Lessons learnt: Silvoarable agroforestry in Greece

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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 field-, farm- and landscape scales, 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 in that it contains results of the studied innovations from one of the systems being studied within work-package 4 which focuses on agroforestry for arable systems. Together with other reports, this document will contribute to Deliverable 4.11 on lessons learnt from agroforestry for arable farmers. Similar reports exist for agroforestry of high nature and cultural value, agroforestry with high value trees, and agroforestry for livestock systems.

2 Trees with arable crops and grassland in Greece

The trees with arable crops and grassland in Greece stakeholder group forms a part of a wider Participative Research and Development Network (PRDN) within work-package 4 focused on agroforestry for arable farmers. The stakeholder group in Greece, as part of the wider PRDN, has addressed the following objectives:

I. to identify examples of the best practices, key topics and innovations to address these topics. Pantera (2014) reported the results of the initial stakeholder meeting which identified the key benefits of integrating trees with arable production as animal health and welfare, disease and weed control, timber/wood/fruit/nut quality and production; the key negative aspects were identified as labour, management costs, losses by predation and mechanisation.

II. to agree and implement within the PRDN an experimental protocol to develop and test proposed innovations at existing experimental plots or through on-farm experiments. This was the focus of the report by Mantzanas et al. (2015) who identified four technical questions related to crop yields, nutrient use, and the effect of crops on tree establishment.

III. to describe a new system with walnut and common beans and investigate new intercrops with aromatic plants. This was completed for the site of Sissani, Voio by Mantzanas et al. (2016) in a system report on silvoarable agroforestry in Greece.

Silvoarable agroforestry covers about 2.2 million hectares in the EU corresponding to about 0.5% of the territorial area. The largest areas of silvoarable agroforestry in the EU are found in Italy, Greece, and Spain (Den Herder et al. 2015). Traditional silvoarable systems can be found all over Greece and cover about 1 million hectares (Papanastasis et al. 2009) but modern systems are rare and are mostly experimental. Agroforestry is a traditional land use system in Voio in Northern Greece, where farmers integrate agricultural production with high value tree species on the same piece of land. The area is characterized by fast growing species (poplars) and walnuts planted inside or at the edges of small farms where dry beans and cereals are cultivated or pastures are established for grazing.

Walnut trees are combined with grapevines, cereals, lucerne, vegetables or dry beans in traditional silvoarable systems (Mantzanas et al. 2006). According to Papanastasis et al. (2009) walnut is a commonly cultivated tree species in the sub-Mediterranean and mountainous Mediterranean zones of Greece. It is planted on arable land either in pure stands or more commonly within arable fields or on their borders, alone or in mixture with other trees. It is usually combined with several crops, especially vines and cereals. In the former case it is a form of silvoarable agroforestry; in the latter it is an agrosilvopastoral systems that includes livestock grazing after the harvest of the cereals. It is rarely used to establish pure silvopastoral systems. Walnut trees are used for nut production, high quality timber, and fuelwood.

3 Objectives

The research site comprised of two arable plots. There was a 0.6 ha site planted with walnut trees (*Juglans regia*) at the end of March 2015 which is intercropped with common beans. There is also a 0.4 ha site planted with cherry trees (*Prunus avium*) and it was intercropped with aromatic plants (spring period). The experimental work sought to answer the following questions:

- How does agroforestry affect crop yield?
- How does crop affect trees at the establishment phase?
- What is the tree root distribution and how do tree roots interact with crop roots during the vegetation period?
- How does agroforestry affect nutrient cycling?

This report focuses on the first two questions because the studied trees are still young and their root system is relatively small with an anticipated low effect on nutrient cycling.

4 Methodology

The research site is located in the village of Sisani, Voio, Western Macedonia, Greece. The area is characterized by fast growing species (poplars) and walnuts planted inside or at the edges of small farms where dry beans and cereals are cultivated or pastures are established for grazing.

Descriptions of the case study systems are provided in Table 1. The two systems (walnut trees intercropped with beans and cherry trees intercropped possibly with aromatic plants), are managed by a young farmer. The total area that the farmer cultivates is 2 ha including the above systems. The bean cultivation is very labour-intensive from the preparation of the plot (from mid-April) until the bean harvest (mid-November). The farmer does all this work by himself in order to reduce production costs.

Table 1. Description of the specific case study system

Specific description of site	
Area	1 ha (trees were established in March 2015)
Co-ordinates	40°26’10.56’’N and 21°29’39.56’’E
Site contact	Kostas Mantzanas
Email	konman@for.auth.gr
Example photograph	

Figure 1. Beans planted between walnut (autumn 2015).

Figure 2. Beans planted between walnut (summer 2017).

Aerial photograph of systems

Figure 3. Aerial photograph showing the layout of the walnut-bean system (Plot 1).

