



**Milestone 4.2 (MS15)**  
**Agroforestry Innovations to be evaluated for Arable Farmers**

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## 1. Context

The AGFORWARD research project (January 2014-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.

Full details of the project can be found on the project website: [www.agforward.eu](http://www.agforward.eu)

This report contributes to the second objective. It compiles the main results produced by the ten stakeholders groups created in AGFORWARD to promote agroforestry for arable farmers in work-package 4. Stakeholders groups held their respective national meetings in the period May to November 2014 to identify the main challenges faced by each actual or potential agroforestry system. The stakeholder groups also proposed potential innovations that could be examined during the project. This report, created during December 2014 and January 2015 identifies the agroforestry innovations suitable for arable systems, that will form the focus of activity during the rest of the project.

## 2. Initial stakeholder meetings

This Participative Research and Development Network (PRDN) focuses on agroforestry for arable farmers. The five objectives for the work-package are:

- i. to identify examples of the best practices, key challenges and innovations to address challenges identified by the stakeholder groups within the PRDN,
- ii. to describe and explain the key inputs, outputs & ecosystem services flows for case studies (in associated with work-package 6),
- iii. to agree within the PRDN, the key innovations or improvements in quantification in order to promote adoption of high value tree systems,
- iv. to agree and implement within the PRDN an experimental protocol to develop and test proposed innovation at existing experimental facilities and through on-farm experiments, and,
- v. to provide and promote guidelines for farmers how to establish economically viable agroforestry practices in arable systems.

Each stakeholder group held a workshop to identify the key innovations to be tested through participatory on-farm research. The groups included farmers, breeders, foresters, landowners, representatives of regional and national associations, agricultural services companies, extension services, NGOs, local action groups, policy makers and scientists.

There are ten groups solely within the agroforestry for arable farmers group (Figure 1), and a stakeholder group organized by the University of Extremadura (Moreno, 2014) also includes a strong

silvoarable component (Table 1). Each group has produced an initial report (see reference list). These eleven reports provide the basis for this analysis.



Figure 1. Silvoarable systems across Europe; in A) Spain, B) Italy, C) Western France, D) UK, E) Switzerland, F) Southern France, G) Greece, H) Western France, I) Germany and J) Hungary

Table 1. Acronym and organisation name, dates and number of stakeholders for the eleven stakeholder meetings that were held as part of the agroforestry for arable farmers participative research and development network.

Acronym and country	Organization	Main contact	Date workshop	Number of stakeholders
USC Spain	University of Santiago de Compostela	Rosa Mosquera Losada and Nuria Ferreiro Domínguez	21/10/2014	14
TEI Greece	Technologiko Ekpedeftiko Idrima Stereas Elladas	Anastasia Pantera and Kostas Mantzanas	11/7/2014	14
INRA France	Institut National de la Recherche Agronomique	Christian Dupraz and Marie Gosme	2/10/2014	11
ORC UK	Organic Research Centre	Jo Smith	18/11/2014	12
BTU Germany	Brandenburgische Technische Universität Cottbus-Senftenberg	Jaconette Mirck	28/08/2014	18
UEx Spain	Universidad de Extremadura	Gerardo Moreno	30/05/2014	20
EVD Switzerland	Eidgenössisches Departement Für Wirtschaft, Bildung and Forschung	Felix Herzog and Mareike Jäger	25/05/2014	22
CNR/VEN Italy	Consiglio Nazionale delle Ricerche/Veneto Agricoltura	Pierluigi Paris and Cristina Dalla Valle	24/06/2014	6
NyME Hungary	Cooperation Research Centre for Environmental Resources Management and Protection (Nyugat-Magyarországi Egyetem Kooperációs Kutatási )	Andrea Vityi	29/08/2014	ca.30
APCA-CH France	Assemblée Permanente des Chambres d'Agriculture, Charentes	Yousri Hannachi and Eric Cirou	30/06/2014	87
APCA-PI France	Assemblée Permanente des Chambres d'Agriculture, Picardy	Regis Wartelle	15/09/2014	15

### **3. Input to innovations to be tested**

The stakeholder workshops in work-package 4 resulted in a list of challenges and innovations proposed by the different partners of AGFORWARD. They are listed in terms of the issues affecting design (Table 2), management, and regulation and policies (Table 3), and socio-economic and environmental impacts (Table 4).

From the stakeholder meetings we concluded the following:

#### **3.1. Design**

For many regions we know far too little about how to establish a profitable agroforestry system for arable farmers. Knowledge gaps exist for key design components such as crop tree combinations, spacing, crop tree competition, shade tolerant crops and harvesting. Therefore the establishment of an agroforestry system itself can be considered an innovation. A decision support tool that reflects the conditions of the different regions will be of great use to farmers.

#### **3.2. Management: tree protection**

Another common challenge is the protection of trees against wildlife and domestic animals. The damage or loss of trees due to wildlife is especially of importance during the establishment period. Adequate tree protection methods should be developed.

