Interreg – IPA CBC
Italy - Albania - Montenegro
EUROPEAN UNION

CROSS BORDER OL

**CROSS-BORDER COOPERATION FOR SUSTAINABLE DEVELOPMENT AND TOURISM, THROUGH VALORIZATION OF RURAL CULTURAL HERITAGE AND CONSERVATION OF NATURAL ASSET OF AREAS WITH ANCIENT OLIVE GROVES**

# Best Practices for Conservation of Ancient Olive Groves


Agricultural University of Tirana - AUT

CIHEAM BARI

URBAN RESEARCH INSTITUTE

Park Authority of Venafro

Municipality of Bar

Association for Sustainable Regional Groves - Valdanos

*Authors:*
Experts and Work groups of Project Partners - Albania, Italy (Venafro), Montenegro
A. Lazaj – Centre of Transfer of Agriculture Technologies, Vlora, Albania
M. B. Forleo, S. Delfine - University of Molise, Italy
M. Knežević – Biotechnical Faculty, University of Montenegro
A. Elezaga, F. Cakuli, K. Hidrio, Valdanos Association, Ulqin (Ulcinj), Montenegro

*Collaborators:*
J. Calabrese, P. Zdruli, G. Ciola – CIHEAM Bari
E. Pesino, G. Cutillo, A. Rossi - Park Authority of Venafro, Molise, Italy
Xh. Cakuli – Association for Sustainable Regional Olive Farming Valdanos, Ulqin, Montenegro

*Coordinated by* P. Pasko and E. Dubla (CIHEAM Bari)

*Acknowledgments go to:*
B. Di Terlizzi and M. Semeraro for general coordination of the project (CIHEAM Bari)
F. Sallaku, E. Kullaj, I. Angoni, E. Demiraj, – Agricultural University of Tirana - Albania
E. Kocani, I. Janushi, E. Vokopola – Urban Research Institute, Albania
A. Živanović, M. Markoč Municipality of Bar, Montenegro and external experts D. Caković and D. Martinović

and to all field collaborators who participated in this project and made possible this publication

ISBN 978-2-85352-606-7

Published by CIHEAM Bari in the framework of the project "INTERREG IPA CBC ITALY-ALBANIA-MONTENEGRO PROGRAMME – Cross-border cooperation for sustainable development of tourism, through valorisation of rural cultural heritage and conservation of natural asset of areas with ancient olive groves

This publication has been produced with the financial assistance of the Interreg IPA CBC Italy-Albania-Montenegro Programme. The contents of this publication are the sole responsibility of all CBO partners (each for the part of their competence in relation to the relative chapters) and can under no circumstances be regarded as reflecting the position of the European Union and of the Interreg IPA CBC Italy-Albania-Montenegro Programme Authorities.

Agricultural University of Tirana - AUT
CIHEAM BARI
URBAN RESEARCH INSTITUTE
Park Authority of Venafro
Municipality of Bar
Association for Sustainable Regional Groves - Valdanos

Ancient olive groves can play a pivotal role in fostering the socio-economic development of a region, as long as they are part of a strategy that can enhance the specific features of the area and preserve its historical and natural landscape heritage, without overlooking production yields, economic sustainability and competitiveness of the olive-growing farms.

Ideally, olive farms should complement income from agricultural production with other activities and services, and interact with other businesses, including for instance tourism and culture. By doing so, they can offer a unique experience to visitors who wish to fully plunge into the local culture and appreciate all that shapes the beauty and appeal of a place, from nature to landscape, from history to local products and traditions.

With regard to the diversification of activities alongside agriculture, a farm can provide a number of services for tourism, such as trekking, hiking, cycle-trekking, guided tours to discover the history and nature of an olive grove, educational activities and food education. All of this is part of an experiential kind of tourism where contact with farmers is essential, as is learning about the cycles of agricultural production, taking part in the farm's activities, or being involved in the preparation of food and its tasting, all within a context that blends beauty with historical, cultural and nature value.

However, for this to happen, the olive groves shall be kept in good condition, adopting low-impact cropping practices (as detailed in the reports by the project's partners), but also preserving the structural elements of historical-cultural value and their nature and landscape components. This approach has a twofold effect because it

not only values the olive grove but also the area as a whole, with a strong positive impact on tourism. Reference is made, for example, to the care of dry-stone walls, terracing, aquariums, mule tracks and rural roads in rammed earth or cobblestones, and traditional rural buildings.

Cropping practices shall ensure that all the agronomic operations for the traditional management of the olive grove are kept, such as pruning that respects the original scaffolding of the tree, avoiding drastic cuts, preserving the monumentality of the canopy, respecting the proportion with the monumental trunk, albeit at higher costs than the management of a specialised olive grove. These additional costs will be compensated for by the exploitation opportunities that a monumental olive grove can offer, both as such and as an eye-catcher within a larger area.

This perspective is reflected in the growing awareness of citizens towards sustainability, contact with nature, authentic places, cultures and people, and the increasing demand for this type of tourism.

This is why the sustainable management of a monumental olive grove cannot be limited to rational agronomic management alone, but must be respectful of a number of apparently demanding elements, which make rural olive-growing areas more appealing and competitive on the market. This helps to generate an income directly and indirectly, both on the farm and in the surrounding area. In fact, this makes farmers active guardians of a stretch of land, with a social role, aware that their farm is a substantial component of a wider context, which they help preserve, safeguarding the value of the landscape.



URBAN RESEARCH INSTITUTE

**PROJECT DELIVERABLE**

| | |
|---|---|
| Project Partner | **LP Agricultural University of Tirana, PP 3 Urban Research Institute, Albania** |
| Work Package | **WP T 1 Identification and conservation of landscape with ancient olive trees and orchards (AOOs)** |
| Deliverable Code | **DT1.3.1** |
| Deliverable Title | **Common report on best practices to be applied by farmers for AOOs conservation and valorisation** |
| Date of submission | **Period 3** |
| Expert | **Dr. Adhurim Lazaj** |

# 1 Extended Summary

Evidence of olive processing dates back to the 6th century AD. The presence of olive tree specimens aged 1500 to 2500 years in many areas of Tirana, Kruja, Durrësi, Berati, Mallakastra, Vlora, etc. with a multitude of cultivars and populations, mostly found close to medieval castles and ruins of millenary civilizations, demonstrate how ancient olive cultivation is in Albania. Many ancient olive orchards (AOOs), cultivated following traditional environment-friendly practices, play an important ecological role, surrounded by a dense system of dry-stone walls where wild shrubs still survive. Such semi-natural habitats create structural conditions allowing the diversification of plant and animal species, some of them are resistant to climate change and can help local populations adapt to it. In our AOOs, a partial cover crop is applied where spontaneous vegetation covers the whole orchard except for under the tree canopy. Mown grass is left on the field as mulch adding more organic matter but also conserving scarce water reserves in the soil. AOOs with low vegetation under the olive canopies reduce the force of rain drops and soil erosion. Another traditional technique used by olive growers is in-situ corral manure. Of particular interest is the cultivation of olives in the so-called "eyebrows" (half-moon). This technique consists in building "eyebrows" with stones or earth mounds on the lower side of the slope to create small terraces. These "eyebrows" retain a lot of nutrients leached downhill as well as leaves and other decayed plant material. Another best practice is the construc-

tion of terraces from dry stones (without using mortar). In cases of high intensity of erosion and in more degraded sites, olive growers have used other measures to establish protective belts using random objects. Another best practice in establishing and successfully managing AOOs is drainage of surface and underground waters. The typical methods applied by olive growers in AOOs consist in drainage of waters through drainage canals and construction of a drainage network in waterlogged prone areas. AOOs are managed as low-input agricultural system. A particular experience found in our AOO is the reduction of the olive fruit fly by the pasturing of turkeys in olive orchards. No herbicide is applied in AOOs. In the selected AOOs, instead of soil tillage, spontaneous plants are mowed at a height which slows down the sprouting of vegetation which will take place when the climate conditions of the crop are more favourable. Mowing is done at a height of 5 - 6 cm from the ground as to create a mulching layer which reduces the water losses by direct evaporation from the soil.



# 2 Introduction

The history of olive growing in Albania goes along the evolution toward a major source of income for rural communities similar to all countries in the Mediterranean basin. Present-day olive growing in Albania is a mastery developed by predecessors, the famous Illyrians. Olive stones have been found in several archaeological excavations. Evidence of olive processing dates back to the 6th century AD. Presence of olive specimens aged 1500 to 2500 years in many areas of Tirana, Kruja, Durrësi, Berati, Mallakastra, Vlora, etc. with a multitude of cultivars and populations, mostly found close to medieval castles and ruins of millenary civilizations, demonstrate how ancient the olive cultivation is in Albania. Their resilience is not only due to adaptation to environmental conditions but also due to the culture and particular attention of the communities towards this plant by improving their knowledge and consequently the cultural practices applied in centuries.

Continued developments of olive cultivation in Albania were experienced during the Byzantine period (5th to 11th century AD), especially in the hilly and pre-mountainous areas. There are historical records indicating olive oil was one of the main commodities traded through the Albanian Vlora harbor to Italy since the 5th century.

With the fall of the Roman Empire and subsequent wars with continuous military campaigns, olive growing was abandoned due to the large-scale devastation of plantations, especially in the coastal areas and deep valleys (15th – 16th centuries). Since those times, as

an incentive to raise the interest in olive growing, Albanian farmers have always had the right to plant olives in state-owned lands. The rules of the time gave the right to own the trees but not the land. The Albanian government provided negligible incentives to olive growing following independence in 1912. Thus, the number of trees increased from 1.1 million in 1939 to nearly 1.5 million in 1945.

Through the implementation of centralized economic planning as well as "voluntary" work, an army of students, volunteers and farm operators were involved under scientific supervision to grow olive trees. Many state olive farms were established in suitable regions. In addition to expansion of the olive area, the actions also included management issues related to old olive orchards. However, despite the high level of human effort and financing, the development of the olive sector was slow due to poor organization, difficult land, and use of unskilled and underpaid workers and lack of marketing, all leading to low yields in the new olive plantations. However, within three decades (1960s to 1990s) the olive area almost tripled from 17,000 ha to 45,000 ha, with yields improving from 7 to 17 kg/tree on average. At that time, olive trees were occupying 6% of arable land. During this period, the maximum recorded olive oil production was 5,048 tons in 1983. Olive oil consumption per capita was extremely low as it was consumed as a medicine. That is why the Albanian people are still willing to pay a premium price even today.

At the beginning of the 1990s, with the advent of market economy, a good part of olive plantations was abandoned due to inefficiency, population emigration and land clearance to open construction sites. Fragmentation of olive farms into very small properties has





caused neglection of this wealth. Youth emigration left the olive orchards culturally unmanaged, with competition of various shrubs and vegetation while under the threat of bush fires. Sadly 10,000 ha of olive orchards were abandoned or destroyed, including the construction of hotels and houses in the Southern Riviera. However, from 1992 to 2008, a total of 2 million new trees were planted in small parcels on hilly soil in an attempt to compensate for low yields and alternate bearing. There has been an overall yield improvement, even with alternate bearing (40,000 tons in 2006, 27,000 tons in 2007 and 56,000 tons in 2008). Nevertheless, more than 50% of the current olive trees do not receive cultural practices; therefore, the production is spontaneous and natural. 100% of the operations are done by hand making them very difficult and increasing the production costs. Existence of centuries-old olive orchards in 1/3 of its surface in addition to the marginal areas creates very high costs.

After 2000, olive growing has been improved in terms of cultivation technology, mainly 5 million plants were planted after 2008. Improvements have been remarkable also in the processing industry with modern lines which have drastically increased the production but more importantly, the quality of olive oil. Currently, Albania has more than 10 million olive trees with a production capacity of 95,000 – 110,000 tons of olive and 7,000 – 11,000 tons of olive oil. Olive trees occupy about 60,000 ha or 8% of arable land, distributed in 120,000 small farms. The value of production is about 30 million €. Labour for cultural practices and harvest accounts for 1 million working days. These indices demonstrate the importance of olive in the socio-economic aspect as well as in terms of landscape.

Albania has more than 1.7 million centuries-old olive trees most of them located around Tirana and Vlora. Most olive orchards are located in hilly and mountainous areas, raising problems for timely harvesting, handling and processing. The results of a national study on olives (2008) show that only 14% of olives trees are planted in a slope up to 15%. A part of farmers has chosen the option to make minimum expenses, i.e. only for harvesting leading to the degradation of olive orchards. Another part of olive orchards have been abandoned, as it is happening in the coastal area, the most productive olive-growing zone. The damage in this case is multifarious, not only for the financial value but also for the other segments of the sector i.e. processing and the whole value chain up to the consumer.

There are rare specimens of adapted olive populations existing in all of these areas, having high economic, environmental, social and breeding value. In many ancient olive orchards (AOOs), cultivated following traditional environment-friendly practices, these populations play an important ecological role, surrounded by a dense system of dry-stone walls where wild shrubs still survive. Such semi-natural habitats create structural conditions allowing the diversification of plant and animal species, some of these AOOs are resistant to climate change and can help local populations adapt to it.





## 2.1 Identification of Good Agricultural Practices in 3 AOOs

The expert has identified Good Agricultural Practices (GAP) associated with the cultivation of olive in the AOOs selected by the Olive Growing Expert. In terms of methodology, the Expert has referred to the experience of CIHEAM – IAMB shared, published and applied in several cooperation projects, in which replicability has been proved. Following a series of visits and meetings in each AOO, the Expert has looked for traditional or modern practices related to soil management, protection of olive trees from pest and diseases, erosion, or related to harvest, postharvest and processing. In particular, the Expert has identified low impact agricultural practices that contribute to spreading the culture of high-quality olive oil and promotion of rural activities related to tourism. The Expert has cooperated with other local experts, old olive growers and other stakeholders for data to be representative and as exhaustive as possible. These practices have been listed to produce a report on the best practices for the conservation of AOOs landscape, a useful tool to be shared with stakeholders toward a better sustainability of the practices also in other areas having same contexts; it can represent an example of participatory approach used to set rules of management of agricultural areas.

The selected AOOs belong more or less to the same age and are managed with the same cultural practices. They are found in the same cultivation belt and are truly representative of centuries-old olive groves in the country. The areas have a typical Mediterrane-

an climate characterized by hot summer and a mild and wet winter. Hills are not higher than 500 m and being close to the sea benefit from its buffering effect.

## 2.2 AOO of Ndroq

The selected AOO in Ndroq is part of a very old massive at an altitude of 367 m, in the South of Erzen river. Ndroq administrative unit is located in the valley crossed by Erzeni river, in the middle of the road between Tirana and Durrës. Ndroq has 9356 inhabitants organised into 2571 families. Its neighbourhoods are scattered in a series of hills covered with olive trees. The old village of Ndroq is further south. It is first mentioned as the village of Androniks with 23 houses in an Ottoman register of Albanian Sanxhak dated 1431-1432. The walls of this dwelling place were rebuilt during the barbarian invasions of IV – VI century. This area is highly civilized and constitutes the oldest testimony of olive cultivation because it contains a great genetic richness, cultures and different civilizations.

Out of 25,000 old olive trees more than 200 are very old and are found in Kërçukje, Sauqet, Grëblles and Varrosh. Some of these trees are close to the castle of Varrosh (Ndroqi) located on the top of the dominant hills (N 41°14'50" E 19°38'54"; 387 m). In the southeast of this Castle, there is a small neighbourhood with few inhabitants while in the past it was the largest neighbourhood. Old





stone mills demonstrate the ancient tradition of olive oil production which dates back to the Roman period. The history of olive cultivation is very ancient testified by the existence of very old specimens (estimated up to 3000 years old) and the hills fully covered with centuries-old olives.

There are 795 ha of olives in the Ndroq area out of which 682 ha are centuries-old olive groves on the hillsides of Ndroq, Grebllesh, Kërcukje, Sauqet, Shesh, Zhurie and Varosh villages. Most of the groves are planted in regular distances, on average 88 trees/ha in a steep soil. About 191 ha are planted in a slope of 15 – 20%, 543 ha in a slope above 25% and 28 ha in terraced hills. The average yield is about 22 kg/plant.

Inhabitants of Ndroq are well known farmers for the cultivation of olives, grapevine, fruit trees and vegetables. They have experienced the cultivation of olives and cooperate very well with olive processors. The quality of oil produced in the area is very high. There are 8 oil processors in the area of Ndroq.

## 2.3 AOO in Marikaj

Marikaj is one of the administrative units of Vora municipality, with a very favourable geographical position and a considerable area planted with olive trees. Vora Municipality includes the city of Vora and the villages of Gjokaj, Mucaj, Sharkë, Marqinet, Gërdec, Marikaj and

Kuç. With almost the same surface as Tirana, 41.9 km², it stretches in the western region of Albania, in the area between Lezha, Durrësi and Tirana, in the middle of Tirana – Durrës road, about 16 km from Tirana, 18 km from Durrës and 9 km from Rinas Airport. For its rich history and assets, Marikaj has been included in the first 100 villages for the development of agritourism. In the area of Marikaj we find the Mediterranean shrubs; it is well known for the hillside cultivation of olive, grapevine, peach, apricot, dogwood, plums, pomegranates and citrus.

The total surface planted with olive trees is 806 ha out of which 155 ha are with centuries-old olive trees (86 ha only in Marikaj). They are planted in soils with slopes above 15%, with an average yield of 27.5 kg/plant and an average density of 80 trees/ha. The selected AOO in Marikaj is part of a very old plantation. The local inhabitants have named it "The Scanderbeg's Olive Orchard" which refers to the time of plantation, more than 500 years ago.

## 2.4 AOO of Preza

Preza is one of Tirana's most ancient villages located north-west of Tirana.

This area is very ancient, and this is demonstrated by some places, such as the castle and some places that still keep the same name as its origin.





It is known as the Fenix city because of its ruins and reconstructions over the centuries. Its existence dates back 2000 years with the construction of the castle. Until the end of the 20s of the XX century, Preza was the administrative centre of 15 villages surrounding it. On both sides of the road to Preza, there are green areas and clean air. The dominant landscape is agricultural with a mixture of arable fields, fruit plantations and olive trees. Preza has a good infrastructure and is visited by many tourists. Centuries-old olive trees are found everywhere in Preza village. Out of a total of 17 ha, there are about 8 ha of very ancient olive groves, mainly on steep soils, in some cases terraced. Olive plantations have an average density of 120 trees/ha, with an average yield of about 25 kg/plant.

The selected AOO in Preza is part of a very old plantation around the castle of Preza on a rock that extends in a north-south direction. In practice, the plantation consists of more than 1000 trees, selected in ancient times for landscaping, economic and fortification purposes. There are 25 of the oldest specimens in Albania and the Mediterranean.

# 3 Good Agricultural Practices in 3 AOOs

The three areas represent some of the oldest olive-growing sites in Albania in Tirana region which demonstrates how old olive growing is in these areas, including agronomic techniques. Olive growers have inherited many good agricultural practices. Furthermore, the current management of these orchards can be classified as low impact. Although there are no substantial differences from practices applied in neighbouring countries, yet there are certain cultural practices which differ even between AOOs. Evidence of best practices applied in the three selected AOOs, including the complexity offered by the current perspective, not only helps to enhance the value of these natural monuments but also serves as a valuable technical tool for all the operators of this sector.

First of all, these AOOs are of great importance and interest as genetic resources. Most of them are already known for the quantity and especially the quality of fruit and oil. With their genetic variability, with well-known and lesser known genotypes, in addition to the production value, they have high value for the conservation of biodiversity. Many trees, that in most cases are abandoned and exposed to degradation factors suffering chronically from lack of cultural care, continue to vegetate and produce (abundantly in some years). Ancient olive trees are an invaluable asset for new plantations and under climate changes. Olive growers in these AOOs grow local varieties by associating cultivars which are compatible in terms of cross pollination. They have included even inferior cultivars in terms of production and quality but with the purpose of improving the production of the main cultivar. This old knowledge is inherited in our three AOOs. The main cultivar 'Ulliri i Bardhë' (white olive) is found associated with Olivaster, cv. 'Ulliri i Zi' (black olive), cv. 'Ulliri i Kuq' (red olive) and in Preza AOO also with cv. 'Kushan'. The Red Olivastër of Tirana is found almost in all ancient olive orchards of Tirana and Durrës. In other olive groves in our country, these olive trees are not planted in a monovarietal pattern. In general, one cultivar is dominant, but others are present as pollinators, and, depending on the olive grove, may account for up to 30% of the total trees.

Ancient olive orchards are adapted and show a high resilience to unfavourable climate conditions. Changing climate and soil conditions have resulted in many cultivars introduced at different times not performing as expected. Even the displacement of autochthonous cultivars outside their typical growing areas has not always led to good yields.

Selection of the best cultivars from these AOOs and their propagation to be used for new plantations constitute a guarantee for their adaptability to the environmental conditions of the area and at the same time is a continuation of the production of typical and quality products. This does not mean that we stop testing new cultivars highly appreciated on the international market and seem to be less adaptable, but the results will always be determined by a combination of genetic, environmental and cultural factors.

