System Report:
Olive Agroforestry in Molos, Central Greece

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Work-package	3: Agroforestry for High Value Trees
Specific group	Olive agroforestry in Molos, Central Greece
Deliverable	Contribution to Deliverable 3.7 (3.1): Detailed system description of a case study system
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Contents

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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.

This report contributes to Objective 2, Deliverable 3.7: "Detailed system description of case study agroforestry systems". The detailed system description includes the key inputs, flows, and outputs of the key ecosystem services of the studied system. It covers the agroecology of the site (climate, soil), the components (tree species, crop system, livestock, management system) and key ecosystem services (provisioning, regulating and cultural) and the associated economic values. The data included in this report will also inform the modelling activities which help to address Objective 3.

2 Background

It is estimated that olive groves cover an area of 806,600 ha in Greece (EUROSTAT 2007) while a large proportion of them (124,311 ha) comprise agroforestry systems with various crops or pasture established in the understory of olive trees (Papanastasis et al. 2009).

Olive (*Olea europea*[1]) is probably the most widespread cultivated tree in Greece. Olive trees alone or in orchards are found in all parts of the country that have a mild Mediterranean climate. The olive tree is considered as one of the least demanding in soil nutrients among the cultivated trees. This is why it is planted in poor, rocky areas with soils mostly derived from hard limestone (e.g. Gomez et al. 2003; Vossen 2007; Duarte et al. 2008). Many olive groves are found on steep mountain slopes that have been terraced with stonewalls to hold the soil. Sometimes other trees such as carobs (mainly in Crete), almonds, walnuts, apricots, fig, poplars, and plums are grown together with the olive trees or along the boundaries of the olive orchards. In the traditional systems, practically all olive trees came from wild plants that were grafted. Edible olives and olive oil are the main products, while secondary products include fodder for animals and firewood. In some places, high quality furniture and handicrafts are made of olive wood.

Olive trees have been grown with: a) animals (sheep, cattle, goats, honey bees, pigs or chickens), b) wheat or other cereals, corn, alfalfa, or grape vines, c) vegetable crops, i.e. melons, beans, onions, or fava beans, or d) wild herbaceous vegetation including some edible plants. Animals grazed on the spontaneous vegetation or on planted crops excluding wheat and barley (Papanastasis et al. 2009).

There is increasing interest in the traditional combination of olive orchards with arable crops (cereals) in the same field in Central Greece (Figures 1 and 2). A meeting of the 'Intercropping of olive groves in Greece' stakeholder group was held on 27 June 2014 at which the group identified

[1] Scientific names according to Euro+Med (2006-) and Flora Europaea (Tutin et al. 1968-1980)

examples of interesting or best practices that involved trees intercropped with aromatic/medicinal herbs, leguminous plants for soil amelioration, and higher quality products for human consumption or for feed.

3 Update on field measurements

Field measurements described in the research and development protocol (Pantera et al. 2015) began in April of 2015 and will continue until the end of 2016. All measurements have been and will be conducted by researchers from the TEI Stereas Elladas in collaboration with researchers from Aristotle University of Thessaloniki, Greece.

4 System description

In the Fthiotida prefecture in Greece, agroforestry is a traditional land use system in which farmers used to combine olive production with grazing and arable crops (vegetables) in the same plot. In this way they ensured a steady economic return every year irrespectively of weather conditions or other type of hazards. The area is dominated by forests (72%), arable land (18.3% cover), and pastures (8.1%) (ELSTAT 2000). Settlements and traffic infrastructure cover around 1.3% of the land area (ELSTAT 2000). Agricultural systems mostly involve field crop production (58%) but also include vegetables (3%), vines (1%), and tree plantations (27%), operating on small plot units (ELSTAT 2013). Typically, farms are small (average size: < 3 ha) and managed as private enterprises. Land is usually owned or rented by farmers. Many of the olive trees in the prefecture are estimated to be more than 200 years old. It is estimated that there are almost 7,000,000 trees in the prefecture which plays a leading role in edible olives production in the country. Table 1 provides a general description of olives intercropped in Fthiotida, Greece.

Table 1. General description of the olives intercropped in Fthiotida, Central Greece

