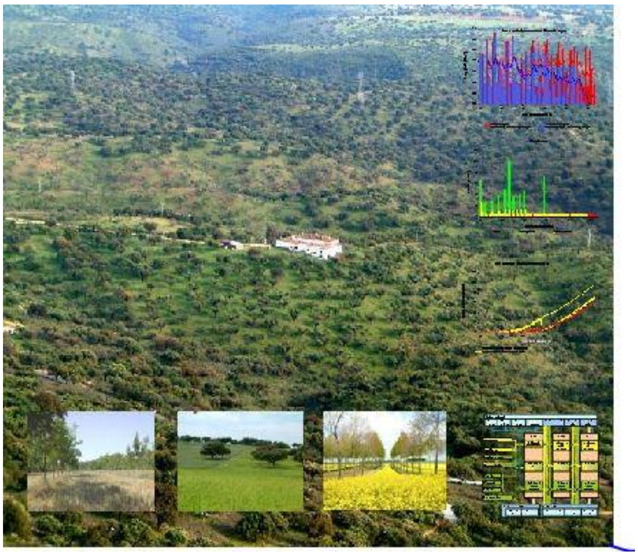
AGFORWARD
Agroforestry for Europe



Identification of Agroforestry Systems and Practices to Model

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1 Context

The aim of the AGFORWARD project (January 2014-December 2017) is to promote agroforestry practices in Europe that will advance sustainable rural development. Within the project there are four objectives:

1. to understand the context and extent of agroforestry in Europe,
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report is an output from work-package 6 which contributes to the third objective. Work-package 6 focuses on the field- and farm-scale evaluation of innovation research that have arisen from about 40 agroforestry stakeholder groups created across Europe. Some research, for example tree protection options, are best determined by technical evaluations in the field. However some research questions require a modelling approach to predict, for example, the financial and economic impact of a new practice over a number of years. This report seeks to identify those agroforestry systems and practices which could be usefully assessed using biophysical agroforestry models such as Yield-SAFE (van der Werf et al., 2007) and Hi-sAFe (Talbot, 2011), or bio-economic models such as Farm-SAFE (Graves et al., 2011).

2 Methodology

The AGFORWARD project has categorised agroforestry practices in relation to four key land use sectors: existing agroforestry systems of high nature and cultural value (HNCV) (covered by work-package 2), integrating livestock and crops into high value tree systems (covered by work-package 3), agroforestry for arable systems (covered by work-package 4) and agroforestry for livestock systems (covered by work-package 5).

During 2014, the partners within the AGFORWARD project facilitated about 40 stakeholder groups across Europe, each resulting in an initial stakeholder reports (Annex A). These stakeholder reports, and four synthesis reports on the innovations to be evaluated (Hermansen et al. 2015; Mirck et al. 2015; Moreno et al. 2015; Pantera et al. 2015), were used to determine the 1) agroforestry practices being considered, and 2) the research and innovations that has been proposed.

1. Agroforestry practices are being described in various ways in the project. This report collates an initial description of the practices being studied by each stakeholder group. During the project, more detailed descriptions of the practices will be developed (for example Milestone 28) are being developed using the template described in Annex B. The contacts for each group are described in Annex C.

2. Whereas some research questions can be addressed by modelling, some cannot. This report attempts to categorise those research questions that are amenable to being resolve with the support of modelling, and those that are not. For example some research questions are knowledge gaps which could be tackled through literature research.

3 Description of the agroforestry systems

The stakeholder meetings organised by the AGFORWARD project has led to the identification of 10 agroforestry systems which are recognised for their high cultural and natural value (Table 1), which are indicated in red in Figure 1. There were also 13 systems focused on the intercropping or grazing of high value trees such as orchards or olive grove (Table 2), indicated in orange in Figure 1. There were 12 systems focused on agroforestry for arable farmers (Table 3) and 11 systems focused on agroforestry for livestock farmers.

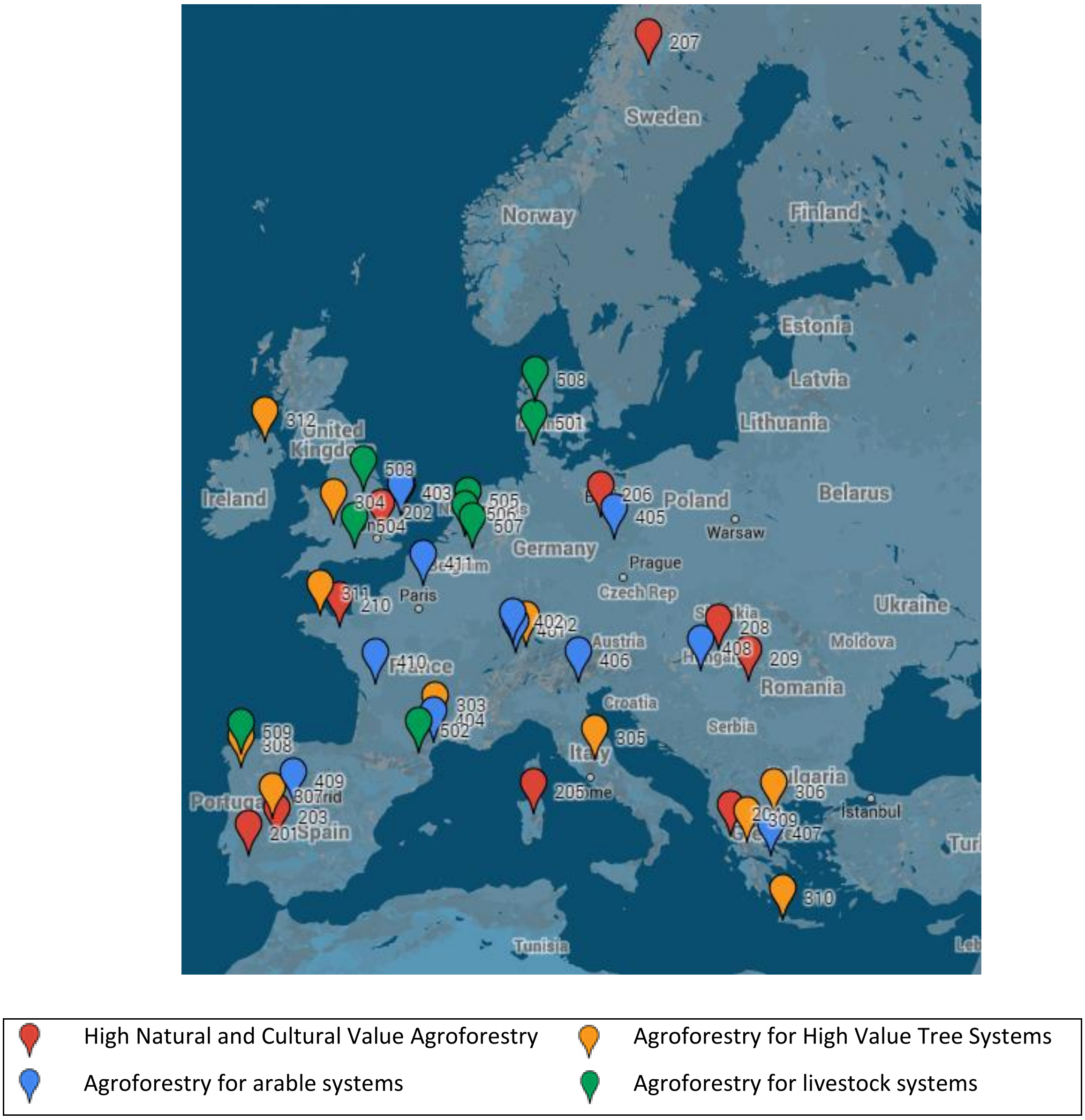

Figure 1. Location of the agroforestry systems[1]

[1] This map is available at: https://www.google.com/maps/d/edit?mid=z1xoYw3gseS0.kOaFKCqmAN7s&usp=sharing

Table 1. Agroforestry systems of high nature and cultural value: the name, location and short description of the selected agroforestry systems

AF-ID	Name	Location	Short description
201	Montado	South and Central Portugal	Low density trees combined with agriculture or pastoral activities. The main tree species encountered in the Montado are cork oak (*Quercus suber* L) and/or holm oak (*Quercus rotundifolia* L). Mixed stands with a combination of these species are also common. Cork oak based *Montado* areas are included in the Portuguese National Forest Inventory (NFI) as part of the cork oak and holm oak forest area, which occupies 736,775 ha and 331,179 ha respectively.
202	Wood pastures and Parkland	UK	Wood pasture and parklands are traditional land uses with presence of open-grown ancient or veteran trees (often pollarded), grazing livestock, and an understory of grassland or heathland. The veteran trees typically have characteristics of large girth, cavities and hollowed stems and branches, water pools, decay pockets, standing deadwood in various states of decay, epiphytes, and fruiting bodies from fungal decay organisms. Around 10,000 to 20,000 ha in "working condition".
203	Dehesa	Central and South Spain	Agro-silvo-pastoral system formed from the clearing of evergreen woodlands where trees, native grasses, crops, and livestock interact positively under management. At present, dehesas occupy 2.3 million hectares in Spain and 0.7 million hectares in Portugal, where they are called "Montados".
204	Valonia oak silvopastora l systems	Valonia, Greece	Agroforestry and specifically silvopastoralism is a traditional land use system in parts of Western Greece where livestock breeders use the valonia oak (*Quercus ithaburensis* subsp. macrolepis (Kotschy) Hedge and Yaltirik) forest for grazing and the collection of acorns. Valonia oak forests cover about 29,630 ha in continental and insular Greece.
205	Grazed oak woodlands in Sardinia	Sardinia, Italy	Much of the Sardinian rural landscape is characterized by a mosaic of agroforestry systems including grazed forests and wooded grasslands where scattered *Quercus* species (holm oak, cork oak and deciduous oak trees) are mixed with permanent or temporary pastures or intercropped with cereals and/or fodder crops. Forests occupy about 5800 km^2 in Sardinia, and about 30% (1800 km^2) are considered to be of high nature value.
206	Spreewald flood plain	Brandenburg , Germany	The Spreewald Biosphere Reserve covers about 475 km^2 and is situated in Brandenburg, South-East of Berlin, Germany. The area is dominated by a network of waterways, and the combination of land ownership and the installation of small transportation canals, that have later been planted with trees has resulted, in places, in tree-lined hedgerows that demarcate relatively small-sized fields. The dominant tree species are black alder (*Alnus glutinosa* (L.) Gaertn.), black poplar (*Populus nigra* L.) and bird cherry or hackberry (*Prunus padus* L.). The grassland is either mowed or grazed by cattle that are used for meat or milk production.
207	Wood pastures and reindeer in Sweden	Sweden	Near the Sami village Njaarke, much of the area is demarcated as Fennoscandian wooden pastures (EU Directive Habitats Code 9070). During the summer, reindeer (*Rangifer tarandus* L.) from Njaarke Sami village are kept in the non-forested mountain areas, but between October and April the reindeer are kept in the winter grazing area of wood pastures.
208	Wood pastures in Hungary	Hungary	Wood pastures were once common in Hungary, but they are currently declining and they are thought to cover about 5500 ha in Hungary. Traditional shepherding occurs in some of the remaining wood pastures, but this practice is threatened. Increasing formal recognition of the cultural and ecological value of wood-pastures has resulted in new types of managers and the emergence of new types of knowledge in the remaining wood pastures.