Agricultural technology interferes in various aspects of the com-

petition of crops in their environment and favours their maximum production. Application of best practices of olive growers in these AOOs has allowed to cultivate land and ensure food resources by improving the living conditions without modifying the landscape.
Agronomic techniques include various interventions on the soil and trees. They affect the biological activity of the soil which is related to the root system. Interventions on trees are linked to the cultural management to form and maintain a stable canopy, preserve a balance between the quantity and quality, protect the plant from pests and diseases and extend the production life. In such a multitude of interventions, an attempt was made to highlight the so-called agricultural best practices, which have a low environmental impact but a high impact on the quality of olive trees, and the promotion of activities linked to rural tourism.
The intensive use of agrochemicals in the soils and plants has not only damaged our health due to the products that we consume but has jeopardized the natural equilibrium and polluted the environment. Fortunately, there is an increased awareness not only of consumers who are keen to consume controlled products but also of producers to find solutions for the productivity and quality of their produce. These changes in behaviour have increased the efforts to select good agricultural practices and systems that are ecologically compatible with environmental and consumers' requirements.
These best practices apply to soil in olive orchards, their management (tillage, with natural or controlled vegetation, covered with shrubs, etc.), fertilization methods, fertilization timing, quantity and type of fertilizer, application of irrigation or not, pruning, protection





from pests and diseases, harvesting and processing of olives.
The cultivation of olive trees following best practices respects the principles of fertility conservation by using the most appropriate methods and equipment; control of erosion from shallow waters; application of fertilization based on plant requirements, natural fertility of the soil and losses; reduction of pesticide residues by choosing the qualitative methods of phytosanitary protection, by identifying pathogens and the correct methods to control them; timely and correct pruning; harvesting and oil extraction; conservation and marketing of oil under the right conditions.
Beside the above, we identified also best practices on the management of the landscape and natural resources of AOOs.

## 3.1 Soil management and fertilization

Most olive trees are located in sub-clayey soils, that are the most appropriate for olive trees. A good part of olive trees are located in stony and rocky soils. Although they do not damage the growth and development of olive trees, without periodical interventions to reduce the negative effects caused by these soils, it will reduce the production. Due to the soil, most of ancient olive orchards are not irrigable. Only 6,300 ha (10% of total hectares) are irrigable but this mainly refers to olive orchards planted in the last 15 years and for the moment do not have an impact on the total production.

The main objectives of soil management are proper plant development, to improve soil fertility, save non-renewable resources and reject the use of products which may contaminate the agro-ecosystem. In return, it will avoid losing soluble elements from leachates and water vapour, using synthetic chemical products, favouring water infiltration, it will preserve the activity of soil-inhabiting plants and animals and will control erosion. Fertility is the ability of the soil to guarantee good olive production on a regular basis. Soil management will depend on soil type, quantity of rainfalls, topology, etc. It consists in shallow tillage, soil cover and spontaneous flora management, erosion protection, drainage, fertilization, irrigation, etc.

In low-impact olive growing, the following techniques were applied:

- **Natural cover crops** – spontaneous plants covering the entire orchard except for around the trees.
- **Organic fertilization** – manure from the same farms is applied periodically depending on the availability and transportation costs.
- **Chemical fertilizers** – NPK is used every year applying 4 – 5 kg/tree.





### 3.1.1 • Cover crops

The use of cover crops, whether spontaneous or grown vegetation, is an alternative to soil management in olive growing. Cover crops help to control the erosion which is quite considerable because of steep slope and heavy rainfalls. Furthermore, cover crops improve the soil physical properties thanks to dense feeder roots which are spread in a uniform and deep manner according to the species. This practice has a great advantage in enriching soil fertility, maintaining soil structure in the long-term and conservation of biodiversity. In our AOOs, a partial cover crop is applied where spontaneous vegetation covers all the orchard except for under the tree canopy. Tap roots ease the deep penetration of water especially in the case of heavy rains. In our AOOs, cover crops are mechanically mowed when they become competitive with the tree for water considering that these olive orchards are not irrigated. Mowed grass is left on the field as mulch adding more organic matter but also conserving scarce water reserves in the soil. Since irrigation is not feasible, this permanent cover crop (repeatedly mown to reduce competition for water to the minimum) is the right solution to preserve the organic matter content in the soil.

It is considered that cover cropping favours the presence of beneficials which control insect pests, reduce soil compaction due to mechanical means, allows the development of olive roots also in the soil shallow layers, reduces nitrogen loss by leaching and consequently the risk of pollution of the deep layers of soil and water table. Moreover, it induces a better availability of phosphorus and

potassium along the soil profile which are immovable elements as well as eases harvesting. Cover crops are typical in biological olive orchards. When one wants to control the cover crops species, sowing is made in autumn, benefiting from the first rains to cover the soil as fast as possible.

**Figure 1.** View of natural cover crops in a AOOs





A best practice applied in our AOO is related to the mowing of grass. Farms mow grasses during the emergence of the ears while for legumes during flowering. This phenological phase in all AOOs corresponds with the onset of competition for water between the cover crops and olive trees. A good management of leguminous plants is one of the best methods to increase nitrogen in the soil.

Depending on the soil and climate conditions of the area, the lawn can cover all or part of the olive grove ground.

This method exploits the advantages offered by both soil management methods, cover crop or tillage.

### 3.1.2 • Organic fertilization

Organic fertilization is the practice of using manure, compost and other organic waste (cake from industrial processing, compost from pruning biomass, sawdust, cereal chaffs, various plant waste, peat, sewage sludge, etc.). This category includes also green manure applied mainly using leguminous plants (mainly fava bean), which is turned under at the end of March until the middle of April.

Organic fertilizers of all types constitute the basis for olive tree nutrition in AOOs, especially in the areas of Ndroq, Marikaj and Prezë with dry, poor, and steep soils. Manure is used, based on the availability and transportation costs, once every 2 – 4 years at a rate

up to 200 – 300 kg/tree in olives planted in distances of 10 – 12 m (40 – 50 kg/tree for young trees). Re-administration of manure will depend on the type of soil. In clayey soil the rates are higher and the period between two applications is longer, while in sandy soils smaller rates are applied every year or every two years. Manure is distributed before tillage. It should not be left on the surface to avoid the loss of nutrients from decay. Manure is applied in autumn or beginning of spring. The organic substances are released gradually and are better supplied to olive trees. In general, the source of the animal manure is the same farm or other farms with a greater number of cattle.

Another traditional technique used by olive growers is in-situ corral manure. During the period from January to May, olive trees are fenced with racks made with branches left from pruning or from shrub shoots, etc. forming a corral in which sheep are left overnight to enrich the soil with urine and manure, followed by soil downturning. The urine is rich in nitrogen and this method enriches soil. It is estimated that a sheep may fertilize 2 $m^2$ if it stays for 12 hours. Ten sheep that stay for 5 days can fertilize an olive tree which occupies 100 $m^2$ adding to the soil 40 kg of nitrogen, 20 kg of phosphorus and 5 kg of potassium or the equivalent of 100 kg/ha fertilizer. After fertilization by corral manure, the soil is tilled. This technique has proven to increase the trees' productive capacity and creates a good coexistence between sheep and olive trees. Additionally, the consumption of fallen leaves by the animals reduces pest and disease pressure. It should be considered that corral manure should not be practiced during wet weather and it is not always beneficial





in the case of low canopies and young plants.

The calculation of the nutrients and the required rates will depend on the type of organic fertilizer (Table 1).

**Table 1. Nutrient content in various organic fertilizers**

| | Nutrients (kg/ton) | | | | |
|---|---|---|---|---|---|
| **Type of fertilizer** | **N** | **$P_2O_5$** | **P** | **$K_2O$** | **K** |
| Cattle manure | 5.0 | 1.4 | 0.6 | 3.8 | 3.1 |
| Poultry manure | 15.0 | 7.2 | 3.1 | 3.5 | 2.9 |
| Pig manure | 6.5 | 3.6 | 1.6 | 5.5 | 4.5 |
| Small livestock manure | 11.5 | 3.5 | 1.6 | 10.4 | 8.6 |
| Horse manure | 7.5 | 2.3 | 1.0 | 6.6 | 5.5 |

*Source: Kristo et al., 2006. Soil science (in Albanian)*

### 3.1.3 • Chemical fertilization

Olive trees have always been considered plants with moderate nutrient requirements. This belief is based on the long life of the olive, the large volume of soil covered by its extensive root system and on the fact that the plant can survive without supplementary fertilizations. On the contrary, in order to synthetize the necessary assimilates for vegetative and reproductive organs, olive trees use mineral nutrients. It is therefore necessary to have a continuous supply of nutrients, a good part of which are removed from the orchard with the fruits. Their quantity will greatly depend on physical (structure, texture, depth) and chemical (pH, mineral and organic contents) properties of the soil, its temperature, water relations, microbiological activity and above all the tree physiology. A balanced nutrition contributes to achieving a good ratio between the growing and reproductive activity of olive trees which take up from the soil all the nutrients they require for their growth. It will ensure an abundant production of fruits and oil. Thus, it is considered of great importance by farmers with AOOs.

Nitrogen is absorbed during the whole growing season; intensity is higher from blossoming to stone hardening. Phosphorus is absorbed in the first part of the growing season although the requirement is usually low. Potassium whose uptake begins with the start of growth recovery, is used in high amounts during oil development in fruits.

These seasonal dynamics are different from the life cycle dynamic of nutrient requirement. Young olive trees require more nitrogen while the mature ones need more phosphorus that is used for the reproductive organs. If nitrogen supply is exceeded at this age, it will cause an imbalance between the vegetative and reproductive activity with consequences on the fruit setting. Potassium and calcium contribute to plant development along the life cycle and should be available in the right quantity. Such nutrient levels change not only with the age of the tree but also with its condition and cultivar. Weak or degraded olive trees require mainly nitrogen while more vigorous plants or those affected by infections benefit more from phosphorus or potassium. If in the cultivation system, young plants are introduced to replace the old ones, we should consider that their requirements are different from the mature trees. There are many more variables that should be considered when we prepare a fertilization plan.

In general, fertilizer rates used in AOOs are estimated empirically. The current fertilization practice is to use chemical fertilizers when available, mainly in the form of superphosphate and nitrogen fertilizers like urea or nitrate.

A more advanced fertilizer practice is based on the replacement of nutrients used every season by the plant to produce fruits. In this case, the following coefficients may be used (Table 2 and 3).

**Table 2. Average nutrient uptake for each quintal of olives produced**

| Product | N (kg) | P (Kg) | K (kg) |
|---|---|---|---|
| **100 kg olives** | 0.9 | 0.2 | 0.1 |
| **Leaves** | 1.8 | 0.5 | 2.7 |
| **Fertilizer ratio** | 2 | 1 | 2 |

**Table 3. Seasonal nutrient uptake by olive trees by age under irrigation**

| | Macronutrients (gr/tree) | | | | Micronutrients (mg/tree) | | | |
|---|---|---|---|---|---|---|---|---|
| **Tree age** | N | $P_2O_5$ | $K_2O$ | MgO | CaO | Fe | Cu | Zn |
| **Year II – V after planting** | 40 – 140 | 10 – 25 | 35 – 195 | – | – | – | – | – |
| **Year VI after planting** | 335 | 55 | 300 | 50 | 380 | 2400 | 136 | 450 |

*Source: Palese et al., 2012. Esigenze minerali e tecniche di concimazione. Accademia Nazionale dell'Olivo e dell'Olio, Spoleto; Collana divulgativa dell'Accademia Volume X*





Proper fertilizer plans require soil tests or tissue analysis and a good knowledge on the allocation of nutrients in different parts of the olive tree (fruit, leaves, wood, etc.). In new olive orchards, soil tests are made before planting in order to add the required nutrients after deep ploughs or in the hole. This is applied for phosphorus and potassium fertilizers as these elements do not move in the soil. In AOOs, it is preferred to make soil tests or tissue analysis periodically. However, in our AOOs, the approximate fertilizer rates for phosphorus and potassium fertilizers are given in Table 3.

**Table 4. Guiding rates of fertilizers based on soil analysis**

| Phosphorus content in soil (ppm) | Estimated $P_2O_5$ fertilizer (kg/ha) | Potassium content in soil (ppm) | Estimated $K_2O$ fertilizer (kg/ha) |
|---|---|---|---|
| 0 – 7 | 40 – 50 | 0 – 100 | 150 – 200 |
| 7 – 14 | 30 – 40 | 100 – 200 | 100 – 150 |
| > 14 | 0 | > 200 | 0 |

Other helpful indicators are tree vigour, vegetative growth, flowering intensity, and nutrient deficiency symptoms. Based on the above requirements and estimation, the olive growers in Albania are choosing a variety of fertilizers from different suppliers (Table 5). Fertilizer quantities and rates should be carefully estimated using the abovementioned methods for each nutrient. Unbalanced

**Table 5. Nutrient content in some chemical fertilizers**

| Nitrogen fertilizers | | Phosphorus fertilizers | | | Potassium fertilizers | | |
|---|---|---|---|---|---|---|---|
| Name | T% | Name | T% | | Name | T% | |
| | N | | $P_2O_5$ | N | | $k_2O$ | k |
| Ammonium nitrate | 33 | Superphos-phate | 16-50 | 7-22 | Potassium chloride | 48-60 | 40-50 |
| Urea | 46 | Diammonium phosphate | 58-60 | 20-30 | Potassium sulphate | 48-50 | 40-42 |
| Sodium nitrate | 16 | Phosphorite | 25-40 | 11-17 | Potassium nitrate | 44 | 37 |
| Diammonium phosphate | 11-12 | | | | | | |
| Potassium nitrate | 13 | | | | | | |

*Source: Kristo et al., 2006. Soil science (in Albanian)*

and high use of fertilizers will damage the equilibrium of nutrients in the soil and nature leading to pollution and reduction of soil fertility. Raising the awareness and knowledge of olive growers on the correct use of fertilizers is important to ensure the quality of the oil and the sustainability of these agroecosystems.

Attention should be paid also to the correct timing and distribution of fertilizers in AOOs. As we described earlier, the nutrient uptake





intensity changes depending on the development of olive trees. Timely application of fertilizers increases the efficiency of fertilization. For instance, application of fertilizers in autumn has a limited efficiency compared to spring application as a part of the nutrients will be lost during winter when the activity of the tree is at minimum. On the other side, application of fertilizers during summer, especially when there is lack of irrigation, will reduce their efficiency. Water is necessary for these fertilizers to become assimilable by the trees. Otherwise, trees will spend a lot of energy and in some cases without getting any benefit from these fertilizers.

When drip irrigation is available, fertigation would be the most efficient method of fertilization of olive orchards. However, this is not the case in AOOs. Another effective method of fertilization is the foliar feeding. It is most used for spraying complex crystalline fertilizers or simply urea. Boron is the most frequent micronutrient applied in AOO before and after flowering to improve fruit setting. It is commonly applied in combination with pesticide treatments.

### 3.1.4 • Tillage management

For a sound and cost-effective management of an olive grove which considers the need to preserve and improve the natural resources and the environment, attention shall be paid to soil tillage which may, sometimes, harm the soil structure and biodiversity and become a financial charge. In our AOOs, tillage is applied under the

canopy of the tree during spring at a depth of 5 – 10 cm to control the spontaneous flora and reduce evaporation.

Tillage is typical in AOOs, especially for dry-farming. It consists in 2 – 3 interventions using ploughs, harrows and discs at various depths depending on the soil type but not exceeding 15 – 20 cm. In irrigated olive orchards, the number of soil tillage operations may change depending on tree growth and cover crops. These operations may start after the spring rains (March – April) and should terminate before the new autumn rains.

The purpose of tillage is to reduce water evaporation from the soil through capillary rise, control the spontaneous flora, bury solid fertilizers, favour uptake and accumulation of water from the rainfalls whilst clean soil facilitates the placement of harvest nets and harvesting operations in general.

Tillage management will depend on the climate conditions and the slope of the soil. In AOOs with a slope higher than 25%, it is obligatory to keep the soil with cover crops, by planting the most appropriated species or by using the spontaneous vegetation. In areas with a smaller slope but also in the plains, and considering that summer is dry throughout the country, the use of cover crops, although mown periodically, creates problems of competition for water.

The common practice in our three AOOs is application of tillage only in the flat "eyebrow" zone of each olive tree while the rest is not tilled, using the natural cover crops (see Figure 1).





### 3.1.5 • Erosion protection measures

Erosion is one of the main challenges in Albanian agriculture. Various researchers have estimated that the loss of soil from erosion in Albania is 80 tons/ha/year. Cultivation of olive trees in hilly areas is prone to erosion favoured by the shallow root system of the plant. Only 15 – 20% of olive orchards are planted in flat field (with a growing trend) while the rest is located on slopes which require permanent measures to protect them from erosion. Erosion is also favoured by the rainfall regime, falling with high intensity in narrow periods, a phenomenon which is attenuated by the climate changes. Slope reduces water infiltration while favouring superficial streams and develops into gullies. From the other side, the extended summer drought, accompanied by heavy rains in the autumn highly favours the erosion, especially in the three AOOs which are in slopes with little low vegetation. AOOs with low vegetation under the olive canopies reduce the force of rain drops and erosion while flowing on the surface.

Faced with the challenges described above, farmers have invented methods of cultivation to reduce this risk since ancient times. Of particular interest is the cultivation of olives in the so-called "eyebrows" (half-moon). This technique consists in building "eyebrows" with stones or earth mounds on the lower side of the slope to create small terraces (Figure 2). This is applied especially when the hill is not entirely terraced. These "eyebrows" retain a lot of nutrients leached downhill as well as leaves and other decayed plant material. Other cultural practices were applied to the "eyebrows" like fertiliza-

**Figure 2.**
View of an "eyebrow" to control erosion and other benefits in AOO of Ndroq

tion with manure and later, green manure with leguminous crops. The latter is frequently applied, and it is an important measure to avoid alternate bearing.

The plantation is dense with presence of cover crops. The terrain has a slope and to protect the trees from erosion, it has been terraced and "eyebrows" have been constructed around most of the trees (Figure 2).
In general, building of terraces requires specialised or traditional knowledge in order to define the direction and the dimensions. Another best practice is the construction of terraces from dry stones





(without using mortar) (Figure 3). This inherited technique, not only uses the stones found in the area to create the terraces and removing them where they can be an obstacle, but it has a series of positive factors for balancing soil hydrological, thermal and microclimatic factors, including an impressive view in terms of landscape. These dry stones offer the opportunity to use the flat space where the olive (not only) can be planted. The heat accumulated by the stones during the day is released during the night, influencing the conservation of thermal balances. Moreover, they allow a better exchange of air in the soil supplying a bigger layer for the rhizosphere activities. Terraces serve also as a nest for a multitude of organisms where they find niches. Some of them are very useful against olive pests and help to conserve the biodiversity and maintain natural agroecosystem balances.

Another important measure to avoid erosion and landslides is to keep shrubs or trees at the border of the plot and in high slopes. This is a best practice that we commonly find in our AOOs. Besides being effective against the erosion, establishment of shrub belts is also a good practice to conserve biodiversity in the agroecosystem. They serve as a sanctuary for antagonists and natural enemies of olive parasites.
In cases of high intensity of erosion and in more degraded sites, olive growers have used other measures to establish protective belts using surrounding objects. More commonly, belts are created with woody material from olive pruning waste or other plants in the form of fences, including stones if found around. In those AOOs where

there is no natural rock they use mound terraces, using the untilled superficial layer kept together by the vegetation in the form of clods to create stable structures.

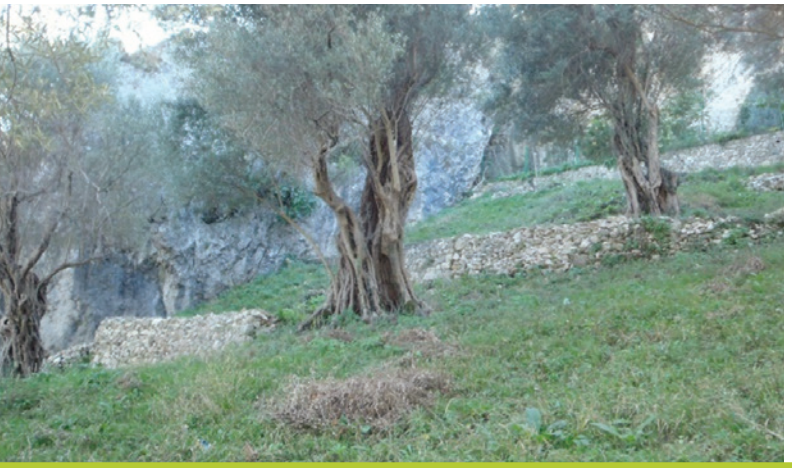


**Figure 3.**
Views of a dry-stone terrace to control erosion and other benefits





Construction of hydrotechnical works (network of canals) to reduce the erosion is one of the most recommended interventions that reduce the speed of water flow (Figure 4). Distances between anti-erosion canals will change depending on the slope and configuration, applying shorter distances in high slopes and larger distances in lower slopes.

