Milestone 5.2 (MS21)
Agroforestry Innovations to be evaluated for Livestock Farmers

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Work-package group 5: Agroforestry for Livestock Farmers
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1. Context

The AGFORWARD research project (January 2014 to December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has 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.

Further details of the project can be found on the AGFORWARD website: www.agforward.eu

The focus of objective 2 is divided across four types of agroforestry systems including agroforestry of high cultural and natural value, agroforestry with high value trees, agroforestry for arable systems, and agroforestry for livestock systems. The latter group forms work-package 5 of the project. During 2014, nine initial stakeholder groups were established across Europe to determine the opportunities, constraints and potential innovations that could help promote the use of agroforestry by livestock farmers (Table 1). The reports describing the initial stakeholder meetings are listed in the reference list. This report describes the potential innovations identified by the groups in work-package 5.

Table 1. The livestock type, acronym and organisation name, dates and number of stakeholders for the stakeholder meetings focused on agroforestry for livestock farmers in 2014.

Livestock	Acronym	Organization and country	Dates of workshop	Number of stakeholders
Pigs	USC	University of Santiago de Compostela, Spain	27 Aug 2014	24
	Ven	Veneto Agricoltura, Italy	30 Sept 2014	22
	AU	Aarhus Universitet, Denmark	30 June and 4 July 2014	2
Poultry	ORC	Organic Research Centre, UK	6 May and 10 June 2014	38
	LBI	Louis Bolk Institute, Netherlands	9 July and 18 Sept 2014	14
	AU	Aarhus Universitet, Denmark	18 Sept 2014	5
Ruminants	IDELE/ INRA	L'Institut de L'Elevage and Institut National de la Recherche Agronomique, France	1 July and 28 Aug 2014	27
	LBI	Louis Bolk Institute, Netherlands	11 Sept 2014	4
	AFBI	AgriFood and Biosciences Institute, UK	3 Dec 2014[a]	9

Note: [a]: initial report also reported under work-package 3

2. Innovations to be tested and developed

A list of challenges and innovations was proposed by the different stakeholder groups on the basis of the workshops. An overview of questions and proposed innovations form the stakeholder workshops are summarized in Appendix A. From the stakeholder meetings it was possible to identify some general and some system specific innovations.

2.1. General innovations

The three general observations were:

- A key message is that, for many regions, 'we' know far too little about how in practice to establish a profitable (economic and other advantages for the farmer) agroforestry systems with livestock. This includes the type and distribution of trees appropriate for different livestock species. So, establishment of an agroforestry system is an innovation in itself. Therefore, many partners agree that there is a need to develop a decision support tool that reflects the contrasting conditions in different regions. For this we could use the data, information, and experiences gathered at the farms and research plots of whatever they have done and combine this with theoretical knowledge. We suggest this to be a common effort among partners.
- Another overarching challenge is to get better estimates of the timing and the quantities of nutrients that woody vegetation may contribute to animals, and how this can be modified by tree management practices such as pollarding, cutting or grazing periods. This has huge impact on the practical planning of feeding and thus resource use. In the Netherlands, there is a table of feeding values from a number of feeds from woody vegetation. There is a need to develop this further as a common effort among partners and to include the possible contributions of feed items found in the range including planted species such as berry bushes and herb mixes.
- Marketing, regulations and policies, as well as documentation of environmental impact are also very important aspects in livestock-based agroforestry systems, and this should be acknowledged in the project as a whole.

2.1. Specific tests suggested

In addition to the above cross-cutting areas, specific tests were suggested within the individual stakeholder groups focussed on particular types of livestock in specific countries:

Pig systems

- *Denmark*: introduction of other woody types of vegetation, other than poplar, in paddocks for sows. To determine the impact on appearance, animal nutrition, and animal behaviour, and the impact on nitrogen leaching from different trees and tree densities,
- *Spain*: inclusion of mulberry *(Morus alba or Morus nigra)* as a feed source in Celtic pig systems and evaluate the nutritive value across a temperature and rainfall gradient, and
- *Italy:* methods to protect newly established trees from pig damage.