AF-ID	Name	Location	Short description
209	Wood pastures in Southern Transylvania , Romania	Southern Transylvania, Romania	Traditionally closed oak woodlands with pigs eating the acorns transformed in the second part of the 19th century in pastures, communally managed with scattered large trees such as oaks, pears, hornbeams and beech grazed by cattle and buffalo.
210	Bocage agroforestry in Brittany, France	Brittany, France	Ancient agroforestry systems based on lines of high-stem and medium-stem trees with the main period of expansion from the 18th Century to the end of the 19th Century accompanying successive cutting and redistribution of parcels linked to inheritance processes with the purpose of have sources of firewood and timber. From the 1950s, the agricultural modernization and intensification, accompanied with collective land reallocation programs, led to a general decrease in hedgerows density and from the 1990s, successive hedge planting schemes have been implemented aiming to maintain the cultural landscape but also to regulate nitrate and phosphorus pollution.

Table 2. Intercropping and grazing of high value tree systems: the name, location and short description of the selected agroforestry systems

AF-ID	Name	Location	Short description
301	Apple trees with organic vegetables in UK	Experimental sites in Suffolk, Gloucestershire and Devon, UK.	Wakelyns Agroforestry, Suffolk: replicated blocks of 7 tree species (apple, lime, hornbeam, cherry, Italian alder, ash, oak and sycamore) with 12m crop alleys between tree rows. Organic arable rotation. Duchy Home Farm, Gloucestershire: very diverse apple system with a national collection of apple varieties, and organic vegetables grown in the alleys. Shillingford Organics, Devon: organic vegetables and arable production in 15 m wide alleys and apple trees.
302	Cherry trees alley cropping in Switzerland	Möhlin, NW Switzerland	16 hectares with 80 cherry trees with rosehip (*Rosa rugosa*), sea buckthorn sanddorn (*Hippophae* sp.) and cornelian cherry (*Cornus mas*) are planted to produce wild berry juice.
303	Wild cherry pastures in France	Aude Department, France	Different tree species planted in 1988 associated with pastures. Two trees densities: 100 trees /ha and 400 trees /ha are compared. A sole crop control and a forestry control were settled. The elevation is 570 m a.s.l., field on a hillside.
304	Timber wood trees with cereals in France	Hérault Department, France	Different tree species, planted in 1995, associated with cereal. Trees in row (13 x 8 m). The main culture is winter durum wheat in rotation with winter protein pea. Sole crop and forestry controls are available. No block design, but large plots are compared. Tree growth and crop yield are monitored each year.
305	Grazed cider orchards in the UK	Hereford-shire, UK.	There are 25,350 ha of 'traditional orchards' in England and Wales, however Defra (2013) suggest that the total commercial orchard area in England and Wales in 2012 was 17,600 hectares. Defra (2013) report that there are about 7000 hectares of commercial cider orchards; approximately a quarter are 'traditional orchards' and three-quarters are 'bush orchards'. Traditional orchards typically have open-grown trees (tree density of less than 150 trees per hectare), whilst bush orchards can have 600 trees/ha. Both types of orchard have grass understoreys which need to be kept short to enable apple harvest. Grazing is practiced in some traditional orchards, but the use of animals in mature bush orchards is less common.
306	Intercropping and grazing olive orchards in Italy	Italy	Over one million ha of olive orchards (*Olea europea*) risk abandonment in Italy, since the low price of olive oil and the de-coupling of subsidies from production have reduced profitability and removing trees is illegal. The particular focus of this system is the intercropping of wild asparagus (*Asparagus acutifolius*), which naturally tends to grow in abandoned olive orchards. Grazing animals, particularly chickens, are proposed as an additional source of income while providing weed

AF-ID	Name	Location	Short description
			control and fertilization, thus lowering costs and impact of the orchard management.
307	Intercropping of olive orchards in Greece (2 groups)	Mostly in Macedonia, N. Greece and Central Greece	The combination of olive orchards with arable crops (cereals) in the same field is a traditional land use system in Greece. The combination of olives and cereals can stabilize the economic return in the context of variable weather conditions. 13,000 ha in Chalkidiki (North Greece) and in coastal areas around the country and in the inland of west and south Greece (Epirus, Aitoloakarnania, Peloponnese, Crete and in most islands of Ionian and Aegean sea).
308	Grazing and intercropping of plantation trees in Spain	Spain	Olive, almond and carob orchards in Spain were traditionally either grazed or intercropped. However, these traditional agroforestry systems have become marginal and new agroforestry practices, based on plantations of quality timber trees such as cherry and walnuts on agricultural land are developing. These are often managed with high levels of inputs. The adoption of grazing and intercropping in such systems has the potential to create economic and environmental benefits. However, there generally is a lack of knowledge and information on appropriate agroforestry management practices and the benefits, what is constraining the adoption of agroforestry schemes to manage these new afforested farmlands.
309	Chestnut systems in Galicia, Spain	Galicia, Spain	Chestnut (*Castanaea sativa* Mille) agroforestry is a traditional land use system in O Courel, Galicia (NW Spain). The chestnuts are recognized under the label of Protected Geographical Indication (PGI), and are exported to markets in Europe.
310	Intercropping of walnut trees in Greece	Eurytania, Central Greece	In Eurytania in central Greece, farmers have historically integrated agriculture with high value species such as walnut and chestnut trees on the same plot.
311	Intercropping of orange groves with arable crops in Greece	Mostly in Western, Central and South Greece and Crete.	Citrus groves of orange, tangerine and lemon trees are a characteristic land use system in Chania, Crete, Greece. In the past, farmers used to cultivate crops in between citrus trees after pollarding them to change varieties. They also used cypress trees as hedgerows to protect citrus trees from winds (as windbreaks). However nowadays they prefer to cut the cypress trees from the hedgerows or to uproot citrus trees and switch to avocado monoculture for higher profit. Only a few farmers still practice agroforestry as citrus trees with intercrops ensuring a steady economic return every year irrespectively of weather conditions or other type of hazards until tree crown fully develops to exclude any form of intercropping. Most of the intercrops are vegetables. After crown development intercrops are replaced by chickens grazing. In Crete, citrus cultivation covers about 4500 ha. For many years, farmers in the Chania area of Crete have cultivated crops between their citrus trees from pollarding until the trees achieve a full canopy. Farmers also use cypress trees as windbreaks to protect the citrus trees from wind.
312	Grazed orchards in France	Normandy, Brittany and the north of the Loire river, France.	Meadow orchards in France were estimated to cover about 600,000 ha in 1950, but the current total is about 150,000 ha. It is estimated that 43% of French pre-orchards are "cider" apple orchards located in Normandy, Brittany and the north of the Loire river (Table 1). One of the new features being attempted by some growers is the grazing of “low-stem orchards” by Shropshire sheep, as the experience of some growers is that the Shropshire breed do not eat the bark of apple trees.
313	Grazed orchards in Northern Ireland, UK	Northern Ireland, UK	The apple industry in Northern Ireland has 223 independent growers farming 1506 ha of orchards, with a typical field size of 1.5 to 4 ha. The grass strips between trees are generally mowed. Between May and the end of July, the apple trees are also typically sprayed every 10-14 days with a fungicide to prevent apple scab (*Venturia inaequalis*). Grazing the orchard with sheep may provide a means of reducing mowing costs and may help with scab control.

Table 3. Agroforestry for arable farms: the name, location and short description of the selected systems

AF-ID	Name	Location	Short description
401	Integrating apple trees with arable crops in Switzerland.	Sursee, Central Switzerland	Innovative farm: 545 apple trees (varieties Boskoop and Spartan) were planted. The intermediate cultures consist of winter wheat, strawberries and sown flower strips.
402	Integrating poplar with arable crops in Switzerland.	Buus, NW Switzerland	Pioneer farmer: farm with a total area of 20 ha. In March 2011, 52 Aspen (*Populus tremula*) were planted. The area between the tree rows was first managed as grassland, is now intercropped with rye, corn and sorghum. The wood of the aspens should be harvested in 30 to 35 years as energy wood.
403	Apple trees or Short rotation coppice with cereals or legumes	Experimental site: Wakelyns Agroforestry, Suffolk, UK.	Silvoarable systems are currently rare in the UK. The few systems that exist are usually based on an alley cropping design with arable crops in the alleys. The tree component consists either of top fruit trees (apples, pears and plums), timber trees, or coppice trees for woodfuel. Organic and conventional silvoarable systems with top fruit (apples, pears) and/or short rotation coppice for bioenergy, and arable crops in the alleys. Alleys typically 12 to 24 m wide.
404	Mediterranean silvoarable systems in France	Southern France	Different tree species, planted in 1995, associated with cereal. Trees in row (13 m X 8 m). The main culture is winter durum wheat in rotation with winter protein pea. Sole crop and forestry controls are available. No block design, but large plots are compared. Tree growth and crop yield are monitored each year since the beginning. Besides the three main tree species (see below), many other tree species are included in an agroforestry arboretum (e.g. *Prunus avium*, *Fraxinus angustifolia*, *Pyrus communis*, *Acer platanoides*)
405	German poplar/willow alley cropping in Germany	Lusatia, Germany.	Although agroforestry on arable farms is not a common practice in Germany, alley cropping systems for woody biomass production are receiving increasing interest due to the potential to produce biomass and agricultural crops at the same time. In Germany alley cropping systems combine rows of fast growing trees (for example poplar, willow or black locust) with agricultural crops.
406	Trees for timber intercropped with cereals in Italy	Veneto Region, NE Italy	Poplar hybrids and species has been intensively managed in Italy for timber production mostly in monoculture plantations, but often in intercropping systems (intercropping of arable crops in between young tree rows) and in linear plantations along field edges, drainage canals and streams. Poplar cultivation, in all the above cultivation models, is currently declining for stagnating domestic timber market.
407	Intercropping of poplar and walnut trees with cereals and beans in Greece	Mostly in northern Greece (Macedonia and Thrace).	Agroforestry is a traditional land use system in Voio in Northern Greece where farmers have traditionally integrated arable production with tree species. In Voio, arable fields containing field beans, cereals and grassland are bordered by walnut trees and fast growing poplars. Agroforestry is a traditional land use system in Voio in which farmers used to combine agricultural production with high value tree species in the same plot. The area is characterized by fast growing species (poplars) and walnuts at the edges combined with dry beans, cereals and pastures.
408	Alley cropping in Hungary	Hungary	It is estimated that there are about 16,000 ha of windbreaks and shelterbelts in Hungary. Although alley cropping occurs in orchards, there is not wide use of the system in arable areas. One alley-cropping demonstration site is near in Fajsz, Bács-Kiskun County, in the Hungarian Great Plain. The agroforestry system consists of *Paulownia tomentosa* var. Continental E. in rows and alfalfa as intercrop.
409	Silvoarable Systems in Spain	Spain	Silvoarable agroforestry consists of widely-spaced trees intercropped with annual or perennial crops. In general, silvoarable production systems are very efficient in terms of resource use, and could introduce an innovative agricultural production system that will be both environment-friendly and economically profitable.
410	Agroforestry for Arable Farmers	Western France	Between 2008 and 2013, 42 agroforestry establishment projects have been completed in the Poitou Charentes region of Western France. In total the projects

AF-ID	Name	Location	Short description
	in Western France		cover an area of 355 ha. The projects have mainly focused on fields that are farmed organically. The systems typically comprise three to five tree species (*Juglans nigra x regia, Juglans regia, Sorbus domesticus, Sorbus torminalis, Prunus avium, Fraxinus excelsior, Acer pseudoplatanus,* and *Quercus* species). The density of trees ranges from 30 to 50 trees per hectare, typically with 27 m between rows which allows a 24 m cultivated area.
411	Agroforestry for Arable Farmers in Northern France	Picardy region, France	Since 2006, seven experimental silvoarable projects have started in Picardy in Northern France. In total 100 ha has been planted. The plot sizes varies between 5 ha and 30 ha. The sites are mainly located on loamy soils and the tree density ranges from 28 trees per hectare to 110 trees per hectare. Each plot has a wide range of tree species. The distance between the tree rows is typically 30 m, but ranges from 26 m to 50 m.
412	Irrigated Silvoarable	Central Portugal	An ad-doc experimental plot is being established by a farmer under his intensive managed pivot irrigated maize plots. The interest of the innovation is to increase the marginal land around the corners, where the pivot irrigation does not reach. The assessment would estimate the yield of the trees which seem to progress at a potential yield. Different species were planted, including black walnuts and wild cherry.