These best practices are inherited by ancient olive growers that are still used today on slopes, to protect also from landslides and help control erosion until the root system of the olive trees have grown enough. Then, the roots system of these olive trees will protect the soil from leaching and terraces from landslides.

**Figure 3.**
View of an anti-erosion canal in an olive orchard

We can only imagine how the land looked like before these AOOs were established and the massive efforts of ancient farmers to grow them successfully. Unfortunately, we find nowadays many cases where these measures against erosion are neglected which is in fact a bad practice. Use of machines for deforestations and preliminary soil preparation during olive planting, brings up poor soil layers and when anti-erosion measures are not taken in due time the consequences are heavy. Moreover, the terraces built with dry stones nowadays are very limited, either because of the construction costs or because, although stones are present on site, they have been removed instead of building the terrace.

## 3.2 Irrigation and Drainage

### 3.2.1 • Irrigation

Irrigation is of interest for young olive orchards but also for mature ones, especially in dry areas. In the selected AOOs there is no irrigation system in place, and this is the case of all AOOs. In general, irrigation is planned during the establishment of new olive orchards. In this case, localised irrigation, especially drip irrigation is applied. This system has several advantages in terms of water use





efficiency, application of fertigation, reduction of soil compression and spontaneous flora control. The network of pipes does not require additional earthwork which could lead to erosion. Application of irrigation is considered of great interest for olive growers to effectively increase production. However, in many cases, they are discouraged by the lack of funding and highly fragmented farm sizes.
Most olive orchards in Albania are located on sloped soils and terraces, requiring an irrigation system that does not favour erosion. This was solved by bringing down the water, through the slope, using pipes and open channels. Through a system of numerous distribution chambers, the water flows through smaller side furrows to four different locations on each terrace. Water is given to the trees in "basins" which are made by raising the soil around the trees. This was found to be an economic and environmentally friendly method implemented first in the area of Lukova and later in the Crown of Tirana. In less sloped soils, the network of channels is open, concave and faced with concrete. Water manholes are evenly distributed in the furrows; the latest going horizontally, crosswise to the slope. From the furrows water is delivered to each eyebrow (Osmani, 2002).

### 3.2.2 • Drainage

Another best practice of great relevance in establishing and successfully managing AOOs is drainage of surface and underground

waters. Waterlogging reduces oxygen in the soil and negatively influences the root system due to reduced respiration and accumulation of toxic substances for the plant. Because of waterlogging for a long period, the soil profiles show grey to light blue layers which indicates the lack of oxygen. Olive trees are highly tolerant to drought but particularly susceptible to waterlogging causing fungal diseases that become virulent causing root rot. Olive orchards planted in areas with high underground water are always under stress. During winter, when the presence of water is higher, these trees suffer from waterlogging, deep roots are under anoxic conditions and die. During summer, characterised by lack of rainfalls, since the upper layer of the soil dries quickly, the tree does not have deep roots to uptake water causing water stress conditions to plants.

Methods to avoid waterlogging conditions will depend on the layout of the soil, its texture and the orchard organization. The typical methods applied by olive growers in AOOs consist in drainage of waters through drainage canals and construction of a drainage network in waterlogged-prone areas. The distances between canals vary from 15 – 20 m to 30 – 40 m deep. Their orientation will depend on the land. These drainage canals will be closer in clayey soils, with little inclination and high underground waters. On the contrary, in sandy and stony soils, in high slopes with deep underground waters, wider distances are applied. Their orientation will ensure water to flow without causing erosion. To avoid erosion and formation of gullies along the lines with maximum slopes, it is necessary to construct protective dams or deep holes.

One of the most difficult situations to remove extra water are soils





with an impenetrable soil layer which is common in clayey soils, favouring massive landslides. Water percolating in these soils is accumulated close to this impenetrable layer making the soil unstable and subject to landslides. Construction of drainage canals filled with stones, gravel or other prefabricated materials is the best practice for drainage of waters. In these cases, drainage canals are 1.5 m deep with a slope of 2% and 20 – 40 m distance between canals. Inhabitants in these areas cover the end of the canal with kindling to reduce the costs of transport for prefabricated materials.

## 3.3 Pest, disease, and spontaneous flora management

Olive trees are susceptible to several pests and diseases although to a lesser extent compared to most fruit trees. In Albania as in the other parts of the Mediterranean, the main pests of olive fruit are olive fruit fly (*Bactrocera oleae*), olive moth (*Prays oleae*), olive scale (*Saissetia oleae*) and wood leopard moth (*Zeuzera pyrina*).

The common diseases of olive trees are olive peacock spot (*Spilocaea oleaginea*), cercospora leaf spot (*Mycocentrospora cladosporioides*) and Verticillium wilt. If not carefully controlled, they may lead to severe losses in production and quality. A bacterial disease which is propagated by infected pruning shears during rainy season is oleander knot (*Pseudomonas syringae* pv. Savastanoi).

AOOs are managed as low-input agricultural system. Thus, AOOs are more "complex", that is to say more similar to natural systems which helps to create a level of "resilience", the ability of a system to resist or tolerate some level of disturbance without compromising its ability to reproduce. A high level of biodiversity in the AOOs maintains a good balance between beneficials and insect pests. Beside the permanent natural cover crops in the entire olive orchard except under the tree canopy, AOOs are surrounded by woodlands and hedges. These are shelters and "production" areas (biofactories) for beneficial insects (predators, parasitoids, alternative preys), mites, birds and other animals (amphibians and small reptiles). In some cases, they provide complementary produce, like pomegranate (*Punica granatum*) and cherry dogwood (*Cornus mas*).

### 3.3.1 • Pests control

**Olive fruit fly (*Bactrocera oleae*)**

The key pest for its impact on the quantity and quality of the olive is olive fruit fly, which is widely distributed in Albania. Infected olive fruits become sourer and also change the organoleptic characteristics of the oil. Larvae may cause a heavy drop of fruits and damage the fruits destined for conservation and oil processing.

There are several methods to control the olive fruit fly. However, designing a strategy to control it requires a good knowledge of the infection and this is achieved through monitoring. This enables to





evaluate the density of the population and the correct stage of this pest. The monitoring consists in analysing the infected fruits or monitoring the adult phase of the pest. The adult is monitored by placing chromotropic or pheromone traps or combined with nutrients.

We have achieved a success if we manage to control the fruit fly before it lays eggs in fruits. To prevent this, we may effectively use poisoned protein (1 kg Buminal + 300 gr Rogor/ 100 litters of water) or Succes 24 CB (1 litre solution in 30 litres of water). These solutions are applied in one square meter from the sunrise side. Treatments are repeated after 21 days (or immediately after the rainfall); a total of 3 – 4 sprays during the season. The preventive control is important from the ecological and toxicological viewpoint because it uses a very low quantity of pesticides.

For several years, the olive fruit fly mass capture method is being widely used to significantly reduce the dynamic of this pest. Ecotraps are made of a 15 – 20 cm bag filled with ammonium carbonate and provided with capsule containing a pheromone which is similar to the sex pheromone of the female fruit fly. This bag is dipped into Deltamethrin solution which has a neuroparalysing activity when it comes into contact with the olive fruit fly. Ecotraps are placed in order to cover the entire olive orchard, starting from end of June and are replaced at the beginning of September. It is important to know the correct placement of the ecotraps. Besides, a common mistake is their positioning which should not be directly exposed to the sun. The farmers should make sure that the capsule containing the pheromone and the bag containing ammonium carbonate are punctured otherwise the traps are useless.

Another method which has been found useful in olive orchards consists in placing a water or juice plastic bottle filled with a 3 % (or 30 – 40 gr diluted in 1 litre water) DAP solution (diammonium phosphate). The plastic bottle is punctured in the upper part with a wire making 5 – 6 holes where the fruit flies will enter attracted by the ammonium gas. Once they fall into the trap they cannot escape. The solution should be continuously mixed because as the gas is released the flies are not attracted any longer.

Similar traps can be prepared using fish waste instead of DAP or other solutions that attract the adult fly.

Treatment of the larvae should be carried out when the active infection in fruits reaches the economic threshold which is common-

**Figure 5.**
View of a turkey farm in an olive orchard





ly found in September when the infection has reached 10 – 15% on eggs and larvae. In general, the plant protection products used aim to kill the larva leaving no residues in the fruit (with active ingredients less soluble in lipids). Until now Dimethoate (Rogor) has been commonly used, but after EU restrictions concerning residues, other products as Phosmet, Deltamethrin, Pyrethrum, Azadirachtin (extracted from Neem tree), Rotenone etc. could be used.

A particular experience found in our AOOs is the reduction of the olive fruit fly by the pasturing of turkeys in olive orchards (Figure 5).

They eliminate the insect pupae which are found on the ground, but their main role is to eliminate the larvae and pupae found in fresh fruits dropped in the ground. The pasturing of turkeys in olive orchards reduces drastically the population of the olive fruit fly and the infections by other generations.

### 3.3.2 • Diseases control

**Olive peacock spot (*Spilocaea oleagina*)**

The causal agent of this fungal disease is Spilocaea oleagina, which infects olive trees. This disease is causing serious problems along the coastline where there is a combination of relatively high air moisture and warm weather. The disease is not common practically in all olive growing areas of Albania.

In general, symptoms are visible from September to April. It in-

fects leaves hampering photosynthesis. In cases of high infections, it causes a defoliation (leaf drop) of branches. As a result, the olive tree will have a rare canopy, weak growth and low yield. On the leaves, the fungus shows black round spots surrounded by a yellow halo (peacock eye).

Control of olive peacock spot is of great interest for olive growers due to its remarkable effect on the yield. To protect the olive trees beside chemical treatments, farmers should also use good agricultural practices.

Cultivar resistance or tolerance is of great importance. Different cultivars have variable levels of susceptibility to olive peacock spot. It is therefore recommended, in areas of high infection, to choose tolerant cultivars; for instance, 'Stërbjak', 'Pulazeqin', 'Ulliri i Hollë i Himarës', 'Kallmet'. Cvs. 'Ulliri i Bardhë i Tiranës', 'Mixan', 'Kripës i Krujës' have moderate tolerance while 'Kalinjot', 'Kokërrmadhi i Beratit' and 'Nisjot' are highly susceptible.

Olive orchard type and training system influence the level of infection. Peacock spot is severe in intensive or super-intensive orchards, where the dense vegetation favours the accumulation of moisture and therefore fungus development. In wet areas or when susceptible cultivars are used, the training system should be based on long distances (between plants and rows). In this regard, regular pruning allows for canopy aeration, ensures good light exposure and no shadowed (more humid) areas. Removal of dropped leaves (turned under) helps to keep the disease under control as they represent an inoculation means.

*S. oleaginea* is a fungus that benefits from wet environment. Thus,



irrigation of olive trees may increase infection. It is therefore recommended that the irrigation system is localized and frequently controlled to avoid waterlogging which may favour the development of fungi.

As for other diseases, correct olive nutrition will also affect the reduction of infection from *S. oleaginea*. Healthy plants, well fertilized and vigorous are less affected by biotic and abiotic stresses.

The strategy to control olive peacock spot requires a good knowledge about the level of infection and its development. This enables also to identify latent stages of the disease through diagnosis and early detection. The diagnostic technique for young leaves consists in dipping a sample of 100 leaves taken from 4 trees/ha, 10 leaves/tree, in 5% sodium hydroxide (NaOH), for 2 – 3 minutes at room temperature. For mature leaves, a warm water bath at 50 – 60°C will show eventually the infection like dark spots on the infected leaf blade.

Testing of young leaves and shoots is carried out when air moisture during spring and summer is particularly high. Another test is carried out during autumn and after harvest. When dark spots are present on more than 20% of leaves, chemical treatments should be applied (depending also on the susceptibility of the cultivar). Chemical treatments are based on copper solutions and are applied when infections are severe. However, if we have susceptible plants or damages by the olive peacock spot in the previous year were serious, we may use preventive treatments. Among the copper solution, oxychlorides are preferred as they are less toxic than Bordeaux Mixture. These contact products have a preventive effect, cause a infected leaves to drop (reduction of inoculum), but may also reduce

the bud differentiation and fruit drop.
In case of high infections, it is advisable to carry out chemical treatments using other plant protection products such as Dodine, 50%+ Tebuconazole, 25% Trifloxystrobin, which are systemic and curative. These products cause less leaf drop and curing effects making them more appropriate during the production periods.
In some areas of the country, where there is a presence of natural gas residues, usually close to oil fields, the use of copper-based products causes leaf damages due to the reaction with sulphur. It is therefore advisable to use alternative plant protection products.
Proper period to apply chemical treatment should be determined by examining infected leaves. If the number has reached the critical threshold, chemical treatment may be necessary only if the environmental conditions are favourable for the dissemination of fungi (rain, high air moisture, etc.). In general, it coincides with vegetation regrowth, thus during March until the beginning of April.
When environmental conditions are not favourable for the disease, 2 chemical treatments are recommended: (1) The first, at the end of winter or spring (after pruning during February – March); (2) The second, in autumn (September – October), always after the first rainfalls.
In cases of high infections after the first treatment, a second treatment can be applied, before the autumn one, before flowering, using systemic fungicides. All treatments applied against olive peacock spot are effective against many other diseases affecting olive trees like tuberculosis, cercospora leaf spot, sooty blotch, etc.





### 3.3.3 • Spontaneous flora management

Spontaneous flora control is a typical cultural practice widely applied in the cultivated part of olive orchard and in many cases also between the rows. The most appropriate method without environmental impact and applied in our AOOs is by eradication or cutting (tillage, cultivation, disking, harrowing). As underlined earlier, for the climate conditions of our country, the most appropriate method of soil management for spring – summer period is to eliminate the spontaneous vegetation to avoid competition for water with olive trees. Another spontaneous plants management method with high efficiency but that pollutes the environment and reduces the biodiversity is the use of herbicides, but this is not the case in AOOs.
AOOs have natural cover crops which exhibit several advantages (see 3.1.1), sometimes with limited competition with century-old olive trees, neither for water, nor for light and nutrients. The olive roots explore soil areas which are much wider than those exploited by herbaceous species; this is especially true for century-old olive trees which have long been fit for our environments and climate conditions. No herbicide treatment is applied in AOOs. In the selected AOOs, instead of soil tillage, spontaneous plants are mowed at a height which slows down the sprouting of vegetation which will take place when the climate conditions of the crop are more favourable. Mowing is done at a height of 5 – 6 cm from the ground as to create a mulching layer which reduces the water losses by direct evaporation from the soil.
Sometimes it is needed to control individual species of spontane-

ous flora due to their prevalence on other species and very high competition. In such circumstances, herbicides could be used only once, as it was the case to control blackberries in the AOO of Preza; after environment friendly methods may be applied.

## 3.4 Pruning

Before proceeding with the pruning operation, we have to carefully observe in detail each plant from all the perspectives and from top to bottom, until we identify the healthy and sick parts. Only then we will be able to identify the future primary branches and possibly, the secondary and tertiary branches on which to construct the new canopy, scaffolding the plant on healthy, efficient, and robust structures. We should also consider the location, age, dimension, physiological and structural state, space available, availability of light, soil type, interventions that might have caused or aggravated the suffering status of the tree (e.g. mutilation of roots, drastic pruning, etc.), presence of trunk cancer.

Common management practices in AOOs imply production pruning, and sometimes, shape pruning. In the selected AOOs, due to lack of labour force and the size of the trees, production pruning is not carried out every year but rather every 4 – 5 years. In the year in which it is performed, it is used to eliminate the sucker shoots in the inner canopy and dead branches. In general, pruning interventions should





**Figure 6a.**
Heavily pruned century-old olive tree

**Figure 6b.**
Advised pruning of an old olive tree

aim to alleviate and aerate the canopy with a balancing of the monumental value of the plant and its productive potential. Olive trees respond quickly to pruning with increased production. Pruning should be carefully applied to retrain the trees in forms that allow for manual or mechanical harvesting but also maintain an equilibrium between various multifunctional uses of historic AOOs, without never depriving them of their monumental character.

Pruning of the giant trees is a very delicate operation that could result fatal in many situations. Historical and marginal olive growing is oriented towards sporadic interventions, every 10 years, with com-

plete and drastic removal of almost all the canopy, which is strongly not recommended following the saying “the axe corrects the olive”. In such cases the olive tree, whose large dimensions constitute a fundamental component of its monumentality, undergoes a heavy depreciation of the aesthetic value which adds to the significant physiological imbalance (Figure 6a) instead of preserving its basic shape (Fig. 6b).

The attempt to reconstruct the removed biomass from the canopy requires a huge allocation of reserves and a decrease in root growth. The results are not always optimistic relative to the expectations of the olive growers who are used to see these patriarchs always capable to react to interventions from man or adversities from nature and even fire. In many cases, the tree is debilitated by drought and parasites, shows a stunted reaction to severe mutilations, with disoriented roots at the base of the trunk that little corresponds to the needs for reconstructing a productive canopy. Moreover, the big cuts of branches become an entry point for trunk cancer that is present making the stability of the entire tree architecture even more unsure.

Vertical vegetation axis capable of expressing a clear dominance is in fact the fundamental element for maintaining a balanced tree structure and for giving the main branches the necessary vigour to heal wounds, even important ones deriving from the lightening of their axis with reasonable side cuts. This caution is also the only solution to respect the monumentality of an evergreen plant, in which the completeness and proportion of a majestic trunk cannot





tolerate the absence of a highly developed foliage. Reasonable and simple cuts should be made to remove dry wood, residues of accidentally fallen branches, exhausted branches that tend to hang in the lower parts of the foliage, clear bifurcations that are not functional to the general balance, and return cuts on weak branches for the balanced shortening of the vegetative axes.

The choice of primary branches should be based on the observation of never pruned century-old olive trees where they are normally positioned in angles varying from about 30° to 45°. These angles should always be maintained and never modified as they represent the ideal angle to keep a vegetative-productive balance. In trees with a healthy structure but high canopy made up of numerous bare branches and with vegetation only in the terminal part, we can apply a gradual reconstruction pruning aiming to eliminate the main branches in the wrong position necessary for the space available. These branches should have a diameter that has to be reduced from bottom to top, in order to terminate with a single shoot. The purpose of the latest is to balance the distribution of the sap between the selected branches, to favour olive production in the medium low parts and limit the growth in height.

When a primary branch is divided into two parts of the same diameter (dichotomous), one of them should be eliminated to create the necessary space. This should be carried out in order to avoid the doubling of the main branch and consequent problems of mutual competition besides those related to the rupture at the bifurcation area. Each secondary branch, in turn, must be chosen alternately with respect to the opposite one in order to facilitate lighting and

the production of olives and shoots which, due to their own weight, will bend and guarantee production over the years. Once the final structure is reached, the canopy management will be simple, long-lasting and economically sustainable. The pruner will be responsible for identifying the natural areas of slowing down of the vegetation by the plant, which must be eliminated because they are unproductive, weak, and intended to be shaded and dried out (production and maintenance pruning). Pruning at the insertion of the main branches should be avoided in all cases, also in the case of "umbrella" olive tree pruning or "headless" pruning since this operation compromises the crown/root ratio. In fact, the growth of the aerial part of a tree is balanced by an analogous growth of the roots influencing the health status, the static stability as well as its monumental aspect.

Pruning of large-sized olive trees presents problems of professional competence, necessity of adequate equipment and obligatory safety measures during the work. It is therefore necessary to use technical assistance services to organize courses for pruning ancient olive trees for olive growers and other operators who work on monumental trees. Modern technology offers many important solutions like pruning equipment on small cranes and elevator carts to create the best ergonomic and safety conditions for workers. Other technical assistance is represented by the correct execution and protection of major cuts with particular care to the inclination of the cutting surface and its temporary protection with adequate wax. It is therefore necessary an adequate and punctual training of pruning masters, because in many cases wrong operations by the





olive growers bring physiological and productive deterioration of ancient olive trees.

## 3.5 Olive harvesting

The most important aspects related to harvesting are the harvesting period, harvesting method and time until processing which have a great influence on the quality of the oil, despite the differences between cultivars. The old practice of harvesting olives when reaching the maximum ripeness is wrong. It should have also been dictated by the old processing technology. Introduction of new modern processing lines has radically changed the concept of harvesting period including other aspects related to the production of high-quality oil. Nowadays, it is determined that the optimal harvesting period for olives is veraison (change of colour of the berries) which is also applied in our AOOs. In many cases, infection by olive fruit fly might influence the harvesting period to avoid massive fruit drop.

Harvesting is a delicate operation that if not correctly applied can compromise the efforts of the entire season and have a negative influence on the quality and quantity of the oil. Harvesting techniques affect the quality of olive fruits. This effect will mainly be depending on the damages caused to the fruits. The best harvesting method is by hand but in AOOs is difficult due to the height of the trees and the associated costs. It has been common practice to use long wood

twigs or plastic rods when the olive fruits change colour. This is not a good practice as it damages the fruits by reducing the quality of the oil, damaging the shoots and causing wounds that lead to infections by diseases (especially *Pseudomonas savastanoi*), and a negative impact on next year's production.

