1 + 1 = 3

Wednesday 29th November 2017

European Parliament, Brussels

AGFORWARD
Agroforestry for Europe

How agroforestry is boosting the revenue and resilience of Europe's farmers

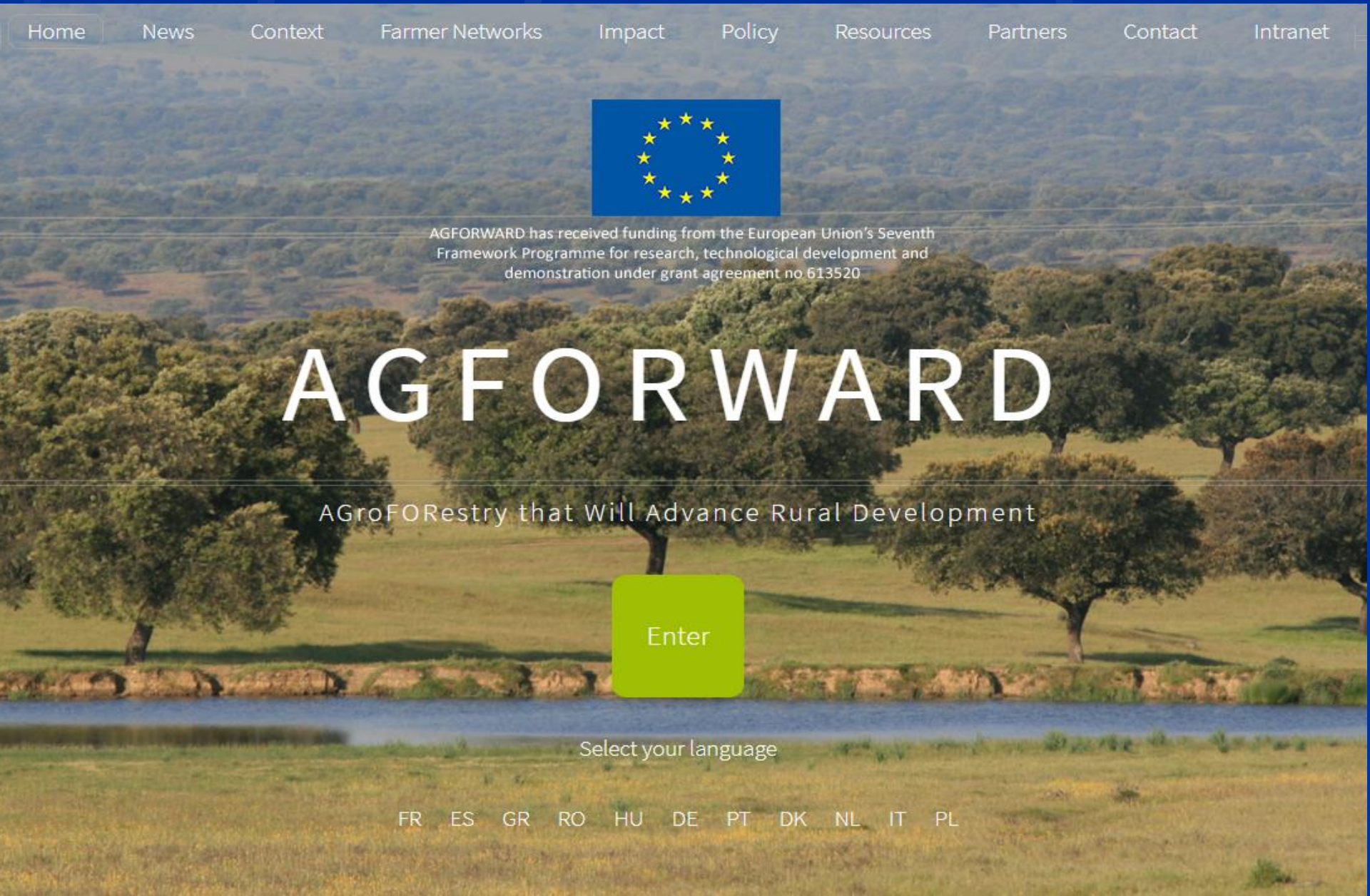
Acknowledgements

The AGFORWARD project is funded by the European Union's Seventh Framework Programme. This presentation describes some highlights of research completed by about 100 researchers across 14 countries and 27 institutions

Paul Burgess, Stephanie Aviron, Fabien Balaguer, Staffan Berg, Manuel Bertomeu, Monique Bestman, Valerio Bondesan, Francesca Camilli, Eric Cirou, Juliette Colin, Nathalie Corroyer, Dominique Desclaux, Nuria Ferreiro Domínguez, Sebastien Dulieu, Christian Dupraz, Josep Crous Duran, Jean-Claude Emile, Nora Fagerholm, Juan Luis Fernandez, Antonello Franca, Dirk Freese, Helene Le Gallic, Kenisha Garnett, Paula Gaspar, Michail Giannitsopoulos, Juan Carlos Gimenez, Nicolas Girardin, Pilar Gonzalez, Marie Gosme, Anil Graves, Helene Gross, Adrien Guichaoua, Yousri Hannachi, Tibor Hartel, Michael den Herder, John Hermansen, Felix Herzog, Silvestre Garcia de Jalon, José Valentin Roches Diaz, Michael Kanzler, Sonja Kay, Marie T Knudsen, Anne Grete Kongsted, Agata Lam, Norbert Lamersdorf, Isabelle Lecomte, Fabien Liagre, Torgny Lind, Maria Ludes Lopez, Marko Lovrić, Nataša Lovrić, Boki Luske, Nina Malignier, Kostas Mantzanas, Robert Mavsar, Jim McAdam, Jaconette Mirck, Gerardo Moreno, Rosa Mosquera-Losada, Delphine Mézière, Sandra Novak, Tania Oliveira, Tim Pagella, Joao Palma, Anastasia Pantera, Andreas Papadopoulos, Vasilios Papanastasis, Piero Paris, Joana Amaral Paulo, Andrea Pisanelli, Tobias Plieninger, Eric Pottier, Fernando Pulido, Antonio Rigueiro, Mercedes Rois, Adolfo Rosati, Jose Javier Santiago, Giovanna Seddaiu, André Sieffert, Fergus Sinclair, Jo Smith, Erich Szerencsits, Claudine Thenail, Ana Tomás, Margarida Tomé, Mario Torralba Viorreta, Eric Valinger, Philippe Vanlerberghe, Anna Varga, Valerie Viaud, Andrea Vityi, Kevin Waldie, Regis Wartelle, Jeroen Watte, Martin Wolfe, Patrick Worms

European Union's Seventh Framework Program for research, technological development and demonstration under grant agreement no 613520

www.agforward.eu



Three presentations

1. What is, where is and why agroforestry?

   Paul Burgess, Cranfield University
   Co-ordinator of AGFORWARD project
   (P.Burgess@cranfield.ac.uk)

2. Practice of agroforestry

   Fabien Balaguer

3. Policy recommendations for Europe

   Rosa Mosquera Losada

What is agroforestry?

Reclaimed arable land in
the Veneto region of Italy is
flat, open, and exposed with few trees


The landowner explained that he was practising agroforestry by planting trees on every third drainage ditch every 90 m


Apple trees on 27 m alleys
on an organic arable farm in England


In many areas trees are
an integral part of the landscape

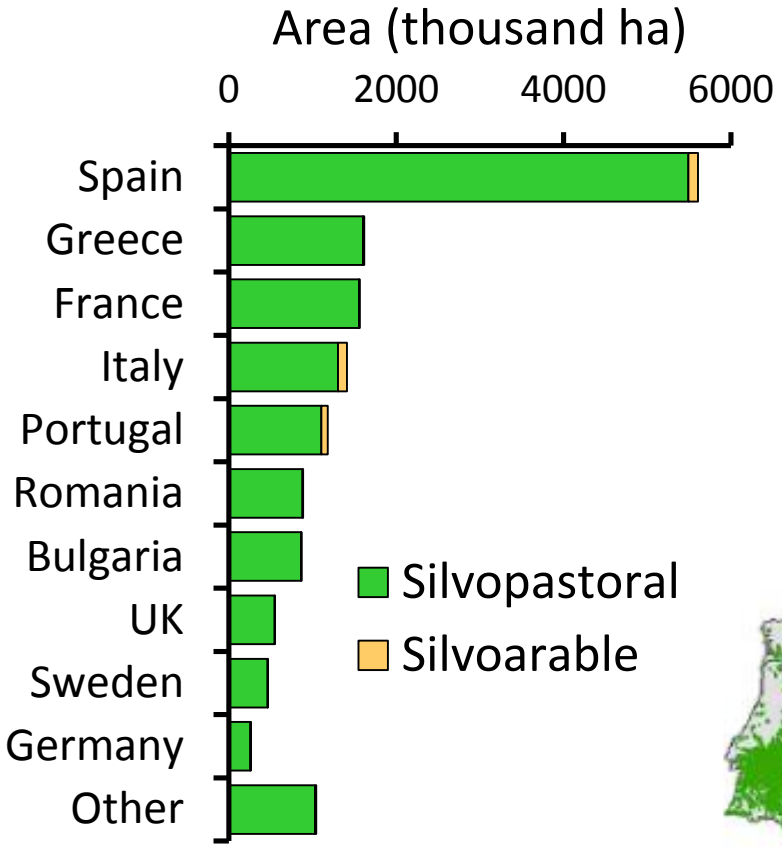
Sheep and wild cherry trees in Galicia

Montado and cattle in Portugal

Silvopasture and silvoarable are the main forms of agroforestry in Europe

Silvopastoral	Silvoarable			
				
Trees and shrubs with forage and animal production	Trees and shrubs intercropped with annual or perennial crops			

