Milestone 3.2 (MS9)
Report on Innovations to be examined for Agroforestry for High Value Tree Systems

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Work-package group 3: Agroforestry for High Value Tree Systems
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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

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 systems which involve high value trees in work-package 3. Stakeholders groups held their respective national meetings in the period May-November 2014 to identify the main challenges faced by each actual or potential agroforestry system. The stakeholder groups also proposed some potential innovations that could be examined.

This report, created during December 2014 and January 2015, attempts to identify the principal agroforestry innovations that can be applied to agroforestry systems with high value trees. Although ecological and socioeconomical contexts vary among sites, the systems share some common challenges. This report describes these challenges and identifies areas for research under the headings of production, management, the environment, and socio-economic issues.

2. Initial stakeholder meetings

This Participative Research and Development Network (PRDN) focuses on agroforestry for high value tree systems including fruit trees (e.g. olive, walnut, chestnut, apple, orange), and trees grown for high value timber (e.g. walnut and wild cherry). This network is focused on work-package 3 of the AGFORWARD project.

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 and ecosystem services flows for case studies (association with work-package 6),
iii. to agree within the PRDN, the key innovations or improvements in knowledge needed 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 innovations at existing experimental plots and through on-farm experiments, and;
v. to provide and promote guidelines for farmers on how to establish economically viable agroforestry practice in high value tree systems.

The research groups that participated in this work-package have already fulfilled the ***first task***, as described in the original proposal, and have established the PDRN comprising stakeholder working groups and held their first meetings (Table 1).

Table 1. References for the ten stakeholder reports on agroforestry for high value trees

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. Avaiable 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

Each group held a workshop, in the national language, with key stakeholders to identify the key innovations to be tested through participatory on-farm research. A total of ten stakeholder groups with an interest in high value tree systems were created across Europe in 2014. There remains a possibility that additional stakeholder groups may still be formed in both Switzerland and in France.

Each meeting identified prominent issues and challenges, examples of best practice, stakeholder-led innovations, and producers willing to participate in future research. Some of the participants also completed questionnaires to rank the key positive and negative aspects of the agroforestry systems. A report (Table 1) was prepared by each partner based on both open discussion and the results of the questionnaires, and they were used to inform this report. The characteristics of the stakeholder groups is summarised in Table 2.

Table 2. Characteristics of the ten stakeholder groups and their initial meeting

Country	Scientific Partner	System	Date of Meeting	Location of Meeting	Number of stakeholders	Reported by (and contact)
UK	CRAN	Grazed orchard in England and Wales	9 June 2014	Monkhide, Ledbury, Herefordshire, England, UK	14	Matthew Upson and Paul J. Burgess Contact: m.a.upson@cranfield.ac.uk
UK	AFBI	Grazed orchard in Northern Ireland	3 Dec 2014	Loughgall, Co. Armagh, Northern Ireland, UK	9	Jim McAdam, AFBI Contact: jim.mcadam@afbini.gov.uk
France	APCA	Grazed orchards	31 July 2014	Saint Michel d'Halescourt, Seine-Maritime, France	25	Nathalie Corroyer Contact: nathalie.corroyer@normandie.chambagri.fr
Greece	TEI	Intercropping of olive groves, Molos	25 June 2014	Molos, Fthiotida, in Central Greece	18	Anastasia Pantera Contact: pantera@teiste.gr
Greece	TEI	Intercropping of olive groves, Kassandreia	27 June 2014	Chalkidiki in Northern Greece	14	Anastasia Pantera Contact: pantera@teiste.gr
Italy	CRA	Intercropping and grazing of olive orchards	27 June 2014	Spoleto, Perugia, Italy	21	Adolfo Rosati Contact: adolfo.rosati@entecra.it
Spain	UEX	Grazing and intercropping of plantation trees	30 May 2014	University of Extremadura, Plasencia, Spain	27	Gerardo Moreno Contact: gmoreno@unex.es
Greece	TEI	Intercropping of walnut trees	29 May 2014	Klafsi, Eurytania, Central Greece	19	Anastasia Pantera Contact: pantera@teiste.gr
Spain	USC	Chestnut agroforestry in Galicia	25 Aug 2014	Estación Científica do Courel, Seoane, Lugo, Galicia	26	Rosa Mosquera-Losada Contact: mrosa.mosquera.losada@usc.es
Greece	TEI	Intercropping of orange groves	2 and 4 Aug 2014	Chania, Crete, Greece	5	Anastasia Pantera Contact: pantera@teiste.gr

3. Synthesising the key positive and negative aspects of agroforestry

As shown in Table 3, most of the people who completed the surveys in the stakeholder groups included people classified according to the age groups of 20-35, 35-50, and 50-65 years. The good representation of people aged 20-35 suggests that agroforestry is of interest to people who will be active in land management over the coming half-century.