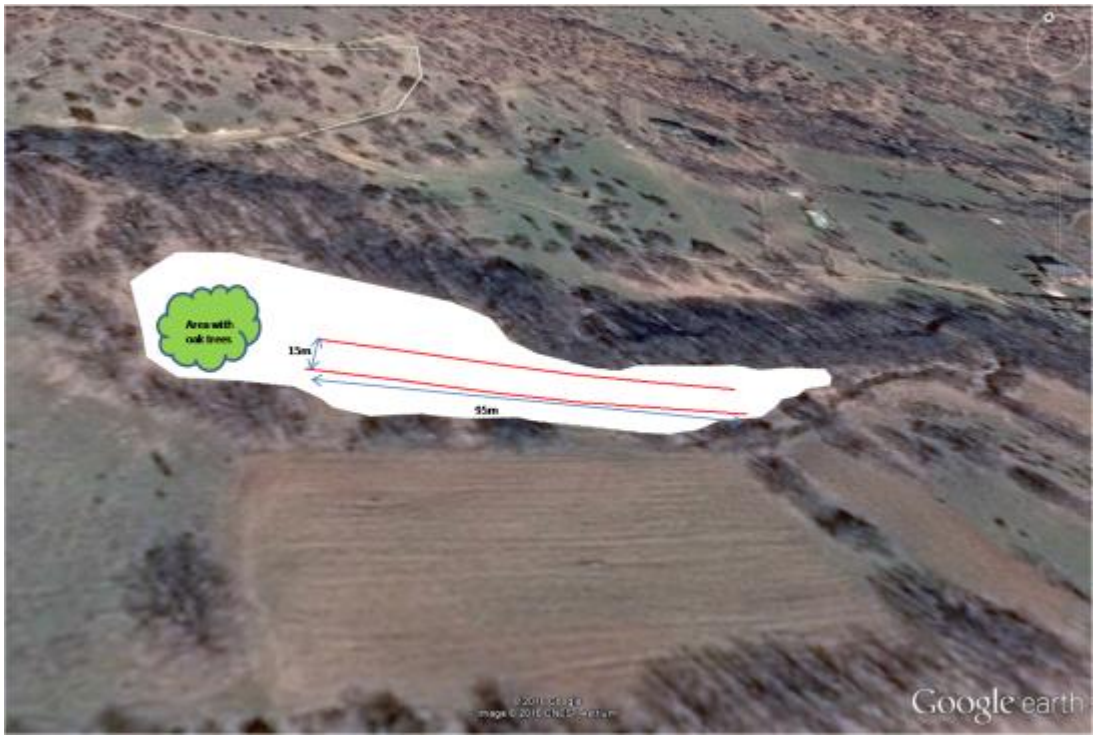

Figure 4. Aerial photograph showing the layout of the cherry trees plantation (Plot 2).

Climate characteristics	
Mean monthly temperature	12.9°C
Mean annual precipitation	508 mm
Details of weather station	Hellenic National Meteorological Service, Station of Kozani, Data from 1955-1997
Soil type	
Soil depth	Approximately 0.7 m
Soil texture	Sandy silt
Additional soil characteristics	pH: 5.58 Organic matter: 3.73%
Aspect	Northwest – Southeast
Tree characteristics	
Species and variety	Plot 1: Walnut (*Juglans regia*) Plot 2: Wild cherry (*Prunus avium*)
Date of planting	Early spring 2015
Intra-row spacing	5 m
Inter-row spacing	15 m
Tree protection	Tubex
Crop understory characteristics	
Species	Plot 1: 1. Common beans (*Phaseolus vulgaris*)
	Plot 2: 2. Lavender (*Lavandula angustifolia*)
Management	Conventional arable crop management with ploughing
Typical crop yield	Common beans (1-1.5 t ha^{-1})
Fertiliser, pesticide, machinery and labour management	
Fertiliser	None
Pesticides	None
Machinery	Need for tractor access in crop alleys to allow soil preparation
Manure handling	None
Labour	Trees: replacement of dead trees and tree line management for weed protection Crops: the management and harvesting of crops is done by hand
Fencing	None, but is necessary in order to protect trees from livestock and wild animals

5 Results

5.1 Tree growth

In the 0.6 ha plot (Plot 1), three tree rows were established with an inter-row distance of 15 m (Figures 2 and 3). The tree distance within the row is 5 m. In total, 54 walnut trees were planted. The mean height of trees was 0.50 m and the mean diameter (measured at a height of 20 cm) was 15 mm at the establishment phase. The walnut tree height and diameter 18 months after the establishment were 1.1 m and 19 mm respectively (Figures 5 and 6).

