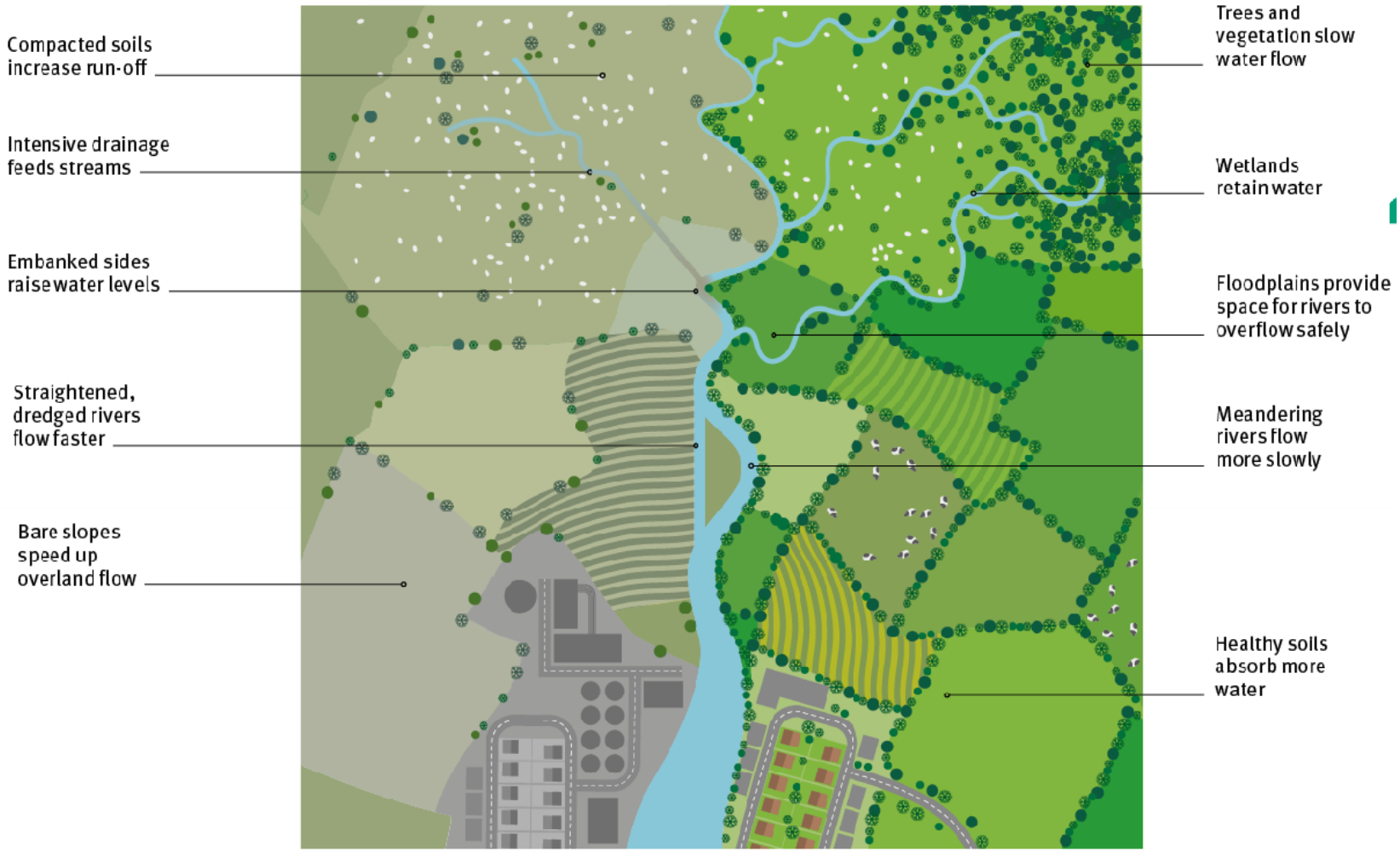


# The place of trees in farming

# Scale and spatial patterns

| | Agriculture | + Trees | + Mosaic |
|---|---|---|---|
| Field-scale |  |  |  |
| Farm-scale |  | |  |
| Landscape-scale | |  |  |

