AGFORWARD
Agroforestry for Europe

Synthesis of the Research and Development Protocols related to Agroforestry for Arable Systems

Project name	AGFORWARD (613520)
Work-package	4: Agroforestry for Arable Systems
Milestone	Milestone 16 (4.3) Synthesis of the research and development protocols related to agroforestry for arable systems
Date of report	28 August 2015
Authors	Jaconette Mirck, BTU Cottbus-Senftenberg, Germany and Paul J Burgess, Cranfield University, UK
Contact	jmirck@gmail.com
Approved	1 October 2015

Contents

AGFORWARD (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD. The views and opinions expressed in this report are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission.

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.

This report contributes to the second objective. It contains a synthesis of 14 research and development protocols, Milestone 16 (4.3), for the participative research and development network focused on the use of agroforestry in arable systems. Agroforestry in arable systems is the focus of work-package 4 in the project. Similar reports exist for agroforestry of high nature and cultural value, agroforestry with high value trees, and agroforestry for livestock systems. Further details of individual protocols can be obtained from the individual documents listed in the reference list.

2 Trial summary

Twelve stakeholder groups have developed research plans focused on trees with arable crops. Some groups are using mature sites and some are using recently established sites. There are three initiatives based on sites greater than 30 years old, six initiatives based on sites aged 10-20 years, nine based on sites 5-10 years old, and six where some of the trees are less than 5 years (Table 1).

The oldest trees are walnut trees within a silvoarable system in Western France (van Lerberghe et al. 2015a, b). There are also mature sites for the INRA wheat shade study for almond, sorb, poplar and olives (Gosme and Desclaux 2015). Younger sites are being studied in Spain as part of the maize and medicinal plant studies, in the UK as part of the weed study, in Germany, in Spain as part of the crop yield competition study, in Switzerland in Sursee and Möhlin, and some of the APCA sites in Picardy. Recently established sites will be studied in Greece, UK as part of the wheat shade study for hazel, in Switzerland at the Buus site, in Italy, in Hungary, and the remaining APCA studies in the Picardy region.

Trees studied include both fast and slow growing species. Fast growing tree species studied include poplar, hazel, Italian alder, black locust, and paulownia. These fast growing tree species will be studied by INRA (wheat shade and weed studies), the Organic Research Centre (ORC) (wheat shade), BTU, EVD (Buus), and NYME. Short rotation coppice systems are also being studied at ORC and BTU. Slow growing species will be studied by all groups except for BTU in Germany.

The most common crop is wheat. However there is also a wide range of other crops including barley, maize, beans, peas, sugar beet, potatoes, horticultural crops and medicinal and aromatic plants. The alley width between the trees varies from 6 m to 96 m. Most hedgerows consist of single rows except for the two short rotation coppice (SRC) systems.

Table 1. Summary of the 14 research and development protocols produced by the 12 stakeholder groups within work-package 4