Table 3. Age range of the participants completed the surveys in each stakeholders meeting.

Age group	AFBI	APCA	CRA-OLI	CRAN	TEI olives C. Greece	TEI olives N. Greece	TEI walnuts	UEX	USC	%
Under 20										**0**
20-35		13	2	4	2	2		7	7	**31**
35-50	3	6	7	1	1	4	8	6	5	**33**
50-65	1	2	3	5	4	3	3	7	8	**29**
Over 65			2	1		1	1		2	**7**

The results from the stakeholder surveys were used to identify the positive aspects of agroforestry with high value trees under five broad categories: production, management, the environment, socio-economic effects, and other (Table 4). The values presented are only intended to provide a relative indication of the importance of a range of issues, with the last column providing a weighted ranking. For example, animal health was identified as the key positive productive aspect (Table 4), and tree regeneration was important from a management point of view. In terms of the environmental and socio-economic effects, soil and income diversity were considered to be important respectively.

Likewise it was possible to categorise the key negative issues perceived by partners regarding agroforestry. From Table 5 it can be seen that losses by predation was a major issue from a production point of view. Complexity of work was seen as a drawback for the management of these systems. The environmental effect “reduced groundwater recharge” was of concern to participants. Administrative burdens were considered to be a drawback from a management point of view.

Table 4. Categorization of the positive aspects of agroforestry (which were ranked overall in the top five or first by at least one stakeholder group) for High Value Tree Systems within four broad categories (1 is the most positive, 2 the next most positive and so on). Please note that these are qualitative values.

Positive aspects	**Aspect**	AFBI	APCA	CRA	CRAN	TEI olives	TEI olives	TEI oranges	TEI walnuts	UEX	USC	**Rank**
Some production effects	Animal health and welfare	1	1	1	3	1	5		4	1	3	**1**
	Wood/fruit/nut production		2			2	3	4	2	5	6	**2**
	Losses by predation		5			8	4				8	**3**
	Crop or pasture production	2	3	2	2	5	6			3	4	**4**
	Animal production		2		1	3	8		5	2	7	**5**
	Crop/pasture quality/food safety		4	4		4	7	1	3	4	5	**6**
	Timber/wood/fruit/nut quality	3	3			7	1	3	5	6	7	**7**
	Disease and weed control		4	5	4	6	2	2	6	8	1	**8**
	Diversity of products		4	3	5	9	9	1	1	7	2	**9**
Some management effects	Tree regeneration/survival		2			5	2	2	2	1	1	**1**
	Originality and interest		1	1	2	2	1	1	4	2	3	**2**
	Inspection of animals		4			1	7		1		8	**3**
	Project feasibility		3	3		4	3	3	5	4	2	**4**
	Complexity of work		4	2		6	5	3	3	3	4	**5**
	Management costs	1	4		1	3	4		4	7	6	**5**
Some environmental effects	Soil conservation			1	2	6	2	2	6	2	2	**1**
	Landscape aesthetics	2			2	4	4	4	2	1	5	**2**
	General environment	1	2	3	4	2	3	3	1	3	4	**3**
	Biodiversity and wildlife habitat	3	1	2	1	2	1	6	9	5	1	**4**
	Climate moderation					5	6	5	4	4	10	**5**
	Carbon sequestration				4	3	7	5	5	6	6	**6**
	Control of manure/noise/odour					1	9	7	11	7	8	**7**
	Runoff and flood control				3	10	5	1	7	8	9	**8**
Some socio-economic effects	Income diversity	3		2	3	1	5	1	4	5	3	**1**
	Rural employment		5				9	6	3	4	1	**2**
	Opportunity for hunting					4	2		11	2	13	**3**
	Farmer image	5	1	1	4	2	4	2	5	3	6	**4**
	Tourism		3			9	1		9	14	7	**5**
	Farmer/owner relationshir					7	10		5	11	12	**6**
	Local food supply		2		2		14	6	10	7	5	**7**
	Profit	1	4		3	3	13	3	8	9	4	**8**
	Regulation		5				3	11	1	15	14	**9**
	Business opportunities	4			1	10	6	4	15	8	2	**10**
Other effects	Conservation of total resources									1		**1**
	Reduced mowing time				1							**1**
	Dependence on external inputs									2		**2**
	Expected economic progress									3		**3**

Table 5. Categorization of the negative aspects of agroforestry (which were ranked overall in the top four or first by at least one stakeholder group) for High Value Tree Systems within four broad categories (1 is the most negative, 2 the next most negative and so on). Please note that these are qualitative values.