In the recent years, harvesting equipment and machines have influenced not only the increase in yields but also the quality of the harvest. The percentage of damaged fruit with these harvesting machines will depend on the specific type and worker's experience but in any case, is smaller than the shaking with twigs while the yield is 2 – 3 times higher. Shaking machines are becoming widespread in olive-growing areas including AOOs. A best practice applied is the use of harvesting nets, that has influenced in avoiding mixing the harvested olives with those found in the ground which negatively affects the quality of the oil.

Another important moment is the postharvest period until processing. To process extra virgin oil, this period should not last more than 24 – 36 hours. Storage of olives after harvest should not cause alterations of the fruit. During storage and transportation, pressing of olive fruits should be avoided. Thus, it is preferred to use plastic crates or birch large woven baskets that allow for circulation of the air, prevent heating from the catabolic activity of the fruit. Fruits kept in plastic bags produce low quality oil.

Oil extraction process starts with the pressing of oils in the processing line. It is important that the olives collected from the ground or stored for a long time after harvest should not be processed together with the clean olives. The processing line should be cleaned after





processing. The processing lines in Albania are in general very modern, included those processing olives from AOOs.

In the **first phase** of processing, olives are washed to remove debris, leaves, etc. that negatively affect the taste and flavour of the oil. It is important that the water should be clean after a series of circulations. The **second phase** is grinding. The method and equipment have a direct effect on the following operations and the quantity and quality of oil. Olive mills can be old types, with stone that are becoming less used due to the low yield although they have several advantages, and the metallic ones. Metallic mills have a high yield, regulating the fragments of the pulp and produce an oil with more phenols and longer consumption period. This could form emulsions that prevent separation of oil and organoleptic characteristics that are more bitter and spicy. During the **third phase**, oil is accumulated and separated from the fruit. Temperature is an important factor. If high, the oil loses the nutritional value, aroma and flavour. Mixing time varies by cultivar, ripening degree and infection. The **fourth phase** is extraction, by pressure or with a decanter. The old method is based on pressure where the cake is spread on canisters and are pressed to extract oil. The modern processing lines use decanter to separate the liquid from the solid phase. In the **fifth phase**, the centrifuge separates the liquid – liquid phases.

Oil storage has the same importance as for other food products. The main risk is the reaction of fatty acids with atmospheric oxygen. This phenomenon reduces the quality of oil. Storage in hermetic conditions is the best method to limit the contact with oxygen. Other factors influencing the quality of storage are room tempera-

ture and the material of the containers where the oil will be stored. Environmental temperature should be uniform and not exceed 15°C to avoid oxidation and the premises should be clean with washable floors and walls with less light.



# 4 Conclusions

Evidence of olive processing dates back to the 6th century AD. The presence of olive tree specimens aged 1500 to 2500 years in many areas of Tirana, Kruja, Durrësi, Berati, Mallakastra, Vlora, etc. with a multitude of cultivars and populations, mostly found close to medieval castles and ruins of millenary civilizations, demonstrate how ancient olive cultivation is in Albania. Many ancient olive orchards (AOOs), cultivated following traditional environment-friendly practices, play an important ecological role, surrounded by a dense system of dry-stone walls where wild shrubs still survive. Such semi-natural habitats create structural conditions allowing the diversification of plant and animal species, some of them are resistant to climate change and can help local populations adapt to it.

The selected AOOs belong more or less to the same age and are managed with the same cultural practices. They are found in the same cultivation belt and are truly representative of centuries-old olive groves in the country. The areas have a typical Mediterranean climate characterized by hot summer and a mild and wet winter. Hills are not higher than 500 m and being close to the sea benefit from its buffering effect. The three areas represent some of the oldest olive growing sites in Albania, in Tirana region, which demonstrates how ancient olive growing is in these areas, including agronomical techniques. Olive growers have inherited many good agricultural practices.

Olive growers in these AOOs grow local populations by associating

cultivars which are compatible in terms of cross pollination. They have included even inferior cultivars in terms of production and quality with the purpose of improving the production of the main cultivar. We find this old inherited knowledge in our three AOOs. The main cultivar 'Ulliri i Bardhë' (white olive) is found associated with Olivaster, cv. 'Ulliri i Zi' (black olive), cv. 'Ulliri i Kuq' (red olive) and in Preza AOO also with cv. 'Kushan'. The Red Olivastër of Tirana is found almost in all ancient olive orchards of Tirana and Durrës.

Ancient olive orchards are adapted and show a high resilience to unfavourable climate conditions. Changing climate and soil conditions have meant that many cultivars introduced at different times do not perform as expected. Even the displacement of autochthonous cultivars outside their typical cultivation area has not always resulted in good performance.

In our AOOs, a partial cover crop is applied where spontaneous vegetation covers all the orchard except for under the tree canopy. Tap roots eases the deep penetration of water especially in the case of heavy rains. In our AOOs, cover crops are mechanically mown when they become competitive for water considering that these olive orchards are not irrigated. Mown grass is left on the field as mulch adding more organic matter but also conserving scarce water reserves in the soil. Since irrigation is not feasible, this permanent cover crop (repeatedly mown to reduce competition for water to the minimum) is the right solution to preserve the organic matter content in the soil. AOOs with low vegetation under the olive canopies reduce the force of rain drops and erosion while flowing on the surface.

Another traditional technique used by olive growers is in-situ corral manure. During the period from January to May, olive trees are fenced with racks made with branches left from pruning or from shrub shoots, etc. forming a corral in which sheep are left overnight to enrich the soil with urine and manure, followed by down-turning the soil. This technique has proven to increase the trees' productive capacity and creates a good coexistence between sheep and olive trees.

Of particular interest is the cultivation of olives in the so-called "eyebrows" (half-moon). This technique consists in building "eyebrows" with stones or earth mounds on the lower side of the slope to create small terraces. These "eyebrows" retain a lot of nutrients leached downhill as well as leaves and other decayed plant material. Other cultural practices were applied to the "eyebrows" like fertilization with manure and later, green manure with leguminous crops. The latter is frequently applied, and it is an important measure to avoid alternate bearing. Another best practice is the construction of terraces from dry stones (without using mortar). This inherited technique, not only uses the stones found in the area to create the terraces and removing them where they can be an obstacle, but has a series of positive factors for balancing soil hydrological, thermal and microclimatic factors, including an impressive view in terms of landscape.

In cases of high intensity of erosion and in more degraded sites, olive growers have used other measures to establish protective belts using surrounding objects. More commonly, belts are created with woody material from olive pruning waste or other plants in the form of fences, including stones if found around.

Another best practice of great relevance in establishing and successfully managing AOOs is drainage of surface and underground waters. The typical methods applied by olive growers in AOOs consist in drainage of waters through drainage canals and construction of a drainage network in waterlogged-prone areas.

AOOs are managed as low-input agricultural systems. Success is achieved if the fruit fly is controlled before it lays its eggs in fruits. To this end, poisoned protein (1 kg Buminal + 300 gr Rogor/ 100 litters of water) or Succes 24 CB (1 litre solution in 30 litres of water) may be used. These solutions are applied in one square meter from the sunrise side. Treatments are repeated after 21 days (or immediately after the rainfalls); a total of 3 – 4 sprays during the season. Preventive control is important from the ecological and toxicological viewpoint because it uses a very low quantity of pesticides. For several years, the olive fruit fly mass capture method has been widely used to significantly reduce the dynamic of this pest. A particular experience found in our AOO is the reduction of the olive fruit fly by the pasturing of turkeys in olive orchards.

The strategy to control olive peacock spot requires a good knowledge about the level of infection and its development. This enables also to identify latent stages of the disease through diagnosis and early identification. The diagnostic technique for young leaves consists in dipping a sample of 100 leaves taken from 4 trees/ha, 10 leaves/tree in sodium hydroxide 5% (NaOH), for 2 – 3 minutes at room temperature. For mature leaves, a warm water bath at 50 – 60°C will show eventually the infection like dark spots on the infected leaf blade.





No herbicide treatment is applied in AOOs. In the selected AOOs, instead of soil tillage, spontaneous plants are mown at a height which slows down the sprouting of vegetation which will take place when the climate conditions of the crop are more favourable. Mowing is done at a height of 5 – 6 cm from the ground so as to create a mulching layer which reduces the water losses by direct evaporation from the soil.

# 5 Reference


CIHEAM/IAMB (2012) *Guidelines for the sustainable management of the century-old olive groves*. LIFE+Cent.Oli.Med. (LIFE 07 NAT/IT/000450) Identification and conservation of high nature value of ancient olive groves in the Mediterranean region.

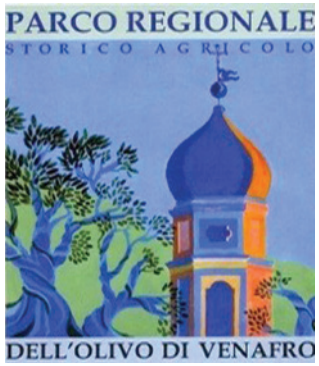
KULLAJ, E, ÇAKALLI, D and A. ÇAKALLI (2007). *Organic olive management*. Monograph

KULLAJ, E. (2012) Following olive footprints in Albania. In: El Kholi et al (Eds.) Following Olive Footprints (Olea europaea L.) - Cultivation and Culture, Folklore and History, Tradition and Uses. *Scripta Horticulturae* No.13, ISBN 978 90 6605 734 0

MULAS, M., MUNTONI, M., PIRAS, F., SANNA, E. and SEDDA, P. (2017) *Manuale di potatura e valorizzazione di ulivi plurisecolari.* COMUNE DI GENURI, Progetto Sperimentale Agro-Ambientale "Genuri in Campagna".

PANNELLI G. (2013). Gli interventi di manutenzione e la cura degli olivi monumentali. *Vita in Campagna*, 11: 29-33.

PANNELLI G., PANDOLFI S. (2007). Il controllo della produzione in olivo mediante forma di allevamento e potatura. In: *Storia della potatura*. 7) Vaso dicotomico come riformarlo. *Olivo e Olio*, 2: 40-44.


**PROJECT DELIVERABLE**

| | |
|---|---|
| Project Partner | **PP 4 Regional Agriculture Historical Park Authority of Venafro, Molise, Italy** |
| Work Package | **WP T 1 Identification and conservation of landscape with ancient olive trees and orchards (AOOs)** |
| Deliverable Code | **DT1.3.1** |
| Deliverable Title | **Common report on best practices to be applied by farmers for AOOs conservation and valorisation** |
| Date of submission | **Period 3** |
| Expert | **Dr. Maria B. Forleo, Dr. Sebastiano Delfine** |
| | Revision: **Emilio Pesino, Giuseppe Cutillo, Adele Rossi** |

# 1 Introduction

Cross Border OL project is funded by the Interreg Italy Albania Montenegro Programme under the Priority Area "Smart management of natural and cultural heritage for the exploitation of cross border sustainable tourism and territorial attractiveness". Its main objective is to promote sustainable tourism development based on the natural asset of the landscape with Ancient Olive Orchards (AOOs). The project will contribute to promoting sustainable tourism activities, conserving and protecting natural resources in areas with AOOs, and raising awareness of local populations on their own cultural heritage linked to traditional olive growing, by activating a process of setting local strategies of development.

Work Package 1 (WP1) deals with the identification and sharing of best practices for conservation of the landscape of ancient olive orchards and aims to identify and characterize the existing natural heritage of the involved countries in terms of landscape and biodiversity richness in AOOs. WP1 should fulfil three deliverables, notably i) mapping olive trees and groves (A.T.1.1), ii) characterization of biodiversity of AOOs (A.T.1.2), and iii) Identification and sharing of best practices for conservation of the landscape of ancient olive orchards (A.T.1.3).

We provide below the results of the third deliverable related to best practices.

Best Practices or good farming practices in Venafro are supposed to be applied by farmers. They will be made available to at least 30 local farmers, extension service agents and technicians and will be disseminated to other stakeholders through extension services and other means of communication. *Parco dell'Olivo di Venafro* will support their implementation in future years by validating and promoting them to a larger number of farmers and land users dealing with management of ancient olive orchards.

The activity aims at facilitating the identification and sharing of best practices with low environmental impact for the conservation of the AOO areas through a set of good agriculture practices such as planting, soil cultivation, soil fertility management, irrigation, spontaneous flora and pest management, pruning, and harvesting. Processing of olive oil is considered for impact both on landscape quality/attractiveness and on olive oil products and on the wine and food offer.

The purpose of the Report is to give a picture of some research findings aimed at offering to public and private stakeholders of the *Parco di Venafro* and to the other Project partners the knowledge tools to pursue the Project aims of stimulating the interest of local and foreign tourists to visit these areas, of promoting the valorisation of typical products and of enhancing sustainable and integrated rural development paths.

To support a better knowledge of the local AOO area, the first stage of analysis was aimed at identifying and collecting the agricultural practices already applied in AOOs in the Venafro area; in a second stage investigating whether best practices are applied or not by local people. The Report describes below some of the agricultural practices applied by farmers in the sample and relate them to the best solutions proposed in the literature under an agronomic point of view.

As far as the methodology of analysis is concerned, a mix of desk and on-site methods of investigation were applied.

A first visit was made to some olive groves located in the study area to obtain a very broad picture of the local situation. Other visits were made to specific farms located in the area of Venafro to have a direct view about the type and quality of cultivation practices and the condition of the trees.

In addition to local visits, a literature search for studies about the olive oil practices applied in the area was made, indeed with little or no success because, with the exception of some historical reports, no studies addressed the olive fields in the area in agronomic terms and economic prospects.

For this reason, a direct survey based on some case studies was implemented. This activity was made with the support of the Ente Parco staff that was responsible for selecting a small number of farms that would be representative of the different practices applied in the Venafro area and available to participate in the survey. The staff of Ente Parco was engaged in administering the questionnaire. The survey was aimed at responding to the objective of investigating the practices locally applied in order to analyse if they could be considered as a best practice under the agronomic point of view.

In order to pursue the direct survey, an ad hoc questionnaire was

set up and structured in different parts:

I. Farms' general data
II. Agronomic practices applied along the cultivation cycle and their costs in the last 3 years
III. Per each practice (e.g. spontaneous flora control, etc.) a detailed set of data: i. technical and quantitative information (e.g. type of practice such as mechanical control of spontaneous flora), year and period of execution, machinery type and hours of use/ha); ii. economic and monetary data (euro/hour, euro/ha)

Six farms agreed to participate to the survey and a general overview of the farms' characteristics is reported below (Table 1). Anyway, and although the questionnaire was administered by the staff from Ente Parco, many data are missing while, whenever provided, the data suffer from some problems of inconsistency.

The preliminary results of this survey were presented during the stakeholders' meeting in Venafro on November 21 2019. The meeting also offered the opportunity to highlight the limits in the data provided so that the Park could begin to involve farmers in a more thorough investigation and discuss with them some inconsistency.

**Table 1. General overview about olive farms in the sample for the direct survey**

| | | | | |
|---|---|---|---|---|
| Altitude m | 200-250 m: 4 farms | | 250-400 m: 2 farms | |
| Farm's type | Family farm: 4 | | Mixed farms: 2 | |
| Olive tree hectares ha | 1 ha: 1 farm | 2-3 ha: 4 farms | 5 ha: 1 farm | |
| Olive trees n./ha | 350-430 trees: 5 farms | | 1000 trees: 1 farm | |
| Olives kg/tree | 20 kg: 2 farms | 25 kg: 2 farms | 30 kg: 2 farms | |
| Family labour unit n | 0 unit: 2 farms | 1 unit: 1 farm | 2 units: 3 farms | |
| External stable work units n. | 0 unit:3 farms | 1 unit: 2 farms | 4 units: 1 farm | |
| External seasonal work units n. | 0 unit: 2 farms | 2 units: 1 farm | 4 units: 2 farms | 6 units: 1 farm |

## 2 Quick look at the agricultural regional context

From the data collected with the Agricultural Census, the ongoing structural change, i.e. a progressive downsizing of Molise agriculture, is confirmed. In 2010 in Molise, 26,272 farms were registered, of which almost 21,000 in the province of Campobasso. Agricultural and forestry farms have decreased over the last decade (-16.7%); the decline in the number of production units was particularly marked in the province of Isernia (-26.4%) compared to that of Campobasso (-13.7%).

On the other hand, the evolution of the sector in the last ten census years showed a decrease in the utilized agricultural area (UAA) in the region (8%), equal to about 198 thousand hectares in 2010. On the other side, a significant increase (+ 180%) of the areas classified as permanent meadows and pastures was observed, passing from 485 ha in 1972, to 838 in 1982, to 963 in 1990, to 1169 in 2000, up to 1355 recorded in 2010.

As a direct consequence of the trends described above, an increase in the average size of the farms was registered: in Molise, the average size of farms rose from 6.8 ha in 2000 to 7.5 ha in 2010 (in Campobasso from 7 to 7.6 ha; in Isernia province from 6 to 7 ha).

Despite the increase in the physical dimensions of the regional farms, the prevalence of very "small" units even under an economic point of view remains in Molise: 75.1% of farms had a standard production of less than 8,000 euros, 14.8% between 8,000 and 24,999 euros and only 10% of the total farms had a standard production of over 25,000 euros.

Arable crops (82% of provincial UAA) prevail in the province of Campobasso, while permanent crops (57%) dominate in the Isernia area, followed by arable crops (33%).

From the results of the last national agricultural census, it emerged that regional olive growing covers 92% of the farms dedicated to the cultivation of permanent crops, equal to 19,262 units (over 73% of the total farms in Molise region) and covers a total area of 15,000 hectares (69% of the agricultural area invested in agricultural permanent crops in the region). This weight of olive growing is higher than in the South regions and in Italy where the olive surface amounts to 58.2% and 47.2% of the area destined for permanent crops, respectively. At the provincial level, most of the regional olive-growing area (80%) is located in the province of Campobasso where over ¾ of the regional olive farms is located.

In line with the structural changes recorded for the entire agricultural sector, there has also been a negative variation in the number of farms involved in the olive-growing sector in Molise, which fell by 5.5% in the region; on the contrary, there was an increase in the areas dedicated to olive growing. At the regional level the increase in the olive area (+ 12.5%) had a different intensity between the two provinces (17.9% Isernia and 11.2% Campobasso).

Although olive growing is widespread throughout the region, the regional olive sector has a low economic weight and is often limited to an integration of income or to a traditional activity. This situation

often leads to the abandonment of olive growing or, at least, to a progressive reduction in its economic sustainability, so that in a vicious circle also the cultivation practices and the production technique are reduced to the essential. According to the regional Office of the National Council for the Agricultural Research (CREA), the amount of specific expenses recorded in the regional olive farms, in fact, is significantly lower than the national average (200 euros per hectare, compared to over 330 euros national average), a clear sign of a low intensification of production processes. Consequently, by limiting the profitability analysis to the main product (olives), the profitability of olive groves in Molise appears to be decidedly lower than the national average, which reaches 1,400 euros per hectare (about 200 euros less per hectare).

Finally, in 2017, the regional olive production came close to 36 tons overall (ISTAT data source): olives intended for human consumption represent a small quota of just 0.8% of the total with 300 tons, confirming a production orientation strongly focused on oil production. Anyway, the size of regional olive oil production is absolutely negligible in the national context.

**Table 2. General overview of olive oil production in Molise Region**

| | 2015 | | | |
|---|---|---|---|---|
| **Area** | **Mills (n)** | **Oil (kg)** | **Olives (kg)** | **Yield** |
| **Molise** | 110 | 40.058 | 323.511 | 12% |
| **Campobasso** | 89 | 36.681 | 300.754 | 12% |
| **Isernia** | 21 | 3.378 | 22.756 | 15% |
| | **2016** | | | |
| **Area** | **Mills (n)** | **Oil (kg)** | **Olives (kg)** | **Yield** |
| **Molise** | 97 | 16.653 | 154.400 | 11% |
| **Campobasso** | 77 | 11.987 | 119.333 | 10% |
| **Isernia** | 20 | 4.667 | 35.067 | 13% |
| | **2017** | | | |
| **Area** | **Mills (n)** | **Oil (kg)** | **Olives (kg)** | **Yield** |
| **Molise** | 106 | 36.011 | 253.010 | 14% |
| **Campobasso** | 86 | 31.663 | 225.920 | 14% |
| **Isernia** | 20 | 4.348 | 27.090 | 16% |

# 3 Quick look at the AOOs in Venafro area

Venafro area is situated at the foot of Mount Santa Croce (1,026 m.a.s.l.) at the border between Molise, Latium and Campania regions. It is located at a height of 222 metres above sea level and the elevation of the municipal territory varies from 158 to 1,205 metres.

The municipality stretches along the homonymous plain crossed by the Volturno and San Bartolomeo rivers whose sources are located in the centre of Venafro plain. Within its area, a Site of Community Interest (SIC) called Monte Corno - Monte Sammucro (IT7212171) was recognized; it covers a total of 1356 hectares, between 610 and 1205 m.a.s.l. and counts on some vegetal habitats, protected birds and mammals. The city counts 11,159 inhabitants (April 2019) and represents the fourth municipality in Molise region.