Partner and country	Stakeholder group	Reference	Study	Tree species	Crop	Age year	Con trol	When	Spacing (m)
USC, Spain	Silvoarable systems in Spain	Mosquera Losada et al (2015)	Maize	Walnut	Maize	7	No	Sept 2015	5 x 6, 2.5 x 6, 1.25 x 6
USC, Spain	Silvoarable systems in Spain	Mosquera Losada et al (2015)	Medicinal plants	Wild cherry	Lemon balm and mint	7	No	Fall 2016	2.5 x 6, 1.25 x 6
TEI, Greece	Trees with arable crops and grassland	Mantzanas et al (2015)	Field beans	Walnut	Common beans	1	Yes	2015/2016	5 x 15
TEI, Greece	Trees with arable crops and grassland	Mantzanas et al (2015)	Aromatic plants	Cherry	Aromatic plants	1	Yes	2015/2016	5 x 15
INRA, France	Mediterranean silvoarable systems in France	Gosme and Desclaux (2015)	Wheat shade	Almond	Wheat	35	Yes	2015	4 x 6
INRA, France	Mediterranean silvoarable systems in France	Gosme and Desclaux (2015)	Wheat shade	Poplar	Wheat	15	Yes	2015	6 x 13
INRA, France	Mediterranean silvoarable systems in France	Gosme and Desclaux (2015)	Wheat shade	*Sorbus domestica*	Wheat	20	Yes	2015	6 x 13
INRA, France	Mediterranean silvoarable systems in France	Gosme and Desclaux (2015)	Wheat shade	Olive	Wheat	10-13	Yes	2015	5 x 6, 2 x 6
INRA, France	Mediterranean silvoarable systems in France	Meziere and Boinot (2015)	Weeds A	Walnut	Barley	20	Yes	2015-2016	4-8 x 13
INRA, France	Mediterranean silvoarable systems in France	Meziere and Boinot (2015)	Weeds B	Poplar	Pea	15	No	2015-2016	4-8 x 13
INRA, France	Mediterranean silvoarable systems in France	Meziere and Boinot (2015)	Weeds B	*Sorbus domestica*	Pea	20	No	2015-2016	4-12 x 13
ORC, UK	Silvoarable agroforestry in the UK	Fradgley and Smith (2015)	Wheat shade	Hazel coppice	Wheat	4?	No	2015-2016	1.5 x 1.5 x 10-12
ORC, UK	Silvoarable agroforestry in the UK	Smith (2015)	Weeds	Six broadleaf species[a]	Vegetables	6?	No	2015-2016	1.5 x 20
ORC, UK	Silvoarable agroforestry in the UK	Smith (2015)	Weeds	Apple	Vegetables, cereals	6?	No	2015-2016	3 x 20-24
BTU, Germany	Alley cropping systems in Germany	Mirck and Quickenstein (2015)	Crop yield	Poplar, black locust (SRC)	Sugar beet	6	Yes	2015-l 2016	0.9 x 0.75 x 1.8 x 24, 48, or 96

Table 1 (continued)

Partner and country	Stakeholder group	Reference	Study	Tree species	Crop	Age year	Con trol	When	Spacing (m)
UEX, Spain	Grazing and intercropping of plantation trees in Spain	Moreno et al (2015)	crop yield competition	Walnut	Cereals	8	Yes	2014-2015	5 x 6
EVD, Switzerland	Integrating trees with arable crops, Switzerland	Herzog and Jäger (2015)	Sursee	Apple	Potatoes, strawberries, flowers	6	No	2011-2017	100 trees ha^{-1}
EVD, Switzerland	Integrating trees with arable crops, Switzerland	Herzog and Jäger (2015)	Möhlin	Sour cherry, apple, various wild berries	Organic horticultural crops	5-6	No	2011-2017	35 trees ha^{-1}
EVD, Switzerland	Integrating trees with arable crops, Switzerland	Herzog and Jäger (2015)	Buus	Poplar	Arable crops	1-4	No	2011-2017	?
CNR/VEN, Italy	Trees for timber intercropped with cereals	Dalla Valle and Paris (2015)	Crop yield	Poplar, oak	Sugar beet	2	Yes	2015-2017	5 x 35
NYME, Hungary	Alley cropping systems in Hungary	Vityi et al (2015)	Crop growth and yield	*Paulownia tomentosa*	Alfalfa	2	Yes	2015-2017	5 x 18
APCA, Charente, France	Agroforestry for arable farmers in Western France	van Lerberghe et al (2015b)	Crop yield	Black walnut	Cereals	43	Yes	2015-2016	7 x 14, 14 x 14
APCA, Picardy, France	Agroforestry for arable farmers in Northern France	Wartelle and, Meziere and Boinot (2015)	Crop yield and weed growth	Six broadleaf species[b]	Wheat, barley, potatoes, sugar beet, oilseed rape	1-7	No	2015-2016	26-50 m between rows
AFAF/IDF, France	Agroforestry for arable farmers in South-West France	van Lerberghe et al (2015a)	Tree yield	Black walnut	Cereals	43	Yes	2016	7 x 14m

[a] Apple, maple, whitebeam, Italian alder, oak, black birch, hornbeam, cherry plum (*Prunus cerasifera*)

[b]Walnut, maple, wild cherry, *Sorbus torminalis, Sorbus domestica,* wild apple tree, and wild pear tree

3 Specific areas of research

3.1 Crop measurements

Because work-package 4 covers silvoarable systems most groups will study crop yield within their agroforestry system (Table 2).