Agroforestry, dominated by silvopastoral systems, covers 3.6% of Europe



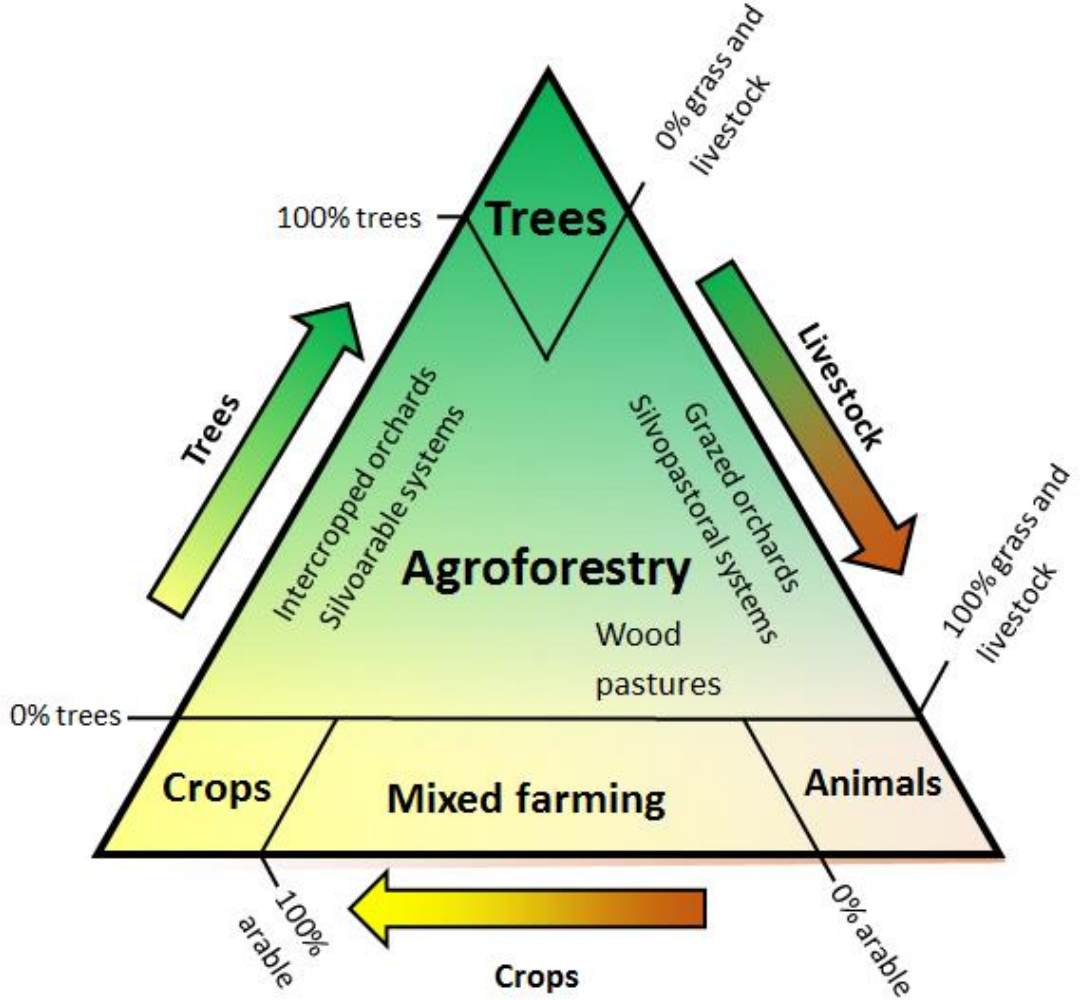
Area of agroforestry: Using LUCAS data:15.4 Mha (3.6% of total area and 8.8% of agricultural area) (den Herder et al. 2017) (excludes 1.8 Mha of homegardens).

Other forms of agroforestry

Silvopastoral	Silvoarable	**Hedgerows, windbreaks and riparian buffer strips**	**Forest farming**	**Home-gardens**
				
Trees and shrubs with forage and animal production	Trees and shrubs intercropped with annual or perennial crops	**Trees and shrubs bordering farm land to protect livestock, crops, and/or soil and water quality**	**Forested areas used for harvest of speciality crops**	**Trees/ shrubs with veg. in urban areas (1.8 Mha)**

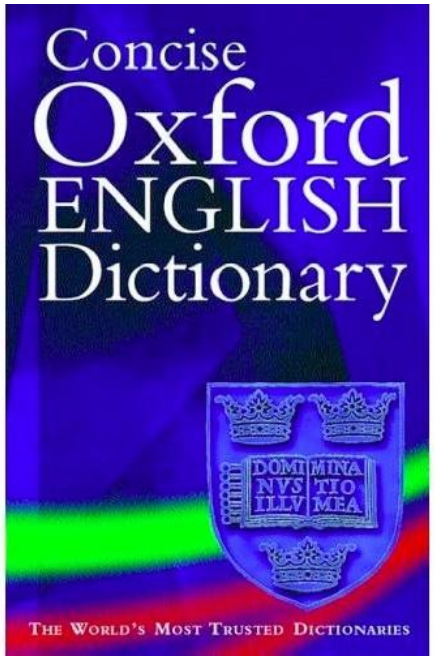
Agroforestry: seeking the synergy between agriculture and trees

Agroforestry:
the deliberate integration of woody vegetation with pasture (consumed by animals) or an agricultural crop

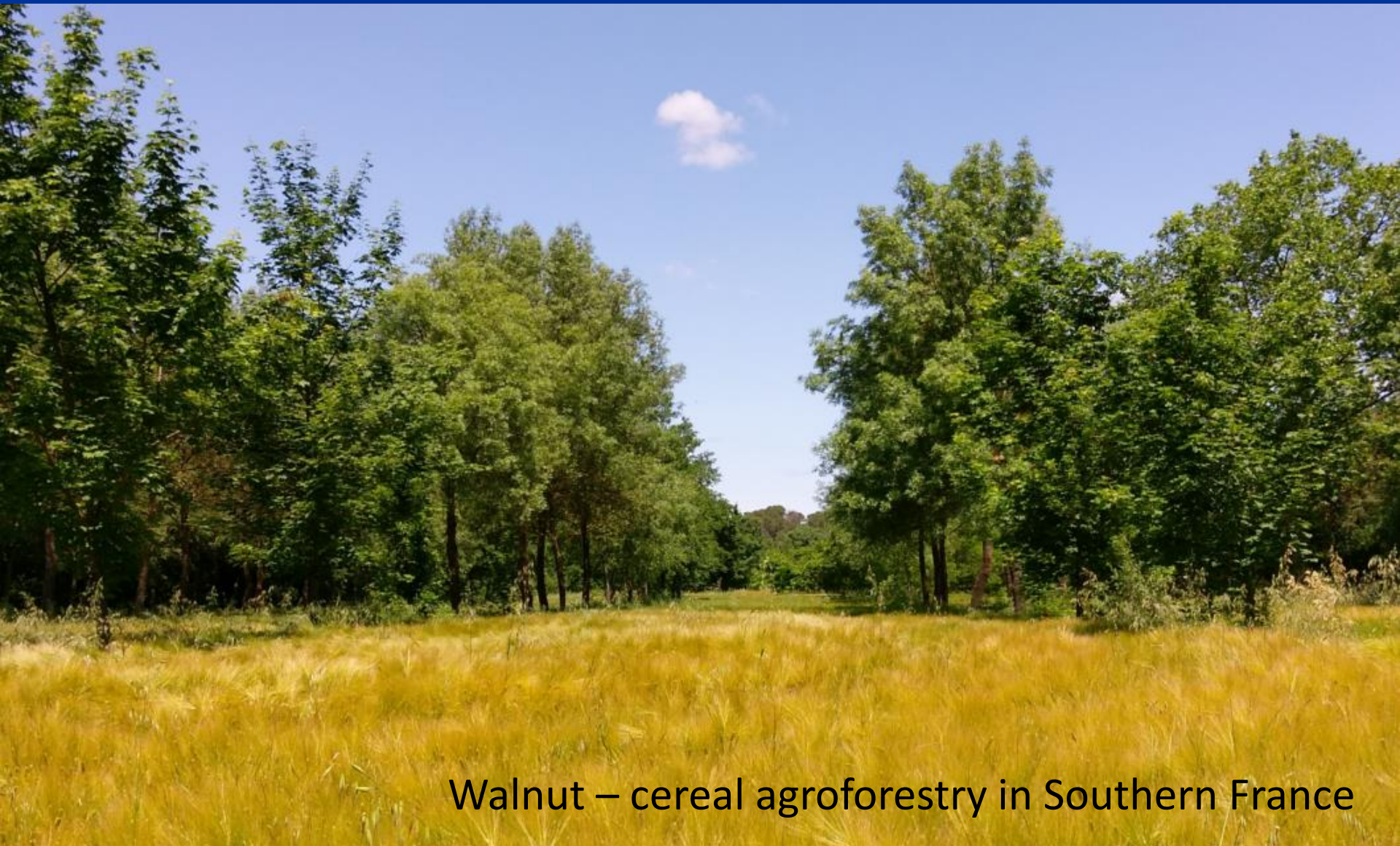


Synergy

- **n**: interaction of two or more agents to produce a **combined effect greater than the sum of their separate effec**ts.