**Photo 1.** Satellite view of Venafro IS Italy ("Map data ©2020 Google")


The old city centre is rich in Roman remains among which the Pandone Castle, the "Verlasce" Amphitheatre, the Roman theatre, some traces of a Roman aqueduct, the walled city of the Samnites dating from the 4th century BCE, and one polygonal Samnite structure of the 1st century BCE. Venafro has a mild climate that derives from being in an exposed southern plain closed from the mountains; but in periods of high-pressure temperature variations may vary from 15 to 20 °C between day and night. Winter is quite cold with rain while it snows very rarely; the intermediate seasons are milder but with frequent rainfall while the summer is very hot.

The local economy is based on agriculture and on commerce, thanks to its strategic position at the crossroads of two state roads. Tourism remains underdeveloped despite artistic, architectural, historical and cultural items that Venafro has to offer to visitors from Molise and Campania regions, but also from Latium region due to the proximity of Venafro to the A1 highway and to the Cassino abbey to which Venafro is twinned. A few kilometers from Venafro is the industrial centre of Venafro- Pozzilli where engineering, manufacturing, construction and food industries are located.

## General information

**Surface area:** 46,45 km²
**Number of trees per ha:** around 350-450 trees per hectare.
**Yield per tree:** from 20 to 25 kg/ha (average of the last 5 years)
**Number of ancient trees (AOO):** around 170 (source: Ente Parco).
**Ancient olive groves in regular or irregular layout:** Irregular layout, in that olive plantation adapts to the slope and irregularity of the area, with plants arranged in precise rows only in the terraced areas.
**Other olive trees younger in age mixed with AOOs:** Yes, there are, but their extension in terms of percentage covered area is not available.
**Olive groves' owners:** private ownership.
**Average age of private owners:** At regional level, the ratio between young farmers under the age of 39 and those over 55 years is 16.5%; the value of this ratio is indicative of the presence of only one young person every 6 farmers over 55 years. Therefore, rather soon, a substantial part of the older farmers will come out from the agricultural sector and many of them will not have a generation that can replace them.
**AOOs abandonment:** Some abandonment is registered, mainly in the past due to some fires and for the lack of profitability. Recently, the phenomenon seems to have stopped but it is not possible to make estimations.
**Olive oil mills available:** Overall, 20 mills are located in the Isernia province, in Venafro one cooperative mill, the other mills are located in neighbouring municipalities.
**Agri-tourism activities in the area:** Recently the sector has shown some developments in the Province of Isernia, but only one agri-tourism is located in Venafro area.
**The potential for expansion of agri-tourism:** The potential could be good by leveraging with professionalism on the AOOs landscape and on the historical heritage of Venafro. Moreover, the good accessibility and connections of Venafro represents a strength compared to other remote municipalities in the region and assure some tourism; on the other side, Venafro is a place of transit towards other destinations and struggles to keep tourists in town. A strong and visible identity and authenticity, with specific skills of farmers, farms' managerial approaches, systemic promotion of agritourism facilities, could improve the attractiveness of the area for different tourist targets, including the emerging rural, environmental and food and wine sectors.
**The main threats to AOOs:** The main threats to AOOs derive from the abandonment of agricultural activities, in particular of olive groves at higher altitudes or those further away from the roads. While forestation and extensification are mainly limited to some macro- areas, atrophies mostly affects the part of the plain near the main road network.

With regard to the main cultivations practiced in the Venafro area, cereals and fodder crops are the most widespread. Anyway, the olive groves are also very common in the area, covering about 420 hectares. Vineyards, horticultural crops and orchards are less common. Due to the particular morphology of Venafro area, it is possible to distinguish a large plain destined to arable land and greenhouses,

and a foothill strip destined to olive growing.

According to data from the 6th ISTAT General Census of Agriculture, about 2010, in Venafro there are 443 farms, of which 353 have olive groves (Table 3), for a total Utilized Agricultural Area (UAA) of 3078 hectares, of which about 420 hectares are covered with olive groves. From 1982 to 2010 the evolution of olive-growing farms and hectares in Venafro was fluctuating (Table 3).

The average size of olive-oil farms in Venafro is greater than that measured in the provinces and has increased in the last census period (Figure1). Despite that, the small size of farms, fragmentation, old farmers and low generational turnover are all indicators of the fragility of agriculture in the area.

**Table 3. Olive oil sector in Molise region and Venafro area**

| Variable | Years | Molise | Campobasso | Isernia | Venafro |
|---|---|---|---|---|---|
| Hectares of surface | 1982 | **13.023,5** | 9.975,2 | 3.048,3 | 557,1 |
| | 1990 | **12.494,1** | 10.019,0 | 2.475,1 | 319,2 |
| | 2000 | **13.374,0** | 10.856,7 | 2.517,3 | 450,2 |
| | 2010 | **15.043,6** | 12.075,6 | 2.968,1 | 421,1 |
| No. of Farms | 1982 | **21.652** | 16.049 | 5.603 | 472 |
| | 1990 | **20.908** | 15.610 | 5.298 | 352 |
| | 2000 | **20.388** | 15.552 | 4.836 | 491 |
| | 2010 | **19.262** | 15.128 | 4.134 | 353 |

About olive oil production, the most recent data provided by ISTAT (Table 2) are limited to the NUTS 3 level, thus giving a picture of the province of Isernia but not of the Venafro area.Within the municipal

**Figure 1. The structural evolution of olive oil average size**

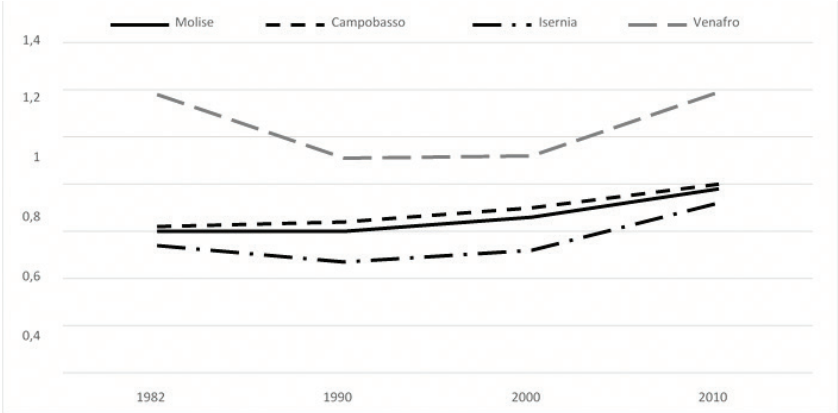
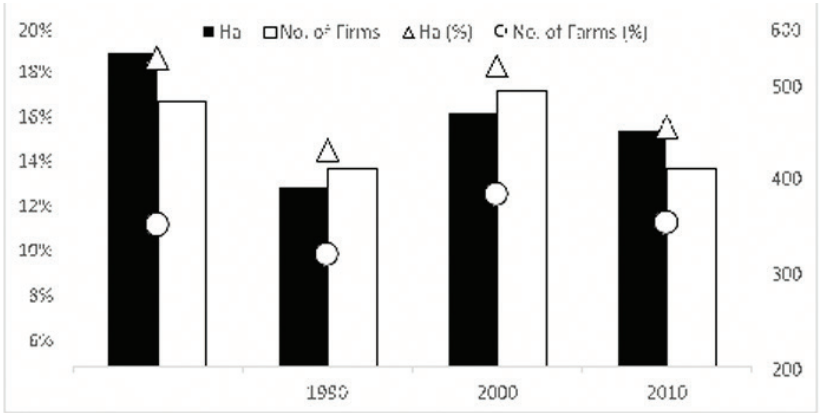



**Figure 2. 2. The role of olive oil cultivation in Venafro in the Isernia province.**

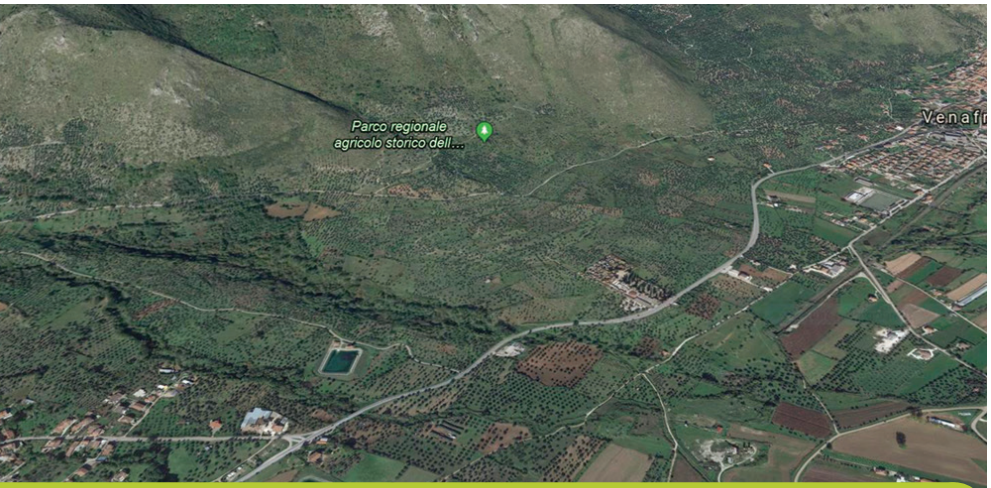



*Note: Vertical bars indicate the hectares and the number of farms reported on the right axis. Symbols refer to the percentages reported of the left axis.*

boundaries, the Regional Olive Park of Venafro is an area where olive trees are historically present, and their cultivation is practiced.

The centuries-old trees that characterize the olive groves owe their ability to produce continuously over many centuries to their perfect adaptation to the environments in which they grow, a condition that allows them to resist environmental adversities by minimizing, or eliminating, external cultivation operations (fertilization, irrigation, pesticide treatments) and maintaining good yields.
The park is characterized by a soil with a texture that, with a few exceptions, is ideal for growing olives. In general, the olive prefers medium-textured, loose, loamy, loam- clay-loam or clay-silty soils, with a pH around neutrality. Loose grounds, unlike heavy soils, facilitating percolation reduce the phenomenon of waterlogging which

**Photo 2.** Satellite view of Olive Park of Venafro area ("Map data ©2020 Google") )








is very harmful to olive trees.

Another characteristic of the Park is the altitude of the olive groves which range from a few meters up to about 500 m asl. In fact, negative variations of the minimum winter temperature, with both early (in November-December) and late (in April-May) frosts could be extremely harmful for the olive tree. For high temperatures, the olive resists temperatures above 40 ° C but, if these last over time, they too will be harmful.
Another important aspect is the availability of water. The olive tree is a heliophilous species and is remarkably resistant to drought, surviving even rainfall below 400 mm in a year.
Finally, the olive greatly reduces its productivity in very humid environments and in those where there are frequently mists, because

**Photo 3.** Ancient olive tree in the Park Area

**Table 4. Olive tree cultivars in the Venafro area.**

| | Aurina | Rossuola | Olivastro Dritto | Olivastro d'Aprile |
|---|---|---|---|---|
| olive weight | 1.0-1.2 g | 1.5-1.7 g | 1.0-1.2 g | 1.0-1.2 g |
| characters | Late and gradual, jet black, spherical | Early and gradual, jet black, ovoid | Late and gradual, jet black, ovoid | Medium and gradual, vinous red, ellipsoidal |
| productivity | Alternate, high | Alternate, average | Constant, high | Constant, high |
| resistance | Cold, water stress | Cold, water stress | Cold, water stress | Cold, water stress |
| oil yield | 16-20% | 16-20% | 16-20% | 16-20% |
| organoleptic characteristics of the oil | Golden yellow colour, delicate and harmonious fruity | Ripe fruity | Ripe olive fruitiness | Fruity olive green |

these conditions favour the attacks of pathogens and pests. Furthermore, rainfall during flowering compromises the setting.

Given the orography of the Park area, we should not overlook the aspects related to hydraulic arrangements, to favour the removal of excess water, facilitate its slow storage in the ground during the wettest periods, reducing erosion and landslides. On flat land, it is necessary to carry out adequate maintenance on the drainage





network to avoid stagnation, while in the hilly soil, in addition to an adequate surface layout, it is necessary to preserve the terracing system and the retaining dry-stone walls.

The Regional Olive Park of Venafro is characterized by the presence of different varieties of cultivated olives typical of the area in which they have been growing for centuries and where they have heavily contributed to the economic support of families.

The most common native cultivar is Aurina. It is a variety, identifiable with the ancient Licinia of the Romans, characterized by a jet-black spheroidal fruit and by the production of a golden yellow oil. In addition to the Aurina cultivar, there are also other ancient varieties including Pallante, Olivastro Dritto, Olivastro d'Aprile, Rotondella and Rossuola. Among these, Pallante and Rotondella are poorly represented.

**Photo 4.** Mule track in the Park Area

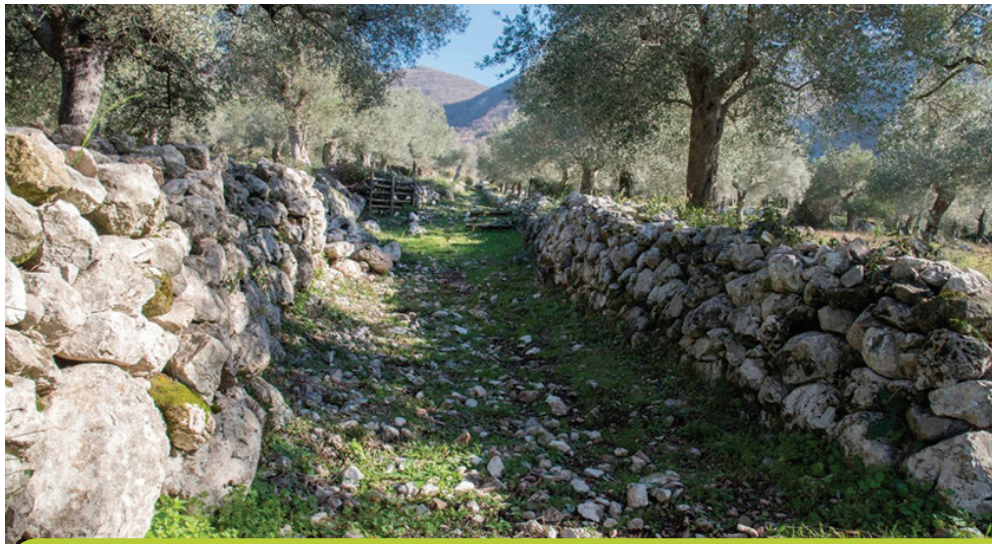


**Table 5. Number of farms applying cultivation practices by year**

| | 2019 | 2018 | 2017 |
|---|---|---|---|
| Soil preparation | 4 | | |
| Pruning | 3 | 2 | 1 |
| Chopping | 1 | 1 | 1 |
| Fertilization | 1 | 1 | |
| Pesticide treatment | | | |
| Irrigation | 1 | | |
| Harvest | 6 | | |

The oil produced in the Park area is recognized by DOP Molise.

Based on the interviews with some local farms, some farming practices applied by olive growers in Venafro are presented in Table 5. The table provides a summary of the practices applied by the sample of farms involved in the survey, reporting the last year in which the practise was applied.



# 4 Good farming practices for olive management

The centuries-old olive trees in the Park areas show a strong adaptation to the environment of Venafro as it fully satisfies the needs of this crop. This condition simplifies crop management by promoting sustainable cultivation techniques with a low environmental impact that make it possible to minimize cultivation interventions (fertilization, irrigation and pesticide treatments) obtaining good productive results both in quantitative and qualitative terms.

The agricultural practices that will be taken into consideration are only those directly related to the management of ancient olive groves such as:

1. Soil management, cover crop and fertilization
2. Irrigation
3. Pruning
4. Pest management
5. Olive harvesting
6. Thickening and replacing dead plants and branches

The discussion of these cultivation practices will refer to historical olive groves, and therefore already existing. The management of these cultural devices will be based, in addition to primary production, on the respect for the environment and the biodiversity pres-

ent, in order to better exploit the territorial reality of the park also in a profitability perspective.

## 4.1 Soil management, cover crop and fertilization

In the Venafro Olive tree Park, where there is a complex topography, land management and soil processing must take into account the effects on its chemical, physical and biological fertility.
In particular, a correct management of the soil allows to:

- improve nutrient use efficiency, avoiding losses due to leaching,
- improve water use efficiency by reducing runoff and evaporation losses,
- improve water use efficiency by promoting the penetration of rainwater and irrigation,
- improve telluric air quality,
- favour spontaneous flora control,
- improve the adaptation conditions of the crop, maximizing the yield,
- keep the land in good structural condition, preventing erosion and landslides,
- promote and stimulate the biological activity of the soil by combining the different cultivation techniques in a sustainable perspective.





The period, the type of soil tillage and the impact these have on the soil and on the crop must be managed correctly in order not to compromise the hydro-geological balance of the place and not to increase the phenomenon of mineralization that leads to the loss of organic matter. Therefore:

- on sloping soils, perform a maximum of two surface tillages per year to control spontaneous plants;
- on flat land, perform a maximum of three tillages per year (between March and September) at a depth not exceeding 10 - 15 cm.

While the use of soil tillage remains valid, we must not overlook other soil management techniques such as cover crop and surface hydraulic arrangements that are often able to limit the damage associated with the excessive presence of water in the cultivation environment. In general, it is always a good practice to use equipment that grinds the soil superficially, without pulverizing it, in order to reduce wounds or cuts in the roots, which predispose to severe infections. This type of tillage allows to control the root depth avoiding too shallow roots and consequent phenomena of water stress.
To limit the loss of water by evaporation from the soil or to break the superficial crust in the loamy soils or to control the spontaneous flora we shall be chopped at a depth of some centimetres. Finally, to break a possible hard pan or to facilitate water drainage to limit landslides, it is better to use a subsoiler up to a maximum of 80 cm and only in inter-rows away from the roots. In excessively clayey soils, it is advisable to avoid tillage when they are in the plastic

state. It should be remembered that all these cultivation operations must be carried out in compliance with the present biodiversity.
As already mentioned several times, a possible alternative to tillage is the use of cover crop especially in soils where the slope is more than 5% to avoid dangerous surface leaching.

Controlled cover crop allows considerable advantages such as:

- add environmental value since it is an environment-friendly technique;
- maintain or increase the amount of organic substance present useful for improving the porosity of the soil and therefore its viability;
- decrease soil compaction (especially in heavy soils);
- prevent and considerably limit surface erosion (in sloping land);
- limit the in-depth leaching of nutrients, particularly nitrogen;
- promote the absorption of nutrients (phosphorus in particular);
- increase animal and plant biodiversity within the agro-olive grove ecosystem with positive effects on the fight against pests (moth and scales);
- facilitate the practice of harvesting (moving equipment and operators and reducing contamination of the olives from the soil) and pruning.

The use of cover crop is not always advantageous in dry environments as it could establish a natural water-nutrition competition between the spontaneous plants of the turf and the olive tree. In





general, it is advisable to keep the height of the grassy turf low in the warmer months and in the vegetative growth.

Even in the light of this necessary clarification, cover crop can be:

1. total, the entire olive grove is covered;
2. partial, only the inter-row is covered;
3. temporary, only in the most humid periods, in the absence of competition, and mown and buried before the vegetative restart;
4. permanent, throughout the year; we will proceed to 2-3 mowings per year, the first before the vegetative growth, the second or the third near harvest;
5. natural, consisting of spontaneous plants;
6. artificial, from single species sowing or from mixture among them.

Every 2-3 years, after harvesting with the soil tilth, it is necessary to make a scarification of the grass to aerate the soil and bury poorly mobile nutrients such as phosphorus and potassium.

It is clear that the combination of these different types of vegetation cover makes the use of cover crop valid in the different orographic contexts of the Park.
In the case of artificial cover crop, it is advisable to use species that are already naturally present in order not to upset the eco-systemic balance that the rich plant biodiversity of the Park has created over the centuries. It is important to foresee a correct presence of carbon and nitrogen in the soil. It will thus be possible to reintroduce

**Photo 5.**
Panoramic view of Park Area on the "Campaglione" location

monocotyledons and dicotyledons by restoring, where necessary due to excessive use of chemical herbicides, the natural plant biodiversity. Combining species with taproots (legumes) with those with fascicled roots (grasses), an improvement in fertility is obtained both in chemical and physical terms (structure / permeability / porosity).

The grassy turf managed with cover crop could also guarantee beneficial actions in terms of fertility such as:

- fixing nitrogen due to the presence of legumes,
- the organization of nitrogen in the soil (leaching reduction) due to the presence of cruciferous plants and grasses,
- the structuring of the soil (aeration) due to the presence of grasses and legumes,
- land cover due to the presence of brassicas and asteraceae.