Table 2. Summary of crop measurements planned within work-package 4

Partner and country	Protocol Title	Crops	Planned measurements	When
USC, Spain	Mosquera Losada et al (2015)	Maize	Yield of maize in Sept at harvest	Sept 2015
USC, Spain	Mosquera Losada et al (2015)	Melissa , Mentha	Yield of lemon balm (*Melissa* spp) and mint (*Metha* spp) medicinal plants using randomly collected samples.	Fall 2016
TEI, Greece	Mantzanas et al (2015)	Field beans	Growing period, labour costs, crop yield	2016
TEI, Greece	Mantzanas et al (2015)	Aromatic plants	Growing period, labour costs, crop yield	2016
INRA, France	Gosme and Desclaux (2015)	Wheat	Seedling emergence (number per m^2), height of plants each week until flowering, phenological stages, number of tillers per plant, chlorophyll content, number of ears per plant, number of grains per spike, 1000 kernel weight, and machine and / or quadrat (1 m^2) yield	2015-2016
ORC, UK	Fradgley and Smith (2015)	Wheat	Yield with plot combine; thousand grain weight; tillers m^2	2015-2016
BTU, Germany	Mirck and Quickenstein (2015)	Sugar beet	1m^2 quadrats using grid	Sept 2015, Fall 2016
UEX, Spain	Moreno et al (2015)	Cereals	Crop yield in nine 0.25m^2 quadrats, number of plants, ears, and grain weight	2016
EVD, Switzerland	Herzog and Jäger (2015)	Potatoes, strawberries , flowers	Based on farmer records at Sursee	2011-2017
EVD, Switzerland	Herzog and Jäger (2015)	Organic horticultural crops	Based on farmers records at Möhlin	2011-2017
EVD, Switzerland	Herzog and Jäger (2015)	Arable crops	Based on farmers records at Buus	2011-2017
CNR/VEN, Italy	Dalla Valle and Paris (2015)	Sugar beet	1 m^2 quadrats on transects perpendicular to tree row, above ground biomass	2015-2017
NYME, Hungary	Vityi et al (2015)	Alfalfa	Forage biomass production for each plot	2015-2017
APCA, Charente, France	van Lerberghe et al (2015b)	Cereals	Two tree densities and control, 1 m^2 plots, seedling emergence, above ground biomass at flowering, 1000 grain weight at harvest	2015-2016
APCA, Picardy, France	Wartelle and, Meziere (2015)	Wheat, barley, potatoes, sugar beet, oilseed rape	1 m^2 quadrants, plants/m^2, tillers/plant, grains/ear, thousand grain weight	2015-2016

The most commonly studied crop is wheat, and sugar beet will be studied at two sites. Other crops include maize, field beans, potatoes, alfalfa and horticultural and aromatic plants. The protocols include very detailed measurements such as those carried out by INRA on durum wheat to those using farmer records in Switzerland. It is anticipated that each group will record the sowing and harvest date of each crop.

3.2 Tree measurements

Most stakeholder groups within work-package 4 will assess tree growth (Table 3). Tree measurements include both tree biomass yield (height, diameter, crown and growing period) and fruit yield. It is anticipated that each growth will record the dates of bud break and leaf fall.

Table 3. Summary of tree measurements planned within work-package 4.

Partner and country	Stakeholder Group	Protocol Title	Trees	Planned measurements	When
TEI, Greece	Trees with arable crops and grassland	Mantzanas et al (2015)	Walnut, cherry	Focus on tree establishment: height, DBH annual basis, growing period	2015-2016
ORC, UK	Silvoarable agroforestry in the UK	Smith (2015)	Eight broadleaf species[a]	Tree height, canopy diameter, survival (dead/alive)	2015-2016
BTU, Germany	Alley cropping systems in Germany	Mirck and Quickenstein (2015)	Poplar, black locust	Tree height, diameter	Autumn 2015, 2016
UEX, Spain	Grazing and intercropping of plantation trees in Spain	Moreno et al (2015)	Walnut	Diameter at breast height	2016
EVD, Switzerland	Integrating trees with arable crops, Switzerland	Herzog and Jäger (2015)	Apple, cherry, sorb tree, pear	Tree yield (fruit harvest) using farmers records and DBH, crown diameter, trunk height, tree height	2011-2017
CNR/VEN, Italy	Trees for timber intercropped with cereals	Dalla Valle and Paris (2015)	Poplar, oak	Height, DBH, branching height, crown radius	2015-2017
CNR/VEN, Italy	Trees for timber intercropped with cereals	Dalla Valle and Paris (2015)	Poplar, oak	Tree basal area and crop equivalent ratio	2015-2017
NYME, Hungary	Alley cropping systems in Hungary	Vityi et al (2015)	*Paulownia tomentosa*	Diameter and height	2015-2017
APCA, AFAF and IDF, France	Agroforestry for arable farmers in Western France	van Lerberghe et al (2015b	Black walnut	Tree circumference at breast height, height, diameter, ground projection crown, weight trunk, and branches.	2016
INRA, France	Mediterranean silvoarable systems in France	Meziere and Boinot (2015)	Walnut, poplar, sorb	Tree budbreak	Spring 2015
INRA, France	Mediterranean silvoarable systems in France	Gosme and Desclaux (2015)	Almond, poplar, sorb, olive	Bud break dates of poplars, Sorb and almond trees; Measure/research available soil depth	2015