Negative aspects	**Aspect**	AFBI	APCA	CRA	CRAN	TEI olives	TEI olives	TEI oranges	TEI walnuts	UEX	USC	**Rank**
Some production effects	Losses by predation	1	1	1		1	1		1		2	**1**
	Crop/pasture quality/food safety		1						2	4	3	**2**
	Diversity of products								1	3	9	**3**
	Animal health and welfare		3						4	2	6	**4**
	Animal production		2						5	7	1	**4**
	Crop or pasture production		1						5	6	4	**5**
	Disease and weed control						2		6	1	7	**5**
	Wood/fruit/nut production				1		3		3	5	5	**6**
Some management effects	Complexity of work	1	1	1	1	2	2		5	2	1	**1**
	Mechanisation		4	2		4	3		4	1	2	**2**
	Labour	3	2		4	3	4		1	3	5	**3**
	Management costs		6	4	2	3	1		2	4	3	**3**
	Project feasibility		5				7		4	5	6	**4**
	Inspection of animals	2	2	3	3	2	5		7		4	**5**
Some environmental effects	Reduced groundwater recharge						2		2	3	5	**1**
	Runoff and flood control								3	4	7	**2**
	Change in fire risk						1		3	1	10	**3**
	Biodiversity and wildlife habitat								1	5	11	**4**
	Control of manure/noise/odour						6		2	7	2	**5**
	Water quality						7		4	2	4	**5**
	General environment		2						9	8	1	**6**
	Landscape aesthetics		1				6		7	8	3	**8**
Some socio-economic effects	Administrative burden	1	1	2	1		1		9	1	2	**1**
	Marketing premium						6		2	5	10	**2**
	Farmer/owner relationship						4		13	7	4	**3**
	Rural employment								11	10	7	**3**
	Business opportunities		4				8		3	4	11	**4**
	Farmer/hunter relationship		3			2	4		8	7	8	**5**
	Cash flow		6			3	5		1	3	15	**6**
	Opportunity for hunting					1	10		11	8	9	**9**
	Market risk	4	5	3			3		15	11	1	**10**
	Regulation	2	2	1		5	7		14	9	5	**12**
Other effects	Expected economic progress									1		**1**
	pasture quality/ food safety				1							**1**
	Dependence on external inputs									2		**2**
	Conservation of total resources									3		**3**
	Cost of fencing boundary	1			2							**3**

4. Challenges and potential innovations

Each stakeholder group identified the key challenges to the selected agroforestry systems. In this section, the challenges and potential innovations are considered under the titles of grazed orchards, olive agroforestry systems, agroforestry with walnuts, chestnut agroforestry systems, and agroforestry with citrus trees.

4.1. Grazed orchards

The grazed orchards included the systems in England and Wales (Cranfield), Northern Ireland (AFBI) and Seine Maritime in France (APCA/ACTA). The group at Cranfield University has already started an unreplicated trial of a grazed and an ungrazed orchard and is collecting data to allow the development of new parameters for the Yield-SAFE model for orchards.

4.1.1. Grazed orchards in England and Wales, UK

Initial idea: grazing sheep in orchards will reduce mowing costs and provide grazing for sheep

Positive aspects: the key positive aspects of orchard grazing included a reduction in management and labour costs related to grass cutting and the benefits for animal production.

Negative aspects/challenges: difficulties included integrating the timing of orchard spraying and the use of sheep, and the complexity of the system.

Innovations after the stakeholders meeting: 1) the use of Shropshire sheep for grazing orchards, as some authors consider that this breed are 'tree friendly', and can reduce mowing costs, 2) improved understanding on how grazing of lower leaves will affect apple production and 3) developing parameters for the YieldSAFE biophysical model for 'bush' orchard systems.