General description of system	
Name of group	Olives intercropped in Molos, Central Greece
Contact	Anastasia Pantera
Work-package	3: Agroforestry for High Value Tree Systems
Associated WP	Silvoarable systems (work-package 4)
Geographical extent	Olive (*Olea europea*) is probably the most widespread cultivated tree in Greece. Olive trees alone or in orchards are found in all parts of the country which have a mild Mediterranean climate. It is estimated that olive groves cover an area of 600,000 ha in Greece (Schultz et al. 1986) and a high proportion (124,311 ha) comprises typical agroforestry systems with various crops or pasture established in the understory of olive trees (Papanastasis et al. 2009).
Estimated area	The total area of the research site is about 10 ha.
Typical soil types	Luvisols
Description	The olive tree is considered as one of the least demanding in soil nutrients among the cultivated trees. This is why it is planted in poor, rocky areas with soils mostly derived from hard limestone. Olive trees have been grown with: a) animals (sheep, cattle, goats, honey bees, pigs or chickens), b) wheat or other cereals, corn, alfalfa, or grape vines, c)

	vegetable crops, i.e. melons, beans, onions, or fava beans, or d) wild herbaceous vegetation including some edible plants. Animals grazed on the spontaneous vegetation or on planted crops excluding wheat and barley (Papanastasis et al. 2009).
Tree species	Olive tree (*Olea europea*); fig trees (*Ficus carica*); grape vine (*Vitis vinifera*) and lemon trees (*Citrus limon*)
Tree products	Edible olives and olive oil, lemons, fig fruits and wood
Crop species	Chickpeas and cereals
Crop products	Chickpeas, figs, grapes, wine; crops are harvested on an annual base. Time of harvest is crop dependent
Animal species	Sheep
Animal products	Milk and meat production
Other provisioning services	Olive tree pruned for fuelwood production Possibility for intercropping aromatic plants and vegetables
Regulating services	Trees provide a microclimate which protects intercrops from frost and extreme temperatures Trees can promote nutrient cycling and increase carbon storage
Habitat services and biodiversity	Many animal species can use the trees and the edges for habitat resulting in increased biodiversity
Cultural services	The modern silvoarable practice may improve the quality of crop production and reduce the management cost.
Key references	See end of report

A description of a specific case study system is provided in Table 2.

Table 2. Description of the specific case study system in Molos, Fthiotida, C. Greece

Specific description of site	
Area	2 ha
Co-ordinates	38°49’22.58” N; 22°37’22.73” E, 11 m asl
Site contact	Dimitrios Kitsikopoulos, Anastasia Pantera
Site contact email	dimifree1@gmail.com pantera@teiste.gr

