Lessons learnt: intercropping of orange groves in Greece

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Deliverable	Contribution to Deliverable 3.8 Lessons learnt from innovations within agroforestry within 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.

This report contributes to the second objective. This report contributes to Objective 2, Deliverable 3.8 which is to describe the lessons learnt from innovations within agroforestry with high value tree systems. Within the project, there were ten stakeholder groups focused on such systems (e.g. grazed orchards, intercropped and grazed olive groves and citrus orchards, and high-value walnut and chestnut plantations). This report focuses on a stakeholder group which focussed on orange production on the island of Crete in Greece.

2 Background

Of the global annual production of 80 million tonnes of citrus fruit, 19 million tonnes come from the Mediterranean and 1.1 million tonnes from Greece. Greek production of citrus fruit originates from an area of about 50,000 ha (500,000 stremma). Of this, there are about 38,780 ha of oranges (ELSTAT, 2015), with the rest being tangerines, lemon and grapefruit. In Crete, citrus cultivation covers 4500 ha, comprising 3300 ha of oranges, 340 ha of tangerines, about 300 ha of lemons and 70 ha of grapefruits. Greece is the 17th of the 121 orange producing countries contributing about 0.8 million tonnes of the world total of 71 million tonnes (FAOSTAT 2013).

In the past, farmers in the Chania area of Crete cultivated crops between citrus trees after pollarding. They also used cypress trees as windbreaks to protect the citrus trees from wind. However many farmers have removed the cypress trees from the windbreaks and have created monoculture stands of citrus trees with the objective of maximizing profit. Only a few farmers still intercrop between citrus trees. This practice can help ensure an economic return each year until the tree canopy fully develops and excludes any form of intercropping. Most of the intercrops are vegetables. After crown development the intercrops are sometimes replaced by poultry production.

3 Initial stakeholders meeting

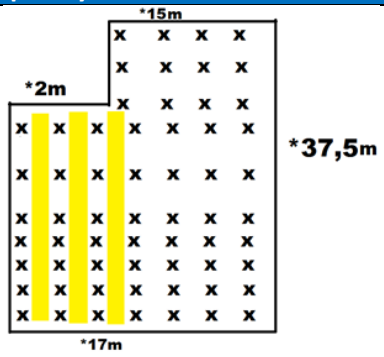
The first meetings of the 'Intercropping of Orange Groves in Greece" stakeholder group were held on 2 and 4 August 2014, at which the group identified examples of interesting or best practices that involved the intercropping of orange trees for increased income and soil amelioration (Pantera 2014). There were two separate meetings (Pantera 2014): one for intercrops and one focused on hedgerows. The first meeting, included five people, took place during a local festival for orange trees. Four described themselves as farmers and there was one policy maker. The second meeting in the village of Skine focused on cypress hedgerows and included two local agronomists.

The participants were asked to complete a brief questionnaire, which sought to highlight the key positive and negative aspects of orange intercropping systems. The rankings were ordered according to a scoring system described by Crous-Duran et al. (2014). The most positive aspects of orange intercropping included runoff and flood control, soil conservation, product quality, and the diversity of products and income. Respondents were environmentally aware since land conservation is important in the area. The qualitative answers indicated that the respondents were concerned with high land and product taxation. In the questionnaire, the key qualitative issues were trying to find new markets that would enhance the price of oranges. In the discussion that followed, the group identified the key issues and challenges that were related to agroforestry. This included the intercropping of aromatic herbs between orange trees as a potential best practice. As a result of this, one farmer agreed to trial the use of a nitrogen fixing intercrop, which he identified as an old traditional practice.

4 Objective, innovation and description of the study

The objective of the study was to increase the productivity and income from the orange grove by growing an additional nitrogen-fixing intercrop (chickpeas) that would enhance soil productivity. This could also help to reduce fertiliser inputs. The trial, fully described by Pantera et al. (2016), is described briefly in Table 1 and illustrated in Figure 1.

