



Lessons learnt - Wild asparagus and other crops in olive orchards in Italy

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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 in that it focuses on the field-testing of innovations from one of the systems being studied within work-package 3, which focuses on “Agroforestry for High Value Tree Systems”. This report contributes to Deliverable 3.8: Lessons learned from innovations in agroforestry for High Value Tree systems.

2 Background

Over one million ha of olive (*Olea europaea* L.) orchards risk abandonment in Italy, since the low price of olive oil and the de-coupling of subsidies from production have reduced profitability. Since removing trees is illegal, the orchards risk large scale abandonment. Intercropping olive trees with economically viable crops, particularly high-value niche crops that are technically compatible with the olive cultivation, may be the best way to increase income from olive orchards, preventing their abandonment, and thus maintaining characteristic olive landscapes. The particular focus of this system is the intercropping of wild asparagus (*Asparagus acutifolius*), a species, which has an already established market for its spears, and naturally tends to grow in abandoned olive orchards. Other possible crops technically compatible with the olive cultivation, such as cur flowers (tulips and daffodils) are considered. Grazing animals, particularly chickens, are proposed as an additional source of income while providing weed control and fertilization, thus lowering costs and environmental impact of the orchard management.

2.1 Initial stakeholder meeting

The first meeting of the stakeholder group on 27 June 2014 was attended by 21 people. The meeting started at the CRA conference room in Spoleto, Italy, and included a field visit to an olive agroforestry system with poultry grazing. This was followed by a field visit to the experimental farm of CRA, where wild asparagus have been intercropped in both a traditional and a super-high-density olive orchard, as well as in an open field without trees. The key positive aspects of the agroforestry system were thought to be soil conservation and animal health and welfare. Negative aspects included complexity and issues of mechanization. Potential innovations that emerged from the meeting are reported below.





The initial stakeholder report (Rosati 2014), the research and development protocol (Rosati and Mantovani 2015), and the system description report (Rosati and Mantovani 2016) provide background data on olive, asparagus and flowers intercropping in Italy, while an innovation leaflet (Rosati 2017) provides additional information on olive asparagus intercropping.

3 Objective, innovation and description

The overall objective of the study was to increase the productivity and income from the olive orchard, by growing additional crops (wild asparagus, flowers) under the trees. The three planned innovations were:

1. To develop best practices for growing wild asparagus and flowers in the olive orchard,
2. To assess the technical feasibility and the economic profitability of the asparagus intercrop,
3. To evaluate production and water conservation.

The system, fully described by Rosati and Mantovani (2015b), is described below:

	
<p>Map of the three systems 1) Super-High-Density olive orchard-asparagus-bulbs, 2) asparagus-bulbs system in an open field, 3) Traditional olive orchard-asparagus-bulbs system.</p>	<p>Wild asparagus intercropping in traditional olive orchard (Picture A. Rosati)</p>
	
<p>Olive-asparagus-bulb system in traditional olive orchard system (Picture A. Rosati).</p>	<p>Olive-asparagus-bulbs system in open field control plot (Picture A. Rosati)</p>
<p>Tree component</p>	<p>Crop/understory/animal component</p>
<p><i>Olea europea</i>, multiple varieties established in 2007. The super-high density system had intra row spacing of 4 m whereas the traditional system 5 m. Super-high density system has intra-row spacing 1.5 m; traditional system 3.5 m. The systems are fenced by wire mesh for protection. Fertilizers: 100 kg N ha⁻¹ (as ammonium sulphate).</p>	<p><i>Asparagus acutifolius</i>, <i>Narcissus</i> L. var. Tete à Tete, Johann Strauss, King Alfred, Ziva Paper withe, and <i>Poeticus Recurvus Tulipa kaufmanniana</i> R. Var. Giuseppe Verdi. Wild asparagus were established in 2014. The bulbs were established in 2015 at 1300 kg ha⁻¹ a⁻¹.</p>