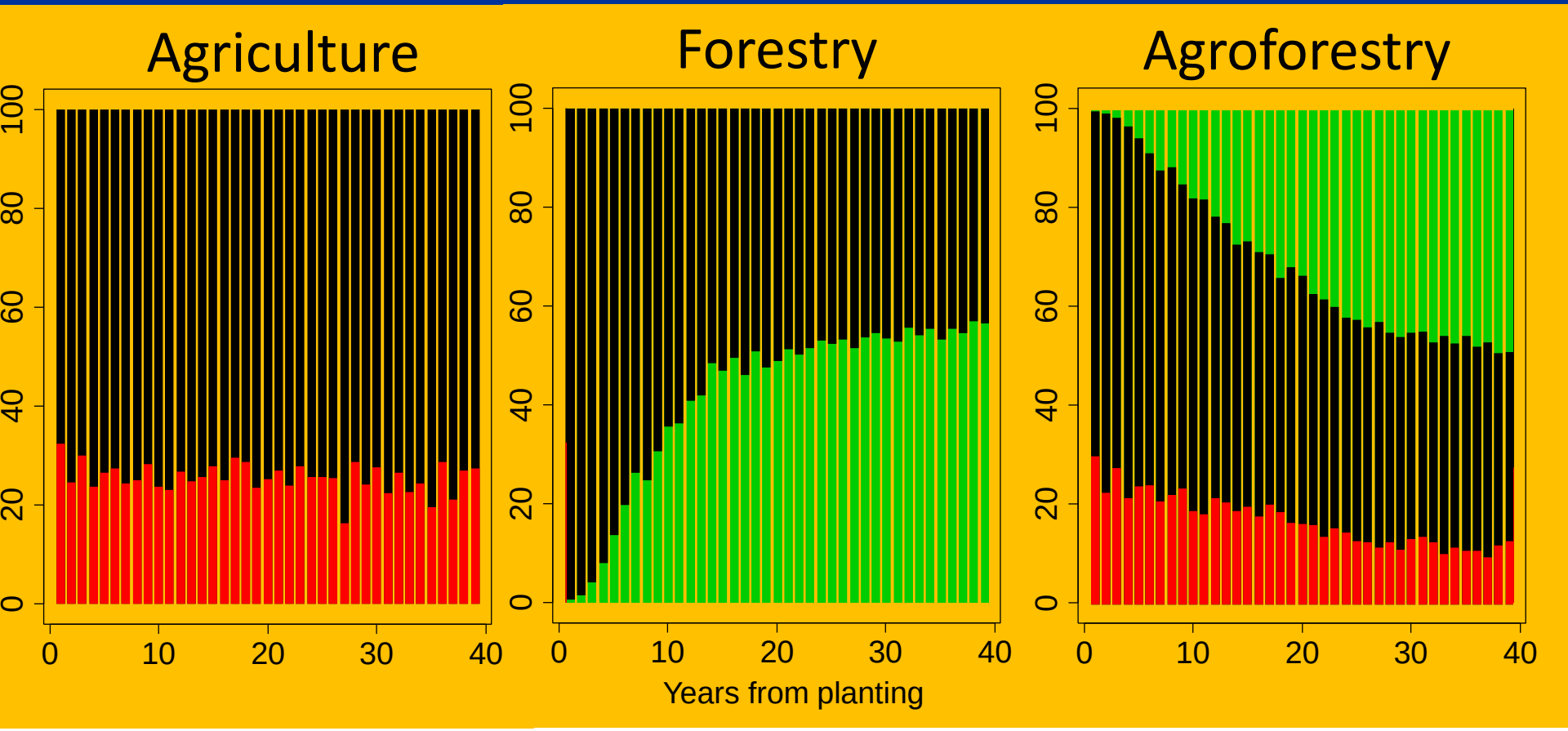


Production: proportion of sunlight used for photosynthesis



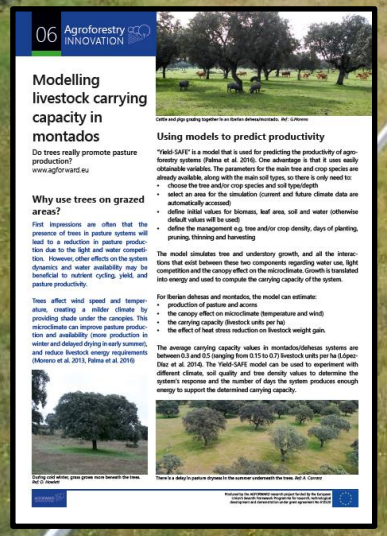
Walnut – cereal agroforestry in Southern France

Production: more sunlight used for photosynthesis



Light intercepted by wheat
Light intercepted by walnut
Not used

Modelled proportion of solar radiation intercepted by wheat monocultures, walnut tree forestry, and a wheat-walnut agroforestry system over 40 years (Dupraz and Liagre 2008)



06 Agroforestry INNOVATION

Modelling livestock carrying capacity in montados

Do trees really promote pasture production?
www.agforward.eu

Why use trees on grazed areas?

First impressions are often that the presence of trees in pasture systems will lead to a reduction in pasture production due to the light and water competition. However, other effects on the system dynamics and water availability may be beneficial to nutrient cycling, yield, and pasture productivity.

Trees affect wind speed and temperature, creating a milder climate by providing shade under the canopies. This microclimate can improve pasture production and availability (more production in winter and delayed drying in early summer), and reduce livestock energy requirements (Moreno et al. 2013, Palma et al. 2016)

During cold winter, grass grows more beneath the trees. *Ref. D. Howlett*

Cattle and pigs grazing together in an Iberian dehesa/montado. *Ref. G.Pisonero*

Using models to predict productivity

"Yield-SAFE" is a model that is used for predicting the productivity of agroforestry systems (Palma et al. 2016). One advantage is that it uses easily obtainable variables. The parameters for the main tree and crop species are already available, along with the main soil types, so there is only need to:

- choose the tree and/or crop species and soil type/depth
- select an area for the simulation (current and future climate data are automatically accessed)
- define initial values for biomass, leaf area, soil and water (otherwise default values will be used)
- define the management e.g. tree and/or crop density, days of planting, pruning, thinning and harvesting

The model simulates tree and understory growth, and all the interactions that exist between these two components regarding water use, light competition and the canopy effect on the microclimate. Growth is translated into energy and used to compute the carrying capacity of the system.

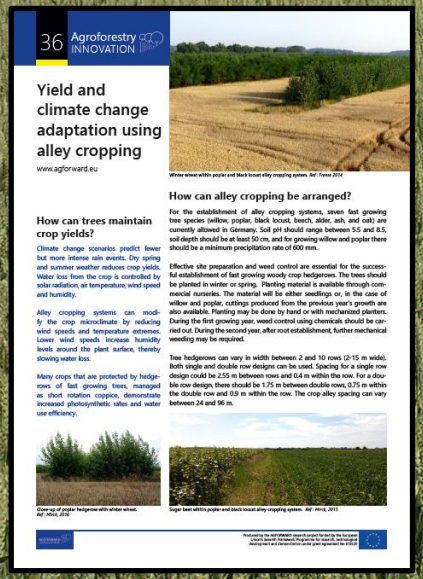
For Iberian dehesas and montados, the model can estimate:

- production of pasture and acorns
- the canopy effect on microclimate (temperature and wind)
- the carrying capacity (livestock units per ha)
- the effect of heat stress reduction on livestock weight gain.

The average carrying capacity values in montados/dehesas systems are between 0.3 and 0.5 (ranging from 0.15 to 0.7) livestock units per ha (López-Díaz et al. 2014). The Yield-SAFE model can be used to experiment with different climate, soil quality and tree density values to determine the system's response and the number of days the system produces enough energy to support the determined carrying capacity.

There is a delay in pasture dryness in the summer underneath the trees. *Ref. F. Correia*

Improved seasonality of forage and fodder production



36 Agroforestry INNOVATION

Yield and climate change adaptation using alley cropping

www.agforward.eu

Winter wheat within poplar and black locust alley cropping system. *Ref: Freese 2014*

How can trees maintain crop yields?

Climate change scenarios predict fewer but more intense rain events. Dry spring and summer weather reduces crop yields. Water loss from the crop is controlled by solar radiation, air temperature, wind speed and humidity.

Alley cropping systems can modify the crop microclimate by reducing wind speeds and temperature extremes. Lower wind speeds increase humidity levels around the plant surface, thereby slowing water loss.

Many crops that are protected by hedgerows of fast growing trees, managed as short rotation coppice, demonstrate increased photosynthetic rates and water use efficiency.

Close-up of poplar hedgerow with winter wheat. *Ref: Wolz, 2016*

How can alley cropping be arranged?

For the establishment of alley cropping systems, seven fast growing tree species (willow, poplar, black locust, beech, alder, ash, and oak) are currently allowed in Germany. Soil pH should range between 5.5 and 8.5, soil depth should be at least 50 cm, and for growing willow and poplar there should be a minimum precipitation rate of 600 mm.

Effective site preparation and weed control are essential for the successful establishment of fast growing woody crop hedgerows. The trees should be planted in winter or spring. Planting material is available through commercial nurseries. The material will be either seedlings or, in the case of willow and poplar, cuttings produced from the previous year's growth are also available. Planting may be done by hand or with mechanized planters. During the first growing year, weed control using chemicals should be carried out. During the second year, after root establishment, further mechanical weeding may be required.

Tree hedgerows can vary in width between 2 and 10 rows (2-15 m wide). Both single and double row designs can be used. Spacing for a single row design could be 2.55 m between rows and 0.4 m within the row. For a double row design, there should be 1.75 m between double rows, 0.75 m within the double row and 0.9 m within the row. The crop alley spacing can vary between 24 and 96 m.