Furthermore, the presence of a particular turf could ensure the presence of honey plants and also guarantee the production of forage.
In the sloping soils of the Park, the absence of cover crop in the rainy months could favour a considerable loss due to leaching of nutrients and nitrogen in particular.
The grassy turf must be managed through appropriate mowing avoiding that it becomes too high (over 20 cm). A strong development of herbaceous species, while increasing the production of organic substance and the fixing of nutrients, increases the competition for water and nutritive elements above all in conditions of limited water availability. The presence of mown plants is useful in warm periods since, by creating a mulching layer, it is possible to reduce water losses by evaporation. To be fair, it must be added that, in order not to reduce the capacity to regrow the grass, the height of the cut from the ground must be 4-5 cm.
In some lowland situations, where it is possible to carry out regular irrigations, it could be useful to foresee a management of the spontaneous flora in a sustainable and eco-compatible perspective. Proper management also starts with controlling the spread of seeds through irrigation water, which is why it is a good practice to filter water for irrigation purposes. As for olive groves with sloping soil, what is said for cover crop is valid. In this case, the spontane-

ous plants, properly managed, become a resource.
The management of soil fertility in the olive groves of the Park must have the objective of improving the characteristics of the soil in terms of physical, chemical and microbiological aspects. From this point of view, the nutritional needs of the olive tree can be managed, which can vary depending on many factors such as: cultivar, phase of the vegetative cycle, plant conditions (epigeal and hypogeal), soil conditions, climate, type of planting, productions to be implemented and cultivation practices adopted.
In fact, nutrients are just one of many factors that contribute to the fertility of a soil. The yield of the olive tree also derives from the development and condition of the roots, on which the plant's ability to adequately assimilate the water and nutrients available in the soil depends. It is important, therefore, that the uptake by plants depends primarily on the volume of earth explored by the roots and, secondly, on the abundance of mineral elements contained in the soil. The assimilable nutrients are present in the circulating soil solution. Therefore, to improve soil fertility it is also necessary to optimize the soil structure on which its porosity also depends. In this way, it will also be possible to improve the relationship between air and soil water that guarantee radical vitality.
Also, the supply of organic substance in adequate form and quantity allows to improve the porosity and water retention capacity, thus favouring a better development of the active roots. In addition to an action on the movement of water in the ground, the organic matter plays a significant action on the temperature and aeration of the soil, on its microbiology, structure, mechanical resistance, colour,





pH and fertility chemistry.
A soil with a good organic matter content tends to have a sub-acid pH value, a useful condition to increase the availability of phosphorus. Furthermore, the organic substance has an effect on the cation exchange capacity (C.S.C.), i.e. on the quantity of exchangeable cations useful to the plant.

In general, it is always useful to maintain a high rate of organic matter in the soil. Therefore, it is possible to:

- use vegetable coverings (cover crop) in which there are leguminous species that naturally fix nitrogen;
- incorporate manure or compost, preferably from Park farms (sustainability). Alongside organic fertilizers, it is possible to use mineral fertilizers to ensure adequate nutrition for the plants. If the farm is organic, it is necessary to use only the fertilizers that can be used and are listed in the annex. I of Reg. (EC) n.889 / 2008 and subsequent modifications (eg. Reg. (EC) n.1254 / 2008, n.710 / 2009 and n. 271/2010).

Annually, the absorption of nutrients undergoes seasonal variations. Among the macronutrients, nitrogen (N) is intensively absorbed from full bloom to hardening of the kernel; phosphorus (P) shows a modest absorption and not in particular periods and potassium (K) is absorbed a lot at the vegetative restart becoming high in the growth of the fruits and olive ripening. If the multi-year development of the olive grove is taken into consideration, uptake varies according to age (young olive trees absorb more nitrogen, adult olive

trees more phosphorus) and also depending on the conditions of the plant (poorly developed olive trees require nitrogen, vigorous plants or plants affected by pests benefit from phosphorus or potassium).
As with other cultivation practices, the fertilization of olive trees in the Park must also be managed in a sustainable perspective that respects the environment and the landscape. It is evident, therefore, that to guarantee the fertility of the olive grove, it is necessary to develop a cultivation strategy that best combines the techniques of land management with the use of plant residues, in view of the maximum reduction of the use of inputs outside the farm. A precise knowledge is therefore necessary of:

- the mineral composition of the soil (analysed about every five years);
- cultivation system (variety, dry or irrigated olive grove, pruning round, planting patterns);
- microclimate;
- health status of the plants;
- expected production in future years.

As suggested in the chapter on cover crop, it is possible to increase soil fertility, where the use of manure is difficult or impractical, through the practice of green manure otherwise called green fertilization.
The practice of green manure brings, on average, dry organic matter up to 3-5 t / ha or a quantity of humus that fluctuates between 0.4-1.2 t / ha depending on the efficiency in the transformation of crop residues. In the Park environments, with a relatively mild climate





in winter and long hot summers, green manure can be made with many herbaceous species (legumes, grasses, cruciferous plants, etc.), single or better mixed. The combination of a taproot-shaped legume with a fasciculate root grass improves physically and chemically (fertility, permeability and porosity) fertility. To ensure an appropriate transformation of the undecomposed organic substance (green manure or pruning residues), it is advisable to bury even 20-30 kg / ha of nitrogen in order to meet the needs of the microbial flora involved in decomposition.
In addition to green manure, it is possible to practice natural fertilization using other sources of organic substance. One possibility is that of manure (20-30 t / ha), zootechnical waste and residues from the processing of bones, wool and hair. Their use in agriculture is regulated by principles that aim to prevent polluting effects. It is known, in fact, that they must be distributed at a distance greater than 10 m from watercourses and 50 m from sources and water sources for human or animal consumption, avoiding the possibility of surface runoff in distribution. The distribution of manure or other organic fertilizers, including composted ones, must be carried out after harvesting, followed by appropriate landfill. In case the organic substance is well composted, alternatively, the biomass can be buried after mowing. To make olive growing and, in particular, fertilization sustainable, it is necessary to point out that a mixed use of the two sources of organic substance, animal and vegetable, is desirable. In fact, the contributions of organic substance resulting from the cultivation of the olive tree must not be forgotten, such as: pruning waste, virgin pomace as it is, exhausted or pitted, and

vegetation water. In this regard, it is useful to remember that there exist some rules of production and agricultural use that must be respected, as it happens for the zootechnical waste.

This is not the case of the Park in its current form, but if you want to establish new plantings, it is necessary to proceed with a series of operations useful for the environmental assessment, the choice of variety, the cultivation practice and fertilization. To ensure proper nutrition of the plants, a basic, organic and mineral fertilizer is required, which cannot be separated from the natural supply of the soil, which must be evaluated with a specific chemical-physical analysis. If present, the specific production protocol must always be respected.

The orographic and climatic variability that characterizes the Park area make the management of the correct nutrition of the olive trees very complex. For this reason, situations representative of the entire district will be analysed.

In general, all cultivated plants, including the olive tree, need all the nutritive elements useful in maintaining and / or enhancing the vegetative-productive capacities and the lack of one or all of the nutritive elements involved can compromise the production of the annual or plant life. An appropriate annual fertilization plan is therefore necessary, commensurate with the production requirements and the pedoclimatic environment.

In general, nitrogen (N) controls the vigour of the plant and its vegetative-productive balance and its deficiency causes less growth activity, flower anomalies, scarcer and more alternate productions. Equally harmful are the excesses of nitrogen especially in relation





to the delay of maturation, to the greater sensitivity to cold and to pest attacks. Nitrogen fertilization, for reasons related to the movement of nitrogen in the soil (leaching), must be performed in a fractional manner and when necessary (40% from vegetative growth to fruit set, 40% from fruit setting to hardening of the kernel and 20% from hardening of the kernel to harvest).

Phosphorus (P205) regulates growth and fruiting; however, deficiencies or excesses are rare. Given the limited nutritional needs of the olive tree and the slow and not always noticeable effects of phosphate inputs, there is a tendency to make modest phosphatic fertilizers. Phosphorus fertilization should be carried out after harvesting, by burying the fertilizer since the phosphorus is not very mobile in the soil.

Potassium (K20) promotes the accumulation of starch, regulates the water balance and increases resistance to environmental adversities. Deficiencies, not very usual, manifest themselves with less intense green colouring of the leaves, apical necrosis and in the most serious cases leaf fall. It is absorbed by the olive in high quantities, always in relation to the productions and the type of soil (e.g. clay soils are rich). Potassium fertilization should be done after harvesting, by burying the fertilizer because potassium is not very mobile in the soil.

Calcium (Ca) is the element absorbed in greater quantities by the olive, but being present in the soil, it is not, if not rarely, administered through fertilization after harvest.

Iron and boron are micro-elements that are particularly important for olive cultivation and should be added to the soil after harvest,

and, only in cases of severe deficiency, through the leaves.
As mentioned above, the amounts of nutrients must be commensurate with the expected production in the future, taking due account of environmental fertility. The method used for the correct calculation of the quantities takes into consideration the uptakes and administration of organic substance (pruning residues and olives) that are carried out in the cultivation practice. In general, every 100 kg of olives, 0.8-1.0 kg of nitrogen, 0.1-0.2 kg of phosphorus and 0.7-0.9 kg of potassium are uptaken. Considering a basic amount for nitrogen, phosphorus and potassium, respectively of 40, 20 and 45 Kg / ha, for a future production of 5 t / ha the following will be necessary:

- N 0,8 x 50 = 40 + 40 = 80 of N/ha unit
- P 0,2 x 50 = 10 + 20 = 30 of P/ha unit
- K 0,7 x 50 = 35 + 45 = 80 of K/ha unit

In order to make nutrition sustainable, these predicted quantities must be increased or decreased based on the analysis of the soil and what was done in the previous year for fertilization.

In practice:

| regarding nitrogen | | | |
|---|---|---|---|
| **Organic matter > 2,0%** | **Excessive vegetative activity** | **Organic fertilizer distribution in the previous year** | **Organic matter < 1,0%** |
| - 20 kg | - 20 kg | - 20 kg | + 20 kg |





| regarding phosphorus | | | |
|---|---|---|---|
| **$P_2O_5$ > 45 ppm** | **$P_2O_5$ < 30 ppm** | **Organic matter < 1,0 %** | **High active limestone content (>10%)** |
| - 10 kg | + 10 kg | + 5 kg | + 5 kg |

| regarding potassium | | |
|---|---|---|
| **$K_2O$ > 330 ppm** | **Organic fertilizer distribution in the previous year** | **$K_2O$ < 250 ppm** |
| - 20 kg | -10 kg | + 20 kg |

In this regard, it is worth remembering that, in order to make fertilization more rational, it is advisable to establish fertilizer doses for each environment and not limit themselves to generic quantities calculated on a climate and soil basis.
With regard to fertilizers, it is a good practice to know in advance the release rate of the nutritive elements which can be more or less high depending on the formulation, be it organic or mineral. Moreover, these differences must be kept in mind when choosing the useful fertilizer administration period.
Beyond the distribution of nutrients on the soil, it is possible to feed the plants by means of foliar fertilization (simultaneously with pesticide administration) and fertigation. For a variety of reasons, including costs and nutritional efficiency, these possibilities cannot be considered ordinary fertilization practices, but could be taken

into consideration to overcome any temporary nutritional crises (nitrogen immobilization). These conditions are more frequent in young olive groves and less frequent in centuries-old groves such as those in the Park.

One aspect that should not be overlooked in optimizing fertilization practice is that of correct distribution. In addition to age, it is useful to distribute fertilizers where the active roots are, from the point of view of absorption. Therefore, if the canopy projection on the soil of the olive grove does not cover more than 50% of the surface, fertilization must be carried out by distributing the fertilizers at the level of the circular crown (about 50% radius) whose outer circumference is the edge of the canopy projection on the soil.
The supply of nutrients can be considered optimal when their distribution allows the achievement of the expected production. In general, the practice of fertilization can be considered suitable when the olive tree has produced a vegetative renewal with shoots 20- 40 cm long that represent the basis for the production of the next year. If this does not happen, perhaps also due to climate variations, it is necessary to appropriately correct the practice of nutrition. Therefore, observing the responses of the plants, by successive approximations, we can identify the optimal fertilization scheme in the conditions in which we operate. It must be remembered, however, that the progressive optimization of fertilization must always take into due consideration other practices that influence the vegetative-productive responses of plants (in particular pruning and irrigation).





Soil preparation practices, where carried out, are shallow with a harrow, generally in the month of March-April; one farm also carries out a treatment in September; one farm carries out shredding in June.
On family running farms, this activity is carried out by internal units and requires about 10 h/ ha. In the other farms, in one case salaried labour is used with an hourly rate of about 3h / ha and at a cost of 10 € / h; one farm declares to use subcontractors for the complete execution of the processing activities, always at a cost of € 10 / h- supported by 1 internal wage earner with a time of 1h / ha with complementary and supervision activities.

Burning practices are carried out between February and April, they are performed by 3 farms, one in the year 2019, the others in 2017. Occasional or paid labour is used for this activity for an hourly rate of 12-15 h / ha and a cost between 6 and 7.5 € / h.
As far as chopping is concerned, three companies carry out only this practice, 2 do chopping and burning. 1 with only family labour, 1 with employees for € 10 / h and 10 h / ha.

Finally, only 2 farms practice fertilization of which: one farm - with 1 ha of olive trees - uses manure in a quantity of 400 quintals per hectare by tractor with manure spreader in March using paid labour for 14 h / ha and 10 € / h; the other farm with 3 ha applies a nitrogen, phosphorus and potassium mix using family labour (2h / ha) and paid labour (1 h / ha for 9 € / h). The farm with 5 hectares of olive trees does not carry out fertilization.

## Questions and issues

*Are olive trees fertilized in every growing season?*
No. Lack of knowledge regarding nutrition makes this practice random with no defined frequency.

Form of fertilization: organic (10 kg/tree or chemical (N P K) (1 kg/tree)

*Is green manuring by planning legume cover crops applied?*
No

*Are pruning branches chopped and used as fertilization sources?*
No, they are often burnt off

*Are olive groves protected by terraces?*
Yes, with elongated and semi-circle type

*Are the spontaneous plants cut each growing season?*
Often not each season. The lack of knowledge related to the practice of spontaneous plants management makes this practice random with no planned frequency.

*Is mulching applied?*
No

*Is tillage implemented?*
No





*Are soil analyses made to check soil fertility?*
No, for the lack of funds and knowledge.

## 4.2 Irrigation

Irrigation practice has contradictory aspects, even in the case of olive trees. In fact, while on the one hand it promotes vegetative growth and therefore productivity, on the other it could compromise quality and favour pest attacks .
Although the olive is a xerophytic plant, which presents biological and physiological mechanisms suitable for saving water, it must be remembered that there may be some phenological phases during which olive trees are sensitive to water stresses, namely:

- bud differentiation (abortion of the ovary), flowering (lower number of flowers) and fruit setting (poor);
- fruit enlargement (fruit drop);
- after stone hardening, there is a reduced development of the fruit (unfavourable pulp / stone ratio), decrease in oil yield and variation in the period of ripening and harvest.

The olive groves of the Park, due to the peculiar orography of the land, may not always benefit from the irrigation practice, a condition that makes these olive groves comparable to the olive groves prevailing in dry farming in Italy. Dry farming is a possible condi-

tion only if there are natural water supplies of at least 600 mm per year. Therefore, if rainfall is around 600 mm per year, irrigation, although not necessary, can certainly contribute to improving vegetative-productive activity, allowing the plant to overcome the criticality of high temperatures and drought.
The absence of irrigation practice does not become a problem if the cultivation technique is able to contain water losses that are the basis for estimating the irrigation volume.

A rational water supply has the following benefits:

- increases production by 20-50%, especially in dry years;
- improves production consistency, by preventing alternate bearing;
- allows the cultivation of olive trees in sandy or loose soils, which are demanding in terms of water consumption;
- in new plantings, it accelerates the formation of the plant, which enters production first.

Micro-irrigation is the recommended method (sprinkler and drip). Irrigation is delivered in a localized manner and with low volumes of water in order to reduce percolation losses and favour an easy and continuous water uptake by the plant. With this type of system, the foliage is not wet and pest attacks, especially by fungi, are reduced. The volume of watering represents the amount of water to be returned to the crop to restore evapotranspiration losses. The calculation of this parameter considers the amount of water that can be easily used by the crop, the texture of the soil and its depth.





In general, sandy and deeper soils need more water. The average volume of watering, which must be quantified by a technician for each olive grove, is on average 2,000 cubic meters per hectare. It is important to avoid water stagnation that can seriously compromise the development and productivity of the plant.
From the point of view of yield, the availability of water, in general, increases the fruitiness of the oil and reduces its bitterness and spiciness with the consequent reduction of oxidative stability over time. Even for this reason, the management of the irrigation practice is very important according to the production objective set.
Only one of the farms surveyed irrigates its olive groves during July and August, drawing water from the local reclamation consortium at an annual cost of about € 200.

## Questions and issues

*Are olive trees irrigated?*
Mainly non-irrigated

## 4.3. Pruning

Centuries-old olive groves in the Park require different pruning interventions according to the plant age. In general, the common management practices require a production pruning, and occasionally, following the replacement of some dried-out plantations, growth pruning. Therefore, during the production phase it is necessary to favour a correct vegetative-productive balance (through a good ratio between leaf surface and wood) linked to the qualitative-quantitative production needs; during growth, it is necessary to give a shape to the tree and a correct plant setting. In this way we try to favour the improvement of the productive and health status of the crop. In fact, a suitable pruning, together with other cultivation operations (fertilization, irrigation, soil management and phytosanitary protection) contributes to obtaining good and constant productions over the years. All this is possible thanks to the fact that pruning, favouring the aeration and penetration of light into the foliage, guarantees a good photosynthetic activity, fundamental to guarantee the differentiation of flower buds, fruit setting and growth. The shape given to the plant with pruning is also useful to facilitate harvesting operations in relation to the type of machine used.

In the event of dry plants in the Park's centuries-old olive groves, it would be necessary to work on the new plants that need appropriate pruning in the first few years. In practice it is necessary to give the plant the chosen shape, obtaining at the same time the beginning of the fruiting and the completion of a strong tree structure in the shortest possible time. Therefore, while respecting the natural needs of the plant, the expert pruner shall initially maintain the lateral ramifications, eliminating only the vigorously misplaced branches (olive suckers). In order to avoid the establishment of wood fungi, it is a good practice to protect the cuts with suitable protective waxes.

The final development of the plant in height and on the sides must be contained, to facilitate both manual and mechanical harvesting.

If one opts for olive mechanical harvesting with trunk shakers, a vase shape would be suitable for the Park environment, which requires plants raised so as to obtain a one-meter-high vegetation-free stem on which 3-4 primary branches are inserted at an angle of around 35-40 ° with respect to the vertical (which varies according to the weight to be borne even in the case of extreme weather events such as snow), and on which the secondary ones, relatively numerous, are raised without sudden changes in direction. Anything that does not respect this geometric distribution of the canopy should be eliminated (hanging branches that do not respond well to vibrations and production). In general, especially if one intends to carry out manual harvesting or with aiding equipment, it will be necessary to limit the height (maximum 4-5 m) and allow the foliage to develop relatively wide.

The choice of the crown shape does not only take into consideration the vegetative-productive balance, the lighting conditions and the type of harvesting but also other aspects useful to:

- facilitate cultivation operations (obstruction),
- reduce labour costs (aiding machines),

- meet specific aesthetic needs (Park landscape).

In the Park's olive groves, a much more important role is assigned to production pruning whose purpose is to preserve the form given with growth pruning, balancing the vegetative-productive activity and eliminating any portions of the canopy damaged by bad weather and pests. Good pruning provides an appropriate intensity (which differs according to the cultivars) that must not compromise the productive activity of the plant without creating excessive self-shadowing. In this way, conditions are created to naturally control (in organic, environmentally friendly and integrated agriculture) the development of pests, above all fungi. Production pruning should be performed, depending on the plants, with an annual frequency.

Pruning activities must be carried out during the vegetative rest period. In areas of the Park where the risk of cold damage is greatest, it should be done after the period of severe frost. Be careful to avoid late pruning which weakens the plant, by withdrawing reserve substances, and compromising its productivity.

The suckers, within the foliage, and the suckers at the base, must be eliminated annually (excessive thickening of the foliage) even in summer.

Another useful and often forgotten operation in the Park is the removal of all rotten wood due to dry rot. This is carried out on plants heavily damaged by dry rot, which are in danger of rotting completely and becoming unproductive. The operation should be carried out at the end of winter, at the same time as pruning, trying not to damage the healthy part of the trunk (presence of vessels) and





taking care to cover the parts of the wood exposed to the air by the rotten wood with wax. Another very important rule is the hygiene of pruning tools. Given the natural presence of pathogenic organisms (olive knot and verticillium wilt), it is recommended to disinfect the tools with copper or sodium hypochlorite solutions.

Given the complexity of the Park's agro-ecosystem, it should be remembered that among the "inhabitants" there are also useful organisms such as birds and useful insects (predators of pests) that must be safeguarded in order to restore and maintain the ecological balance in the olive groves. Therefore, by managing the pruning schedule, it will be possible to create and maintain useful habitats for the reproduction of these beneficial organisms.