Table 4. Agroforestry for livestock farms: the name, location and short description of the selected systems

AF-ID	Name	Location	Short description
501	Pigs in energy crops in Denmark	Jutland, DK	Integrated production of free-range pigs and energy crops. The energy crops are willow and/or poplar. The energy crops are established in paddocks with lactating sows and piglets. The paddocks are organised so that they include two or more rows of poplar/willow in addition to an area with grass clover.
502	Wild cherry pastures in France	Aude Department France	Different tree species planted in 1988 associated with pasture. Two trees densities: 100 trees /ha and 400 trees /ha were compared. A sole crop control and a forestry control were settled. Elevation = 570 m, field on a hillside
503	Woodland Eggs in the UK	UK	Some of the eggs produced by hens with access to areas of trees are marketed as “woodland eggs”. To qualify as ‘woodland eggs’, the UK Woodland Trust, which adds its logo to the woodland eggs sold by Sainsbury’s plc (a major UK retailer), specifies 20% cover in the free range area with some trees within a 20 m distance from the shed. In 2013, the Woodland Trust reported the sale of about 400 million “woodland eggs” through Sainsbury’s, equivalent to about 3.4% of the UK market (Burgess et al., 2014). Other retailers also sell woodland eggs
504	Woodland poultry in the UK	UK	Poultry meat: the output of meat from poultry in the UK (£2.3 billion in 2013) is second only to cattle. The proportion of chickens and other poultry with access to trees is not known.
505	Fodder trees for cattle and goats in the Netherlands	Duinboeren region , NL	Several dairy cow and goat farmers in the Duinboeren region of the Netherlands were participants of the Farms’ Network for Fodder Trees and Multifunctional Land Use (2012-2014). During that project four test sites with fodder trees were planted on four farms. Within the original project dairy goats and cows were allowed to browse on fodder trees such as willow (Salix spp).
506	Cherries and chickens in the Netherlands	NL	There are approximately 2,300 hectares used for free-range poultry in the Netherlands. However it is only since 1999, that farmers have looked at combinations of poultry with trees. In farmers’ network ‘Trees for chickens’ four poultry farmers have planted fruit trees. In another project, two poultry farmers have planted willow plantations. Independent from these projects, several other organic and free-range poultry farmers have planted walnut trees, fruit trees, Christmas trees, and willows in

AF-ID	Name	Location	Short description
			their free range areas.
507	Agroforestry for poultry in the Netherlands	Netherlands	No description
508	Agroforestry for organic poultry and pig production in Denmark	Denmark	Velfærdsdelikatesser® (welfare delicacies) is a new initiative within organic meat production in Denmark. The initiative is seeking to promote natural and diverse livestock production (including the use of local breeds) on small organic farms. The meat is then sold directly to consumers in distinctive. The initiative offers potential for agroforestry systems where pigs and poultry are combined with fruit and vegetable production.
509	Agroforestry with pigs in Galicia, Spain	Galicia, Spain	Celtic pigs are an autochthonous pig breed of Galicia. The breed is believed to derive from northern-central European pig breeds. They are usually farmed in semi-extensive or extensive conditions in forest areas where chestnut (*Castanea sativa* Miller) and oak (*Quercus robur* L.) trees are dominant.
510	Agroforestry resistant to seedling browsing in Portugal	Alentejo, Portugal	Honey Locust (*Gleditsia triacanthos*) is leguminous tree, having a deep taproot growing down 3-6 m deep and few lateral roots that make it suitable for agroforestry systems. Furthermore, in young plants, stems bear very large, flat thorns and the young trees form very dense thorny thickets, providing defence to animal browsing, where coppice regrowth and pods are a valuable fodder. It begins bearing pods 3 years after planting and it can produce 20-75 kg pods/tree within 8 years. However this system is underutilized.
511	Agroforestry with Eucalyptus Portugal	Ribatejo, Portugal	Eucalyptus is a typical forest species. However, there is interest to evaluate what would be the yield of Eucalyptus under lower plantation densities as that could provide a grass complement to enable grazing. This is a systems practiced in e.g. Brazil, but an evaluation is needed under temperate/Mediterranean climates.

4 Innovations to model

At the stakeholder meetings (Annex A), about 130 potential innovations were identified. Within the AGFORWARD consortium, there is experience with working three agroforestry models (Table 5).

Table 5. Brief description of three agroforestry models

Model name	Brief model description
Yield-SAFE	A "parameter-sparse" mechanistic bio-physical model than run of a daily time-step that describes tree and crop growth in response to changes in solar radiation, temperature, and rainfall (van der Werf et al. 2007)
Farm-SAFE	A bio-economic model, that works on an annual time-step, that links the outputs from Yield-SAFE with information on labour and input use, and financial values (such as arable crop and tree revenues and together with grants) to predict the net present value of systems at a plot- or at a farm-level (Graves et al., 2010)
Hi-sAFe	A 3-D agroforestry model that describes tree and crop interactions using "voxels" (Talbot, 2011).

Each innovation was reviewed to determine if there was an opportunity to use one of the above three models to help answer the questions raised. It was considered that 60 innovations (out of 130) could potentially be helped by at least one of the models (see Tables 6, 7, 8 and 9). Most of the model-related questions were related to "System design and Management" (Figure 2). Hence from this initial scoping study, models could potentially help in about 50% of these questions. The research questions which cannot be effectively answered by using bio-economic models are discussed in Section 6.

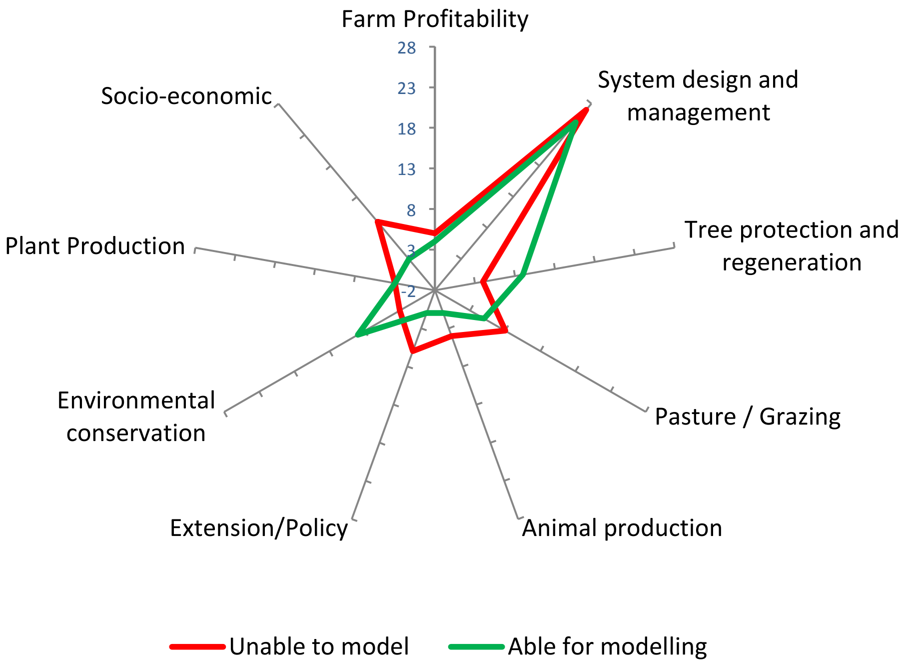

Figure 2. Number of questions from areas of innovation where three agroforestry models (Yield-SAFE, Farm-SAFE, Hi-sAFe) are able or unable to help answer research questions

Table 6. High natural and cultural value agroforestry: the capacity of 28 innovations identified in agroforestry systems of to be addressed (Y = yes; N = no) by three agroforestry models (Y: Yield-SAFE; F: Farm-SAFE; H: Hi-sAFe).

Area	Proposed research	Part-ner	Model Y	F	H	Comment
Farm profitability						
Branding HNCV agroforestry product. Trademark. Valuing product	Dehesa trademark	UEX	N	Y	N	Farm-SAFE could help to assign a value to a Dehesa system product
Product diversification. New products (tannins, dyes, aromatic, medicinal, mushrooms, firewood, biomass)	New acorn-derived products	ISA UEX	Y	Y	N	Can quantify the availability of new products, but not finding novel products.
	Promote knowledge on human consumption of acorns in different products	ISA	Y	Y	N	Yield-SAFE/Farm-SAFE could estimate economic viability to promote knowledge. Could quantify the availability of acorns.
Green Accounting System. economical evaluation of ecosystem services (ES)	Comparison of ES between agriculture, agroforestry and forestry	ISA	Y	Y	N	Ecosystem services will be quantified and linked to Yield-SAFE
System design and management						
Design and management of the systems to (new) multiple purposes. Synergies among three components (tree, pasture/crop and livestock)	Consultative process between Sami and foresters for the long-term planning	EFI-SLU	Y?	Y?	Y	Yield-SAFE could provide biomass estimations for animal husbandry capacity. Hi-sAFe could predict grass production for various tree density/design/management
Adaptive design of hedgerows	Shift from single model of novel hedgerow to modular models and progressive management techniques.	INRA	N	N	Y	Yield-SAFE does not account for spatial details. Hi-sAFe can model hedgerows by turning off the toric symmetry in one direction
	Development of appropriate management frameworks for silvopastoral systems aimed at promoting synergies between grazing animals, pasture and trees	CNR	Y?	Y?	Y	Yield-SAFE/Farm-SAFE could contribute for the system design for management options. Hi-sAFe can model hedgerows by turning off the toric symmetry in one direction
Tree layer management	Innovative [tree] species able to resist to livestock	ISA	Y?	Y?	Y	Yield-SAFE does not model mortality. But could calibrate/validate tree species (spiky) if there are data available. Hi-sAFe can predict the size of the trees, and threshold on the size may be used to determine when the trees are livestock-safe
Three dimensional design and management (layers, width, spatial connections)	Windbreaks rejuvenation	BTU	N	N	Y	YS does not account for spatial designs. Hi-sAFe does, but dies not predict the climate mitigation by a windbreak. It can only predict tree