Sugar beet within poplar and black locust alley cropping system. *Ref: Wolz, 2015*

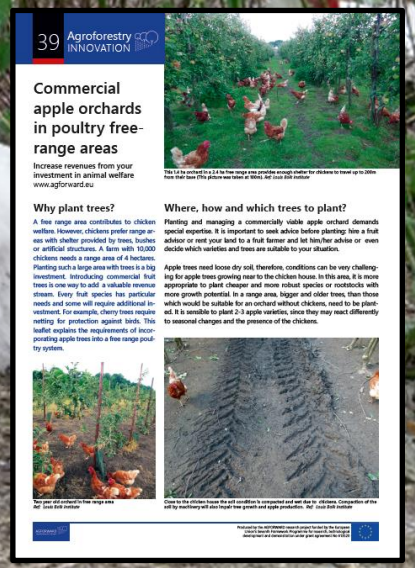
Produced by the AGFORWARD research project funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 613520

Shelter benefits for arable production in Germany

Animal welfare benefits

Woodland eggs

- Hens use more of their range
- Less feather pecking damage
- Fewer wild fowl visits



39 Agroforestry INNOVATION

Commercial apple orchards in poultry free-range areas

Increase revenues from your investment in animal welfare
www.agforward.eu

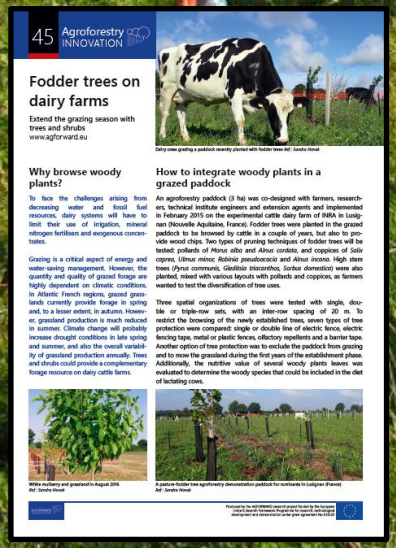
Why plant trees?

A free range area contributes to chicken welfare. However, chickens prefer range areas with shelter provided by trees, bushes or artificial structures. A farm with 10,000 chickens needs a range area of 4 hectares. Planting such a large area with trees is a big investment. Introducing commercial fruit trees is one way to add a valuable revenue stream. Every fruit species has particular needs and some will require additional investment. For example, cherry trees require netting for protection against birds. This leaflet explains the requirements of incorporating apple trees into a free range poultry system.

Where, how and which trees to plant?

Planting and managing a commercially viable apple orchard demands special expertise. It is important to seek advice before planting: hire a fruit advisor or rent your land to a fruit farmer and let him/her advise or even decide which varieties and trees are suitable to your situation.

Apple trees need loose dry soil, therefore, conditions can be very challenging for apple trees growing near to the chicken house. In this area, it is more appropriate to plant cheaper and more robust species or rootstocks with more growth potential. In a range area, bigger and older trees, than those which would be suitable for an orchard without chickens, need to be planted. It is sensible to plant 2-3 apple varieties, since they may react differently to seasonal changes and the presence of the chickens.



45 Agroforestry INNOVATION

Fodder trees on dairy farms

Extend the grazing season with trees and shrubs
www.agforward.eu

Dairy cows grazing a paddock recently planted with fodder trees *Ref : Sandra Novak*

Why browse woody plants?

To face the challenges arising from decreasing water and fossil fuel resources, dairy systems will have to limit their use of irrigation, mineral nitrogen fertilisers and exogenous concentrates.

Grazing is a critical aspect of energy and water-saving management. However, the quantity and quality of grazed forage are highly dependent on climatic conditions. In Atlantic French regions, grazed grasslands currently provide forage in spring and, to a lesser extent, in autumn. However, grassland production is much reduced in summer. Climate change will probably increase drought conditions in late spring and summer, and also the overall variability of grassland production annually. Trees and shrubs could provide a complementary forage resource on dairy cattle farms.

How to integrate woody plants in a grazed paddock

An agroforestry paddock (3 ha) was co-designed with farmers, researchers, technical institute engineers and extension agents and implemented in February 2015 on the experimental cattle dairy farm of INRA in Lusignan (Nouvelle Aquitaine, France). Fodder trees were planted in the grazed paddock to be browsed by cattle in a couple of years, but also to provide wood chips. Two types of pruning techniques of fodder trees will be tested: pollards of *Morus alba* and *Alnus cordata*, and coppices of *Salix caprea*, *Ulmus minor, Robinia pseudoacacia* and *Alnus incana*. High stem trees (*Pyrus communis, Gleditsia triacanthos, Sorbus domestica*) were also planted, mixed with various layouts with pollards and coppices, as farmers wanted to test the diversification of tree uses.

Three spatial organizations of trees were tested with single, double or triple-row sets, with an inter-row spacing of 20 m. To restrict the browsing of the newly established trees, seven types of tree protection were compared: single or double line of electric fence, electric fencing tape, metal or plastic fences, olfactory repellents and a barrier tape. Another option of tree protection was to exclude the paddock from grazing and to mow the grassland during the first years of the establishment phase. Additionally, the nutritive value of several woody plants leaves was evaluated to determine the woody species that could be included in the diet of lactating cows.

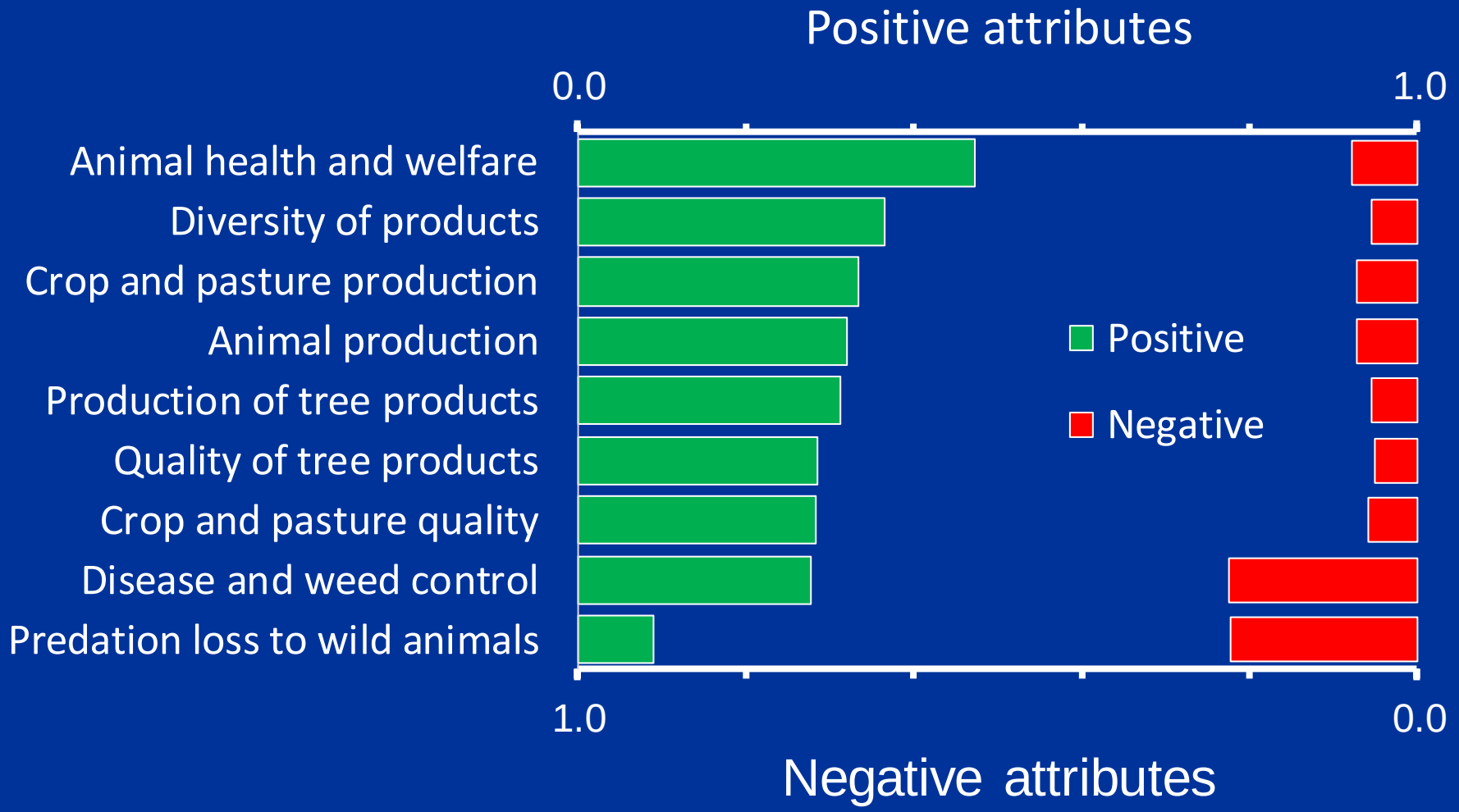
White mulberry and grassland in August 2016 *Ref : Sandra Novak*

A pasture-fodder tree agroforestry demonstration paddock for ruminants in Lusignan (France) *Ref : Sandra Novak*

Produced for the AGFORWARD research project funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 613520

Tree fodder database: leaves of black locust, chestnut, white mulberry and ash have crude protein levels of 22%

Farmers also recognise production benefits of agroforestry



Responses of 344 stakeholders across 30 stakeholder groups (Garcia de Jalon et al. 2017)

24 Agroforestry INNOVATION

Economic benefits of grazed apple orchards in England

Grazing under half-standard or standard trees
www.agforward.eu

Shropshire ewes and lambs in a traditional cider apple orchard in Herefordshire, England (March 2017)

Why graze orchards with sheep?