4.1.2. Grazed orchards in Northern Ireland, UK

Initial idea: an area of cider and dessert cultivars was established in 1998, and a heritage site was established in 2002. This could provide a basis for comparing apple and livestock performance under grazing. Other potential ideas included integration of sheep with conventional Bramley apple production; the involvement of local apple producer groups, and encouraging policy involvement.

Positive aspects: grazing sheep were considered to reduce mowing costs and to remove freshly fallen green leaves with benefits of reduced disease transmission.

Negative aspects/challenges: during the meeting, challenges included the timing of grazing, guidance on the age of trees to start grazing, stocking rate and damage to trees (bark and twigs), and the advantages and disadvantages of sheep grazing in orchards (to certain soil properties, fruit quality-quantity, disease transmission and application of chemicals, sheep and harvest interval and product contamination, sheep management by fencing). Other issues included selection of grass species and sheep breed, fertilisation of the orchard (generally and sheep contribution on this), sheep pests and deseases, other suggested livestock for grazing orchards, and the issue of grants and subsidies.

Innovations after the stakeholders meeting: five potential innovations resulting from the meeting were: 1. grazing management guidelines, 2. improved guidance on sheep breeds, 3. improved understanding of the environmental benefits, 4. an improved understanding of how sheep could improve income, and 5. the grazing of leaf litter to reduce apple scab infections.

4.1.3. Grazed orchards in Seine Maritime Department, France

Initial idea: 1. Feasibility study of grass control because of animal management and a study of the competition between grass and trees. 2. Study of the impact of the tree density on grass productivity. 3. Study of fruit production in two pruning options. 4. Assessment of the tree value. 5. Technical and economic management of the interaction between trees and animals.

Positive aspects: these included animal health and welfare and production, biodiversity improvement, an increase in income from grazing sheep, a contribution to disease and weed control, and improved touristic value.

Negative aspects: 1. Decreased production, 2. Sheep management, 3. Working time, 4. Investment, 5. CAP grants, 6. Require large surfaces, 7. Require multi expertise.

The challenges included: increasing technicality, the need for more experiments and training, and complementary competencies on farm

Items to discuss: Grass management in orchards: less working but needs more N fertilizer? Role of grazing on regulation of pests and diseases. The type of pest should be identified.

Comments – suggestions for all orchards above:

- To test the hypothesis that grazing reduces number of fungal ascospores for diseases such as apple scab.
- Role of sheep on eating damaged apples on the ground.
- The benefits, or otherwise, of sheep manure as a fertilizer and soil enhancer.
- The effects of sheep on soil compaction, and the rodent population.
- To investigate the contribution of grazing animals to weed control.

4.2. Intercropping and grazing of olive groves

This second generic system is the intercropping and grazing of olive systems, including two stakeholder groups in Greece (TEI at Chakidiki and at Molos) and one stakeholder group in Italy (CRA). The Italian system was focusing on the use of asparagus, which is not consumed widely in Greece. In Greece there was an initial focus on the use of aromatics.

4.2.1. Intercropping olives and cereals in Greece

Initial idea: the initial ideas of the group based at Chakidiki were: 1) to evaluate the current trends, constraints and opportunities for renovation of the system, 2) to test the viability and economical interest of innovative practices, and 3) to monitor a number of environmental services of the system at the plot scale.

Positive aspects: these included a steady economic return each year irrespective of weather conditions or other hazards, quality and diverse products, biodiversity and wildlife habitat improvement, and soil conservation.

Negative aspects: 1.Problems in combining and coordinating the individual cultural practices of trees and crops in the system, 2. Farmers are used to olive tree monocultures and, therefore, reluctant or afraid of extra work and cost if they intercrop them.

Items to discuss: 1. Inventory of the extant traditional olive tree systems intercropped with cereals and evaluation of their economic viability, 2. Establishment of a controlled experiment involving three treatments (olive trees+ wheat, olive trees + a mixture of wheat and vicia, and olive trees alone as a control) to collect reliable data, 3. Evaluation of the ecosystem services provided by intercropping olive tree monocultures.

4.2.2. Intecropping olives and vegetables in Greece (TEI, Molos)

Initial idea: 1.To determine the current trends, constraints and opportunities for system renovation. 2. To test the viability and economical interest of certain innovative practices proposed in stakeholder workshops. 3. To monitor a number of environmental services of the system at the plot scale.

Positive aspects: 1. Animal health and welfare, 2. Control of manure/noise/odour, 3. Tree production (in this case: olives), 4. Biodiversity and wildlife habitat and animal production, 5. Aesthetics, 6. Environment.