Table 1. Description of the orange intercropping study

<table>
<tr><th colspan="3">Reference</th></tr>
<tr><td>Reference:</td><td colspan="2">Pantera et al. (2016)</td></tr>
<tr><td>Innovation summary:</td><td colspan="2">A legume intercrop can improve soil health and produce food or animal feed</td></tr>
<tr><th colspan="3">Map of system</th></tr>
<tr><td colspan="2"> 
</td><td>A 0.2 ha area has been intercropped with chickpeas and potatoes. Each yellow line includes two rows of chickpeas.

Another 0.2 ha of the orchard contains orange trees and other tree species, and the rest are only orange trees that were used as a control. The trial design with the chickpeas is highlighted in yellow.

The trial is located in Western Crete (Google maps). More information about the system can be found here:</td></tr>
<tr><th colspan="2">Tree component</th><th>Understory component</th></tr>
<tr><td colspan="2">Orange (Citrus sinensis) represents the tree component. Local farmers have switched to different varieties, from local types to “Californian” and lately to the “faloforo” and “merlin” types. Presently “Valencia” is the predominant variety mainly used for juice. The harvest season for “Valencia” oranges lasts typically from March to July-August. Orange trees for juice production typically combine a clonal rootstock to give the tree a particular growth habit, and a clonal scion that determines fruit quality.</td><td>Chickpeas (Cicer arietinum) and potatoes (Solanum tuberosum)</td></tr>
</table>

Figure 1. Orange trees intercropped with leguminous plants (Photo A. Pantera)

Although the field study was focused on Crete, the intercropping of orange trees also occurs in other parts of Greece (Figure 2).

Figure 2. The intercropping between orange trees in Agrinio, prefecture of Aetoloarnania in Western Greece (Photo A. Pantera)

5 Results in 2015 and 2016

In 2015, orange production met the farmer's expectations. The yield from the orange trees was effectively the same in the orange and chickpeas treatment (which received no fertilizer) and the control orange treatment that received nitrogen fertilizer. There were minimal chickpea yields as the low rainfall during the spring affected flowering.

In 2016, even though the establishment and yield of the chickpeas was very successful the farmer preferred to cultivate the field and incorporate the chickpeas for soil amelioration. This could indicate that farmers are still reluctant to use chickpeas for production but rather familiar of using N-fixing plants as natural fertilizers.

In both years, orange production was similar in the intercropped site and in the control site. Chickpeas production was lower in the intercropped site and this was attributed to tree shading. However even this low production can provide an income to the farmer.

Some soil samples were taken (Papamichos and Alifragis 1985) to determine the level of nitrogen (Kjeldahl), phosphorus (Olsen), organic matter content (Loss on ignition) and pH (electrometric measurements). No statistically significant differences were found in any of the soil parameters tested between the orange trees with chickpeas not receiving any chemical fertilizer and the fertilised orange trees without chickpeas. There were only three replicates of each treatment, and this may explain the lack of a response.

6 Conclusions – lessons learnt

The following conclusions can be drawn from the study:

1. Production of orange fruits and orange juice are the primary objectives of the system. During a period when the orange crop canopy was incomplete, intercropping with a nitrogen-fixing crop was possible.
2. Intercropping with chickpeas can contribute to soil nitrogen content and reduce the requirements for chemical fertilizers.
3. Other nitrogen fixing intercrops for orange groves could be beans and peas.
4. The establishment of an effect of nitrogen-fixing intercrop on soil properties was limited by the small number of replicates (three per treatment). Results from other trials suggest that nitrogen-fixing species can necessitate additional phosphorus (Pantera et al. 2017).
5. Shading from the tree reduced intercrop yields, relative to an unshaded area, however the farmer can still benefit from growing an intercrop.
6. Even though the establishment and yield of the chickpeas was good in 2016, the farmer decided to cultivate the field and incorporate the chickpeas to improve the soil, rather than harvest them.

7 Acknowledgements

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