Orchard grazing can offer financial and environmental benefits. The experience of stakeholders in the AGFORWARD project is that some lowland sheep breeds (e.g. Shropshire) can successfully graze on orchards which have been pruned to a height of 1-2 m without noticeable losses in apple yields. Sheep producers can profit from an additional source of grass in the orchards, and the release of grazed land for hay production. Orchard owners can profit from reduced mowing costs, increased nitrogen cycling and a rent from the sheep owner. There can also be societal benefits in terms of employment and plant biodiversity.

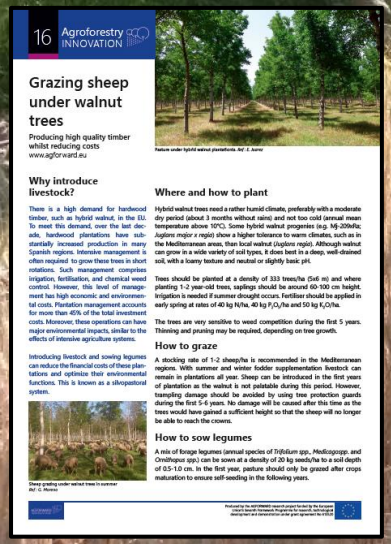
Electric fencing was used in the trial to separate the grazed and ungrazed parts of the orchard.

Cider apple orchards and sheep

Cider apple orchards have significant economic, biodiversity, and societal benefits. (Robertson et al. 2012) Cider apples are sold for their juice rather than their appearance and therefore the pesticide regime can be less intensive than that required for dessert apples.This reduction in agrochemical use provides opportunities for integrating sheep. In the UK, about a third of the cider apple orchards are comprised of "standard" or "half-standard" trees, which have been pruned to a height of 2 m and 1-2 m respectively. This pruning allows the yields from apple trees to be maintained when the grass understorey is grazed by "tree-friendly" sheep. In England, orchard owners commonly use Shropshire sheep because, if managed correctly, they cause minimal levels of bark damage.

A key feature of grazed orchard systems is that it is necessary for the sheep to be absent from the orchard for 60 days before apple harvest (generally from August to October) to minimise faecal contamination of the fruit. Hence, a sheep producer must have access to separate non-orchard grassland where the sheep can be kept at this time. Thus, a grazed orchard system involves sheep, apple trees, the grass understorey, and an area of separate non-orchard grasslandfor supplementary grazing.

Annual cycle of sheep production showing the location and movement of sheep between an orchard (inner circle) and an area of non-orchard grassland (outer circle). Sheep must be absent from the orchard for 60 days before apple harvest, and need to be kept on the non-orchard grassland at this time. The sheep may use both the orchard and non-orchard grassland from November to February before being housed indoors for lambing. In April, the ewes and lambs can use the orchard until August and the grassland area can be used for hay production. The cycle then starts again.



16 Agroforestry INNOVATION

Grazing sheep under walnut trees

Producing high quality timber whilst reducing costs
www.agforward.eu

Pasture under hybrid walnut plantations. Ref.: E. Ivarez

Why introduce livestock?

There is a high demand for hardwood timber, such as hybrid walnut, in the EU. To meet this demand, over the last decade, hardwood plantations have substantially increased production in many Spanish regions. Intensive management is often required to grow these trees in short rotations. Such management comprises irrigation, fertilisation, and chemical weed control. However, this level of management has high economic and environmental costs. Plantation management accounts for more than 45% of the total investment costs. Moreover, these operations can have major environmental impacts, similar to the effects of intensive agriculture systems.

Introducing livestock and sowing legumes can reduce the financial costs of these plantations and optimize their environmental functions. This is known as a silvopastoral system.

Sheep grazing under walnut trees in summer
Ref.: C. Moreno

Where and how to plant

Hybrid walnut trees need a rather humid climate, preferably with a moderate dry period (about 3 months without rains) and not too cold (annual mean temperature above 10°C). Some hybrid walnut progenies (e.g. MJ-209xRa; *Juglans major x regia*) show a higher tolerance to warm climates, such as in the Mediterranean areas, than local walnut (*Juglans regia*). Although walnut can grow in a wide variety of soil types, it does best in a deep, well-drained soil, with a loamy texture and neutral or slightly basic pH.

Trees should be planted at a density of 333 trees/ha (5x6 m) and where planting 1-2 year-old trees, saplings should be around 60-100 cm height. Irrigation is needed if summer drought occurs. Fertiliser should be applied in early spring at rates of 40 kg N/ha, 40 kg P_2O_5/ha and 50 kg K_2O/ha.

The trees are very sensitive to weed competition during the first 5 years. Thinning and pruning may be required, depending on tree growth.

How to graze

A stocking rate of 1-2 sheep/ha is recommended in the Mediterranean regions. With summer and winter fodder supplementation livestock can remain in plantations all year. Sheep can be introduced in the first years of plantation as the walnut is not palatable during this period. However, trampling damage should be avoided by using tree protection guards during the first 5-6 years. No damage will be caused after this time as the trees would have gained a sufficient height so that the sheep will no longer be able to reach the crowns.

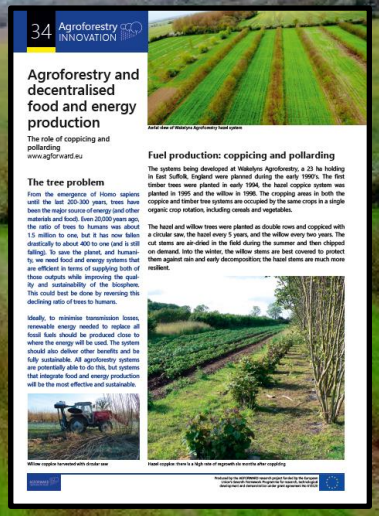
How to sow legumes

A mix of forage legumes (annual species of *Trifolium* spp., *Medicago*spp. and *Ornithopus* spp.) can be sown at a density of 20 kg seeds/ha to a soil depth of 0.5-1.0 cm. In the first year, pasture should only be grazed after crops maturation to ensure self-seeding in the following years.

Produced by the AGFORWARD research project funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 613520

Intercropping or grazing with sheep increased tree diameter growth of walnuts

Increasing farm revenue


34 Agroforestry INNOVATION

Agroforestry and decentralised food and energy production

The role of coppicing and pollarding

www.agforward.eu

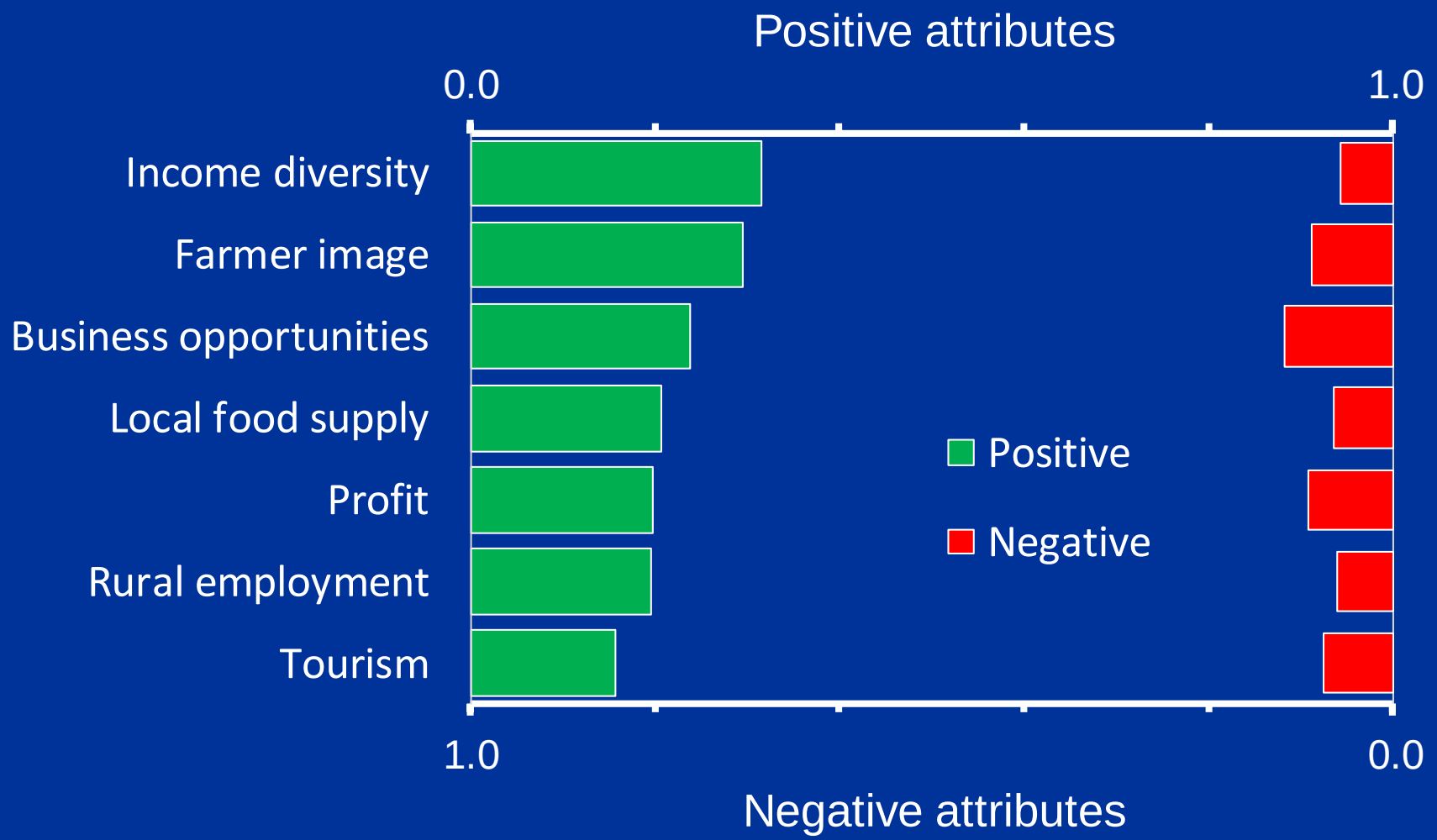
The tree problem

Fuel production: coppicing and pollarding

System	Crop	Land area (%)	Yield (t DM/ total ha)	Value (£/t)	Output (£/ha/yr)
Monocultures	Short rotation coppice (SRC)	100	8.33	60	**500**
	Organic wheat	100	5.00	270	**1350**
Agroforestry	SRC	20	3.35	60	201
	Organic wheat	80	5.13	270	1385
					1586