Area	Proposed research	Part-ner	Model Y	F	H	Comment
						growth and the impact of the windbreak on the crops ignoring wind modification (only shade and root competition for water and nitrogen)
Livestock management	Appropriate stocking rate. Stocking rate matching to forage resources and to CAP	TEI UBB	Y	Y	Y	YS will estimate livestock capacity according to productivity
Tree protection and regeneration						
Reconciling grazing with trees (cost-efficient protection of saplings)	Dead branch - Deadwood shelters	ISA UEX BTU	N	Y	N	Could be included in a single evaluation of tree protection measures: cost benefit analysis
	Artificial thorny protectors	UEX NYME	N	Y	N	
	Tree guards, e.g. Tubex	NYME	N	Y	N	
	Thorny and/or Nursery Shrubs	UEX UBB NYME	N	Y	N	
	Chemical organic repellents	UEX	N	Y	N	
	Planting of new structures	BTU	N	Y	N	
	Grazing management/exclusion	TEI UBB	N	Y	N	
	Periodical grazing	UBB	N	Y	N	
	Fencing (cost-efficient structures)	NYME BTU	N	Y	N	
Pasture quality and fodder autonomy						
Overcome strong seasonality of “natural” forage resources	Fodder crops: cereal varieties adapted to shade and tree competition	UEX	Y	Y	Y	YS could help improve rotation efficiency, including shade tolerant varieties (by changing radiation use efficiency parameter)
	Retaken of pruning trees for acorn production & fodder	TEI	Y	Y	Y	YS could be parametrized to estimate % of thinning/pruning biomass for animal usage. Yield-SAFE can do this. Already done by the dehesa
Increase pasture productivity and quality	Pastures rich in legumes adapted to oak shade and grazing pressure	UEX	Y	Y	N	YS can compare different radiation use efficiency between pasture species (data is needed to validate). We could assume grass production and link it to different ME.
	Adapted silviculture for grazing. Need of early thinnning	UBB EFI-SLU	Y	Y	Y	YS could run on different thinning regimes to estimate pasture production. About timing. could consider dif times for thinnings

Area	Proposed research	Part-ner	Model Y	F	H	Comment
Grazing schemes and cost-effective herding						
Livestock species	Cattle and buffalo instead of sheep in wood-pastures.	UBB	Y	Y	N	YS could estimate pasture productivity under forest and estimate animal capacity.
Animal production						
Diversification (Geese, turkeys, red deer …)	Extensive turkey production under montado.	ISA	Y	Y	N	Animals will be referred to Forage Units. Prices and costs can be adjusted to economic model
Nature conservation						
Soil protection; stocking rate matching to forage resources and to CAP	Rotational herding	UEX UBB	Y	Y	N	YS can estimate productivity and estimate animal capacity and Farm-SAFE can relate that with different CAP policy support (incentives)
Organic matter and soil carbon sequestration	Ramial wood chips and other organic mulch	UEX INRA	Y	Y	N	YS can estimate thinning and pruning biomass and incorporated in soil and estimate carbon sequestration. Farm-SAFE can link to chipping costs (or other mulching costs)
Policy and governance						
Specific measures and grants, and long term regulations	Payment for historical landscapes	BTU	N	Y	N	Only if it is agroforestry

Table 7. Intercropping and grazing of high tree value systems: the capacity to address nine research questions (Y: yes; N: no) using three agroforestry models (Y: Yield-SAFE; F: Farm-SAFE; H: Hi-sAFe).

Proposed research	Partner	Model Y	Model F	Model H	Comment
Production					
To study the productive consequences of managing walnut and poplar plantations with grazing compared to intensive management (tillage and chemical inputs	UEX	Y	Y	Y	Typical case for Yield-SAFE, always depending on data availability to validate results
Improve income through diversification with sheep as an additional produce in apple orchards	AFBI	Y	Y	N	Typical case for Yield-SAFE, always depending on data availability to validate results
Parameterisation of the Yield-SAFE biophysical model for 'bush' orchard systems	CRAN	Y	Y	N	Yes, as long as there is data to validate estimates from the model
Management					
Plant species to be intercropped (TEI olives-N. Greece, C. Greece), (Walnuts, UEX), (TEI orange groves) or managed (APCA/ACTA apple orchards)	TEI UEX APCA/ACTA	Y	Y	N	Yield-SAFE can test various species. Parameterization needs to be done for all needed tree species.
Grazing management guidelines and tests on apple orchards	AFBI	Y	Y	N	But Yield-SAFE can help on a sensitivity analysis
Best practices for growing wild asparagus with olives	CREA	Y?	Y?	N	Perhaps the system can be modelled as long as there is data
Environmental issues					
Evaluation of ecosystem services with olive agroforestry in N. Greece	TEI	Y	Y	N	Ecosystem services will be quantified and linked to Yield-SAFE
Environmental benefits of grazing (AFBI) and soil chemical characteristics (APCA/ACTA) in apple orchards)	AFBI APCA/ACTA	Y	Y	N	N inputs/outputs can be estimated per Animal unit and estimate, .i.e. N fertilization
Socio-economic issues					
Inventory of the extant traditional olive tree systems intercropped with cereals and evaluation of their economic viability in N. Greece)	TEI	N	Y	N	Not a Yield-SAFE/Farm-SAFE exercise. This is done in a deliverable from WP1

Table 8. Agroforestry for arable farms: the capacity to address 16 research questions (Y: yes; N: no) using three agroforestry models (Y: Yield-SAFE; F: Farm-SAFE; H: Hi-sAFe)

Area	Proposed Research	Partner	Model Y	F	H	Comment
Design						
How to breed agroforestry-adapted crops?	Breed for shade tolerant or agroforestry adapted crops	INRA, ORC	N	N	Y	This needs to be parameterized with for example, higher radiation use efficiency. If data from crops available this could be done
What are the best tree-crop combinations and what are their interactions?	Assess physiological behaviour, root competition of cereals with trees	USC, TEI, INRA, BTU, Uex, EVD, APCA-CH, APCA-P	N	N	Y	Typical Hi-sAFe assessement
What is best spatial design that minimizes competition for light and nutrients?	Optimize alley width, tree line orientation and use cultivar diversification, shade tolerant varieties close to trees.	TEI, INRA, BTU, Uex, EVD, APCA-CH, APCA-P	N	N	Y	Alley with can be estimated but Hi-sAFe is better for this matter
How to design efficient agroforestry systems? How can harvest of crops and trees be synchronized?	Reconsider crop and tree species to synchronize harvest	EVD	Y	Y	Y	Yield-SAFE could help improve rotation efficiency
How can new crops serve a purpose in agroforestry systems?	Study how new crop species (aromatic plants, cut flowers, berries) can improve product diversity	USC, TEI, ORC	Y?	Y?	N	Perhaps productivity of new crop species could be estimated, providing yield data for calibration/validation
How can trees species choice be improved?	Study how multiple tree species can improve product diversity	TEI, ORC, CNR/ VEN	N	N	Y	Yield-SAFE does not model multiple tree species. With Hi-sAFe, it is possible to explore the behaviour of new tree species (real or theoretical).
Can soil depth be a limiting factor?	Compare establishment on deep/shallow soils	TEI, INRA	Y	Y	Y	Yield-SAFE can perform a sensitivity analysis on soil depths
Can trees be added in irrigated plots with pivot systems	Estimate gross margin including the trees grown in the corners of the pivot systems	ISA	Y	Y	N	Yield-SAFE can estimate non limited tree growth and Farm-SAFE can estimate the gross margin of the plot
Management						
How can agroforestry systems best be managed and mechanized (e.g. pruning, harvesting times/cycles)?	Establish methods to improve management efficiencies of agroforestry systems	EVD, CNR/VEN, APCA-PI	N	N	Y	Not a Yield-SAFE/Farm-SAFE exercise. Typical Hi-sAFe exercise
How can nitrogen fixing trees influence crops?	Assess the potentials of nitrogen fixing trees	ORC	N	N	Y	Yield-SAFE does not have an N model influencing the crop growth. This could be assessed by Hi-sAFe, but the reverse is easier to model : impact of fixing crops on non-fixing trees
Socio-economic						

Area	Proposed Research	Partner	Model Y	F	H	Comment
How do trees influence crop yields?	Compare using Land Equivalency Ratio	ORC, BTU, UEX	Y	Y	Y	LER could be present in all assessments
Environmental impacts						
What are the biodiversity benefits?	Assess biodiversity of agroforestry systems and how this can be maximized	USC, TEI, ORC	Y	Y	N	Not a Yield-SAFE/Farm-SAFE exercise. But satellite ES assessments can do this
How much carbon is fixed and how to maximize this?	Assess carbon sequestration potential over agroforestry systems life span	USC, ORC, EVD	Y	Y	Y	RothC model was incorporated in Yield-SAFE and can estimate soil carbon sequestration, in addition to the above ground assimilated carbon
Can trees protect the crops from heat exhaustion?	Use models and experiments to predict heat protection potential	(TEI), INRA	N	N	Y	Yield-SAFE does not have heat models affecting crops
Can trees reduce soil erosion and improve soil health?	Assess effect of agroforestry on soil health and micro-climate	BTU, Uex, APCA_PI	N	N	Y	Depends on definition for soil health. Hi-sAFe can predict soil temperature and humidity in 3D
Can trees improve water regulation?	Use agroforestry to increase water use and irrigation efficiency	INRA, BTU	Y	Y	Y	Yield-SAFE can compare productivity with irrigation schedules

Table 9. Agroforestry for livestock farms: the capacity to address 16 research questions (Y: yes; N: no) using three agroforestry models (Y: Yield-SAFE; F: Farm-SAFE; H: Hi-sAFe)

Proposed research	Part-ner	Model			Comment
		Y	F	H	
Design					
System design: How many trees do you need to optimize the mineral uptake by dairy cows, and to maximise yields of trees and pasture?	LBI	Y	Y	Y	YS can estimate biomass and convert it to metabolizable energy
Use of fast growing species such as willow or poplar	Ven	Y	Y	Y	Productivity of new species could be estimated, providing yield data for calibration/validation
Introduction of new crops on farms (Mulberry)	USC	Y	Y	N	Productivity of new crop species could be estimated, providing yield data for calibration/validation
Management					
Can trees contribute to mineral uptake?	LBI	N	N	Y	YS does not have a nutrient model influencing the tree growth. This could be assessed by Hi-sAFe, but only for Nitrogen
How much labour is needed per tree species/plantation type?	LBI	N	Y	N	Farm-SAFE could help with labour requirements. Data would be needed
What are the nutritional (and medicinal) value of trees and shrubs? What place can ligneous forages take in the diet of cows?	IDELE/ INRA	Y	Y	N	YS could relate energy from fruits/crops to act as sources for animal production (animal capacity). Data is needed.
A high interest in knowing the potential of native shrubby, herbaceous and tree species as nutritional resources for Celtic Pig	USC	Y	Y	N	YS could relate energy from fruits/crops to act as sources for animal production (animal capacity). Data is needed.
Gleditsia could be an interesting tree species as it is spiky in earlier stages, preventing browsing. It would be interesting to estimate its growth an energy content as feedstock, and the equivalent added monetary value	ISA	Y	Y	N	YS can be calibrated to this specie if data/literature is available and Farm-SAFE could estimate the equivalent value in terms of feedstock equivalences
Eucalyptus is the tree species with more are in Portugal and farmers are interested to explore the potential of this species with lower densities and provide pasture for grazing	ISA	Y	Y	N	YS, can be calibrated for eucalyptus, and an assessment on light and water competition can be made to explore the threshold on tree density that allows silvopasture. Comparison of forest and silvopasture can be explored with Yield-SAFE and Farm-SAFE
Socio-economic					
Look for profitable combinations	LBI	Y	Y	N	Farm-SAFE can help with the economic viability of the systems

5 Synthesis

5.1 Identifying the appropriate model

It is apparent in Section 4 that the potential suitability of the agroforestry model depends on the research question. While Yield-SAFE and Farm-SAFE are designed for long-term assessments, the more detailed Hi-sAFe model can be used for detailed short-term assessments. All three of the models can be used for some common issues, for example: exploring various designs of agroforestry plantations (e.g. tree density, choice of crops), various tree and crop management options, the potential impact of climate change, and the calculation of land equivalent ratios.