Negative aspects: these included losses by predation, the cost of animal inspections and mechanisation, regulation, and management costs.

*Items to discuss***:** 1. Trees intercropped with aromatic/medicinal herbs, 2. leguminous plants for soil amelioration, and 3. higher quality products for human consumption or for feed.

4.2.3. Integration of olives with animals and crops in Italy (CRA)

Initial idea: Improving income from olive orchards of low profitability. Design, test and demonstrate new systems that combine low environmental impact with labour efficiency and profitability.

Positive aspects: these included additional and alternative income to the farmer while improving the sustainability of the system.

Negative aspects: complexities of work and of administration/regulation and losses by predation.

Innovations proposed: develop best practices for growing wild asparagus in the olive orchard, develop portable butchering facilities for processing the meat at small scale, and propose other viable crops/animal species with good marketability to be intercropped. Use of “bulb” crops (flowers) are being considered among other possible crops.

4.3. Walnut systems

This is the focus of two stakeholder groups: one in Spain (UEX) and one in Greece (TEI). The Spanish group emphasized grazing whilst the Greek group emphasized on intercropping.

4.3.1. Grazing and intercropping of plantation trees in Spain

Initial idea: 1. Evaluation of current trends, constraints and opportunities. 2. To test the viability and economical interest of certain innovative practices on a proposal from stakeholder workshops. 3. To monitor certain common environmental services such as carbon and biodiversity at a plot scale.

Positive aspects: improvement of economic and environmental benefits.

Negative aspects: Technical problems: 1. Lack of research on management systems and on tree-crop/pasture interactions; 2. Lack of demonstration plots and of information regarding management practices appropriate for these systems; 3. Lack of interested technicians and forest managers. Economic uncertainty: 3. Lack of financial instruments and incentives and; 4. Low value of by-products (e.g., small-size wood, thinning); 5. Lack of marketing opportunities and risks.

Challenges and innovations: 1.Grazing high quality timber plantation: To study the productive and ecological consequences of managing walnut and poplar plantations with grazing compared to intensive management (tillage and chemical inputs). 2. Legumes as fertilizers: To study the

culture of different fodder legume species and varieties to reinforce the N nutrition of the trees. 3. Potential of wild cherry pollarding to reduce stem cavitation during the summer drought.

Comments – suggestions: The large distances between trees (if the purpose is to develop large trunks) could provide an opportunity to cultivate legumes (such as vetch, chicpeas of lentils) as a green manure or forage legume. Sheep grazing could be another opportunity with, for example, barley for direct grazing or as a fodder crop. The group confirmed that intercropping legumes (to be harvested, grazed, or used as green manure) and controlling herbaceous layer (that compete with trees for water and nutrients) by grazing are two potential areas of interest.

4.3.2. Agrosilvopastoral systems with walnut in Greece

Initial idea: the three initial ideas were quite broad, namely: 1) evaluation of current trends, constraints and opportunities, 2) testing the viability and economical interest of innovative practices, and 3) to monitor environmental services, at plot scale.

Positive aspects: these included the variety of products, biodiversity, and environmental sustainability.

Negative aspects: a key negative issue identified by the stakeholders was the low cash flow from an agroforestry system. Generally, the small land area per property is not sufficient for high income, especially in this region where the growing season is short. Respondents also thought that there are low marketing and business opportunities. High taxes and tight regulations concerning land use and management procedures posed by the government represent another obstacle to farmers. Arable and livestock farming is also not a popular occupation among young people. The lack of sufficient subsidies, that could contribute to overcome the problem of low cash flow from the system, is another negative issue for the farmers. Another issue raised was the opening and maintaining of the traditional water channels, and the indifference of local authorities. Finally, another problem raised by all participants was the low walnut production for the past five years.

Challenges: Among the issues raised were the continuation of the system, the species to intercrop and specifically aromatic/medicinal plants or pulses, the effect of shade and climate change on crop and walnut production.

4.4. Chestnut systems

An agroforestry system using chestnut was the focus of the stakeholder group in Galicia in north-west Spain.

Initial idea: the initial idea was to use the system for demonstration with a focus on both fruit (e.g, chesnut) production and also animal production.

Positive aspects: these include a range of socio-economic, production, environmental and management effects (Table 4).