Poultry systems

- *UK:* a) Methods such as corridors so that hens will use the range more effectively and/or labour saving methods for weed control in newly established trees. b) Selection of a shade-tolerant understory mix that could also contribute towards the nutrition and health of the birds.
- *Netherlands:* choice of trees at poultry farms, facilitating partnerships between tree people and poultry farmers. Modelling of costs and benefits (economic and other advantages) of different types of plantations.
- *Denmark:* methods (corridors) to have hens to use the range more effectively in fruit orchards.

Ruminant systems

- *France:* methods to protect trees from damage by livestock, spatial organization of trees or shrubs to optimize both woody and herbaceous forage production and animal welfare, nutritional value of woody forage, and methods to simplify and limit the supplementary work induced by the presence of trees.
- *UK:* value of tree fodder versus protecting trees from damage; suitable species for silvopastoral systems (especially alternatives to *Fraxinus*).
- *Netherlands:* mechanization of harvest of fodder trees, protection of fodder trees against livestock, nutritional value of trees, optimize nature management by goats, modelling of costs and benefits, and optimizing system design.

3. Specific areas of research, data collection, and demonstration activity

This section describes the planned specific areas of research, information and data collection, and demonstration activities within work-package 5, which will be developed in the coming months. They cover closing the knowledge gap (Table 2), planned experiments (Table 3), and other trials and demonstration activities (Table 4).

Table 2. Activities to close the knowledge gap on agroforestry for livestock systems.

Activity	**Details**	**Partners involved (Lead in bold)**
1. Synthesising existing knowledge of best practise – revisiting previous results including non-published data and experience form the established network to judge *best practice* in relation to tree species, tree density, spatial organization, pruning, animal density and design of the system etc. and how this influences animal welfare, productivity, nutrient leaching etc.	A report will be established for a) Ruminant systems b) Poultry systems, and c) Pig systems	 **INRA,** IDELE, AFBI, ORC, LBI **ORC,** LBI, AU **AU,** USC, VEN
2. Systematizing information on nutritive value of woody vegetation for livestock	Establishing a 'feed table' relevant for the different animal species with the necessary documentation of sampling	**LBI,** all partners

Table 3. Planned experiments

Experimental activity	Details	Partners involved
1.Nutritive value of woody vegetation for livestock	A: Inclusion of mulberry (*Morus alba* or *Morus nigra*) as a feed source in Celtic **pig** systems (nutritive value evaluation across a temperature/rainfall gradient for different varieties)	**USC**
	B: Nutritive value evaluation of various forage trees in **dairy cow** systems in relation with season (leaves from summer and autumn)	**INRA**
2. Environmental impact - pigs	Nitrate leaching in a combined production system of energy crops and free range **pigs** – effect of distance from willow rows (suction cups will be installed at various distances from willow rows)	**AU**
3. Shade tolerant sward **relevant** for poultry	Comparative experiment with different sward in agroforestry and pasture	**ORC**
4. Productivity of silvopasture with wood and no-trees grazing for sheep	This will be finalizing and interpreting two already established experiments, including assessment of forage production and impact on sheep health and welfare	**AFBI,** IDELE

Table 4. Other trials and demonstration activities (continued overleaf)