4 Results

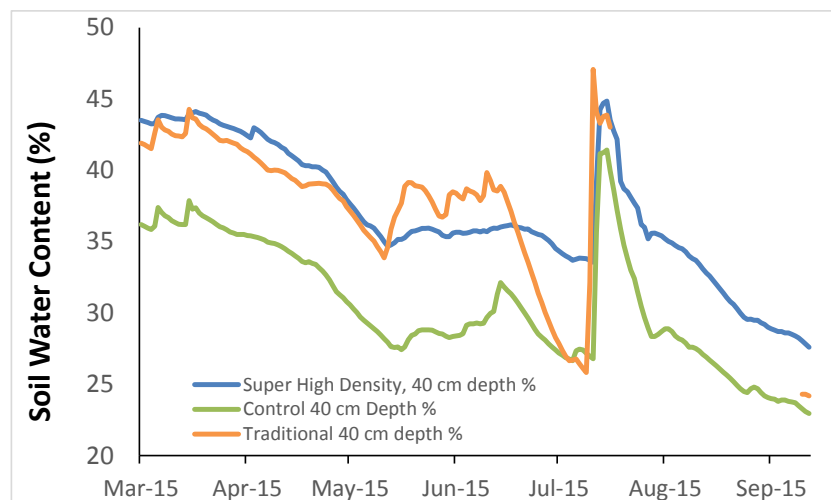
The results indicate that photosynthetic rates of the wild asparagus, previously unknown, appear to be similar to those of cultivated asparagus. The wild asparagus appears to have high tolerance of high temperatures, with an optimal temperature of about 30°C and positive photosynthetic rates up to 45°C. The light transmitted through the olive trees and available to the asparagus, was about 40% in the traditional orchard and about 46% in the super-high density. This was due to the hedge-like shape of the super-high-density systems where the small trees do not intercept most of the light incident over the inter-row during the most sunlit hours of the day, unlike the trees in the traditional systems where the much bigger trees have an almost complete canopy cover. In fact, the spatial variation in the super-high-density treatment was much greater with the proportion of transmitted light ranging from 24% under the tree rows, to 62% between the rows (the range was only 36-50% in the traditional system).

Asparagus growth and productivity was greater in the open field control, than within the olive orchards, indicating that the effect of greater light availability was more important than the effect of higher temperatures and evapotranspiration, despite the fact that soil moisture was higher under the trees (Figure 1). Thus within an olive orchard, positioning the wild asparagus where light availability is greatest is likely to result in higher yields.

In traditional orchards the light under tree canopy is relatively uniform and asparagus can be planted anywhere where it is convenient. In super high density orchards, light levels and asparagus growth is highest in the middle of the inter-row, while asparagus growth is limited in the dense shade under tree lines. As a drought-resistant plant, wild asparagus can be grown under the olive orchard with no additional water, increasing the water use-efficiency. In fact, the soil water content was higher under the shade of the trees, suggesting that trees obtained their water from deep soil layers, while their shade reduced evaporation from the surface layers, thus probably allowing the wild asparagus plants to access more water from the top soil, with their superficial roots.

Figure 1 shows the soil water content at 40 cm of depth, along the asparagus row, either under the tree row of the super-high-density orchard, in the traditional orchard, or in the open field control. Soil humidity was always higher under the olive trees.

Figure 1. Effect of the presence of super high density olive trees, a traditional olive system, and the open field control on the soil water content from March to September 2015. Data are from one sensor (SM150T, Delta-T Devices) per system, placed in the middle of the plot. The sensors provided gravimetric soil water content, after specific soil calibration.



Asparagus yield could not be evaluated during the first two years because asparagus spears cannot be harvested before the plant is at least 2-3 years of age. Preliminary data has been collected in spring 2016 from plants that were 2 years old. In the same way that the yield is still to be evaluated, the labour requirement for planting and harvesting the asparagus is still to be determined. However, from previous experience on cultivating the wild asparagus (in open fields and not under the olive trees) the productivity can be estimated to be about 50-100 g/plant, or 1.5-3.0 tonne/ha. Preliminary data from this trial suggest that these values may be reduced somewhat (20-30%) under the olive trees, depending on the level of shade. However, preliminary data on quality evaluation, carried out during the last two years on the spears produced by the three systems, suggest that tree shade increases the proportion of the edible part of the spears, thus compensating, at least in part, the yield reduction in the shade.