Negative aspects/challenges: the highly ranked negative aspects of the agroforestry system included tree mortality, the difficulty in using certificated plants in afforestation, soil maintenance when implementing the agroforestry systems, system design (spacing of the trees and mechanisation in the field), abandonment of rural areas by young people, and poor financial support. The challenges identified from the meeting included the production and availability of grafted plants, the introduction of new products (e.g. mushroom, honey and medical plants), training, the use of practical demonstration trials, and the effects of irrigation on chestnut trees (Table 5).

Innovations after the stakeholders meeting: the first innovation suggested by the stakeholder was the production of grafted plants of selected varieties of chestnut by using the technique of micrografting. Secondly there was an interest in developing techniques to increase mushroom production in old chestnut stands. There could also be the potential of intercropping of these systems with ornamental flowers such as azaleas or berries or other acidophilic plants.

4.5. Orange trees intercropped with vegetables

The only system involving citrus trees was an agroforestry system based on the intercropping of oranges on the Greek island of Crete.

Initial idea: as with the other Greek stakeholder groups, the initial ideas were quite broad including 1) an evaluation of current trends, constraints and opportunities, 2) testing the viability and economical interest of innovative practices, and 3) monitoring selected environmental services, at plot scale.

Positive aspects: these included multiple products, and a steady economic return less dependent on weather conditions.

Negative aspects: the negative issues associated with citrus agroforestry systems included losses by predation, mechanization, regulation, and management costs.

Challenges – innovations: a suggested innovation by the stakeholder group was to grow new intercrops with aromatic plants (which may be medicinal) or legumes for soil amelioration, or higher quality products for human consumption or for feed.

Subsequent discussions: aromatic plants could be a good option but they do not combine well with irrigated orange trees. Hence an alternative option would be to include chickens which could reduce weeds and provide an additional source of nitrogen. Beans and chickpeas are also possible nitrogen fixing plants. Watermelon is also an alternative intensive option but there are potential pathogen issues to consider.

5. Innovations to be tested and developed

During the next three years of AGFORWARD, the stakeholder groups will experimentally test selected technical innovations, involving replicates and controls where possible. The innovation proposed to be tested have been categorised under four broad areas of production, management, environment, and socio-economic effects as used in the survey of stakeholders (Tables 4 and 5).

5.1. Production

- Quality assessment of products (TEI olives, C. Greece)
- To study the productive consequences of managing walnut and poplar plantations with grazing compared to intensive management (tillage and chemical inputs) (UEX walnuts)
- Improve income through diversification with sheep as an additional produce (AFBI, apple orchards)
- Techniques to increase mushroom production (Chestnuts, USC)
- To study the interactions of Shropshire sheep and apple trees (CRAN, grazed orchards)
- Parameterisation of the YieldSAFE biophysical model for ‘bush’ orchard systems (CRAN apple orchards)

5.2. Management

- Plant species to be intercropped (TEI olives-N. Greece, C. Greece), (Walnuts, UEX), (TEI orange groves) or managed (APCA/ACTA apple orchards)
- Animal species (olives CRA-OLI) (CRAN, apple orchards) – breed used (AFBI, apple orchards) and effect on pests and diseases (APCA/ACTA apple orchards)
- Grazing management guidelines and tests (AFBI, apple orchards)
- Techniques to increase mushroom production (Chestnuts, USC)
- Graft production of selected varieties of chestnuts (Chestnuts, USC)
- Best practices for growing wild asparagus (olives CRA-OLI)

5.3. Environmental issues

- Evaluation of ecosystem services (TEI olives- N. Greece)
- To study the ecological consequences of managing walnut and poplar plantations with grazing compared to intensive management (tillage and chemical inputs) (UEX walnuts)
- Environmental benefits of grazing (AFBI, apple orchards), on soil chemical characteristics (APCA/ACTA apple orchards)

5.4. Socio-economic issues

- Inventory of the extant traditional olive tree systems intercropped with cereals and evaluation of their economic viability (TEI olives- N. Greece)
- Improve income through diversification with sheep as an additional produce (AFGBI, apple orchards)
- Propose high marketability products and test (this could fit in the management as well) (olives CRA-OLI)

During the next 12 months, each partner will provide a detailed systems description and monitoring of the inputs, flows, and outputs of the key ecosystem services of at least one case study system within each stakeholder working group. The description will cover agroecology (climate, soil), components (tree species, crop system, livestock, management system), structure (planting arrangement, age, weed management policy), and key ecosystem services (provisioning, regulating and cultural), and associated economic values.

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