The parameter-sparse Yield-SAFE is probably best suited to allow the determination of the animal carrying capacity of different agroforestry designs, by modelling the impact of the trees on, for example, grass growth. Hi-sAFe has been developed to determine nitrogen budgets. The bio-economic Farm-SAFE model is most appropriate for economic analyses.

5.2 Tree, crop and livestock species currently modelled

Some innovations will require more parameterisation of the model for new tree species, new crops, hedgerows, and in the case of Yield-SAFE and Farm-SAFE, livestock. A resume of tree, crop and livestock species identified in the innovations and the current state of models' calibration is shown in Table 10, 11, and 12.

5.3 Research questions for modelling

At present, the research questions still need to be refined before modelling can begin in earnest. Questionnaires along with data collection forms are under development and will be provided to the partners to help clarify what results can be expected from the models depending on the availability of measured data (e.g. from field protocols). Based on discussions, the use of the models can remain solely the preserve of the modelling team (Modelling team), or it can be a co-operative approach. If the models are only used by a small modelling team, the stakeholder groups will need to provide the data, the modellers will provide the simulations, and the two parties will help analyse the results. In the co-operative approach, the modellers will train others to use Yield-SAFE, Farm-SAFE or Hi-sAFe. The visiting person will run the simulations and modellers provide assistance in case of any problem, and help to analyse the outputs. Cooperation is the preferred method because it tends to be faster and, will increase the number of future experts on using the model. During the project, four modelling workshops are intended to gather interested researchers willing to participate in the modelling of the innovations/systems for WP2-WP5.

Table 10. Tree species identified in the innovations and the current extent of calibration

Common name	Latin name	Yield-SAFE calibration	Hi-sAFe calibration
Norway maple	*Acer platanoïdes L.*		
Sycamore	*Acer pseudoplatanus*		
Italian alder	*Alnus cordata*		
Red Alder	*Alnus rubra*		
Siver birch	*Betula alba*		
Hornbeam	*Carpinus betulus*		
Orange tree	*Citrus sinensis*		
Cornelian cherry	*Cornus mas*		
Hazel	*Corylus avellana*		
Ash	*Fraxinus excelsior*		
Honey locust	*Gleditsia triacanthus*		
Sea buckthorn	*Hippophae rhamnoides*		
Common walnut	*Juglans regia*	**Yes**	
Hybrid walnut	*Juglans regia X Juglans nigra*		**Yes**
Apple tree	*Malus domestica*	**Yes**	
Olive tree	*Olea europea*		
Empress tree	*Paulownia tormentosa*		
Stone pine	*Pinus pinea*	**Yes**	
Monterey pine	*Pinus radiata*	**Yes**	
Poplar hybrids	*Populus x canadensis*		
White poplar	*Populus alba*	**Yes**	
Black poplar	*Populus nigra*	**Yes**	
Poplar	*Populus spp*	**Yes**	**Yes**
Aspen	*Populus tremula*	**Yes**	**Yes**
Wild cherry	*Prunus avium*	**Yes**	
Valonian oak	*Quercus ithaburensis subs. macrolepis*		
Sessile oak	*Quercus petraea*		
Holm oak	*Quercus rotundifolia*	**Yes**	
Cork oak	*Quercus suber*	**Yes**	
Black locust	*Robinia pseudoacacia*		
Rosehip	*Rosa rugosa*		
Willow	*Salix viminalis*		
Pagoda tree	*Sophora japonica*		
Service tree	*Sorbus domestica L.*		
Small-leaved lime	*Tilia cordata*		

Table 11. Crop species identified in research questions and the current extent of calibration

Common name	*Latin name*	Yield-SAFE	Hi-sAFe[2]
Alfalfa	*Medicago sativa*		**Yes**
Aromatic plants			
Barley	*Hordeum vulgare*	**Yes**	
Common bean	*Phaseolus vulgaris*	**Yes**	
Common vetch	*Vicia sativa*		
Durum wheat (winter)	*Triticum turgidum L. subsp. Durum*	**Yes**	
Fallow		**Yes**	
Grass (improved)		**Yes**	
Grass (natural pastures)			**Yes**
Grass (sown mixtures)			
Lupins	*Lupinus spp.*		
Maize	*Zea mays*	**Yes**	**Yes**
Oats	*Avena sativa*	**Yes**	
Oilseed rape	*Brassuca napus*	**Yes**	**Yes**
Potatoes	*Solanum tuberosum L*	**Yes**	
Protein pea (winter)	*Pisum sativum L cv Blizzard*		
Rhubarb	*Rheum rhabarbarum*		
Rye (perennial)	*Secale multicaule*		
Rye (winter)	*Secale cereale*		
Salads (lettuce)	*Lactuca sativa*		
Sown flowers			
Soybean	*Glycine max*		**Yes**
Squashes (courgette or pumpkin)	*Cucurbita pepo*		
Strawberry	*Fragaria × ananassa*		
Sugar beet	*Beta vulgaris*	**Yes**	
Sunflower	*Helianthus annuus.*	**Yes**	**Yes**
Wheat (spring and winter)	*Triticum spp.*	**Yes**	**Yes**
White, red and crimson clovers	*Trifolium spp*		

[2] The Hi-sAFe model uses the crop models available within STICS. http://www6.paca.inra.fr/stics_eng

Table 12. Livestock identified in the research question and the current state of calibration

Livestock	Breed	Agroforestry system	Yield-SAFE calibration
Cattle	Exotic Limousine, Charolês; Native Alentejana, Mertolenga	Montado	There is a Livestock Metabolisable Energy Requirement (LMER) for a Livestock Unit which will be used as default value. Other references can support the change of this value for specific livestock.
Chicken	Unspecified	Intercropping of orange groves with arable crops in Greece	
Goat	Unspecified	Valonia oak silvopastoral systems	
Goat	Serpentina, Charnequeira	Montado	
Horses	Lusitano, Sorraia	Montado	
Pigs	Black Iberian pig races Caldeira, Ervideira, Loira	Montado	
Pigs	Modern crossbreed Danish Landrace x Yorkshire x Duroc	Pigs in energy crops in Denmark	
Sheep	Galician breed	Agroforestry with sheep in Galicia, Spain	
Sheep	Bizet breed	Wild cherry pastures in France	
Sheep	White Merino, Black Merino	Montado	
Sheep	Shropshire breed -UK	Grazed orchards in the UK	
Sheep	Unspecified	Valonia oak silvopastoral systems, Chalkidiki, Molos and Intercropping poplar and walnut trees with cereals and beans in Greece	

6 Innovations not to be modelled

The participants at the workshop (20th April 2015 – 30th April 2015) in Monchique, Portugal also examined how, if at all, the non-modelling research questions should be tackled. From the initial analysis, and with a consultation with all the modelling partners, six research approaches were identified

Table 13. Six research approaches have been suggested to address the research questions raised by the stakeholder groups

Code	Principal research approach	Description
M	Modelling	Primarily questions associated with biophysical or economic issues
S	Social science methods	Issues related to adoption and farmer responses to agroforestry
P	Policy analysis	
F	Field-based methods	Trials and demonstrations
E	Experiment	For example laboratory-based analyses
L	Literature	Literature review

Tables 14, 15, 16 and 17 provide an initial description of those research questions which are probably best addressed using a non-modelling method. It is assumed that literature review is an appropriate technique in each method.

Table 14. High natural and cultural value agroforestry: research questions which are probably best addressed through a non-modelling approach such as social science (S), policy analysis (P), field-based work (F), or experiment (E)

Area	Proposed research / Innovation	Part-er	Comment	Approach (see table 13)
Farm profitability				
Branding HNCV agroforestry product. Trademark. Valuing product	Certification of animal husbandry products	TEI	Result from Yield-SAFE/Farm-SAFE/Hi-sAFe could reinforce the concept, but not model it directly. Evidence provision from results to help with certification.	S
	Improved knowledge of customer and tax payer interest (Questionnaires: protocol ready)	UEX NYME	Not a model exercise	S
Product diversification. New products	*Phlomis fruticosa* as understorey crop	TEI	Could be modelled if data is available, unclear what the purpose of the ground-bed is.	S
Quality of tree products (e.g. cork quality vs management)	Assessment of cork quality respect to management practices: debarking intensity, height	ISA	There are no models readily available for strengthening Yield-SAFE in this aspect	S
System design and management				
Three dimensional design and management (layers, width, spatial connections)	Renewing encroach-abandoned wood pastures	NYME	Landscape level. Not for Yield-SAFE.	F
	Open young stands that enable reindeer movements and herd control	EFI-SLU	This is a landscape architecture exercise. Yield-SAFE is not sufficiently spatial.	F
	Rebuilding connections between hedgerows and scattered farms across the landscape. Anchoring new plantations on remnants of old hedgerows. Linking the design of ground structure and vegetation layers; use of forest plough to facilitate bank making if necessary.	INRA	This is a landscape architecture exercise. Yield-SAFE is not sufficiently spatial	F
Infrastructures for livestock transport. Transhumance		?		P
Tree protection and regeneration				
Reconciling grazing with trees (cost-efficient protection of saplings)	Invisible Fencing for livestock exclusion	CRAN	Not a Yield-SAFE exercise, but Farm-SAFE could compare estimates for costs	F
Tree species diversity. Native	Protection of native tree	UBB	Not a Yield-SAFE exercise	F

Area	Proposed research / Innovation	Part-er	Comment	Approach (see table 13)
species	species.	NYME		
	Avoidance of exotic tree species as e.g. *Pinus contorta*.	EFI-SLU	Not a Yield-SAFE exercise	F
Tree decay (pests, diseases and wildfire), and fruit losses	An adequate silvo-environmental management practices for pests and diseases control	UEX	Yield-SAFE does not account for pests and diseases	F
Pasture quality and fodder autonomy				
Overcome strong seasonality of "natural" forage resources	Forest grazing and pannage	NYME	Yield-SAFE could estimate pasture productivity under forest and estimate animal capacity. However pannage by pigs involve other understorey nutrient sources (e.g. Truffles, worms) that Yield-SAFE does estimate	F
Restoration of degraded pastures / disturbed areas	Equipment for re-establishment of lichens at the disturbed area harmful	EFI-SLU	Lichens are not a crop, not even a plant. It would be necessary to estimate with a different model with different parameters	F
Grazing scheme and cost effective herding				
More efficient and even use of extensive forage resources	Fast-intensive rotational grazing	UEX UBB		F
	Best practice and solution of forest grazing and pannage	TEI	Yield-SAFE could estimate pasture productivity under forest and estimate animal capacity. However pannage by pigs involve other understorey nutrient sources (e.g. Truffles, worms) that Yield-SAFE does estimate	F
	Grazing regulation		??	P
Cost-efficient herding. Technology	Facilities location	UEX UBB	Not a Yield-SAFE exercise, possibly a Farm-SAFE exercise	L
	GPS herding	UEX CRAN EFI-SLU	Not a Yield-SAFE/Farm-SAFE/HS	L
	Virtual/Invisible fencing	UEX CRAN EFI-SLU	Not a Yield-SAFE exercise, possibly a Farm-SAFE exercise	L
	Grazing and herding technology	NYME EFI-SLU	Not a Yield-SAFE exercise, possibly a Farm-SAFE exercise	L
Animal production				
Genetic selection. Docility & Browsing behaviour. Local races	Not elaborated	?	Not a Yield-SAFE/Farm-SAFE exercise	L