#### **3.3. Management: weed and disease management**

A third overarching challenge is weed and disease management and how the trees affect the presence of weeds and disease. One innovative weed management method is the use of aromatic plants. The effect of trees on the presence of crop diseases needs to be assessed. Common weed and disease management methods need to be developed.

#### **3.4. Regulation and policies**

A fourth challenge mentioned by multiple partners is the administrative burden and the lack of long-term funding for agroforestry system establishment. An online portal or information sessions through farmers unions may simplify the grant application process. This can be reached through improved lobbying in Brussels.

#### **3.5. Socio-economic and environmental effects**

A fifth issue is the willingness of people wanting to pay a premium price for agroforestry products can be improved through marketing.

Table 2. Design challenges and Innovations distilled from the stakeholder meeting reports.

		USC	TEI	INRA	ORC	BTU	UEX	EVD	CNR/VEN	NymE	APCA-CH	APCA-PI	Suggested Innovation
Design	How to breed agroforestry-adapted crops?			x	x								Breed for shade tolerant or agroforestry adapted crops
	What are the best tree-crop combinations and what are their interactions?	x	x	x		x	x	x			x	x	Assess physiological behavior, root competition of cereals with trees
	What is best spatial design that minimizes competition for light and nutrients?		x	x		x	x	x			x	x	Optimize alley width, tree line orientation and use cultivar diversification, shade tolerant varieties close to trees.
	Need to see agroforestry	x										x	Develop show case farms
	How to design efficient agroforestry systems? How can harvest of crops and trees be synchronized?							x					Reconsider crop and tree species to synchronize harvest
	How can new crops serve a purpose in agroforestry systems?	x	x		x								Study how new crop species (aromatic plants, cut flowers, berries) can improve product diversity
	How can trees species choice be improved?		x		x				x				Study how multiple tree species can improve product diversity
	Can soil depth be a limiting factor?		x	x									Compare establishment on deep/shallow soils

Table 3. Management and regulation and policy challenges and Innovations distilled from the stakeholder meeting reports.

		USC	TEI	INRA	ORC	BTU	UEX	EVD	CNR/VEN	N/M/E	APCA-CH	APCA-PI	Suggested Innovation
Management	How do agroforestry systems influence crop disease? How can their influence be prevented?			x					x	x			Assess how crop and tree interaction changes the presence of diseases.
	How can crop and tree products (fruits/nuts) harvest be synchronized?							x					Establish efficient harvest methods for agroforestry systems
	How can agroforestry systems best be managed and mechanized (e.g. pruning, harvesting times/cycles)?							x	x			x	Establish methods to improve management efficiencies of agroforestry systems
	How can nitrogen fixing trees influence crops?				x								Assess the potentials of nitrogen fixing trees
	How can trees in agroforestry systems best be protected against domestic animals and wildlife?	x		x				x		x	x	x	Design cost effective wildlife protection system using either natural or artificial products
	How can old agroforestry systems best be renewed?		x		x								Establish methods for renewal at end of life
	How do agroforestry systems affect the presence of weeds? What innovative weed management methods can be developed?		x	x	x			x		x	x	x	Use natural sources or plants (aromatic plants) to protect against weeds and function as pollinator resource
	How can the application of chemicals best be managed in agroforestry systems?	x						x					Study legal constraints regarding use of chemicals
Regulation and policies	How can the administrative burden/bureaucracy be reduced?	x				x	x		x	x	x	x	Simplification of grant process for establishment of agroforestry
	How can CAP reforms result in clear and long-term funding for agroforestry? How can regulators and technicians be educated about agroforestry?		x		x	x	x			x	x	x	Improve agroforestry lobby in Brussels and member states

Table 4. Management and regulation and policy challenges and Innovations distilled from the stakeholder meeting reports.

		USC	TEI	INRA	ORC	BTU	UEX	EVD	CNR/VEN	NYMIE	APCA-CH	APCA-PI	Suggested Innovation
Socio-economic	How can information about agroforestry systems be more accessible?		x		x					x	x		Establish an online portal for agroforestry and establish reference farms that can be visited
	Are people willing to pay more for agroforestry products?			x	x	x	x						Improve marketing and branding of agroforestry products (e.g. woodland eggs)
	Can business opportunities be created through participatory breeding?			x									Involve agrofood industry stakeholders from the onset of the project
	How can long-term investments/funding be guaranteed?					x	x					x	Conduct a cost benefit analysis
	How can land tenure become more flexible to allow agroforestry establishment?		x		x	x						x	Educate landowners of agroforestry benefits and increase flexibility of land tenure
	How can we improve knowledge and value of agroforestry products?		x	x				x	x				Evaluate timber quality in agroforestry systems and the value of wood thinnings
	How do neighboring farmers influence the establishment of agroforestry? What role do technicians play?					x					x	x	Assess impact of social aspects and technicians on agroforestry system establishment rates
	How do trees influence crop yields?				x	x	x						Compare using Land Equivalency Ratio
Environmental impacts	What are the biodiversity benefits?	x	x		x								Assess biodiversity of agroforestry systems and how this can be maximized
	How much carbon is fixed and how to maximize this?	x			x			x					Assess carbon sequestration potential over agroforestry systems life span
	Can trees protect the crops from heat exhaustion?		(x)	x									Use models and experiments to predict heat protection potential
	Can trees reduce soil erosion and improve soil health?					x	x						Assess effect of agroforestry on soil health and micro-climate
	Can trees improve water regulation?			x		x							Use agroforestry to increase water use and irrigation efficiency

#### 4. Specific innovations suggested

The facilitating organisations for the various stakeholder groups have identified the following innovations under the headings of 1) design, 2) management and protection, 3) regulation and policies, 4) socio-economics, and 4) environmental impacts.