**Photo 6.**
Panoramic view of dried walls in the Park Area

At the end of the pruning operations, it is a good practice to correctly manage the pruning residues. If healthy, they can represent a resource to be reused in the process of managing the fertility of the olive grove and therefore of its productivity. Therefore, it is a good practice to grind and spread pruning residues on the ground to replenish organic matter losses. In doing so it also contributes to limiting the risk of fires that have often damaged the Park's olive groves in the past.
Pruning is carried out in all interviewed farms with the help of a chainsaw.

### Questions and issues

*Pruning frequency.*
Within the Venafro area, pruning is not carried out annually; in fact, among the interviewed farms, the year 2019 was the last year in which pruning was applied in 3 cases, the year 2018 in 2 cases and also the year 2017 in 1 farm. It takes place between the months of February (1 farm), March (4 farms) and April (1 farm).

*Pruning activity* is mainly carried out by paid or occasional labour, except for a farm where the labour force involved in pruning was provided by the farmer's family. The execution time varies from 20h/ha to 24h/ha up to a maximum of 30h/ha and with a cost of 6 €/h, 7.5 €/h up to 10 €/h. A farm declared the use of both chainsaws and scissors.





Pruning has a rather variable *annual cost* depending on the data provided on the type of operation, the time spent in manual or mechanical use, the duration of the work and its external cost: a stated annual cost of €300 with external labour - whose time and/or hourly cost was not specified - and 430 trees/ha; a cost of €1750 for 250 plants performed manually and external labour (on average €5/tree); a cost of €2500 for pruning with chainsaw and scissors, without specifying time or cost; a cost of €3200 with chainsaw and external labour (€8/tree).

## 4.4. Pest and pathogen management

For natural reasons, all farming environments are also infested with pests harmful to crops. Therefore, a sustainable protection strategy is needed, able to control harmful organisms, which uses all the factors and techniques available to keep their populations below the thresholds that entail economic damage, in full compliance with ecological, toxicological and economic principles. Protection strategies must have, as an ecosystem, an appropriate balance between useful and harmful organisms in such a way that the olive grove system is able to withstand or tolerate a certain level of disturbance without affecting its capacity to produce.
In order to be environmentally friendly, the control system must include agronomic, physical, mechanical and biological measures

and, only if these do not guarantee an appreciable pest control, the chemical technical means allowed in an integrated perspective. For protection techniques to be correct, olive growers must know the potential harmfulness of pests active in their area; only thanks to this knowledge, it will be possible to make the most appropriate farming choices thereby reducing the harmfulness of such organisms.
The presence of pests must be detected by accurate sampling and monitoring methods that aim to verify the extent of the inoculum or pest population on the crop. Accurate and consistent sampling is a prerequisite for a successful pest management programme.
Evidence of sampling and monitoring activities will be recorded periodically on special "farm monitoring sheets".

The most suitable time of intervention is evaluated in relation to:

- of the development phase of the harmful species and its degree of danger;
- the progress of infestations;
- the simultaneous presence of more harmful species;
- weather forecasts.

The choice of active substances to be used must be made on the basis of:

- the effectiveness against the pest to be controlled;
- delay time depending on the time of harvest;
- the absence of danger to beneficial organisms;
- the impact of the product on human health, animals and the environment;





- the possibility of using some agrochemicals allowed by (organic) farming methods.

The practice of pest management does not disregard the use of equipment that must be maintained every year to ensure efficient and effective operation. After each treatment, the equipment must be thoroughly cleaned in all its parts to avoid the risk of possible contamination with active substances not allowed by the crop protection plan.
Used agrochemicals packaging, expired or unusable packaging must be disposed of, in accordance with current legislation on the disposal of "hazardous waste", at specialized centres. It should be remembered that the washing of agrochemicals packaging must be carried out concurrently with the preparation of the treatment mixture and the water for washing packages shall be disposed of through the treatment itself and not dispersed in the environment.
Even the washing of mechanical equipment must take place in circumstances that prevent possible contamination, even if point-like, of active substances in the environment.
There are several pests that can affect olive productivity. These include: bacteria, pathogenic fungi and insects. Given the complexity of managing many pests, it is advisable to consult an expert technician.

## Bacterial infections

**Olive knot (*Pseudomonas syringae pv. savastanoi)***

This bacterial disease affects all the plant organs, especially branches and leaves, with globose overgrowth (knots) after injuries caused by pruning, frost and hail. Due to its etiology and microbiological characteristics, it is advisable to remove the diseased parts, and disinfect both the cutting surfaces and the tools used. Since the bacterium spreads through the wounds, it is necessary to intervene immediately after events that cause them (frost, hail) with copper salts such as 1.5-2.0% Bordeaux mixture or with 0.4-0.6% copper oxychlorides ( 50% copper). In the case of infected olive trees, it is useful to prune, separately in the dry period, those affected by the knot from the healthy ones to avoid the spread of the disease. At the end of the pruning, also as a general preventive rule, it is appropriate to treat with copper-based products, which also have good control over other fungal diseases such as the olive scab.

## Fungal diseases

**Olive scab (*Cycloconium oleaginum = Spilocaea oleagina*)**

This fungal pathology mainly affects the leaves causing their early fall with damage both to the lack of differentiation of axillary buds (reduction of production for the following year) and to yield in olives and oil. The disease, like all fungal diseases, is favoured by conditions of high humidity and even more by frequent rains in spring.





Therefore, it is necessary to keep the foliage well ventilated (regular pruning). Infections occur in spring or autumn, when the relative humidity is high, and the temperature exceeds 5 ° C. In particular, in optimal temperature conditions (12-18 °C) and high relative humidity, the incubation period can last even just 2 weeks after which the characteristic grey-brown spots appear on the leaves. Early diagnosis should be performed by the end of the incubation period; it is carried out by immersing the leaves for 1-2 minutes in a 5% NaOH solution heated at 50 ° C. In the absence of specific methods of investigation, an intervention in spring (by mid-late March) in ventilated areas or a double treatment (spring and autumn) in areas with poorly ventilated with copper products is desirable. Given the natural co-presence with other parasites, it is useful to point out that with these treatments we can also fight olive knot, olive anthracnose and cercospora leaf spot.

**Olive anthracnose (*Colletotrichum gloeosporioides*)**

This disease affects especially the fruits, on which round and depressed spots appear followed by an orange exudate with the spores of the fungus. The fruit withers and falls prematurely. The optimum environmental conditions for germination of conidia are temperatures of 25° C and relative humidity minimum of 92%. Under these conditions the incubation period is about a week. In case of strong attacks, it is useful to intervene when chlorotic symptoms appear at the beginning of spring with copper products (oxychloride or Bordeaux mixture). It is advisable to carry out balanced and not excessive fertilizations as well as performing short shift pruning.

### Verticillium wilt (*Verticillium dahliae*)

This pathogen is very frequent in southern Italy; it invades the vascular system penetrating through lesions of various origins. The alteration of the affected plant is evidenced by the drying of one or more branches or of the whole tree, particularly in young plants (new plants and nurseries). The presence of this pest in the vessels makes the pest control very difficult. It is essentially based on preventive measures that primarily concern the nursery owners (sale of certified plants), who must take the scions from healthy plants and use clean soils. In the field, associations with *solanaceae* and cucurbits must be avoided, paying maximum attention to the use of agricultural vehicles, capable of producing injuries, on soils that may be infected. Solarization is another means of control. As an alternative it is possible to use the ascomycete *Talaromyces flavus*, which is able to destroy the microsclerotia of the pathogen present in the soil.

### Cercospora leaf spot (*Mycocentrospora cladosporioides*)

This fungal disease presents its symptoms first on the underside of the leaves with irregular, often confluent spots covering the entire leaf blade, which takes on a lead-grey colour. On the upper blade, yellowish chlorotic areas develop which then become brownish and finally necrotic. The alterations can also affect the twigs and fruits on which characteristic reddish-brown spots are visible. The affected leaves and fruits fall off early. The fall of leaves leads to a halt in tree development, drying out of branches, reduces the induction and differentiation of bud flowers and the growth of fruiting





branches. The fungus can produce infection in spring and autumn. Scientific evidence has shown that the time of maximum spore production, and therefore of greater spread of the disease, occurs at the end of the summer with the first rains and the concomitant lowering of the temperature. These conditions favour the germination of the spores that produce a mycelium that is first maintained outside the leaves and subsequently penetrates through wounds and natural openings (lenticels). The fungus develops in the leaf tissues, in the spaces between the cells, producing the aforementioned symptoms. Treatments with copper salts, balanced fertilizations, the use of resistant cultivars and rational pruning are very effective for disease control.

### Sooty mold (*Capnodium spp., Alternaria spp., Cladosporium spp.*)

The sooty mould is a fungal alteration caused by fungi of the species *Capnodium spp., Alternaria spp.*, which induce the formation, on leaves, branches and fruits, of a blackish layer of mycelium, of conidiophore and conidia of different fungal species saprophytes that do not present any direct feeding relationship with the host plant. These fungi in fact develop and take nourishment from the sugary substances present in the physiological honeydew, emitted by the plant in particular moments of stress or emitted by pests such as *Saissetia oleae*. Other factors predisposing to the attack of sooty mould can be the excess of nitrogen and phospho-potassium fertilizations. As with other fungi, it is advisable to use copper-based products and to prune the affected trees more frequently.

## Pests

### Olive moth (*Prays oleae*)

Among the olive pests there is also the moth. This olive tree insect makes three generations a year, the first (April - June) on flowers, the second (May - mid July) on fruits and the third (from late autumn) on leaves. Only the generation that affects the fruits can be particularly harmful in some years, as the females, between the setting and growth of the little fruit, lay eggs on the olives near the peduncle. The newly-hatched larvae penetrate inside the pulp, until reaching, the kernel; subsequently, during in September, the mature larvae emerge from the olive on the side of the peduncle causing the olive drop.

Despite the presence of the insect can reach very high values, it is rare that the infestation becomes very severe. This is thanks to the high number of natural antagonists such as the parasitoid *Chelonus eleaphilus* which naturally grows on the common osyris (*Osyris alba L.*) and is able to control the olive moth. High temperatures (over 28° C) and low relative humidity (60%) also reduce the population by intervening respectively on mortality and hatching.

In case of need, it is possible to treat only against the carpophagous generation and when the population density reaches the level of harmfulness, equal to 15-20%. It is also possible to use *Bacillus thurigiensis* which is included in the regulations of organic farming, at the beginning of flowering, thus controlling the generation of the pests. It should be noted that the moth is also controlled by other parasites and predators: *Ageniapsis fuscicollis praysinicola, Elasmus steffani*, etc. In addition to insecticide treatments, copper treatments can also be of some efficacy, and those with natural biocides such as *pyrethrum* and *azadirachtin*.

### Olive fruit fly (*Bactrocea oleae*)

The olive fruit fly is the most harmful pest of the olive tree because, although it does not damage the plant, it negatively affects the quality of the oil. By morphology, this insect is similar to the domestic fly, but smaller in size. In case of a very strong attack it is also possible to observe the olive drop.

This insect does not have a defined but variable cycle in relation to the environment, with more generations per year, of which one is present in summer and the others in autumn. Normally, in the hottest areas, there are up to 3-4 generations a year. The development of the fly, especially of juvenile stages, is strongly influenced by the temperature with an optimum between 16 and 30°C. High summer temperatures, on the other hand, cause phenomena of high mortality of eggs and young larvae. Furthermore, the persistence of high temperatures (over 35°C) causes the reproductive activity of adults and the development of eggs to stop.

A rational and sustainable control activity involves the monitoring of adults, using, if necessary, the assistance provided by qualified technical assistance service.

The monitoring activity is very useful and must be carried out using traps (2-3 per hectare) appropriate as those chromotropic (yellow) and / or pheromones (in different numbers depending on the product), which will be hung at the beginning of the summer and in the

middle of the foliage, checking them weekly. Having the Park a very variable territory it is necessary to make precise assessments for each olive grove as to pest control such as the olive fly. Monitoring will provide the degree of active infestation. If it exceeds the intervention threshold (4-8% olives with fertile stings or given phytosanitary bulletin thresholds), the appropriate control activities will be put in place that must always be inspired by the sustainability of the operation.
As with all pest management, in addition to direct control, prior control dictated by the knowledge of the pest is also possible and desirable.

If a direct protection against the olive fly is necessary, this can be implemented in different ways through:

- mass capture which involves the use of adhesive supports properly equipped with bait (hydrolysed protein or ammonium bicarbonate solution);
- the use of "Attract & kill" traps that act thanks to a feeding bait and a pheromone and kill thanks to synthetic insecticides (e.g. deltamethrin lambda-cyhalothrin). They are installed in early summer.
- a mixture of protein baits, activated with natural pyrethrin, which will be sprayed on part of the plant, on all rows or on alternate rows according to the infestation.

Besides synthetic insecticides, natural pesticides can be used such as:





- biocides, they kill the insect directly (pyrethrum, rotenone, azadirachtin, Spinosad);
- repellents, they act on the behaviour of adults (sodium silicate, soy lecithin);
- phage-inhibitors, act on eating behaviour or as growth regulators.

Another possibility of defence is that of the so-called "mating disruption", which implies the dispersion of the fly pheromone in the environment in order to disorient males in the search for females.
The use of substances such as copper salts reduces oviposition by acting on the feeding of the fly.

A correct management of spontaneous biodiversity (cover crop, hedges) allows the presence of useful insects, capable of naturally containing the fly population, such as:

- *Eupelmus urozonus* (parasitoid) that develops on the honey locust (*Gleditschia triacanthos L.*) and on the false yellowhead (*Dittrichia viscosa L.*),
- *Psyttalia concolor* (parasitoid) that develops on the common jujuba (*Zyziphus sativa Gaertn.*).

If you want to opt for an agronomic protection, you can manage the infestation through:

- the correct irrigation practice (alternating with dry periods),
- the pruning that must not be very intense in order not to concentrate the attack on a few olives present (larger),

- complete collection, avoiding leaving uncollected fruit on the plants, because they ensure the continuity of the phytophagous generations.

Finally, it should be remembered as a rule that the small and early ripening varieties are less affected by the olive fly.

### Olive weevil (*Otiorrhynchus cribricollis*)

This insect is a very common curculionid beetle. It is an insect that, as an adult, practices the typical "half-moon" tooth erosion on the leaf margins. It also eats the bark of the young shoots or, with strong infestations, the petioles of leaves and olives causing considerable drops. In the form of larva, instead, it acts in the soil feeding on the roots of host plants. The damage caused by this insect is evident above all on young olive trees and only occasionally on the olive tree. The insect has one generation a year and the adult emerges in late spring, but only reproduces and lays its eggs in autumn winter in the soil to complete the cycle the following year.
Since these are insects, monitoring is also important in this case and must be carried out from May / June to the end of July and from September to November, monitoring adult activity on apical leaves. In the case of overt infestation, it could be useful to use bait plants or leave some suckers at the base of the trunk to direct the leaves of these branches towards the tree. A strategy for the control of this insect consists in applying around the trunk or main branches bands of synthetic wool in which the insects remain trapped. The weevil rises on olive trees during the night or during the coolest hours of the day, sheltering in the soil during the central part of the day.





### Black Olive Scale (*Saissetia oleae*)

This plant pest generally reproduces once a year, with staggered hatching from the olive's vegetative regrowth to its ripening, which is more marked in July-August in plants where excessively dense vegetation can create a humid microclimate favourable to scale growth. Cold winters, which cause the death of many overwintering eggs and nymphs, lead to large reductions in the presence of the insect. High summer temperatures also lead to high mortality. The damage to the plant is linked to the removal of sap and the emission of honeydew on which the sooty mold is installed. Its monitoring involves the random sampling, on different plants of the olive grove, of at least 20 branches per hectare. As mentioned, due to their concomitant on the same plant, the fight against black olive scale cannot be separated from the sooty mold.
For both adversities agronomic control is of fundamental importance since both are favoured by high humidity and reduced lighting of the foliage. Therefore, a regular pruning through foliage thinning is essential, associated with a fertilizing plan that does not favour an excessive vegetative development, as well as the drainage of excess water.
Black olive scale is also controlled by numerous natural enemies such as beetles and hymenoptera. In particular, the lentisk plant (*Pistacia lentiscus L.*) favours the presence of *Scutellista cyanea* which is a parasitoid of the black olive scale.

### Olive bark beetle (*Phloetribus scarabaeoides*)

The olive bark beetle digs tunnels in the axil of young twigs. It does not cause great damage and its control is simple. The control consists in the use of natural baits such as fagots formed by the remaining branches of the pruning in the shadiest areas of the olive grove. Between the end of April and the beginning of May, these bundles must be collected and burned.

### Olive leaf moth (*Palpita unionalis*)

This pest is more aggressive in young plants, where vegetative apexes may be attacked by olive leaf moth larvae, which form a tangle of silken threads between the leaves. The last larval stages of the insect manage to feed on the whole leaf and, in years with high presence of individuals, they also affect the growing olives. Before the treatment, monitoring is carried out from April-May to July and from September to November-December, checking for eroded leaves on the new shoots. In the case of the presence of larvae, biological control is also possible by a treatment with *Bacillus thuringiensis*.

## Questions and issues

*What kind of treatments are implemented to control pests and diseases?*

None of the surveyed farms stated that they implement pest treatments due to lack of knowledge about pest management practice.





# 4.5 Harvesting

Harvesting is a critical operation as it is directly related to the quantity and, above all, the quality of the olives and therefore of the oil. Correct harvesting makes it possible to check the entire crop management in terms of effectiveness and efficiency.

Time and harvesting methods are important. The right time to harvest the olives (October-December) is crucial for the quality of the oil. Colour break is the right time because the olives are richer in active ingredients useful for human health. If there is a staggered ripening, as is often the case, harvesting should take place when a little more than half of the olives have darkened. In the case of olive groves with several cultivars, harvest the early varieties first and then the others. A parameter that should not be underestimated in terms of harvest time is the resistance of the olives to detachment, which decreases during ripening, making it easier for the fruit to fall. A late ripening harvest often reduces the quantity of olives harvested due to pre-harvest dropping. Fallen olives should not be harvested as they produce poor quality oil. Earlier harvesting often reduces damages from pests (caused by the olive fly) and weather (rainfall and cold) improves organoleptic quality.

It is a common opinion that a late harvest improves the percentage oil yield . This theory is not correct as this increase is linked to the reduction in water content of the olives. It is true,

however, that a late harvest, although it does not affect the production of the area, negatively affects its quality.

Finally, the excessive permanence of the olives on the plant reduc-

es the differentiation of flower buds with consequent phenomenon of alternate bearing. In general, an early harvest produces an oil with a green colour, a herbaceous fruitiness and relatively high levels of bitterness and spiciness due to the high phenol content. In contrast, a late harvest produces an oil of a less intense green or yellowish colour, with fruity and bitter hints and a relatively low level of spiciness. These different qualities can also be spent in terms of the type of oil to be produced. In fact, depending on the production objective of the farm, it is possible to identify: an early age for obtaining an oil strongly characterized from a sensory point of view and rich in antioxidant substances such as phenols ("new" oil or high nutritional value oil); and an intermediate and, in some cases, medium-late age, for cultivars that have a limited drop, to obtain a standard extra virgin olive oil suitable for large-scale distribution.

In addition, the cultivation technique can influence the harvest time. In fact, in more vigorous and more loaded plants there is a slowing down of the maturation of the olives. As far as the harvesting method is concerned, it is not easy to give precise indications given the strong differences in terms of age and shape of the olive trees present in the Park. In general, it is possible to rely on a manual and / or mechanical harvesting. In this regard it is useful to remember that all those techniques that damage the drupes are to be avoided since the damaged olives can undergo phenomena of product degradation. Beyond the drupes, plants that must not be damaged due to improper use of aiding machines (shakers, vibrators applied on the trunks or main branches) must also be protected. Better manual or facilitated collection.





During the harvest of the olives from the tree, the fruit must never come into contact with the soil (nets). In this phase it is also useful for the staff to reduce direct contact with the olives (gloves) to a minimum. The olives harvested must be temporarily stored in rigid and ventilated containers approved for contact with food. It is necessary to follow these suggestions correctly, since it is believed that the time and way of harvesting, storing and waiting time before processing affect the oil quality by over 80%.

Immediately after harvest, it is necessary for the olives to be immediately delivered to the reference oil mill and pressed, to preserve the qualitative characteristics they have at the time of harvest. If the olives were to remain in the perforated containers for more than 10 hours, it is advisable to place them in a thin layer (maximum 25/30 cm) and place the boxes or bins in cool, well-ventilated rooms, away from sources of contamination (diesel oil). All the suggested devices must also be revisited in the light of the certifications (organic) or specifications imposed.

Of the farms interviewed, two units carry out manual harvesting: one farm with the support of occasional labour (300 h / ha) at 7.5 € / ha; the second farm by using family labour for 2 h / ha and occasional labour at a cost of 7 € / ha.

The mechanical harvesting is practiced by the remaining four farms: one of these uses only family labour; the other farms use family labour and paid labour for a cost from 6 €/h to 10 €/h.