Trial/demonstration activity	Details	Partners involved
1. Nutritive value of woody vegetation for livestock	Livestock (heifers) preferences for leaves etc. from different tree species (on-farm trials) and analyses of leaf material	**ORC,**LBI
2. Protection of newly established trees	A: testing different methods to protect recently implemented trees from damage by livestock (**ruminants**)	**INRA,** ACTA, LBI
	B: development and testing different methods to protect newly established trees from pig damages will • using different type of shelters, considering resistance, material, labor and management costs for the first 3 years, (trees: willow, poplars, black locust, in high density rate) • animal-tree interactions and animal behavior and welfare recorded for sows, piglets and growing-fattening heavy pigs.	**VEN,** AU, (USC protocol for assessment)
3. Spatial organization of trees, dairy cows	Testing different spatial organization of trees and shrubs in a plot grazed by dairy cows, in order to optimize both woody and herbaceous forage production and animal welfare, while limiting the workload.	**INRA**
5. Tree varieties for sheep	Plots of different clones of cherry and sycamore (looking at all aspects from planting, protection, grassland management and tree care)	**AFBI**
6. System design for poultry	Comparison of tree plantations for poultry, modelling costs and benefits and investigating possibilities for partnerships between tree people and poultry farmers.	**LBI**
7. System design for ruminants (goats)	Optimize system design of fodder trees, including harvest mechanization, frequency of harvesting and modelling costs and benefits of trees.	**LBI**

4. Acknowledgements

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Appendix A. Questions raised, concerns and/or proposed innovations by different stakeholder groups

Table A.1 Questions related to the design of systems and policies, regulations and subsidies

	Animal	Challenges/innovations
Design of systems		
NL	*Poultry*	Choice of tree breeds with respect to vulnerability to diseases.
NL	*Poultry*	Which fruit species are suitable for the chicken range area in relation to manure and digging the roots by the chicken?
NL	*Poultry*	Which species/breeds of fruit trees are suitable in chicken run, concerning diseases and labour?
NL	*Poultry*	Identifying smart combinations of trees and poultry
NL	*Ruminants*	System design: How many trees do you need to optimize the mineral uptake by dairy cows, and to maximise yields of trees and pasture?
UK	*Poultry*	The design and management surrounding the chicken houses to encourage birds to range further away from the houses.
UK	*Poultry*	Suitable species selection (and medicinal qualities) of cover plants were mentioned
UK	*Poultry*	The distance from the henhouse to the trees is usually about 10 m, but that might be too far for the birds. Corridors with higher grasses, rapeseed, mustards etc. Establishment of higher grasses and legumes outside the shed to encourage birds to use the range.
UK	*Poultry*	Choice of suitable species for range cover: trees, shrubs, bushes etc.
DK	*Pigs*	Trial tests of 'funny/exciting' wood species with nutritional value for the pigs and which are possibly to grow in between energy crops
DK	*Monogastrics*	Lack of knowledge: suitable plant varieties, technology, description of best practice, technical data
DK	*Pigs*	Description of 'best practice', technical data from the farms as bench-marking, 'from bare soil to an agroforestry system' (system-design)
DK	*Pigs*	Identification/test of different trees/shrubs varieties suitable for pigs (fast-growing, resistant, nutritional value)
FR	*Ruminants*	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)?
FR	*Ruminants*	Need for advice on the practical implementation of these new systems
FR	*Ruminants*	Need for the development of technical references
IT	*Pigs*	Which species to plant
IT	*Pigs*	Use of fast growing species such as willow or poplar
ES	*Pigs*	Introduction of new crops on farms (Mulberry)
Policies, regulations and subsidies		
NL	*Poultry*	Importance of long-lasting regulation. Trees grow slowly. After you have planted them under a certain regulation, it would be desirable if the regulations stay the same.
NL	*Poultry*	Regulation clearer or at least less negative on trees
NL	*Poultry*	Subsidy for networks
NL	*Poultry*	Sustainable policy
NL	*Poultry*	Subsidies that last over 6 years
DK	*Monogastrics*	Legislation/subsidy rules
ES	*Pigs*	Lack of financial support
ES	*Pigs*	Land consolidation
ES	*Pigs*	Control by the Government of products from Celtic Pigs (need of certification or label for meet produces similar to the Iberian breed)
UK	*Poultry*	Planting trees compromises land values and impacts future use of land for production

Table A.2 Questions related to production and management.