##### Design

All	Fill knowledge gaps regarding key design criteria (see Section 3.1)
INRA, ORC, UEx:	Breeding for shade tolerant or agroforestry adapted crops
EVD:	Reconsider crop and tree species (fruit trees) to synchronize harvest
INRA, TEI:	Assess role of soil depth
APCA-PI:	Need to show case agroforestry

##### Management and protection

All	Develop cost effective tree protection methods (see Section 3.2)
All	Use natural sources or plants to protect against weeds (See Section 3.3)
INRA, CNR/VEN, APCA-PI	Assess how crop and tree interaction changes disease occurrence (See Section 3.3)
ORC	Assess the potentials of nitrogen fixing trees
TEI, ORC	Establish methods for renewal at end of life

##### Regulation and policies

All	Simplify grant process for establishment of agroforestry (Section 3.4)
All	Improve agroforestry lobby in Brussels (See Section 3.4)

##### Socio-economics

INRA, ORC, BTU, UEx	Improve marketing and branding of agroforestry products (Section 3.5)
ORC, APCA, NyME	Improve accessibility of information through online portal and reference sites
INRA	Business opportunities can be created through the involvement of agrofood stakeholders from the beginning of breeding projects for agroforestry adapted crops
BTU, UEx, APCA-PI	Conduct a cost benefit analysis to assess viability of agroforestry systems
TEI, ORC, BTU, APCA	Educate landowners about agroforestry benefits resulting in improved flexibility of land tenure
TEI, INRA, UEx, CNR/VEN	Assess product quality and product diversification
TEI, ORC, APCA	Assess influence of neighboring farmers and technicians on agroforestry system establishment
TEI, ORC, BTU, UEx	Compare yields of conventional and agroforestry systems through the use of land equivalent ratio

##### Environmental impacts

USC, TEI, ORC	Assess how biodiversity of agrosystems can be maximized
USC, ORC, EVD	Assess carbon sequestration potential
INRA, NyME	Use models and experiments to predict heat protection potential
USC, BTU, UEx	Assess whether agroforestry systems affect soil health
INRA, BTU, NyME:	Assess water use efficiencies
UEx:	Assess the benefits of agroforestry to produce food under current climate change (warming and early high temperatures)

## **5. Specific areas of research**

The five broad areas of research are focused on i) design and competition, ii) tree protection, iii) mechanization, iv) weed and disease management, v) marketing.

### **5.1. Design**

Studies are proposed to develop standard design criteria that minimize crop tree competition for agroforestry systems. The objectives are:

- 1) Identify best tree crop combinations for agroforestry in different regions of Europe. This will include the assessment of new crop species (e.g. aromatic plants, cut flowers, berries) to improve product diversity.
- 2) Assess competition between crops and trees for light, water and nutrients at different spatial designs.
- 3) Develop shade tolerant crops/ agroforestry adapted crops and their flower fertility through breeding.

### **5.2. Management - tree protection**

Studies are proposed to develop methods to protect trees within agroforestry systems from wildlife and domestic animals. The objectives are:

- 1) Design cost effective wildlife and domestic animal protection systems using natural and/or artificial products.

### **5.3. Management - weed and disease management**

Studies are proposed to develop innovative methods for weed and disease management within agroforestry systems. The objectives are:

- 1) Assess the potentials of natural sources or plants (aromatic plants) to combat weeds within agroforestry systems and in the case of plants assess how they can serve pollinators. In addition, assess whether the use of herbicides can be reduced as a result of firstly using agroforestry systems and secondly using natural sources to combat weeds.
- 2) Assess how crop tree interactions change the occurrence of diseases and develop methods that prevent the increased presence of diseases.

### **5.4. Management and socio-economic - Mechanization**

Studies are proposed to improve the mechanization of management and production in agroforestry systems. The objectives are:

- 1) Establish methods to improve management and production efficiencies through mechanization, and assess how this affects the overall profitability of the system.

### **5.5. Socio-economic and environmental impacts - Marketing**

Studies are proposed to improve our understanding of consumer behavior in regards to agroforestry products. The objectives are:

- 1) Identify agroforestry products from silvoarable systems and their potential markets.
- 2) Assess the willingness of people to pay a premium price for agroforestry products.
- 3) Identify marketing strategies for agroforestry products.

## 6. Acknowledgements

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