# Trees and catchment management




Schematic diagram of how trees, together with other land management measures can reduce flooding (Francis, 2016)

# Conclusions

1. Many farm systems have significant environmental costs – primarily related to greenhouse gas emissions
2. Surveys like LUCAS are quantifying multiple land use.
3. Integrating trees with farming can offer benefits in terms of:
   - land productivity
   - carbon sequestration, biodiversity, and soil erosion control
   - improved animal welfare and reduced downstream flooding
4. Systems involve components, processes, and patterns. The appropriate pattern of integrating trees in agriculture depends on understanding benefits, costs and scales.
5. Many farmers successfully manage **farming** with trees. There is scope for a move from an “either-or” to a “yes-and” mentality.

# References


Aertsens J, De Nocker J, Gobin A (2013). Valuing the carbon sequestration potential for European agriculture. Land Use Policy 31: 584–594

AGFORWARD (2016). AGFORWARD website. www.agforward.eu

Bright A, Joret A (2012) Laying hens go undercover to improve production. Veterinary Record 170: 228.

Burgess PJ, Belot V, Buachie E, Cuartero de Frias F, Nedved K, Rodriguez Arquero E (2014). The economics of woodland eggs in the UK. In: 2nd European Agroforestry Conference 4-6 June 2014, Cottbus, Germany Book of Abstracts. 67-70.

Chatterton J, Graves A, Audsley E, Morris J, Williams A (2015). Using systems-based LCA to investigate the environmental and economic impacts and benefits of the livestock sector in the UK. Journal of Cleaner Production 86: 1-8.

den Herder M, Moreno G, Mosquera-Losada MR, Palma JHN, Sidiropoulou A, Santiago Freijanes JJ, Crous-Duran J, Paulo J, Tomé M, Pantera A, Papanastasis V, Mantzanas K, Pachana P, Papadopoulos A, Plieninger T, Burgess PJ (2016). Current extent and trends of agroforestry in the EU27. Deliverable Report 1.2 for EU FP7 Research Project: AGFORWARD 613520. (15 August 2016). 2nd Edition. 76 pp.

Francis, A. (2016). Debating Natural Capital. Presentation at "Debating Natural Capital" Conference, London 7 November 2016. http://www.leafuk.org/eblock/services/resources.ashx/001/312/441/Angela_Francis.pdf

Graves AR, Burgess PJ, Palma JHN, Herzog F, Moreno G, Bertomeu M, Dupraz C, Liagre F, Keesman K, van der Werf W Koeffeman de Nooy A, van den Briel JP (2007). Development and application of bio-economic modelling to compare silvoarable, arable and forestry systems in three European countries. *Ecological Engineering* 29: 434-449.

IGD (2008). Noble Foods and Sainsbury's Woodland Eggs – Improving Animal Welfare and Supporting Farmers. http://www.igd.com/our-expertise/Sustainability/Ethical-social-issues/3513/Noble-Foods-andSainsburys-Woodland-Eggs--Improving-Animal-Welfare-and-Supporting-Farmers/ (accessed 15/03/14)

Torralba M, Fagerholm N, Burgess PJ, Moreno G, Plieninger T (2016). Do European agroforestry systems enhance biodiversity and ecosystem services? A meta-analysis. Agriculture, Ecosystems and Environment 230: 150–161

Upson M (2014). The Carbon Storage Benefits of Agroforestry and Farm Woodlands. Unpublished PhD Thesis, Cranfield University.

Upson MA, Burgess PJ, Morison JIL (2016). Soil carbon changes after establishing woodland and agroforestry trees in a grazed pasture. Geoderma 283: 10-20.

Wheater HS, Ballard C, Buygina N, McIntyre N, Jackson BM (2012) Chapter 22 Modelling Environmental Change: Quantification of Impacts of Land Use and Land Management Change on UK Flood Risk In: System Identification, Environmental Modelling, and Control System Design (Eds: L. Wang, H. Garnier),, Springer-Verlag London Limited

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# Thank you

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