More details on the olive asparagus system can be found in the system dissemination leaflet ([Rosati 2017](#)) and results were also presented by Mantovani et al. (2016) at the [Third European Agroforestry Conference](#) in Montpellier.



Wild asparagus plant ready to be transplanted in the olive orchard (Picture A. Rosati)

Wild asparagus plants transplanted in the olive orchard with plastic mulch (Picture A. Rosati)



Wild asparagus plants transplanted in the olive orchard with straw mulch (Picture A. Rosati)



Chickens can weed and fertilized both the olive trees and the asparagus plants (Picture A. Rosati)

Regarding growing flower bulbs in the olive orchard, it was noted that the narcissus and tulip vegetation appeared in the fall, after the time for olive harvesting. The flowers appeared between February and early April, while the vegetation dried and died by late April-early May. This appears to be compatible with field operations in the orchard, since olive harvest can be carried out before the bulbs' vegetation appears, thus the bulb cultivation poses no impediment to olive harvest, and the latter does not result in damage to the flower plants. Similarly, olive pruning can be carried out either immediately after harvest (i.e. before the emergence of the bulbs' vegetation) or in late April (this is a common practice where winter frost may damage olive vegetation and thus pruning is delayed until frost risk is over). In both cases pruning and bulb vegetation do not interfere with one another. It appears therefore that cultivating winter season bulbs in the olive orchard is technically feasible, allowing for integration of farmers income from olive orchard, while providing green soil cover during the winter (useful against soil erosion), and enhancing the landscape, with potential benefits to the farmers (for agri-tourism activities).

5 Main lessons

- High yielding olive trees need plenty of light and need to be spaced apart. Hence both traditional and super-high-density orchards intercept no more than 50-55% of the sunlight. The rest will fall on the ground and can encourage weeds. This light can be used by another crop which can increase the orchard productivity and the farmer's income. The understory crop must be adapted to shade. One possible crop is wild asparagus (*Asparagus acutifolius*) which is a culinary

specialty in the Mediterranean. The spears can be harvested and sold in local markets. Growing under the trees, the asparagus does not affect the olive yield.

- Growing the wild asparagus in olive orchards appears technically possible with no major concerns.
- Planting wild asparagus in the middle of the inter-row in super high density orchards needs to be evaluated based on the machinery available for weed control and olive harvest, otherwise the asparagus plants can be in the way. Planting them along the tree row is probably less productive, but poses fewer obstacles.
- Yield of wild asparagus may be slightly reduced under the olive trees, particularly where there is more shade (e.g. under the tree row in super high density orchards), but the edible (i.e. tender) part of the spear increases, at least partly compensating for the reduction in spear yield.
- Given the potentially high prices of wild asparagus spears, the income from their cultivation in the olive orchard can increase significantly the overall income from the orchard. However, the labour and the skills required to manage the intercropped orchard also increase.
- Narcissus and tulips appear to be good candidates for alternative intercrops since their vegetative cycle begins after olives are harvested in the autumn, and terminates in spring when it is still possible to prune the trees, thus not interfering with most olive orchard management practices. However, farmers intending to exploit this possibility should carefully evaluate the market possibility of such intercrops.

More about the results can be found at the following link, where a pdf file and a slide show are available: <http://train.agforward.eu/language/en/intercropping-of-olive-orchards-in-italy/>

A leaflet describing the cultivation of wild asparagus under olive trees is available here: [https://www.agforward.eu/index.php/en/intercropping-and-grazing-of-olive-orchards-in-italy.html?file=files/agforward/documents/leaflets/Olive asparagus innovation leaflet 28 Mar 17 .pdf](https://www.agforward.eu/index.php/en/intercropping-and-grazing-of-olive-orchards-in-italy.html?file=files/agforward/documents/leaflets/Olive%20asparagus%20innovation%20leaflet%2028%20Mar%2017.pdf). More information is also available in the reference list provided below