[a]: apple, maple, whitebeam, Italian alder, oak, black birch, hornbeam, cherry plum

3.3 Weed management and tree protection

Both weed management (NYME) and the influence of trees on arable weed presence (INRA, APCA) will be studied in work-package 4 (Table 4). The group in Hungary will also assess straw as a weed management method and both INRA and APCA will use transects perpendicular to the tree row to study how the trees influence weed competition within the crop alleys. Tree protection in the form of bio-repellents will studied in Hungary.

Table 4. Summary of weed management and tree protection measurements planned within work-package 4

Partner and country	Stakeholder group and reference	Trees	Crops	Methods	When
INRA, France	Mediterranean silvoarable systems in France (Meziere and Boinot 2015)	Walnut, poplar, sorb	Barley, pea	Arable weed communities and weed crop interactions: 90 1m^2 quadrats along transects x 2 fields, species and abundance in crop alleys, species and abundance class (Barralis scale) in understory, weed relative biomass (ratio weed biomass/crop and weed biomass)	2015, 2016
INRA, France	Mediterranean silvoarable systems in France (Meziere and Boinot 2015)	Walnut, poplar, sorb	Barley, pea	Weed crop interactions: 9 quadrats crop area x 2 fields, ratio weed dry mass/crop dry mass Less plots in 2016	2015, 2016
NYME, Hungary	Alley cropping systems in Hungary (Vityi et al 2015)	*Paulownia tomentosa*	Alfalfa	Weed management: straw as weed prevention, photos before and after Protection of trees from wildlife: damage monitored with photos, test biorepellents outside agroforestry field	2015-2017
APCA, Picardy, France	Agroforestry for arable farmers in Northern France (Wartelle and, Meziere 2015)	Seven tree species[a]	Wheat, barley, potatoes, sugar beet, oilseed rape	Weed crop interaction: three samples per trial, recording species and the proportional cover of bare earth and leaf litter	2015

[a]:Walnut, maple, wild cherry, *Sorbus torminalis, Sorbus domestica,* wild apple tree, wild pear tree

3.4 Pests and diseases

The occurrence of pest and diseases will be studied in the UK and in Hungary (Table 5). Methods will include both digital photos and leave and stem sample assessments.

Table 5. Summary of pest and disease measurements planned within work-package 4

Partner and country	Stakeholder group and reference	Trees	Crops	Measurements	When
ORC, UK	Silvoarable agroforestry in the UK (Smith 2015)	Eight broadleaf tree species[a]	vegetables, cereals	No method described	2015-2016
NYME, Hungary	Alley cropping systems in Hungary (Vityi et al 2015)	*Paulownia tomentosa*	Alfalfa	Effect of trees on crop disease using photos and samples	2015-2017

[a]Apple, maple, whitebeam, Italian alder, oak, black birch, hornbeam, cherry plum

3.5 Shade tolerance and light radiation

Shade tolerance and the availability of light to the crop layer in the alleys will be studied (Table 6). Light availability will be both measured with hemispherical photos (INRA, UEX, CNR/VEN) and a Li-Cor LAI 2000 or 2200. In addition, shade tolerance of wheat will be tested in France and the UK.