Area	Proposed research / Innovation	Part-er	Comment	Approach (see table 13)
Livestock health (water quality, reinfection from wild fauna, sheltering …)	GPS collars. Control of access to water point and supplementary food. Control of animal health. Monitoring herd position	UEX EFI-SLU	Not a Yield-SAFE exercise, possibly a Farm-SAFE exercise	L
	Design of the structure and location of novel hedgerows for enhancing sheltering.	INRA	Yield-SAFE is not spatial	L
Control of predators	Not elaborated	?	??	L
Extension				
Open school; maintenance of local knowledge	Pilot Farms (economically healthy)	ISA	Not a Yield-SAFE/Farm-SAFE exercise	F
Open school; maintenance of local knowledge	Favouring the design (and diffusion) of a model of "cooperative of skills and machines pool" for re-developing bocage agroforestry.	INRA	Not a Yield-SAFE/Farm-SAFE exercise	L;S;P
Nature conservation				
Soil protection; stocking rate matching to forage resources and to CAP	Combining crop rotation management, pasture management and 3 dimensional design and management of hedgerows to avoid soil erosion.	INRA	Typical Hi-sAFe exercise but no erosion in Hi-sAFe	L
Fire control	Effect of grazing exclusion on the wildfire behaviour.	CNR-ISPAAM	Yield-SAFE can estimate biomass that can be converted to fuel and assess the impact of the grazing for reducing fire hazard	L
Fire control	Low input techniques of firebreaks management	?	Yield-SAFE is not spatial, and this research needs spatial relations	L

Table 15. Intercropping and grazing of high tree value systems: : research questions which are probably best addressed through a non-modelling approach such as social science (S), policy analysis (P), field-based work (F), or experiment (E)

Area and proposed research/innovation	Partner	Comment	Approach
Policy and governance			
Specific measures and grants, and long term regulations: Proposals for a specific status of the hedgerows of high and medium stem trees in the 2nd but also 1st pillar of the CAP to support their maintenance.	INRA	Not a Yield-SAFE exercise but could be eventually accounted by Farm-SAFE	P
Production			
Quality assessment of products (TEI olives, C. Greece)	TEI	Yield-SAFE estimates productivity but not quality	L
Techniques to increase mushroom production (Chestnuts, USC)	USC	Yield-SAFE does not model mushroom	F
To study the interactions of Shropshire sheep and apple trees (CRAN, grazed orchards)	CRAN	Yield-SAFE can estimate pasture productivity and animal capacity and FM can estimate economic interactions with sheep varieties	F
Management			
Animal species (olives CRA-OLI) (CRAN, apple orchards) – breed used (AFBI, apple orchards) and effect on pests and diseases (APCA/ACTA apple orchards)	CRA CRAN AFBI APCA/ACTA	Yield-SAFE can estimate animal capacity in the orchards, but not effects on diseases	F;L
Techniques to increase mushroom production (Chestnuts, USC)	USC	Yield-SAFE does not model mushrooms	F;L
Graft production of selected varieties of chestnuts (Chestnuts, USC)	USC	Yield-SAFE can estimate the productivity but parameterisation of a grafted tree should be considered as a new "specie" with different parameters, that could be linked to Farm-SAFE costs of grafting and early revenues from the tree	F

Table 16. Agroforestry for arable farms: : research questions which are probably best addressed through a non-modelling approach such as social science (S), policy analysis (P), field-based work (F), or experiment (E)

Area and proposed research		Partner	Comment	Approach
Socio-economic issues				
	Propose high marketability products and test (this could fit in the management as well)	CRA	Result from Yield-SAFE/Farm-SAFE/Hi-sAFe could reinforce the concept, but not modelling it directly	S
Design				
Need to see agroforestry	Develop show case farms	USC APCA-PI	Not a Yield-SAFE/Farm-SAFE/HS exercise.	F
Management				
How do agroforestry systems influence crop disease? How can their influence be prevented?	Assess how crop and tree interaction changes the presence of diseases.	INRA CNR/VEN NymE	Yield-SAFE does not model disease effects. However crude analysis could be done on effects of some diseases affecting leaf area (improving radiation interception by crops)	L
How can crop and tree products (fruits/nuts) harvest be synchronized?	Establish efficient harvest methods for agroforestry systems	EVD	Not a Yield-SAFE/Farm-SAFE exercise. This is not directly done by Yield-SAFE, but rather a calendar analysis for optimizing efficiency of production could be done	L;F
How can trees in agroforestry systems best be protected against domestic animals and wildlife?	Design cost effective wildlife protection system using either natural or artificial products	USC INRA ORC EVD NymE APCA-CH APCA-P	Not a Yield-SAFE/Farm-SAFE exercise.	L;F
How can old agroforestry systems best be renewed?	Establish methods for renewal at end of life	TEI ORC	Not a Yield-SAFE/Farm-SAFE exercise.	L;F
How do agroforestry systems affect the presence of weeds? What innovative weed management methods can be developed?	Use natural sources or plants (aromatic plants) to protect against weeds and function as pollinator resource	TEI INRA ORC BTU Uex EVD CNR/VEN NymE APCA-CH APCA-P	Not a Yield-SAFE/Farm-SAFE exercise.	F;L
How can the application of chemicals best be managed in agroforestry systems?	Study legal constraints regarding use of chemicals	USC EVD	Not a Yield-SAFE/Farm-SAFE exercise.	P
Regulation and policies				
How can the administrative burden/bureaucracy be reduced?	Simplification of grant process for establishment of agroforestry	TEI ORC BTU Uex NymE APCA-CH APCA-P	Not a Yield-SAFE/Farm-SAFE exercise.	P

Area and proposed research		Partner	Comment	Approach
How can CAP reforms result in clear and long-term funding for agroforestry? How can regulators and technicians be educated about agroforestry?	Improve agroforestry representation in Brussels and member states	USC TEI INRA ORC BTU Uex EVD CNR/VEN NymE APCA-CH APCA-P	Not a Yield-SAFE/Farm-SAFE/HS exercise. However results from Yield-SAFE/Farm-SAFE/Hi-sAFe can support representation by interested parties	P
Socio-economic				
How can information about agroforestry systems be more accessible?	Establish an online portal for agroforestry and establish reference farms that can be visited	TEI ORC NymE APCA-CH	Not a Yield-SAFE/Farm-SAFE exercise. This is a deliverable from WP9. (map)	P;S
Are people willing to pay more for agroforestry products?	Improve marketing and branding of agroforestry products (e.g. woodland eggs)	INRA ORC BTU Uex	Not a Yield-SAFE/Farm-SAFE exercise.	S
Can business opportunities be created through participatory breeding?	Involve agrifood industry stakeholders from the onset of the project	INRA	Not a Yield-SAFE/Farm-SAFE exercise.	S
How can long-term investments/funding be guaranteed?	Conduct a cost benefit analysis	BTU Uex APCA_PI	Yield-SAFE/Farm-SAFE can help on this assessment, including ES approach	P
How can land tenure become more flexible to allow agroforestry establishment?	Educate landowners of agroforestry benefits and increase flexibility of land tenure	TEI ORC BTU APCA_PI	Not a Yield-SAFE/Farm-SAFE exercise.	P
How can we improve knowledge and value of agroforestry products?	Evaluate timber quality in agroforestry systems and the value of wood thinnings	TEI ORC UEX CNR/VEN	Yield-SAFE/Farm-SAFE can estimate the production and value of wood thinnings	E

Table 17. Agroforestry for livestock farms: research questions which are probably best addressed through a non-modelling approach such as social science (S), policy analysis (P), field-based work (F), or experiment (E)

Area and proposed research	Partner	Comment	Approach
Socio-economic			
How do neighbouring farmers influence the establishment of agroforestry? What role do technicians play? Assess impact of social aspects and technicians on agroforestry system establishment rates	ORC APCA_CH APCA_PI	Not an Yield-SAFE/Farm-SAFE exercise.	S
Design			
Which fruit species are suitable for the chicken range area in relation to manure and digging the roots by the chicken?	LBI	Root analysis more developed in Hi-sAFe	F;L
Which species/breeds of fruit trees are suitable in chicken run, concerning diseases and labour?	LBI	Farm-SAFE could help with labour requirements	F;L
The design and management surrounding the chicken houses to encourage birds to range further away from the houses.	ORC	Yield-SAFE is not spatial	F;L
Trial tests of 'funny/exciting' wood species with nutritional value for the pigs and which are possibly to grow in between energy crops	AU	Yield-SAFE could relate energy from crops to pig production (animal capacity). Data is needed.	F;L
How should the trees or shrubs be spatially organized to optimize both woody and herbaceous forage production and animal welfare (while avoiding the accumulation of dungs under the trees)?	IDELE/INRA	Yield-SAFE is not spatial	F;L
Regulation and policies			
Subsidy for networks	LBI	Not a Yield-SAFE/Farm-SAFE exercise.	P
Management			
Can fruit trees contribute to health and productivity of own bees?	LBI	Not a Yield-SAFE/Farm-SAFE exercise.	F;L
Multipurpose use of the range, combination of poultry with cattle. One farmer has set up the trees in triangles, which he can fence-in during the periods where he grazes cattle.	ORC	Yield-SAFE does not model multiple tree/crop/animal species neither the spatial design	F;L
Use of straw around trees to control weed and increase the amount of worms and insects which are available for foraging poultry.	AU	Not a Yield-SAFE/Farm-SAFE exercise.	F;L
The nutritional value of fruits and nuts from the trees and bushes for monogastrics.	AU	Yield-SAFE could relate energy from fruits/crops to act as sources for animal production (animal capacity). Data is needed.	E
Development of machinery suitable for harvesting energy crops 1.20 m above ground (this height is needed to avoid pigs eating the new sprouts after harvesting)	AU	Not a Yield-SAFE/Farm-SAFE exercise.	E:L
The nutritional value of fruits and nuts from trees and bushes for pigs and poultry	AU	Yield-SAFE could relate energy from fruits/crops to act as sources for animal production (animal	E

Area and proposed research	Partner	Comment	Approach
		capacity). Data is needed.	
Description and data from ‘all’ AF systems in DK – pigs and poultry	AU	Not a Yield-SAFE/Farm-SAFE exercise.	S
Which methods are to be used for easily and efficiently protecting recently implemented trees against livestock grazing on patches?	IDELE/INRA	Not a Yield-SAFE/Farm-SAFE exercise.	L;F
Socio-economic			
Alternative business models - partnerships between 'tree' people and poultry farmers	LBI	Yield-SAFE does not model multiple tree/crop/animal species neither the spatial design	P;S;L

7 Acknowledgements

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8 References

Graves AR, Burgess PJ, Liagre F, Terreaux JP, Borrel T, Dupraz C, Palma J, Herzog F (2011) Farm-SAFE: the process of developing a plot- and farm-scale model of arable, forestry, and silvoarable economics. Agroforestry Systems 81 (2):93-108. doi:10.1007/s10457-010-9363-2

Hermansen JE, Kongsted AG, Bestman M, Bondesan V, Gonzalez P, Luske B, McAdam J, Mosquera-Losada R, Novak S, Pottier E, Smith J, van Eekeren N, Vonk M (2015) Agroforestry Innovations to be evaluated for Livestock Farmers - AGFORWARD Milestone 5.2 (MS21) report.