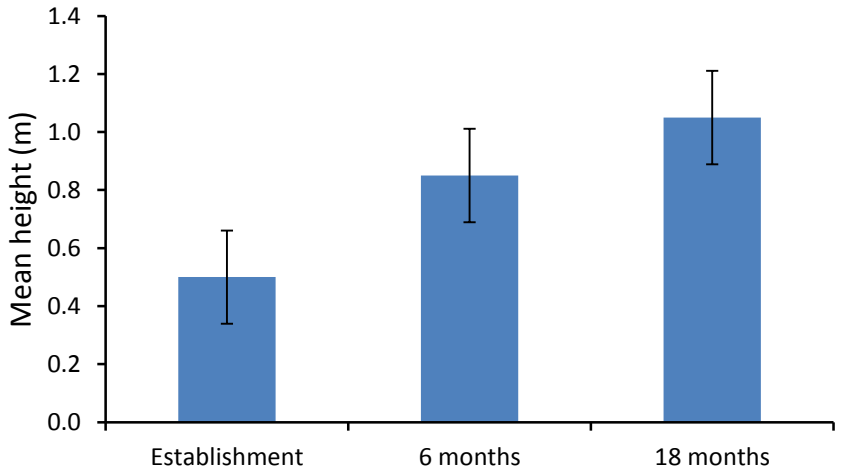

Figure 5. Average height (m) of walnut trees 6 and 18 months after the establishment (n = 54). Error bars represent the standard error.

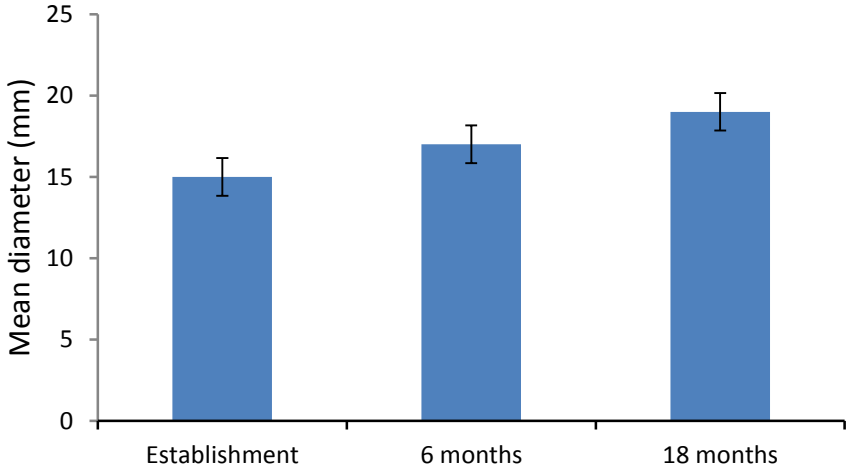

Figure 6. Average diameter (mm) measured at the height of 0.2 m of walnut trees 6 and 18 months after the establishment (n = 54). Error bars represent the standard error.

In the 0.4 ha plot (Plot 2), two rows of cherry trees were established at the same inter-row (15 m) and intra-row (5 m) distance as the first plot. In total 40 trees were planted. The mean height was 2 m and the mean diameter (measured at the height of 0.2 m) was 20 mm at the establishment phase. During the first year of the establishment only 20 cherry trees survived. The main reason was the drought that occurred in the months after planting. The soil depth is about 50 cm and although the soil was wet at planting in March 2015, the months after tree planting were very dry. The dead trees

were replaced in March 2016. In the summer of 2016 several trees (close to 20%) were damaged by wild animals (based on the farmer's assumptions these were bears and wild hogs) since the plot was not fenced (Figure 7).

Figure 7. A cherry tree damaged by wild animals

5.2 Crop yield

The 0.60 ha plot was intercropped with common beans (*Phaseolus vulgaris*), which were sown on 15 May 2015 and harvested on 10 November 2015 (Figure 1). The yield was 1000 kg ha^{-1}, lower than the average for the area which is about 1500 kg ha^{-1}. The lower yield was probably due to a lack of fertilizers and pesticides application. It was the farmer's decision not to use any fertilizers and pesticides. In the following two years the production was higher, close to the average of the area, after fertilization with monopotassium phosphate 0-52-34 (300 kg ha^{-1}). Although the original plan was to plant the second plot with roses in the spring of 2016, it was planted with lavender in March of 2017. The lack of weed and irrigation management in the spring and summer periods resulted in low growth of the lavender plants (Figure 8).

Figure 8. Lavender plants among weeds in the second plot

6 Lessons learnt from the trial

1. Intercropping of walnut trees and common beans is a traditional system in Voio Municipality where the plots are small (less than 1 ha) and trees are arranged at the edge of the plots. Modern agroforestry systems with the above combination could be established in larger plots with the appropriate management.

2. Successful intercropping requires farmers to be experienced or well-trained. Tree management needs also time and labour inputs for optimum results.

3. It is important that fields where modern agroforestry system are established are fenced or well protected to minimize damage from wild and domestic animals. In addition, a soil analysis is needed before tree planting to avoid unexpected problems in trees and crop.

4. Farmers should be aware that additional treatments have to be applied to both crops and trees in order to increase the productivity of this system. For example, trees need watering in summer period the first 2-3 years of establishment in dry areas.

7 Acknowledgements

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