Table 6. Summary of shade and light radiation measurements planned within work-package 4

Partner and country	Stakeholder group and reference	Trees	Crops	Methods	When
INRA, France	Mediterranean silvoarable systems in France (Gosme and Desclaux 2015)	Almond, poplar, sorb, olive	Wheat	Hemispherical photos of trees before and after budbreak/pruning Crop measurements are described in Table 2	2015
ORC, UK	Silvoarable agroforestry in the UK (Fradgley and Smith 2015)	Hazel	Wheat	Yield with plot combine; thousand grain weight; tillers m^2 and LiCor LAI 2000	2015-2016
BTU, Germany	Alley cropping systems in Germany (Mirck and Quickenstein 2015)	Poplar, black locust	Sugar beet	LAI LiCor 2200 and PocketLAI app. LAI max 2015 in August, again in 2016 more frequently with PocketLAI and with LiCor 2200 for cross referencing	2015-2016
INRA, France	Mediterranean silvoarable systems in France (Meziere and Boinot (2015)	Walnut, poplar, sorb	Barley, pea	Hemispherical photos on weed sampling days, PAR calculated with Winscanopy, measured before and after budbreak, after summer (but before leave fall) at LAI max	2015-2016
Uex, Spain	Grazing and intercropping of plantation trees in Spain (Moreno et al, 2015)	Walnut	Cereals	Hemispherical pictures in quadrats (estimate of radiation reaching the crop)	2015-2016
CNR/VEN Italy	Trees for timber intercropped with cereals (Dalla Valle and Paris 2015)	Poplar, oak	Sugar beet	Hemispherical photos for total light transmittance (TLT in %), transects perpendicular to tree row. Maybe PocketLAI in 2016	2015

3.6 Soil and tree/crop health

Soil and tree/crop health will be studied using a range of indicators. These include nutrient status of the leaves of the crop (USC) and the tree (BTU, UEx) (Table 7). Soil health will be assessed by USC, TEI, BTU, EVD and NYME. In addition, carbon sequestration and nitrogen remediation potential will be studied in silvoarable systems by UEx. It is anticipated that all partners will provide soil texture data, which is required for tree and crop growth models.

Table 7. Summary of tree/crop and soil health measurements taken within work-package 4

Partner and country	Stakeholder group	Tree or crop health	Soil health	When
USC, Spain	Silvoarable systems in Spain (Mosquera Losada et al 2015)	Nutrient status of the maize: N, P, Ca, Mg, Na.	Soil status beneath maize: N, P (Olsen/Mehlich), Ca, Mg, Na. C to 25 cm	Sept 2015 – Jan 2016
BTU, Germany	Alley cropping systems in Germany (Mirck and Quickenstein 2015)	Nutrient status of poplar and black locust leaves using litter bags: litter fall, lignin, N,P,K and C of leaves, litter breakdown	Soil samples: N, P, K and C (possibly lignin). Total organic carbon (TOC), Nmin, aggregate stability, active C, HWC, pH, EC	2015-2016
UEX, Spain	Grazing and intercropping of plantation trees in Spain (Moreno et al 2015)	Nutrient status of tree leaves: N, P, and K	Mineral N, P and K at quadrat locations (0-30 cm depth)	Spring 2014-2015
TEI, Greece	Trees with arable crops and grassland (Mantzanas et al 2015)	Plant material: major nutrients (NPK)	Soil samples (N, P, K, and C)	2015-2016
EVD, Switzerland	Integrating trees with arable crops, Switzerland (Herzog and Jäger 2015)		Organic content, soil profile and soil physical properties, pH, P, K and Mg. Visual assessment soil quality	2011-2017
NYME, Hungary	Alley cropping systems in Hungary (Vityi et al 2015)		Soil organic matter (SOM), pH, soil moisture capacity, water soluble salt, $CaCO_3$ m/m%, soluble P_2O_5, K_2O, and N (NO_3^-, NO_2^-) mg/kg were measured in 2014 to provide a baseline	2015-2017

3.7 Water use and root distribution

Water availability is one of the key parameters of the Yield-SAFE model. This parameter will be studied in work-package 4 using two different approaches. The first approach focuses on root distribution, this is being studied at the Greek and German sites through taking soil cores and separating coarse and fine roots from the soil (Table 8). The second approach will assess water availability, which is studied through soil moisture measurements in Germany, stable oxygen isotopes in soil water in Italy and microclimate parameters in Hungary.