Mirck J, Cirou E, Camilli F, Crossland M, Dalla Valle C, Fernandez-Lorenzo JL, Ferreiro-Dominguez N, Gonzalez-Hernandez P, Gosme M, Hannachi Y, Herzog F, Howlett S, Jäger M, Mosquera-Losada MR, Moreno G, Pantera A, Paris P, Pisanelli A, Rigueiro-Rodriguez A, Smith J, Tsonkova P, Vityi A, Wartelle R, Wolfe M (2015) Agroforestry Innovations to be evaluated for Arable Farmers - AGFORWARD Milestone 4.2 (MS15) report.

Moreno G, Berg S, Burgess P, Camilli F, Crous-Duran J, Franca A, Hao H, Hartel T, Lind T, Mirck J, Palma J, Paulo JA, Pisanelli A, Seddaiu G, Thenail C, Tsonkova P, Upson M, Valinger M, Varga A, Viaud V, Vityi A (2015) Innovations to be examined for High Nature and Cultural Value Agroforestry - AGFORWARD Milestone 2.2 (MS3) report.

Pantera A, Burgess PJ, Corroyer N, Ferreiro-Domínguez N, Fernández-Lorenzo JL, González-Hernández P, Graves A, McAdam J, Moreno G, Mosquera-Losada R, Rigueiro-Rodríguez A, Rosati A, Upson M (2015) Report on Innovations to be examined for Agroforestry for High Value Tree Systems - AGFORWARD Milestone 4.2 (MS15) report.

Talbot G (2011) L'intégration spatiale et temporelle des compétitions pour l'eau et la lumière dans un système agroforestiers noyers-céréales permet-elle d'en comprendre la productivité? . Université de Montpellier, Montpellier

van der Werf W, Keesman K, Burgess P, Graves A, Pilbeam D, Incoll LD, Metselaar K, Mayus M, Stappers R, van Keulen H, Palma J, Dupraz C (2007) Yield-SAFE: A parameter-sparse, process-based dynamic model for predicting resource capture, growth, and production in agroforestry systems. Ecol Eng 29 (4):419-433. doi:DOI 10.1016/j.ecoleng.2006.09.017

Annex A. Stakeholder meetings reports covering four land use sectors

Reports on High Natural and Conservation Value Agroforestry Systems (WP2)

Crous-Duran J, Amaral Paulo J, Palma J (2014). Initial Stakeholder Meeting Report: Montado in Portugal. 4 September 2014. 12 pp. Available online: http://www.agforward.eu/index.php/en/montado-in-portugal.html

Moreno G (2014). Initial Stakeholder Meeting Report: Dehesa farms in Spain. 17 September 2014. 19 pp. Available online: http://www.agforward.eu/index.php/en/dehesa-farms-in-spain.html

Pisanelli A, Camilli F, Seddaiu G, Franca A (2014). Initial Stakeholder Meeting Report: Grazed oak woodlands in Sardinia. 15 October 2014. 9 pp. Accessed online: http://www.agforward.eu/index.php/en/grazed-oak-woodlands-in-sardinia.html

Pantera A (2014). Initial Stakeholder Meeting Report: Valonia oak silvopastoral systems in Greece. 17 September 2014. 9 pp. Available online: http://www.agforward.eu/index.php/en/valonia-oak-silvopastoral-systems-in-greece.html

Hartel T (2014). Initial Stakeholder Meeting Report: Wood Pastures in Romania. (Ed. PJ Burgess). 16 November 2014. 8 pp. http://www.agforward.eu/index.php/en/wood-pastures-in-southern-transylvania-romania.html

Vityi A, Varga A (2014). Initial Stakeholder Meeting Report: Wood pasture in Hungary. 13 pp. 18 October 2014. Available online: http://www.agforward.eu/index.php/en/wood-pasture-in-hungary.html

Tsonkova P, Mirck J (2014). Initial Stakeholder Meeting Report: Agroforestry in the Spreewald Flood Plain, Germany. 20 October 2014. 8 pp. Available online: http://www.agforward.eu/index.php/en/agroforestry-in-the-spreewald-flood-plain-germany.html

Thenail C, Viaud V, Hao H (2014). Initial Stakeholder Meeting Report: Bocage agroforestry in Brittany, France. 2 December 2014. 10 pp. Available online: http://www.agforward.eu/index.php/en/bocage-agroforestry-in-brittany-france.html

Upson M, Burgess PJ (2014). Initial Stakeholder Meeting Report: Wood pasture and parkland in the UK. 2 October 2014. 10 pp. Available online: http://www.agforward.eu/index.php/en/wood-pasture-and-parkland-in-the-uk.html

Berg S, Lind T (2014). Initial Stakeholder Meeting Report: Wood pasture and reindeer in Sweden. 27 October 2014. 13 pp. Available online: http://www.agforward.eu/index.php/en/wood-pastures-and-reindeer-in-sweden.html

Reports on High Value Tree Agroforestry Systems (WP3)

Moreno G (2014). Initial Stakeholder Meeting Report Grazing and intercropping of plantation trees in Spain. 17 September 2014. 12 pp. Available online: http://www.agforward.eu/index.php/en/grazing-and-intercropping-of-plantation-trees-in-spain.html

Mosquera Losada R, Ferreiro-Domínguez N, Fernández Lorenzo JL, González-Hernández P, Rigueiro Rodríguez A (2014). Initial Stakeholder Meeting Report: Chestnut agroforestry in Galicia, Spain. 23 September 2014. 9 pp. Available online: http://www.agforward.eu/index.php/en/chestnut-agroforestry-in-galicia-spain.html

Rosati A (2014). Initial Stakeholder Meeting Report Intercropping and grazing of olive orchards in Italy. 6 August 2014. 7 pp. Available online:

http://www.agforward.eu/index.php/en/intercropping-and-grazing-of-olive-orchards-in-italy.html

Pantera A (2014). Initial Stakeholder Meeting Report: Intercropping of olive groves in Greece (Kassandreia). 20 October 2014. 8 pp. Available online: http://www.agforward.eu/index.php/en/intercropping-of-olive-groves-in-greece.html

Pantera A (2014). Initial Stakeholder Meeting Report: Intercropping of olive groves in Greece (Molos). 20 October 2014. 9 pp. Available online: http://www.agforward.eu/index.php/en/intercropping-of-olive-groves-in-greece.html

Pantera A (2014). Initial Stakeholder Meeting Report: Intercropping of Walnut Trees in Greece. 20 October 2014. 8 pp. Available online: http://www.agforward.eu/index.php/en/intercropping-of-walnut-trees-in-greece.html

Pantera A (2014). Initial Stakeholder Meeting Report Intercropping of Orange Groves in Greece. 18 November 2014. 7 pp. Available online: http://www.agforward.eu/index.php/en/intercropping-of-orange-groves-in-greece.html

Corroyer N (2014). Initial Stakeholder Meeting Report: Grazed Orchards in France. 1 December 2014. 8 pp. Available online: http://www.agforward.eu/index.php/en/grazed-orchards-in-france.html

Burgess PJ (2014). Initial Stakeholder Meeting Report: Grazed Orchards in the UK. 18 July 2014. 8 pp. Available online: http://www.agforward.eu/index.php/en/Grazed_Orchards.html

McAdam J (2014). Initial Stakeholder Meeting Report: Grazed orchards in Northern Ireland, UK. 4 December 2014. 9 pp. Available online: http://www.agforward.eu/index.php/en/grazed-orchards-in-northern-ireland-uk.html

Reports on Silvoarable Agroforestry Systems (WP4)

Cirou E, Hannachi Y (2014). Initial Stakeholder Meeting Report Agroforestry for Arable Farmers in Western France. (Ed. PJ Burgess). 14 November 2014. 9 pp. Available online: http://www.agforward.eu/index.php/en/agroforestry-for-arable-farmers-in-western-france.html

Gosme M (2014). Initial Stakeholder Meeting Report: Mediterranean Silvoarable Systems in France. 8 October 2014. 12 pp. Available online: http://www.agforward.eu/index.php/en/mediterranean-silvoarable-systems-in-france.html

Jäger M, Herzog F (2014). Initial Stakeholder Meeting Report Silvoarable systems with fruit and high value timber trees in Switzerland. 11 November 2014. 9 pp. Available online: http://www.agforward.eu/index.php/en/integrating-trees-with-arable-crops-switzerland.html

Mosquera Losada MR, Ferreiro-Domínguez N, Fernández Lorenzo JL, González-Hernández P, Rigueiro Rodríguez A (2014). Initial Stakeholder Meeting Report Silvoarable Systems in Spain. 29 October 2014. 8 pp. Available online: http://www.agforward.eu/index.php/en/silvoarable-systems-in-spain.html

Moreno G (2014). Initial Stakeholder Meeting Report Grazing and intercropping of plantation trees in Spain. 17 September 2014. 12 pp. Available online: http://www.agforward.eu/index.php/en/grazing-and-intercropping-of-plantation-trees-in-spain.html

Pantera A (2014). Initial Stakeholder Meeting Report: Trees with arable crops and grassland in Greece. 20 October 2014. 9 pp. Available online: http://www.agforward.eu/index.php/en/trees-with-arable-crops-and-grassland-in-greece.html

Pisanelli A, Camilli F, Dalla Valle C, Paris P (2014). Initial Stakeholder Meeting Report: Trees for timber intercropped with cereals in Italy. 7 October 2014. 6 pp. Available online: http://www.agforward.eu/index.php/en/trees-for-timber-intercropped-with-cereals-445.html

Smith J, Wolfe M, Crossland M, Howlett S (2014). Initial Stakeholder Meeting Report: Silvoarable Agroforestry in the UK. 21 November 2014. 8 pp. Available online: http://www.agforward.eu/index.php/en/silvoarable-agroforestry-in-the-uk.html

Tsonkova P, Mirck J (2014). Initial Stakeholder Report: Alley Cropping Systems in Germany. 19 September 2014. 9 pp. Available online: http://www.agforward.eu/index.php/en/alley-cropping-systems-in-germany.html

Vityi, A (2014). Initial Stakeholder Meeting Report: Alley Cropping Systems in Hungary. 23 October 2014. 11 pp. Available online: http://www.agforward.eu/index.php/en/alley-cropping-systems-in-hungary.html

Wartelle R (2014). Initial Stakeholder Meeting Report Agroforestry for Arable Farmers in Northern France. (Ed PJ Burgess). 16 December 2014. 10 pp. Available online: http://www.agforward.eu/index.php/en/agroforestry-for-arable-farmers-in-northern-france.html

Reports on Agroforestry for Livestock Systems (WP5)