Personal communication, Martin Wolfe, 2017)

Agroforestry can open business opportunities



Responses of 344 stakeholders across 30 stakeholder groups (Garcia de Jalon et al. 2017)

Agroforestry is biodiverse and stores high levels of carbon

20 Agroforestry INNOVATION

Olive trees intercropped with chickpeas

Increasing income from your olive grove
www.agforward.eu

Why chickpeas?

Chickpeas (*Cicer arietinum* L) are valued as a high quality food for humans. They are also an excellent source of protein for animal feed. They are easy to cultivate, requiring little management and, in general, have low treatment costs. They have high monetary value, so a farmer can gain considerable additional income from cultivating chickpeas among trees.

One of the important characteristics of chickpeas is their low water demand. This makes them ideal for intercropping with trees of similar water economy in Mediterranean and other dry ecosystems.

Another important feature of chickpeas is the nitrogen they provide to the soil by the symbiotic relationship of their roots with nitrogen fixing bacteria. This benefits the farmer by reducing the need for expenditure on nitrogen fertilizers, which also protects the soil and water from nitrogen contamination.

Olive production was similar to the plots of mineral fertilization to those intercropped with chickpeas
Ref. Dimitra Kleftogianni

Where and how to plant

A trial was conducted in Molos, Central Greece, in a 67 year-old olive grove of "Kalamon" and "Amphissa" varieties. Tree spacing between the trees was 10m. The trial involved three treatments with three replications: olive trees + chickpea, olive trees + oregano and olive trees alone as a control.

A 0,2 ha area was cultivated with chickpeas and a smaller one with oregano. Another 0,2 ha of the orchards contained olive trees and other tree species and the rest only olive trees. This was used as control. The rows where chickpeas were cultivated were 5 m x 60 m wide. A local variety of chickpeas named "Amorgos" was used. This variety was developed by the Hellenic Research Institute and is resistant to fungus infections. The seed quantities were 80 kg/ha. In 2015, crop sowing was delayed until the first week of April due to the wet spring period. Oregano was sown in spring of 2016. The trial was repeated over three years (2015, 2016 and 2017).

The best timing for seeding is between late February and March for lower altitudes. However, at higher altitudes, it can be sown up to late April.

Olive production is expected to be high in the intercropped plots in 2017. *Ref. A. Pantera*

Produced by the AGFORWARD research project funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 613520

Benefits of legumes, wild flowers and mulches in tree rows

35 Agroforestry INNOVATION

Trees and crops: making the most of the space

Managing the tree understorey for increased food production and biodiversity
www.agforward.eu

Shrubtable system at Tolhurst Organics, June 2015. Ref : Organic Research Centre

Why manage the understorey?

In many agroforestry systems, the area between the trees and under the tree canopy is an overlooked and underutilised space. Unmanaged, this can create problems with weed control. This space can be put to productive use through planting crops that are adapted to shady conditions. In addition, when managed correctly, the tree understorey can be a resource for biodiversity, providing a habitat for beneficial insects and a food resource for crop pollinators.

Understorey crop and management options for horticultural agroforestry systems can include cut flowers, rhubarb and globe artichokes. These are all crops which thrive in the shade and can be sold alongside other produce. The understorey can also be sown with wild flowers, with species chosen to attract pollinators and provide habitat for beneficial predators.

Daffodils in flower, April 2016 Ref : Organic Research Centre

Understorey crop options: what works?

Different approaches to understorey management have been trialled at an organic farm in southern England. The farmer, Iain Tolhurst, has planted a mixture of trees for fruit, timber and coppice products in single rows. Tree species are: apples (18 varieties); field maple (*Acer campestre*); whitebeam (*Sorbus aria*); Italian alder (*Alnus cordata*); oak (*Quercus robur*); black birch (*Betula lenta*); hornbeam (*Carpinus betulus*); wild cherry (*Prunus avium*). There are 20 m cropping alleys between where vegetables are grown as part of an organic rotation. The alley width was chosen to fit with the farm irrigation system, and tree rows oriented north/south. The system is still young. Trees were planted into existing ground vegetation in March 2015, and woodchip mulch was applied around each tree to reduce weed competition.

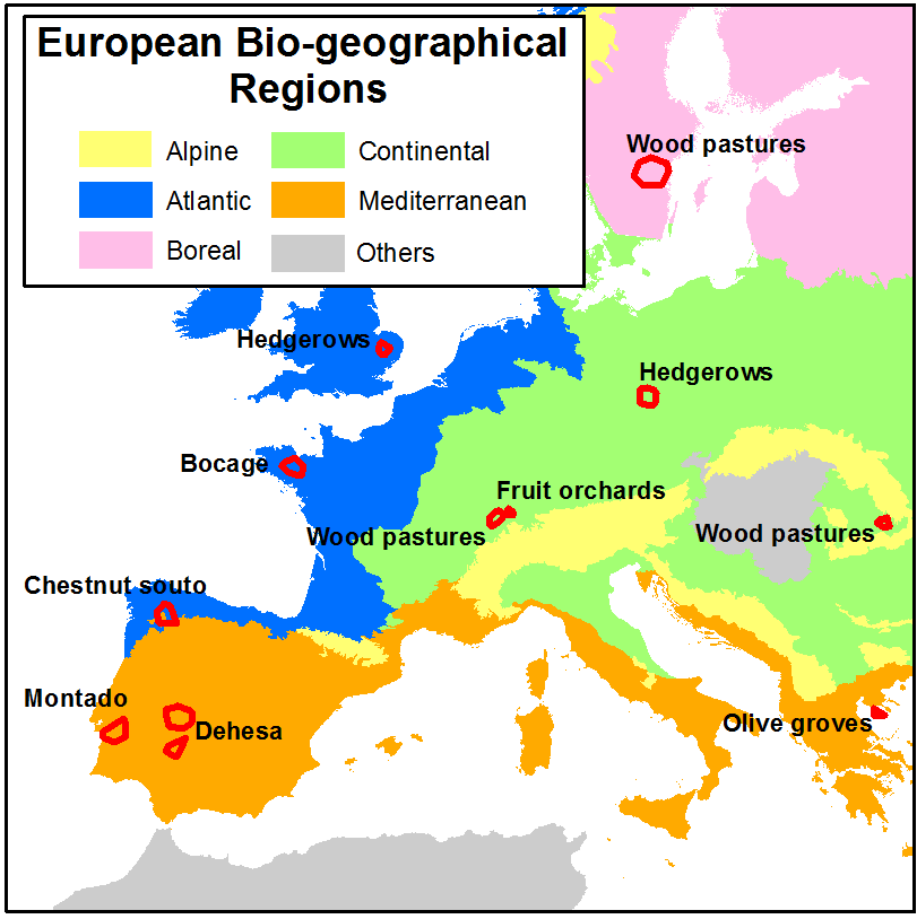
In December 2015, the understoreys of two tree rows were planted with daffodil bulbs (*Narcissus sp.*) with groups of 70 bulbs between each tree. In March 2016, rhubarb crowns were planted into another row; 90 crowns in total over the 150m row. The first saleable harvest of a small number of daffodils was in spring 2016, with the first main crop in spring 2017. Full production of rhubarb is expected in 2019. Ten species of cut flowers were sown in modules in spring 2016 and planted out in summer 2016. Globe artichokes grown from seed were planted in another tree row in late summer 2016, with the first crop likely to be in 2018.

The daffodils and the globe artichokes have been planted into rows sown with a diverse legume and herb mix for pollinators. In one tree row, the understorey has been left as a long-term beetle bank with perennial grasses and tall herbs to provide overwinter habitats for pest predators. Other options for understorey crops are shade-tolerant culinary herb species or species with pharmaceutical properties, such as Melissa.