	Animal	Challenges/innovations
Production/management		
NL	*Poultry*	Can trees contribute to mineral uptake?
NL	*Poultry*	Can fruit trees contribute to health and productivity of own bees?
NL	*Poultry*	How much labour is needed per tree species/plantation type?
NL	*Poultry*	Effects of trees on mortality caused by birds of prey
NL	*Poultry*	Promotion of trees in poultry free range areas
NL	*Poultry*	Management of the trees
NL	*Poultry*	Weed control in Miscanthus
NL	*Ruminants*	Protection of browsing trees from goats: It is difficult to manage goat browsing on fodder trees as the goats are so fond of trees that they are liable to destroy them. How can we design a good browsing area for goats on a farm?
NL	*Ruminants*	Fodder trees for dairy cows: Which trees do dairy cows prefer as a fodder? How much would they eat from the trees?
UK	*Poultry*	The development of shade-tolerant sward mixtures that can persist under the trees and may have medicinal benefits for birds
UK	*Poultry*	techniques for reseeding bare areas
UK	*Poultry*	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.
UK	*Poultry*	Tree protection
UK	*Poultry*	Weed control
UK	*Poultry*	Trees reduced light and ventilation
UK	*Poultry*	Difficulties in getting birds in at night
UK	*Poultry*	Trees blocked drains
DK	*Poultry*	Use of straw around trees to control weed and increase the amount of worms and insects which are available for foraging poultry.
DK	*Monogastrics*	The nutritional value of fruits and nuts from the trees and bushes for monogastrics.
DK	*Pigs*	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)
DK	*Monogastrics*	Labour intensive system
DK	*Monogastrics*	Effect on animal behavior/welfare [pEco]
DK	*Monogastrics*	The nutritional value of fruits and nuts from trees and bushes for pigs and poultry
DK	*Monogastrics*	Description and data from 'all' AF systems in DK – pigs and poultry
DK	*Pigs*	Pigs in poplar:+/- sow access to trees - effects on animal behaviour, effects on N leaching
FR	*Ruminants*	Which methods are to be used for easily and efficiently protecting recently implemented trees against livestock grazing on patches ?
FR	*Ruminants*	What are the nutritional (and medicinal) value of trees and shrubs? What place can ligneous forages take in the diet of cows?
IT	*Pigs*	Tree protection from pigs
ES	*Pigs*	Lack of raw materials for animal feed: Nutritional quality of most common native plants in forestry lands - high fiber content
ES	*Pigs*	A high interest in knowing the potential of native shrubby, herbaceous and tree species as nutritional resources for Celtic Pig

Table A.3. Questions related to the environment and socio-economic issues

	Animal	Challenges/innovations
Environment		
NL	*Poultry*	Biodiversity benefits
NL	*Poultry*	How much C is fixed and how to maximise this
NL	*Ruminants*	Business opportunities for management of natural areas by dairy goats:
DK	*Monogastrics*	Quantification of effect on climate/environment [pEco]
ES	*Pigs*	Fire risk and soil erosion
Socio-economics		
NL	*Poultry*	Look for profitable combinations
NL	*Poultry*	Trust in entrepreneurs
NL	*Poultry*	Costs and benefits
NL	*Poultry*	Alternative business models - partnerships between 'tree' people and poultry farmers
DK	*Monogastrics*	Development of marketing concepts
IT	*Pigs*	Meat quality from agroforestry
IT	*Pigs*	Consumers perception of meat from AF systems
ES	*Pigs*	Low profitability in the farms established with Celtic Pig
ES	*Pigs*	Difficulty in establishing farms due to the lack of available land
ES	*Pigs*	Abandonment of rural areas by young people
ES	*Pigs*	Return of young people to rural areas
ES	*Pigs*	Dissemination of research through practical trials
NL	*Ruminants*	How do I economically profit from trees?
NL	*Poultry*	What are the profitable possibilities of marketing agroforestry fruit?
FR	*Ruminants*	Need for the development of economic references