Example photograph

Figure 1. Intercropped area in an olive grove

Figure 2. The production of olives

Map of system

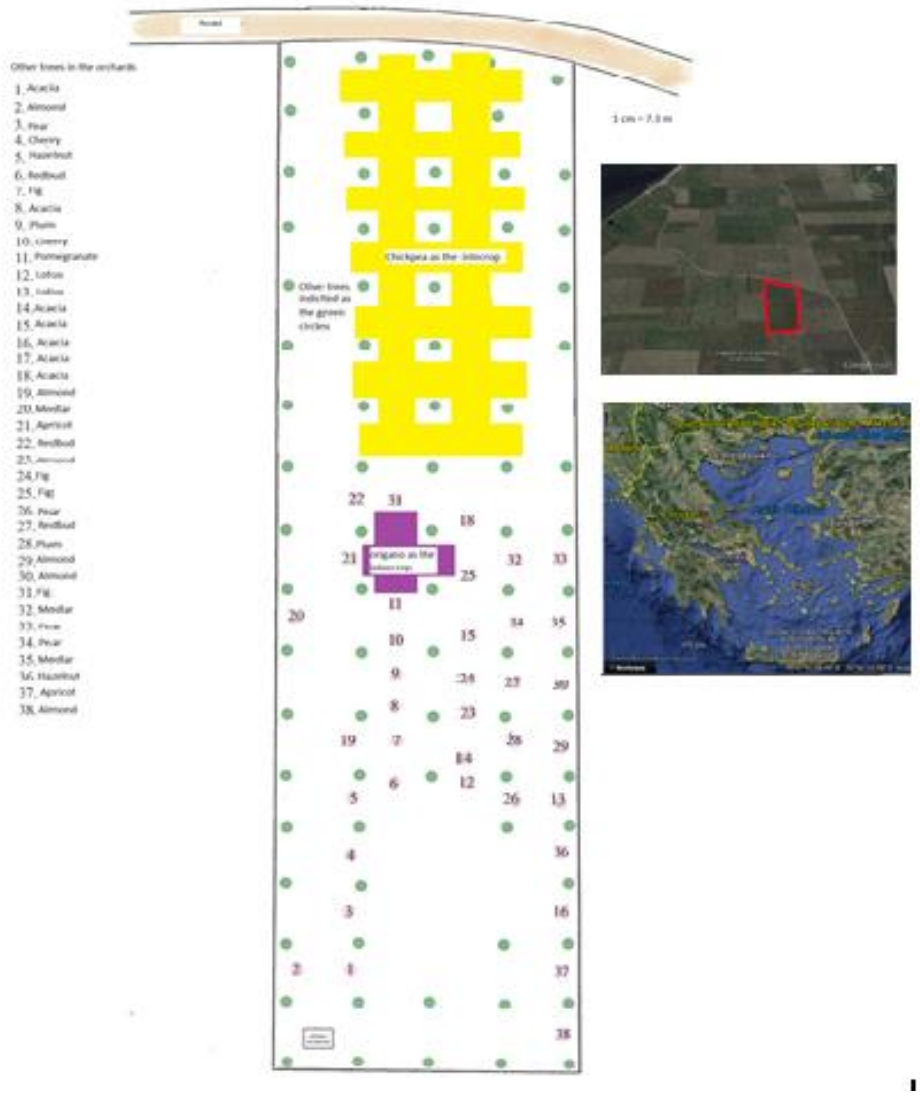

Figure 3. Schematic map of the experiment

Climate characteristics	
Mean monthly temperature	16.5°C
Mean annual precipitation	574 mm
Details of weather station	Hellenic National Meteorological Service, Station of Lamia, data from 1970-1997. There are rarely spring frosts
Soil type	
Soil type	Luvisols
Soil depth	≥ 1 m
Soil texture	SCL Sandy-clay-silt
Soil pH	7.97
Aspect	East
Tree characteristics	
Species and variety	Olive tree (*Olea europea*), “Kalamon” and “Amfissa” variety
Typical olive production	100 kg tree^{-1}

Date of planting	1950
Intra-row spacing	10 m
Inter-row spacing	10 m
Tree protection	None
Typical increase in tree biomass	Not available
Crop understory characteristics	
Species	Chickpeas (*Cicer arietinum*) and oregano (*Origanum vulgare*)
Management	Conventional arable crop management with ploughing
Typical crop yield	Chickpeas: approx. 2 t ha^{-1}; oregano 970-1800 kg ha^{-1} (Tzouramani et al. 2008)
Fertiliser, pesticide, machinery and labour management	
Fertiliser	None to the trees of the experiment, but there was N fertilisation of the control trees
Pesticides	Copper sprayed
Machinery	Need for tractor access in crop alleys to allow soil preparation
Manure handling	None
Labour	For olive harvest
Fencing	No

5 Experimental design and treatments

The experiment involves three treatments with three replications, namely olive trees + chickpea, olive trees + oregano and olive trees alone as a control (Table 3). A 0.2 ha area was cultivated by chickpeas and will be with oregano. Another 0.2 ha of the orchards contains olive trees and other tree species and the rest are only olive trees and will be used as control. The experimental design is shown in Figure 3. The rows where chickpeas will be cultivated are 5 m x 60 m wide. The seed quantities were 80 kg ha^{-1}. In 2015, crop sowing was delayed until the first week of April due to the wet spring period. Oregano will be sown in spring 2016.

Table 3. Description of the two treatments and the control

Treatment A (Olives + chickpea)	**Treatment B (Olives + oregano)**	**Treatment C (Olives)**
Chickpea (5 m x 60 m)	Oregano	Control

6 Measurements – first results

The measurements taken in the two treatments in Table 4.

Table 4. Measurements at the site

Agroforestry component	Measurements	
Tree characteristics	Tree increment	It will be calculated at the end of the experiment using tree-ring analysis
	Trees canopy inside each experimental plot	To be included
	Two diameters of tree canopy in a cross form will be measured for each tree in m	To be included
	Tree breast height diameter	On average 0.5 m at the point that branches ramify
	Leaves examined for their nutrient content (five per tree)	To be included
	The height to the base of the tree canopy	To be included
	All measurements will be repeated at the beginning and at the end of the trial	
	Olive production with intercrop	7 kg tree^{-1}; 840 kg ha^{-1}
	Olive production without intercrop	7 kg tree^{-1}, 840 kg ha^{-1}
Crop characteristics	2015: Chickpea grown with olives	30 kg ha^{-1}. Even though the seeds established well (93%) and grew vigorously, final yields were poor due to the unfavourable spring weather (continuous rain) and rodent damage.
Soil characteristics	Soil pH	7.97
	Soil texture	Sand 59.2%, silt 24.0%, clay 16.8%
Management characteristics	Tree damage from machinery	None
	Dates of any field operations	Seeding on 4 April 2015 Weeding on 9 May and 29 June 2015
	Labour inputs	1400 € ha^{-1} (for seeding, weeding, watering etc)
	Transportation cost	350 € ha^{-1} (includes transportation to the field for all tasks by the farmer)
	Cost of fertilizer (Cu)	75 € ha^{-1}
	Pruning …	450 € ha^{-1}
	Total cost for 2015	2275 € ha^{-1}

In 2015, olive production was low due to the unfavourable climate conditions during blossoming stage. The yield from the olive tree was effectively the same in the olives & chickpeas treatment (which received no fertilizer) and the control olive treatment that received N fertilization. The level of chickpea production was minimal as the rain during the spring affected flowering and because of rodent damage

7 Acknowledgements

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