Rhubarb establishing in the understorey, Sept 2016 Ref : Organic Research Centre

Produced by the AGFORWARD research project funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 613520

Modelling ecosystem services for landscapes with and without agroforestry

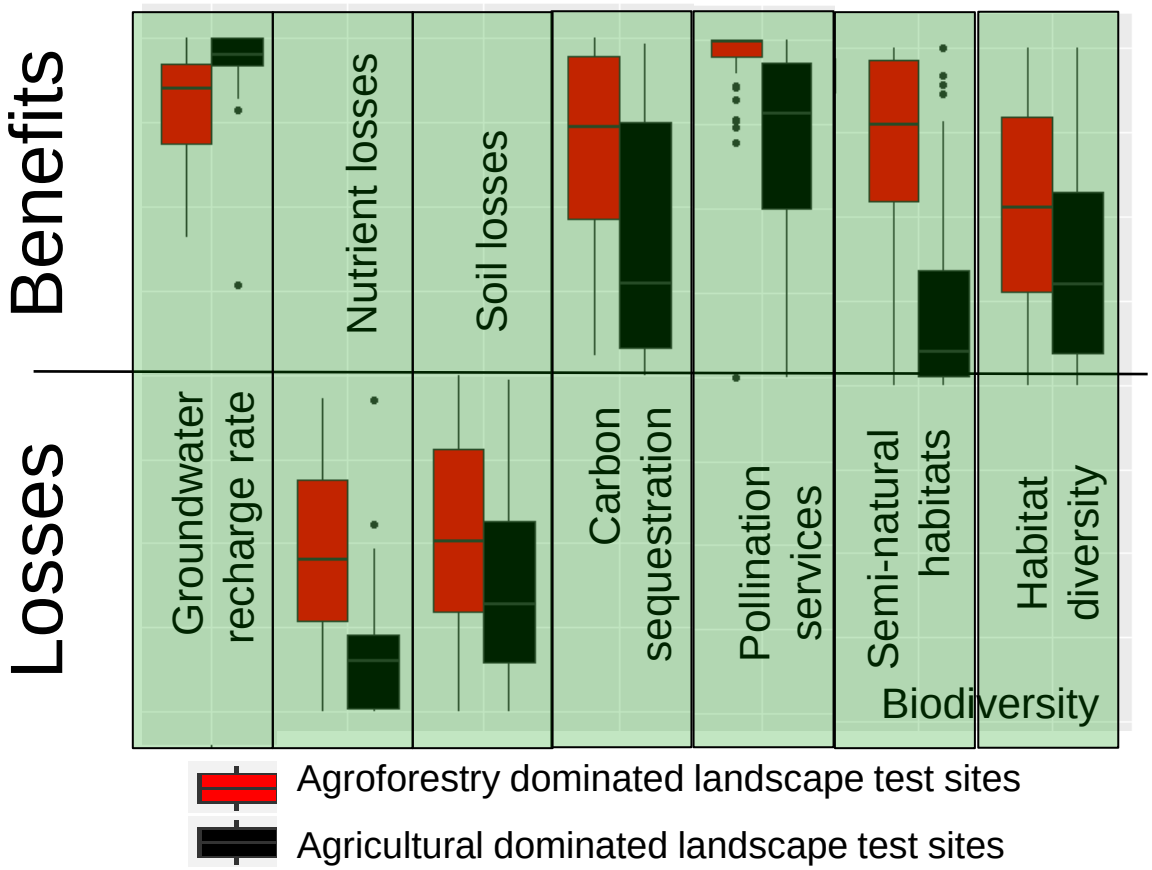


Ecosystem services modelled:

- Crop biomass yield
- Groundwater recharge rate
- Nutrient retention
- Soil conservation
- Carbon sequestration
- Biodiversity
  - Functional biodiversity (Pollination)
  - Habitat diversity

Kay et al. (2017) Agroforestry Systems

Comparison of agroforestry and agricultural landscapes across 12 sites



Agroforestry landscapes

Higher:

- Nutrient retention
- C sequestration
- Soil conservation
- Pollination services
- Proportions of semi-natural habitats

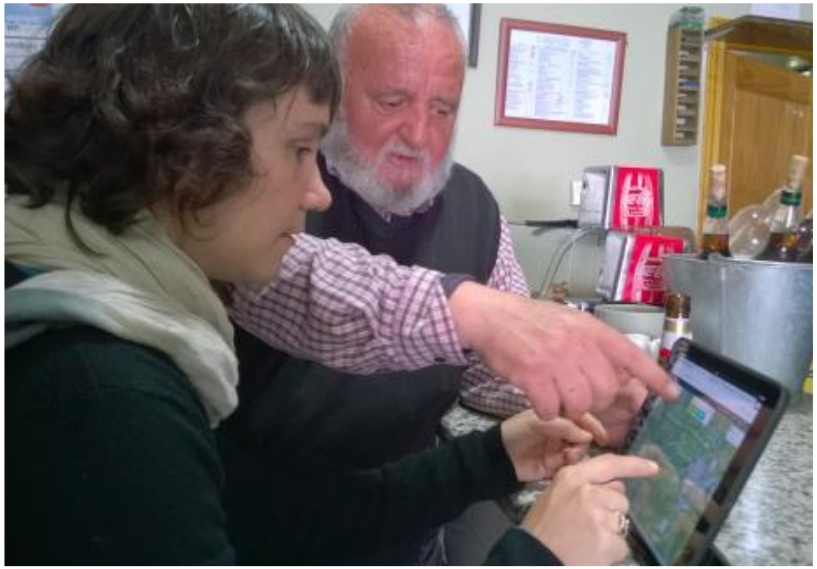
Lower:

- Groundwater recharge

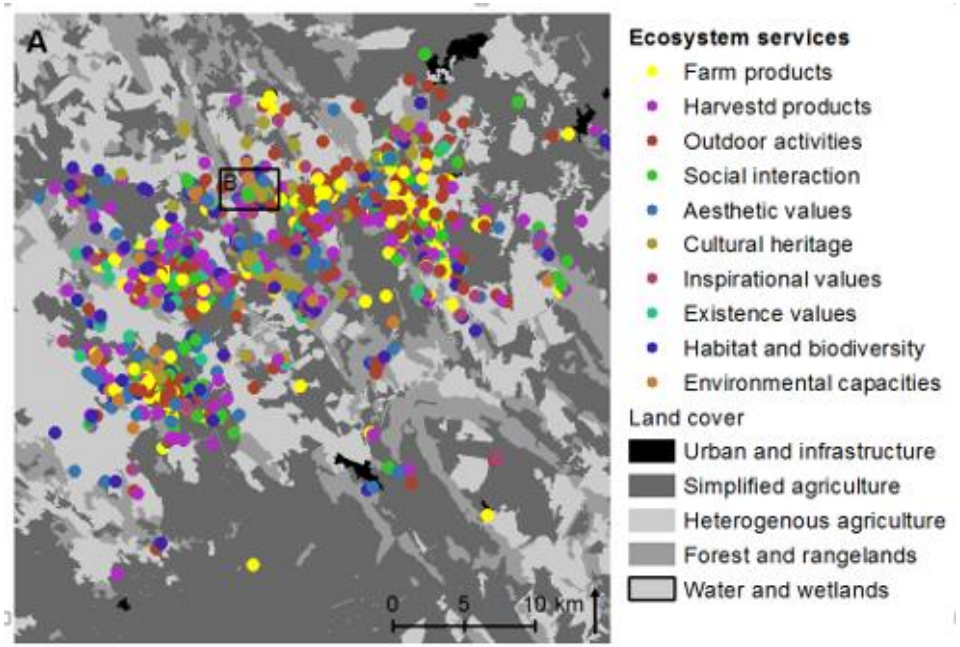
Kay et al. (2017) Agroforestry Systems and supported by Torralba et al. (2016)

Public preference for mosaic landscapes

13 study sites in 10 countries
2300 respondents
28,878 locations of ecosystem services