Bestman M (2014a). Initial Stakeholder Meeting Report: Agroforestry for poultry systems in the Netherlands (9 July meeting). 25 September 2014. Louis Bolk Institute, Netherlands. 5 pp. Available online: http://www.agforward.eu/index.php/en/agroforestry-for-poultry-systems-in-the-netherlands.html

Bestman M (2014b). Initial Stakeholder Meeting Report: Agroforestry for poultry systems in the Netherlands (18 September meeting). 25 September 2014. Louis Bolk Institute, Netherlands. 7 pp. Available online: http://www.agforward.eu/index.php/en/agroforestry-for-poultry-systems-in-the-netherlands.html

Bondesan V (2014). Initial Stakeholder Meeting Report: Free-range Pigs with Energy Crops in Veneto, Italy. (Ed. P Burgess). 21 November 2014. Veneto Agricultura, Italy. 8 pp. Available online: http://www.agforward.eu/index.php/en/free-range-pigs-with-energy-crops-italy.html

Kongsted AG (2014a). Initial Stakeholder Meeting Report: Agroforestry for organic poultry and pig production in Denmark. 29 October 2014. Aarhus University, Denmark. 7 pp. Available online: http://www.agforward.eu/index.php/en/agroforestry-for-organic-poultry-and-pig-production-in-denmark-583.html

Kongsted AG (2014b). Initial Stakeholder Meeting Report Free-range pigs integrated with energy crops in Denmark. 4 September 2014. Aarhus University, Denmark. 7 pp. Available online: http://www.agforward.eu/index.php/en/free-range-pigs-integrated-with-energy-crops.html

Luske B (2014). Initial Stakeholder Meeting Report: Fodder trees for cattle and goats in the Netherlands. 6 October 2014. Louis Bolk Institute, Netherlands. 6 pp. Available online: http://www.agforward.eu/index.php/en/fodder-trees-for-cattle-and-goats-in-the-netherlands.html

McAdam J (2014). Initial Stakeholder Meeting Report: Grazed orchards in Northern Ireland, UK. 4 December 2014. AFBI, Northern Ireland. 9 pp. Available online: http://www.agforward.eu/index.php/en/grazed-orchards-in-northern-ireland-uk.html

Mosquera-Losada MR, Ferreiro-Domínguez N, Fernández Lorenzo JL, González-Hernández P, Rigueiro Rodríguez A (2014). Initial Stakeholder Meeting Report: Agroforestry with Pigs, Galicia, Spain. 25 September 2014. University of Santiago de Compostela, Spain. 9 pp. Available online: http://www.agforward.eu/index.php/en/agroforestry-with-pigs-in-galicia-spain.html

Pottier E (2014). Initial Stakeholder Meeting Report: Agroforestry with Ruminants in France. (Ed PJ Burgess). 10 November 2014. Institut de l'Elevage, INRA. 9 pp. Available online: http://www.agforward.eu/index.php/en/agroforestry-with-ruminants-in-france.html

Smith J, Vieweger A, Zaralis K (2014a). Initial Stakeholder Meeting Report: Woodland Eggs in the UK. 3 July 2014. Organic Research Centre, UK. 6 pp. Available online: http://www.agforward.eu/index.php/en/Poultry-systemUK.html

Smith J, Vieweger A, Zaralis K (2014b). Initial Stakeholder Meeting Report: Woodland Poultry in the UK. 16 May 2014. Organic Research Centre, UK. 5 pp. Available online: http://www.agforward.eu/index.php/en/Poultry-systemUK.html

Annex B. Example of fact sheet

Basic Agroforestry system information.				
AF system ID	X – XX		**Name**	Poplar silvoarable and linear systems
AGFORWARD Classification	[ ] High Natural and Cultural Value (WP2) [ ] High Value Tree Systems (WP3) [X] Silvoarable (WP4) [ ] Silvopastoral (WP5)			
Present Location	Italy, Po Valley, plain and hilly areas of peninsular italy			
Description	Poplar hybrids and species has been intensively managed in Italy for timber production mostly in monoculture plantations, but often in intercropping systems (intercropping of arable crops in between young tree rows) and in linear plantations along field edges, drainage canals and streams. Poplar cultivation, in all the above cultivation models, is currently declining for stagnating domestic timber market. Urgent environmental concerns connected to Global Changes (Carbon sequestration, bioenergy, soil erosion control) should open new prospective for poplar silvoarable systems and linear plantations, combining local bioenergy production with food security and environmental amelioration, such us phytoremediation.			
Area occupied (estimation)	No reliable official statistics are available for intercropping systems. For linear planations, just local regional statistics are available, often not homogeneous as time series, such the ones for Lombardia Region, reporting wood production from linear plantations, without stratification amongst tree species (e.g. Populus, Platanus, Salix). The last census in Lombardia (year 2000) reports 21,459 km of linear plantations (15.18 m/ha), producing annually 180.000 m^3 of timber.			
Soil type	Alluvial soils			
Tree species	Poplar hybrids (*Populus x canadensis*) *Populus alba, Populus nigra*			
Crop species	Corn (Zea mays), wheat (Triticus spp.), barley (Hordeum volgare), soybean (Glycine max), sunflower (Heliantus annuus), alfalfa (Medicago sativa), clovers (Trifolium spp.)			
Animal species	Occasional sheep grazing in peninsular Italy.			
Products	From trees: timber (plywood, pallets, wooden fruit boxes), bioenergy; From undercover: crops, fodder.			
Economic interests	Traditionally poplar plantations have produced 50% of the domestic timber production in Italy, with a declining trend because of the imports competition. Forest certification and local bioenergy production could reverse the negative trend. Furthermore, new grants (from Rural Development Plans) for farmers establishing new silvoarable systems could be a new opportunity for implementing poplar based agroforestry.			
Other services	Soil and Water protection, Carbon sequestration, Biodiversity, Phytoremediation.			
Experimental sites for the project? Where?	Farm "La Casaria" – Masi (Padova), Italy			
Photographs	https://www.flickr.com/photos/agforward/15688904930/ https://www.flickr.com/photos/agforward/15690432297/ https://www.flickr.com/photos/agforward/15690432297/			
AF System contact	**Name**	Cristina Dalla Valle Pierluigi Paris	**Email**	cristina.dallavalle@venetoagricoltura.org piero.paris@ibaf.cnr.it
References (5 to 10)	Paris P., Mareschi L., Ecosse A., Pisanelli A., Sabatti M., Scarascia Mugnozza G., 2011. Comparing Hybrid Populus Clones For SRF Across Northern Italy After Two Biennial Rotations: Survival, Growth And Yield. Biomass and Bioenergy, 35:1524-1532. Doi: 10.1016/j.biombioe.2010.12.050. M. Sabatti, F. Fabbrini, A. Harfouche, I. Beritognolo, L. Mareschi, M. Carlini, P. Paris, G. Scarascia-Mugnozza, 2014. Evaluation of biomass production potential and heating value of hybrid poplar genotypes in a short-rotation culture in Italy. Industrial Crops and Products, Products 61: 62–73. Doi: 10.1016/j.indcrop.2014.06.043. Paris P, Mareschi L, Sabatti M, Tosi L, Scarascia-Mugnozza G, 2014. Nitrogen removal and its determinants in hybrid Populus clones for bioenergy plantations after two biennial rotations in two temperate sites in northern Italy. iForest, Biogeosciences and Forestry (in press).			
Hipothetical Modeling combinations	**Hybrid poplar linear plantation + corn/wheat** Hybrid poplars silvoarable system+corn/wheat			
Other comments	The same poplar based agroforestry systems are possible in many other European countries. So far we do not know if similar factsheets have been prepared by other project partners. We do believe that poplar linear plantations are one of the most common form of agroforestry systems across Europe, and therefore their biophysical and economic modeling should be an important aim for the Agforward Project.			

Annex C. Source of data and contact for each agroforestry system

AF-ID	Stakeholder meeting	Fact Sheet	Contact	Email
201	X	X	Joana Amaral Paulo, João Palma, ISA, Portugal	joanaap@isa.ulisboa.pt joaopalma@isa.ulisboa.pt
202	X	X	Paul Burgess, CRAN, UK	p.burgess@cranfield.ac.uk
203	X		Gerardo Moreno, UNEX, Spain	gmoreno@unex.es
204	X	X	Anastasia Pantera, TEI, Greece	pantera@teiste.gr
205	X		Antonello Franca, CNR-ISPAAM, Italy	a.franca@cspm.ss.cnr.it
206	X	X	Jaconette Mirck and Penka Tsonkova, BTU, Germany	jmirck@tu-cottbus.de penka.tsonkova@tu-cottbus.de
207	X		Erik Valinger SLU-EFI, Sweden	erik.valinger@slu.se
208	X		Andrea Vityi and Anna Varga NYME, Hungary	vityi.andrea@emk.nyme.hu varga.anna@gmail.com
209	X		Tibor Hartel UBB, Romania	hartel.tibor@gmail.com
210	X		Claudine Thenail and Valérie Viaud, INRA- Rennes, France	Claudine.thenail@rennes.inra.fr Valerie.viaud@rennes.inra.fr
301		X	Jo Smith, ORC, UK.	jo.s@organicresearchcentre.com
302		X	Felix Herzog, Agroscope,CH,	felix.herzog@agroscope.admin.ch
303			INRA, FR	
304		X	Lydie Dufour, INRA, FR	dufourl@supagro.inra.fr
305	X	X	Paul Burgess, CRAN, UK.	p.burgess@cranfield.ac.uk
306	X		Adolfo Rosati CRA-OLI, IT.	adolfo.rosati@entecra.it
307	X	X	Anastasia Pantera, TEI, GR and Konstantinos Mantzanas, Aristotle Univ. of Thessaloniki, GR	pantera@teiste.gr konman@for.auth.gr
308	X		Gerardo Moreno, UNEX, SP	gmoreno@unex.es
309	X		Rosa Mosquera Losada, USC, SP	mrosa.mosquera.losada@usc.es
310	X		Anastasia Pantera, TEI, GR	pantera@teiste.gr
311	X	X	Anastasia Pantera, TEI, GR	pantera@teiste.gr
312	X		Nathalie Corroyer, INRA-Normandy, France	nathalie.corroyer@seine-maritime.chambagri.fr
313	X		Jim McAdam, AFBI, UK.	jim.mcadam@afbini.gov.uk
401	X	X	Felix Herzog, Agroscope, CH.	felix.herzog@agroscope.admin.ch
402		X	Felix Herzog, Agroscope, CH.	felix.herzog@agroscope.admin.ch
403	X	X	Jo Smith, ORC, UK.	jo.smith@orc.admor.uk
404	X	X	Marie Gosme, INRA, FR.	marie.gosme@supagro.inra.fr
405	X	X	Jaconette Mirck and Penka	jmirck@tu-cottbus.de

AF-ID	Stakeholder meeting	Fact Sheet	Contact	Email
			Tsonkova, BTU, DE.	penka.tsonkova@tu-cottbus.de
406	X	X	Pierluigi Paris CNR-IBAF, IT	piero.paris@ibaf.cnr.it
407	X	X	Anastasia Pantera, TEI, GR.	pantera@teiste.gr
408	X		Andrea Vityi and Anna Varga NYME, HU.	vityi.andrea@emk.nyme.hu varga.anna@gmail.com
409	X	X	Rosa Mosquera Losada, USC, SP	mrosa.mosquera.losada@usc.es
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