6 Acknowledgements

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7 References

- Benincasa P, Tei F, Rosati A (2007). Plant density and genotype effects on wild asparagus (*Asparagus acutifolius* L.) spear yield and quality. *HortScience* 42(5):1163–1166.
- Dal Bosco A, Mugnai C, Rosati A, Paoletti A, Caporali S, Castellini C (2014). Effect of range enrichment on performance, behaviour and forage intake of free-range chickens. *Journal of Applied Poultry Research* 23: 137–145; doi: 10.3382/japr.2013-00814
- Mantovani D, Benincasa P, Rosati A (2016). Olive (*Olea europaea* L.) and wild asparagus (*Asparagus acutifolius* L.) agroforestry system: asparagus performance and its best positioning in the olive orchard. In: Book of abstract 3rd European Agroforestry Conference, Montpellier, France, 23-25

- May 2016. ISBN: 978-2-87614-717-1, EAN: 9782876147171. Pages: 229-231.
http://www.agroforestry.eu/conferences/III_EURAFConference
- Paolotti L, Boggia A, Castellini C, Rocchi L, Rosati A (2016). Combining livestock and tree crops to improve sustainability in agriculture: a case study using the Life Cycle Assessment (LCA) approach. *Journal of Cleaner Production* 131: 351-363.
- Rosati A (2011). Asparagi nell'oliveto e la produzione raddoppia. *Olivo e Olio*, 7/8: 20-24.
- Rosati A, Concezzi L, Dal Bosco A, Mugnai C, Paoletti A (2012). Video related to the results of a project on Olive, chickens and wild asparagus: www.youtube.com/watch?v=ALw73WwUr2o/
- Rosati A, Castellini C, Dal Bosco A, Mugnai C, Paoletti A (2012). Manuale per la coltivazione consociata olivo, asparago selvatico, pollo rustico. Edizioni 3A-PTA. Researchgate: 10.13140/RG.2.1.3665.4805.
- Rosati A, Piottoli L, Cartoni A, Dal Bosco A, Castellini C (2014). Polli al pascolo nell'oliveto Risparmio a tutto campo. *Olivo e Olio*, 6: 4-7.
- Rosati A (2014). Dall'olio extra vergine d'oliva non si guadagna? Ecco strade alternative per ricavare reddito dall'oliveto. *Teatro Naturale*, 27 giugno.
- Rosati A (2014). Coltivare asparagi selvatici e allevare polli in un piccolo oliveto. *Vita in Campagna*, 12: 44-48.
- Rosati A (2014). Initial Stakeholder Meeting Report Intercropping and grazing of olive orchards in Italy. https://www.agforward.eu/index.php/en/intercropping-and-grazing-of-olive-orchards-in-italy.html?file=files/agforward/documents/WP3_IT_intercropping_olives.pdf
- Rosati A (2015). Per fare reddito nell'oliveto può essere utile tornare alla consociazione. Il futuro è l'agroforestry. *Teatro Naturale*, 29 settembre.
- Rosati A, Boggia A, Castellini C, Paolotti L, Rocchi L (2015). Polli nell'oliveto, anche l'ambiente ci guadagna. *Olivo e olio*, 6: 4-8.
- Rosati A, Mantovani D (2015a). Research and Development Protocol for the intercropping of olive orchards in Italy. https://www.agforward.eu/index.php/en/intercropping-and-grazing-of-olive-orchards-in-italy.html?file=files/agforward/documents/WP3_I_Olives_intercropping_protocol.pdf
- Rosati A, Mantovani D (2015b). System report: Intercropping of Olive Orchard in Italy. https://www.agforward.eu/index.php/en/intercropping-and-grazing-of-olive-orchards-in-italy.html?file=files/agforward/documents/WP3_I_Olives_intercropping_system_description.pdf
- Rosati A, Boggia A, Castellini C, Paolotti L, Rocchi L (2016). When chickens graze in olive orchards, the environmental impact of both chickens and rearing and olive growing decreases. . In: Book of abstract 3rd European Agroforestry Conference, Montpellier, France, 23-25 May 2016. ISBN: 978-2-87614-717-1, EAN: 9782876147171. Page: 362-364.
- Rosati A (2017). Wild asparagus in olive orchards. https://www.agforward.eu/index.php/en/intercropping-and-grazing-of-olive-orchards-in-italy.html?file=files/agforward/documents/leaflets/Olive_asparagus_innovation_leaflet_28_Mar_17.pdf