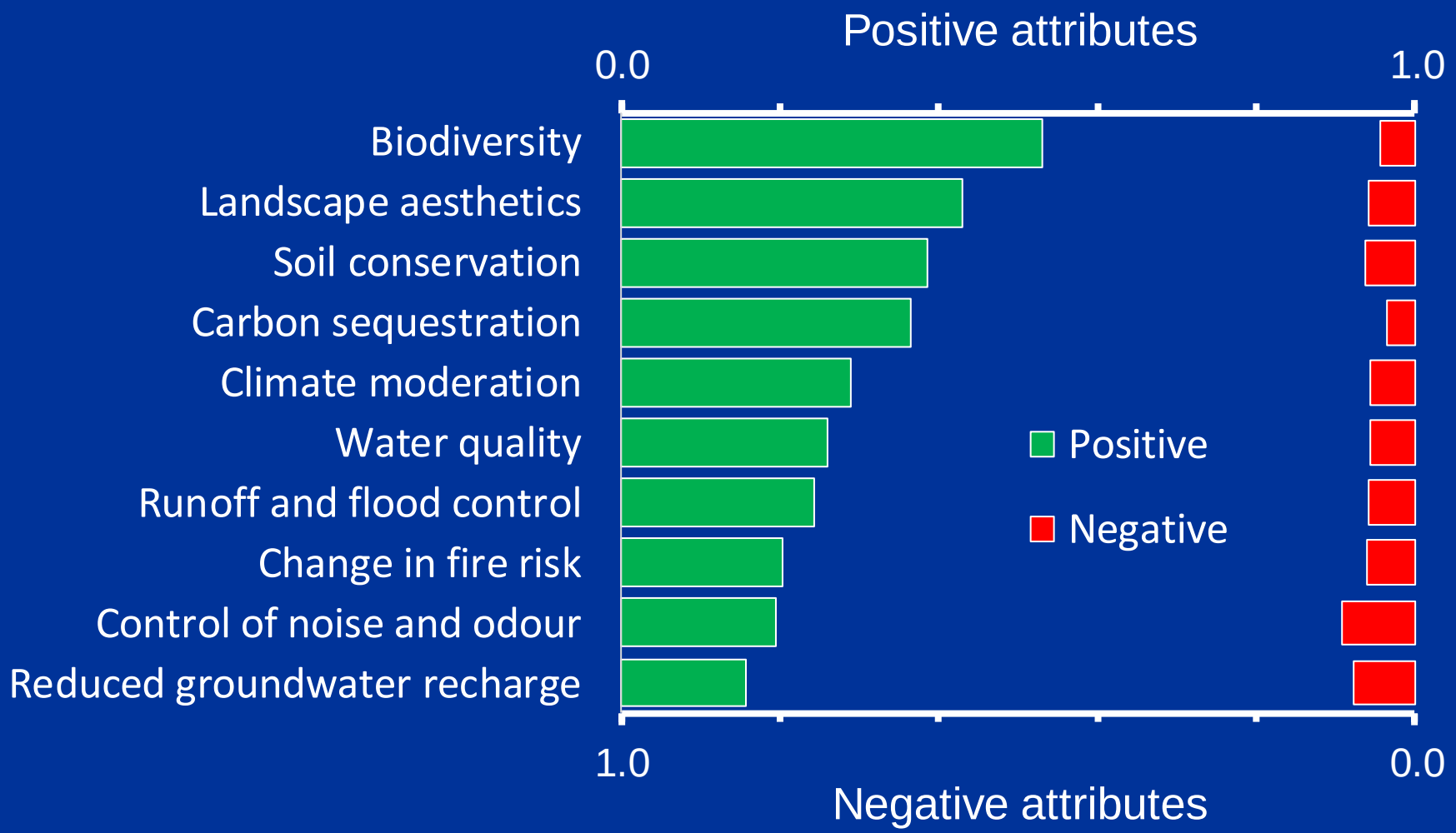


Plieninger et al (Submitted)



Public Participation GIS showed that mosaic landscapes
(Sum and diversity of services increase with landscape richness)

Agroforestry increases environmental resilience



Responses of 344 stakeholders across 30 stakeholder groups (Garcia de Jalon et al. 2017)

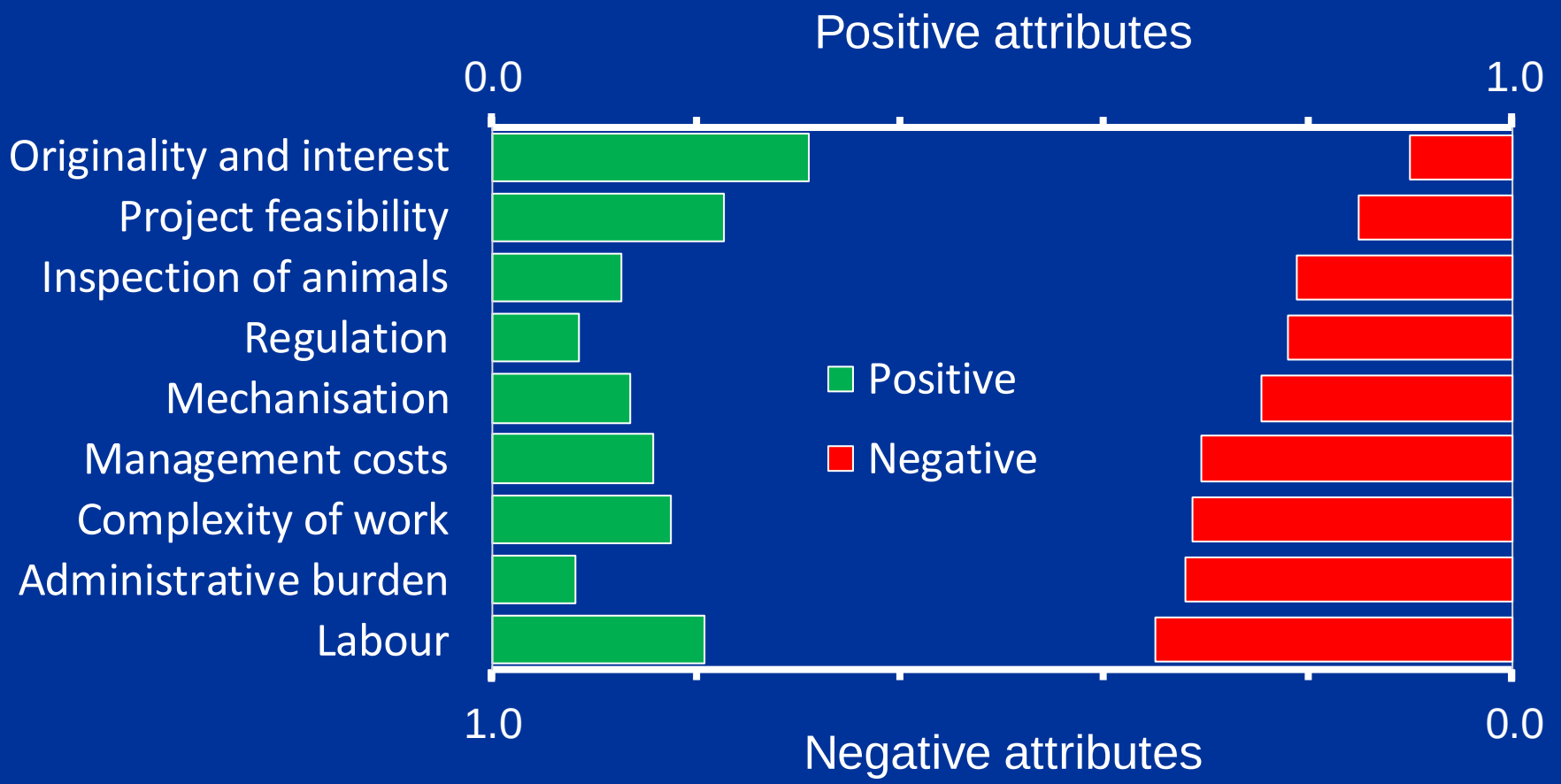
1 + 1 = 3

Agroforestry delivers:

1. Production and animal welfare benefits
2. Business opportunities
3. Environmental benefits

But…..

Farmers indicate that agroforestry has labour and administrative costs



Responses of 344 stakeholders across 30 stakeholder groups (Garcia de Jalon et al. 2017)

Farmers with vision

Agroforestry in Europe:

1. More important than you think
2. Production and societal benefits such as improved animal welfare, diversified income, greater resource efficiency, increased carbon storage and biodiversity and enhanced soil conservation
3. Is undertaken by farmers with vision

References

AGFORWARD (2017). AGFORWARD website. www.agforward.eu

den Herder, M., Moreno, G., Mosquera-Losada, R.M., Palma, J.H.N., Sidiropoulou, A., Santiago Freijanes, J.J., Crous-Duran, J., Paulo, J.A., Tomé, M., Pantera, A., Papanastasis, V.P., Mantzanas, K., Pachana, P., Papadopoulos, A., Plieninger, T., Burgess, P.J. (2017) . Current extent and stratification of agroforestry in the European Union. Agriculture, Ecosystems and Environment 241: 121–132.

Dupraz C, Liagre F (2008) Agroforesterie : Des arbres et des cultures Broché. France Agricole

Emile JC, Delagarde R, Barre P, Niderkorn V, Novak S (2017). Evaluation of the feeding value of leaves of woody plants for feeding ruminants in summer. 19th EGF Symposium on "Grassland resources for extensive farming systems in marginal regions: major drivers and future scenarios", Alghero, Sardinia (Italy) Grassland Science in Europe, vol 22, 548-550.

Fagerholm N, Torralba M, Burgess PJ, Plieninger T (2016). A systematic map of ecosystem services assessments around European agroforestry. Ecological Indicators 62: 47–65.

Fagerholm, N, Oteros-Rozas E, Raymond CM, Torralba M, Moreno G, Plieninger T (2016). Assessing Linkages between Ecosystem Services, Land-Use and Well-Being in an Agroforestry Landscape Using Public Participation GIS." *Applied Geography* 74 (August). Elsevier Ltd: 30–46. doi:10.1016/j.apgeog.2016.06.007.

Fagerholm, N, Torralba M, Moreno G, Girardello M, Herzog F, Aviron S, Burgess, P.J. et al. (2017). European Cross-Site Analysis of Place-Based Ecosystem Services in Multifunctional Rural Landscapes. Submitted.

García de Jalón, S., Burgess, P.J., Graves, A., Moreno, G., McAdam, J., Pottier, E., Novak, S., Bondesan, V., Mosquera-Losada, M.R., Crous-Durán, J., Palma, J.H.N., Paulo, J.A., Oliveira, T.S., Cirou, E., Hannachi, Y., Pantera, A., Wartelle, R., Kay, S., Malignier, N., Van Lerberghe, P., Tsonkova, P., Mirck, J., Rois, M., Kongsted, A.G., Thenail, C., Luske, B., Berg, S., Gosme, M., Vityi, A. (2017). How is agroforestry perceived in Europe? An assessment of positive and negative aspects among stakeholders. Agroforestry Systems. DOI 10.1007/s10457-017-0116-3

Kay S, Crous-Duran J, Garcia de Jalon S, Graves A, Palma JHN, Roces-Diaz JV, Szerencsits E, Weibel R, Herzog F (2017). Landscape-Scale Modelling of Agroforestry Ecosystems Services: A Methodological Approach. Submitted.

Kay S, Crous-Duran J, García de Jalón S, Graves A, Ferreiro-Domínguez N, Moreno G, Mosquera-Losada MR et al. (2017). "Spatial Similarities between European Agroforestry Systems and Ecosystem Services at the Landscape Scale." Agroforestry Systems. doi:10.1007/s10457-017-0132-3.

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