Table 8. Summary of water use and root distribution measurements planned within work-package 4

Partner and country	Stakeholder group and reference	Root distribution	Water use	When
TEI, Greece	Trees with arable crops and grassland (Mantzanas et al 2015)	Soil cores in tree plots and ref site in summer 2016, to 75 cm depths, analysed in 15 cm sections, soil cores washed with water, crop, tree coarse and fine roots separated. Trees only 1 year old, maybe 12 year old site used instead.		2016
BTU, Germany	Alley cropping systems in Germany (Mirck and Quickenstein 2015)	Root distribution: root cores, 15 cm sections to 60 cm depth, crop, tree coarse and fine roots separated	Soil moisture using grid/transect, soil physical properties (pF curves)	Sept 2015
UEX, Spain	Grazing and intercropping of plantation trees in Spain (Moreno et al 2015)	Cereal and tree rooting profiles will be measured in 1-m-depth soil cores	Soil moisture will be gravimetrically measured in April and June	2016
CNR/VEN, Italy	Trees for timber intercropped with cereals (Dalla Valle and Paris 2015)		Water oxygen stable isotopes	2015-2017
NYME, Hungary	Alley cropping systems in Hungary (Vityi et al 2015)	Root distribution measurements in objectives for 2016	Microclimate parameters above and below ground by agrometeorology station. Soil cores in tree plots and control site at 10, 20, 40, 60 cm to determine physical soil parameters and humus content.	2015-2017

3.8 Biodiversity

Improved biodiversity is often mentioned as a benefit of agroforestry compared with conventional agricultural systems. The biodiversity of invertebrates and plants will be studied in the UK, and the effect of agroforestry on birds will be assessed in Switzerland (Table 9).

Table 9. Summary of biodiversity measurements planned within work-package 4

Partner and country	Stakeholder group	Flora biodiversity	Faunal biodiversity	When
ORC, UK	Silvoarable agroforestry in the UK (Fradgley and Smith 2015)	Flora diversity to be measured by quadrats	Invertebrates: pitfalls, soil cores, sweep netting/transects or pan traps	2015-2016
EVD, Switzerland	Integrating trees with arable crops, Switzerland (Herzog and Jäger 2015)		Bird species: evaluation of agroforestry to promote bird species	2011-2017
INRA, France	Mediterranean silvoarable systems in France (Meziere and Boinot 2015)	90 1 m^2 quadrats along transects x 2 fields. Presence/absence and abundance of all spontaneous species in alley crops and understory. Diversity alpha, beta, gamma, Shannon index, Pielou's index.		2015-2016

3.9 Socio-economic issues

Socio-economic issues that will be studied within work-package 4 include fertilizer application in Spain, establishment and management costs of understory vegetation in the UK, costs of farm machinery in Switzerland, timber quality in Italy, and the potential of using leaves as livestock feed in Hungary (Table 10). The social aspects of agroforestry will also be studied in Switzerland through yearly interviews with farmers.

Table 10. Summary of socio-economic measurements planned within work-package 4

Partner and country	Stakeholder group and reference	Focus of study	Methods	When
USC, Spain	Silvoarable systems in Spain (Mosquera Losada et al 2015)	Fertilizer (medicinal plants)	With an without fertilizer (sheep manure) treatments for *Mentha*	2016
ORC, UK	Silvoarable agroforestry in the UK (Smith 2015)	Economics - understory management	Establishment costs, management costs, product outputs	2015-2016
EVD, Switzerland	Integrating trees with arable crops, Switzerland (Herzog and Jäger 2015)	Economics (farm machinery and labor)	Use farm machinery and labor input recorded based on farmers records	2011-2017
CNR/VEN, Italy	Trees for timber intercropped with cereals (Dalla Valle and Paris 2015)	Timber quality	Non-destructive measurements and observations on tree trunk	2015-2017
NYME, Hungary	Alley cropping systems in Hungary (Vityi et al 2015)	Livestock fodder leaves	Suitability evaluated	2015-2017
EVD, Switzerland	Integrating trees with arable crops, Switzerland	Farmers perception	Yearly interview farmers on positive and negative perceptions	2011-2017

3.10 Design

The actual design of agroforestry systems will be studied in Germany and in Switzerland (Table 11).

Table 11. Summary of design measurements planned within work-package 4

Partner and country	Stakeholder group and reference	Trees	Crops	Methods	When
BTU, Germany	Alley cropping systems in Germany (Mirck and Quickenstein 2015)	Poplar, black locust	Sugar beet	Crop yield at various hedgerow spacings	2015-2016
EVD, Switzerland	Integrating trees with arable crops, Switzerland (Herzog and Jäger 2015)	Apple, cherry, sorb tree, pear	Organic crops, horticulture	Spacial layout system with GPS and GIS	2011-2017

4 Acknowledgements

The AGFORWARD project (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD, Theme 2 - Biotechnologies, Agriculture & Food. The views and opinions expressed in this report are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission.

5 References

Dalla Valle C, Paris P (2015). Research and Development Protocol for Timber Trees intercropped with Cereals in Italy. 2 April 2015. 9 pp. Available online: http://agforward.eu/index.php/en/trees-for-timber-intercropped-with-cereals-445.html

Fradgley N, Smith J (2015). Research and Development Protocol for Silvoarable Agroforestry in the UK. 9 April 2015. 8 pp. Available online: http://agforward.eu/index.php/en/silvoarable-agroforestry-in-the-uk.html

Gosme M, Desclaux D (2015). Research and Development Protocol for the Participatory Plant Breeding of Durum Wheat for Mediterranean Agroforestry Group. 2 March 2015. 13 pp. Available online: http://agforward.eu/index.php/en/mediterranean-silvoarable-systems-in-france.html

Herzog F, Jäger M, (2015). Research and Development Protocol for Integrating Trees with Arable Crops, Switzerland. 9 March 2015. 13 pp. Available online: http://agforward.eu/index.php/en/integrating-trees-with-arable-crops-switzerland.html

Mantzanas K, Papanastasis V, Pantera A, Papadopoulos A (2015). Research and Development Protocol for Silvoarable Agroforestry Group in Greece. 30 March 2015. 6 pp. Available online: http://agforward.eu/index.php/en/trees-with-arable-crops-and-grassland-in-greece.html

Meziere D, Boinot S (2015). Research and Development Protocol for Weed Management in Mediterranean Silvoarable Group in France. 9 June 2015. 9 pp. Available online: http://agforward.eu/index.php/en/mediterranean-silvoarable-systems-in-france.html

Mirck J, Quickenstein A (2015). Research and Development Protocol for Alley Cropping in Germany. 9 March 2015. 11 pp. Available online: http://agforward.eu/index.php/en/alley-cropping-systems-in-germany.html

Mosquera Losada MR, Ferreiro-Domínguez N, Fernández Lorenzo JL, González-Hernández P, Rigueiro Rodríguez A (2015). Research and Development Protocol for Silvoarable Systems in Galicia, Spain. 28 March 2015. 6 pp. Available online: http://agforward.eu/index.php/en/silvoarable-systems-in-spain.html

Moreno G, López-Díaz ML, Garcia MB (2015). Research and Development Protocol for Cereal Production beneath Walnut in Spain. 20 March 2015. 7 pp. Available online: http://www.agforward.eu/index.php/en/silvoarable-systems-in-spain.html

Smith J (2015). Research and Development Protocol for Silvoarable Agroforestry in the UK (part 2). 23 March 2015. 6 pp. Available online: http://www.agforward.eu/index.php/en/silvoarable-agroforestry-in-the-uk.html

van Lerberghe P, Malignier N, Cirou E (2015a). Research and Development Protocol for Agroforestry for Walnut Trees on Arable Land in France. 22 July 2015. 5 pp. Available online: http://agforward.eu/index.php/en/agroforestry-for-arable-farmers-in-south-west-france.html

van Lerberghe P, Malignier N, Cirou E (2015b). Research and Development Protocol for Agroforestry for Arable Farmers in Western France. 17 August 2015. 6 pp. Available online: http://agforward.eu/index.php/en/agroforestry-for-arable-farmers-in-western-france.html

Vityi, A, Marosvolgyi B, Kiss A, Schettrer P (2015). Research and Development Protocol for Alley Cropping in Hungary. 24 March 2015. 9 pp. Available online: http://agforward.eu/index.php/en/alley-cropping-systems-in-hungary.html

Wartelle R, Meziere D (2015). Research and Development Protocol for Agroforestry for Arable Farmers in Northern France. 17 August 2015. 6 pp. Available online: http://agforward.eu/index.php/en/agroforestry-for-arable-farmers-in-northern-france.html