The stated annual cost data about harvesting shows some inconsistency: two farms both with 350 plants / ha and a product of 20kg and 25 kg respectively state 1000 € / y and 500 € / y for mechanical

harvesting, in the first farm with the employment of family and paid labour, in the second farm relying only on employees, with a similar hourly cost in the two farms (€ 9 / h and € 10 / h).

### Questions and issues

*How are olives harvested?*
Both manually and mechanically
By hand: Yes
By harvest tools or use of aiding machines: Yes
By mechanical shakers: No
By tractor shakers: No

## 4.6. Thickening and replacing dead plants and branches

In some cases, a low number of plants per hectare or dead plants requires an increase in the density of plants In this condition, it is important to avoid overplanting by choosing a regular distance not less than 8x8 m. Replacing dead plants is a complex process which, as already discussed in the previous paragraphs, must begin with





soil preparation, moving from appropriate nutrition up to a growth pruning.

### Questions and issues

*Are new trees planted in the AOO area?*
Yes, mostly in autumn when water availability is higher

*Are dead plants and branches removed regularly?*
Yes, twice per year.

*Are basal shoots removed?*
Yes, mostly with every pruning.

# 5 Conclusions

As described in the previous sections, some critical points on olive growing in the Venafro area have been highlighted, showing on the one hand the need for more in-depth investigations and on the other hand the urgent need for interventions in order to maintain olive oil cultivation in the area at a minimum viable level. To address both points, it is essential to work with farmers and their networks. Participation in the survey by farmers was rather limited and their feedback of economic and agronomic data quite low. Much effort should be devoted to improving the participatory culture, with actions whose benefits are clearly perceived and with actors whose reliability, competence and trust are prerequisites for collaborative approaches.

We have drawn attention to the need for more management practices along the cultivation cycle. Indeed, the situation seems to be in a state of crisis. It must be said that a quite complete processing cycle is found only in two farms: 1 farm with 3 hectares of olive trees applies pruning, burning, fertilizing and irrigation; 1 farm with 1 ha of olive tree practices tillage, pruning, shredding, fertilizing. In the remaining farms, the practices applied are very limited, essentially pruning and chopping and/or burning. In all farms and especially in those where the cultivation practices are reduced to the minimum, the only cost item of a certain relevance is that relative to pruning. Many questions remain unsolved and many things are not known.

In order to improve the olive farming system and enhance the conservation of biodiversity and valorisation of the natural cultural heritage, it should be necessary to implement a local information system strictly involving local farmers and related operators. The culture of data, the trust in providing data, the awareness of tools usefulness at farm level should be augmented. Farmers should be supported with the existing operational tools to assess their efficacy and efficiency in olive growing, and agricultural extension services are crucial for delivering information and assistance to farmers.

For the persistency and integrity of the local olive heritage it is important to involve public and private sectors and commit them towards a joint strategy focused on economic and environmental-friendly management practices that may help these agricultural areas support their local economic development. A development based on a strategy in which AOOs together with the historical heritage support the enhancement of the territorial specificity, the conservation of the olive orchards ancient system and their historical landscape heritage without disregarding the economic yields and farms' economic sustainability and competitiveness. Furthermore, olive growing farms should integrate other functionalities and services or they should interact with other firms (such as firms in the tourism and the cultural sectors) in order to offer a complete experience to tourists interested in appreciating local assets, from the nature to the landscape, the history, the products and the traditions.

For this to happen, a premise is that the olive groves should be kept in good agronomic and environmental conditions (e.g. herbaceous and shrubby layer kept under control). The traditional practice of

sheep grazing is very important under an agronomic point of view, but it has also an economic value characterizing the past of Venafro olive-growing landscape that is getting lost. No practice is not the best practices, both under environmental, agronomic, economic, historical, and touristic valorisation, while the low intensity of cultivation practices in the area, when best oriented, could be the premise for a high natural value area.



## MONTENEGRO


**PROJECT DELIVERABLE**

| | |
|---|---|
| Project Partner | **PP 5 Municipality of Bar, Montenegro** |
| Work Package | **WP T 1 Identification and conservation of landscape with ancient olive trees and orchards (AOOs)** |
| Deliverable Code | **DT1.3.1** |
| Deliverable Title | **Common report on best practices to be applied by farmers for AOOs conservation and valorisation** |
| Date of submission | **Period 3** |
| Expert | **Dr. Mirko Knežević** |

# 1 Introduction

Cross Border OL project is funded through the **Interreg Italy-Albania-Montenegro Program** under the Priority Axis "*Smart management of natural and cultural heritage for the exploitation of cross border sustainable tourism and territorial attractiveness*". Its main objective is to promote sustainable tourism development based on the natural asset of the landscape with Ancient Olive Orchards (AOOs). The project will contribute to promote sustainable tourism activities and to conserve and protect natural resources in areas with AOOs in order to recover awareness of local populations on their own cultural heritage linked to traditional olive culture, by activating a process of setting local strategies of development.
Stakeholders that are involved within CROSS BORDER OL project are considered at local and national level. Local olive growers, local government, local tourism organization, private owners of local restaurants and accommodation facilities, Ministry of Agriculture, Forestry and Water Management, Ministry of Ecology, Spatial Planning and Urbanism, Administration for the Protection of Cultural Properties are identified as positively influenced SHs.

In order to complete the activities under the first implementation work package (WP T1), identification and sharing of best practices for conservation of the landscape of ancient olive orchards aiming to identify and characterize the existing natural heritage of the involved countries in terms of landscape and biodiversity richness in AOOs

had to be composed. WP T1 should fulfill three deliverables, notably:

I. Mapping olive trees and groves (A.T.1.1),
II. Characterization of biodiversity of AOOs (A.T.1.2), and
III. Identification and sharing of best practices for conservation of the landscape of ancient olive orchards (A.T.1.3).

Project Management Team of PP5, Municipality of Bar, managed to identify ancient olive groves and individual trees, as well as historical-cultural spots within the nearby area of the Old Town of Bar, Dzidzarin olive orchard. The deliverables, such as layers in GIS ready for maps production, completed the activity. Also, biodiversity was characterized within the same orchard and numerous plant species were identified, as well as two species protected with national legislation (*Cyclamen hederifolium* and *Spiranthes spiralis*), and six endemic plant species.

Best practices brochure aims at facilitating the identification and sharing of best practices with low environmental impact for the conservation of the AOO areas through a set of good agriculture practices such as planting, soil cultivation, soil fertility management, irrigation, weed and pest management, pruning and harvesting.

In order to determine the best agronomic practices, suitable for Džidžarin olive orchard and overall olive growing in the area of Bar municipality, the Project Management Team of PP5 conducted surveys, validated results on the field, incorporated the advice of external experts and, based on the data collected and processed, successfully prepared practically useful manual/guide for olive growing intensification.





**Photo 1.**
Old olive tree in Bar municipality
(Age certificate issued by the Faculty of Istanbul University)

# 2 The review of montenegrin oliviculture

Montenegro is a south-eastern Mediterranean country that has a total area of 13 812 km², and total population of about 650 000 people. Montenegro's coastline is 293.5 km long, with very attractive beaches and touristic places.

Olive orchards cover about 3200 ha, or 1/3 of the total surface under fruit trees in Montenegro. Olive trees are grown along a coastline, influenced by the Mediterranean climate. Average temperature is 15.5°C, with absolute minimum of -8.5°C and absolute maximum of 40.0°C. Average annual rainfall is about 1652 mm. The olive growing area is mainly hilly (85%), on the slopes of the mountain massifs of Orjen, Lovćen and Rumija. Proof of its long history is few thousand-old groves, with two outstanding specimens – the 'Old olive' at Mirovica, Bar, estimated to be more than 2200 years old (Photo 1) and the 'Big olive' in Ivanovići, Budva, estimated to be close to 2000 years old. It is considered that the total number of olive trees is close to 420 000. The average age of olive trees is from 150 to 200 years. Tree height is from 7 to 10 m, going up to 15 meters. This is not suitable for intensive agricultural practices, such as pest control and harvesting. The majority of olives are in need for duly pruning. Average yield of about 4 to 8 kg/tree, or about 1 liter oil/tree is not sufficient to cover national consumption. Most olive groves have size between 0.2 ha and 2.0 ha, while relatively large





areas exist in Luštica (20 000 trees) and Ulcinj – Valdanos (80 000 trees), both protected by law. There are numerous autochthonous varieties, domestic and domesticated. The Montenegrin coast, according to the olive growing, may be divided in two sub-areas: Bar sub-area (municipalities of Ulcinj, Bar and Budva, where Žutica variety predominates with 95%) and Boka-kotorska sub-area (municipalities of Tivat, Kotor and Herceg Novi, where besides Žutica, there are other varieties too, such as *Crnica, Lumbardeška, Sitnica,*

**Photo 2.**
Old olive tree in Bar label – a natural monument under state of protection since 1957, in whose honour the traditional event Meetings under the old olive is organised

*Šarulja* etc.). Foreign varieties such as *Picholine, Leccino, Coratina, Itrana, Ascolana tenera* are present at about 3% in olive orchards. There is interest in varieties with large fruits and resistance to the low winter temperatures. Depending on the year, the total production of olive oil in Montenegro is estimated at 400-500 tons. Plants are mainly produced by rooting, mist propagation, but there are recent requests for grafted Žutica for windy areas. Even though there is unfavorable terrain and trees are high, mechanical harvesting is almost impossible and traditional ways of harvesting by picking the fruits from the ground are slowly changing. Nowadays, nets are widely used for harvesting, also hand shakers and other mechanical tools. Harvesting time is estimated according to the fruit colour and the oil content. The main issues are pests (*Bactrocera oleae - Prays oleae*) and pathogens (*Spilocaea oleaginea*).

Olive farmers are grouped into four Associations of olive growers that, besides regular activities like assistance, communication with the Ministry of Agriculture, Forestry and Water Management, providing extension services, supporting pest control, soil quality improvement, machinery credits etc., organize traditional events dedicated to olive and olive oil (*Maslinijada* and *Ex Albis Ulivis* in Bar and *Days of young olive oil* in Boka Kotorska).



# 3 Olive growing in Bar municipality: Dzidzarin case study

The municipality of Bar has a long tradition when it comes to olive production, due to its natural characteristics, geographical position and soil composition. More than 1000 hectares are dedicated to olive growing with more than 100 000 olive trees, and a significant number could be considered as ancient or monumental.

Olive tree plantation, Džidžarin, is one of the biggest, most beautiful and most valuable olive complexes in Bar, which is few hundred meters apart from the Old town of Bar fortress. Historical value of Džidžarin, with the remains of stone bridges and mills, orthodox and catholic churches, mosque, gives this orchard an extraordinary value.

Best Practices in Montenegro are supposed to be applied by the farmers in the selected area of Džidžarin. They will be available for at least 30 local farmers and many more, extension service agents and technicians and will be disseminated to other stakeholders through various means of communication. The Ministry of Agriculture, Forestry and Water Management of Montenegro (acting as affiliated partner in this project) will support their implementation in future years by validation and promotion to the various interested stakeholders on the national level.

The selected area of Džidžarin orchard has similarities in terms of environmental and natural assets, landscape and richness of bio-

diversity as well as in the implementation of traditional agricultural practices with olive landscapes in Italy and particularly Albania. The purpose of this brochure is to stimulate the interest of local and foreign tourists to visit these areas, promote valorization of typical products.

**Photo 3a**
**Photo 3b**
Ancient olive groves in Dzidzarin.





**Table 1: Olive growing in Bar – general information**

| Location information | Crop information | Climate characteristics |
|---|---|---|
| Džidžarin olive orchard | Main olive variety Žutica (98%) | Mean Tmax 27.8°C |
| Municipality of Bar | Average yield 4-8 kg/tree | Mean Tmin 4.3°C |
| South-eastern part of the Montenegrin cost | Average age 150-200 years | Mean Tavg 15.6°C |
| Coordinates 42°05′N 19°08′E | Tree density 8x8 m (≈10 000) | Mean annual rainfall 1652 mm |
| Elevation ≈ 65-250m a.s.l. | Rainfed agriculture | Average annual sunshine 210.6h |
| Surface area ≈ 69 ha | Predominant soil type *Eutric cambisol* | (clay loamy texture class) |

**Photo a - b** - Various souvenirs from olive fruits, olive wood, olive oil and olive as a symbol are made by the local craftsmen and exhibited in the souvenir shops within the Old town of Bar. This is one of the best practice examples for the valorization of natural and cultural heritage and important component for agritourism development.

**Photo 4a**
**Photo 4b**
Ancient olive groves in Dzidzarin.

## 3.1 GENERAL INFORMATION ABOUT DZIDZARIN

After conducting soil survey in February 2019 and validating the data on-field, general information about olive growing in this orchard is presented below.





**Table 2: Summary of ordinary agronomic practices**

| Characteristics | Values |
|---|---|
| Surface area | ≈70ha |
| Estimated number of total olive trees | ≈10 000 trees |
| Number of trees per ha | ≈ 140 trees |
| Yield per tree | ≈ 4-8 kg/tree |
| Estimated number of ancient trees | ≥ 5 000 trees |
| Estimated percentage of ancient trees | ≥ 50% |
| Yield per ancient olive tree | ≈ 4-8 kg/tree |
| Plantation shape in AOOs | Mostly irregular due to relief |
| Intercropping with other fruit trees | No, single olive orchards |
| Intercropping with cereals/vegetables | No, single olive orchards |
| Younger trees mixed with AOOs | Yes, in about 20% of the complex |
| Ownership of the olive orchard | public-private |
| Average age of private owners | N/A (family business) |
| Abundant ancient olive orchards | Rare (if the owner lives abroad) |
| Rural infrastructure availability and functionality | Need for urgent repairs |
| Availability of olive oil mills | Yes, two mills |
| Agri-tourism activities on-going in this area | Yes (touristic tours from Old town) |
| Potential for expansion of agri-tourism | Very high (historical-cultural assets) |
| Main threats to AOOs | Insect "Olive fruit fly" and summer fires |

**Photo 5**
Satellite image of Dzidzarin olive orchard ("Map data ©2019 Google")

**Photo 6**
Cultural-historical treasure Džidžarin: Newly renovated ancient bridge






**Photo 7**
Cultural-historical treasure in Džidžarin - St. Urban church remaining

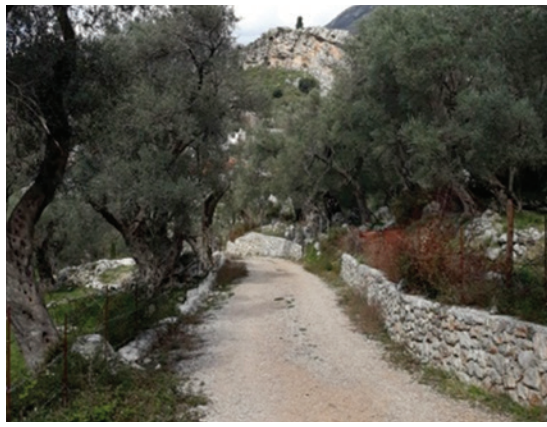


**Photo 8a and 8b**
Old trace leading to Old town of Bar and main road through the orchardbridge

# 4 Good farming practices for olive management

## 4.1 PRUNING

Pruning is an indispensable management practice for all olive groves and in particular for AOOs as it helps balance the relationship between vegetative and reproductive systems; adjusts the plant to light and solar conditions easing the penetration inside the canopy; provides suitable canopy aeration since an insufficient aeration accelerates the spread of fungal diseases; helps cultivation operations. Production pruning should be carefully planned not to be either too intensive (over-pruning) or too light, but it has to be carried out each year at least every two years. The practice of cutting sucker shoots should be applied when pruning is made every 4-5 years or more. Care should be taken during pruning not to disturb the birds and their nests since they provide natural protection for the olives from various dangerous insects that attack olives. Finally, pruning has to be done during the dormancy period and after late frosts. In case of vigorous trees, late pruning around April is advisable as this practice provides equilibrium between growing and reproduction of the trees. Sucker branches inside the canopy have to be cut off during summer to avoid competition for water and nutrients with the productive part of the trees.





*Frequency of pruning in Dzidzarin:*

Neglected for a long time

Performed 2 to 5 years

**Performed 1 to 2 years**: Even though pruning is regularly performed in most of the orchards, there is a strong need for reducing tree height since the majority of the trees is from 7 to 10 meters high, going up to 15 meters. This is a strong restriction to the implementation of intensive agriculture (Photo 6).

**Photo 9**
Ordinary olive height in Bar

## 4.2 SOIL MANAGEMENT AND FERTILIZATION

Soil management is crucially important for the growing and production capacity of olives as well as for maintaining and increasing soil fertility level. Sustainable soil management protects soil from erosion and helps maintain the vegetation cover along the slopes, thus increasing soil fertility and conserving biodiversity. General rules for proper fertilization into AOOs are provided below.

- Nitrogen is absorbed throughout the growing season but should be provided intensely from blossoming to stone hardening;
- Phosphorus is absorbed in the first part of the growing season, but $P_2O_5$ requirements for olives are rather low;
- Potassium uptake begins with the growthe recovery after the dormancy but should be used in higher doses during the oil accumulation period in the fruits.

It is very important that fertilization is carried out based on soil analyses, the status of the trees, and available soil moisture, as well as to the tree response to fertilizers. In general, it is advisable for a plantation with 278 plants/ha (6x6 meters distance) that produce about 41 kg/ha of olives to use 50 kg/ha phosphorus, 170 kg/ha potassium, and 95 kg/ha nitrogen. Since the number of trees in AOOs areas is lower (usually 120 plants/ha), these recommendations should be adjusted accordingly.

It is a wrong conclusion that the needs of olives for mineral nutrition are negligible just because certain yield may be obtained without





fertilization. Fertilization improves the physical and chemical properties of soil , which has a positive impact not only on yield increase and quality of olive oil but also on increasing its resistance to relatively low temperatures, droughts, diseases and pests.

The intensive growth of olive trees will be significantly improved with the proper fertilization regime. The use of slow-release fertilizers during the first years of development of new plantations is recommended. Alternatively, soluble fertilizers can be used with high efficiency, especially through the irrigation system. If the fertilizer is applied separately, it should be ensured that fertilization is carried out before the rain. Numerous growers in Mediterranean countries apply organic fertilizers every second year. The surface

**Photo 10**
Usual height of olive trees in Bar

**Photo 11**
Soil profile
in Džidžarin

layer of organic material can be fertilized from livestock or food remains, but growers should carefully use it because it is difficult to achieve a good balance of nutritive elements only with this method of fertilization.

It is very important to always avoid placing a fertilizer or manure to the trunk. No matter which type of fertilizer should be used, the best method is to add it in smaller quantities and more often during the growing season. Avoid abundant use of soluble fertilizers that can damage the plant and leach into groundwater. The amount of mineral fertilizer application should be based on the yield, nutrient absorption, soil nutrition analysis, leaf nutrition analysis, leaf symptoms, experimental fertilizer results and nutrition recycling.





## Methods and time of fertilization

The largest amount of olive's root system mass is located from 15 to 20 cm. Therefore, it is recommended that potassium and phosphorus fertilizers, as slowly mobile, be applied during deep soil cultivation, in approximately 400-500 kg/ha of superphosphate and potassium phosphate, depending on the agrochemical soil analysis. Later, during regular agro-technical operations, these fertilizers should be introduced into the soil in the same amount every 5-6 years, at a depth of 20-30 cm.

Nitrogen is added in the breeding period in the amount of 30 g/seedling in the first year, in the second year 70 g/seedling, in the third year 120 g/seedling and in the fourth year 170 g/seedling. After the fourth year, the amount of nitrogen to be added is calculated on the basis of yield in that year, but as the literature states, for every 100 liters of olive oil, 2.0 - 2.8 kg / ha of nitrogen should be added. Nitrogen is applied on the surface or by shallow cultivation and is added in two periods: 50% at the end of February and 50% at the end of March.

Requirements for intensive plantings of mature olive trees are 150 to 250 kg/ha nitrogen, 60 to 80 kg/ha of phosphorus ($P_2O_5$) and 100 to 200 kg/ha of potassium ($K_2O$), while for basic fertilization, needed nutrition ratio is 1:2:3.

At the location of Dzidzarin, agrochemical soil analyses were conducted indicating that the theoretical application mentioned above is not always easy to achieve.

Based on the classification of soil according to the pH in KCl, soil may be characterized with neutral reaction. $CaCO_3$ content increases with depth and medium lime transition to very lime. The content of organic matter, as usual, decreases with depth. It is very *humic* only in a thin surface layer and then poorly *humic*, while in the lowest layer it is very poorly *humic*.

The thin surface layer, which in fact represents a grass bush, is characterized by the high content of easy available phosphorus and potassium. The content then falls significantly in the following layer, where the soil is poorly provided with phosphorus and moderately provided with potassium. At the depths over 30 cm, the soil is poorly available with elements.

Bearing in mind the age of the trees, it's clear that no suitable soil preparation was possible at that time, such as deep tillage and application of fertilizers in a deep part of the soil profile. Due to the fragmentation of plots and land configuration , the application of

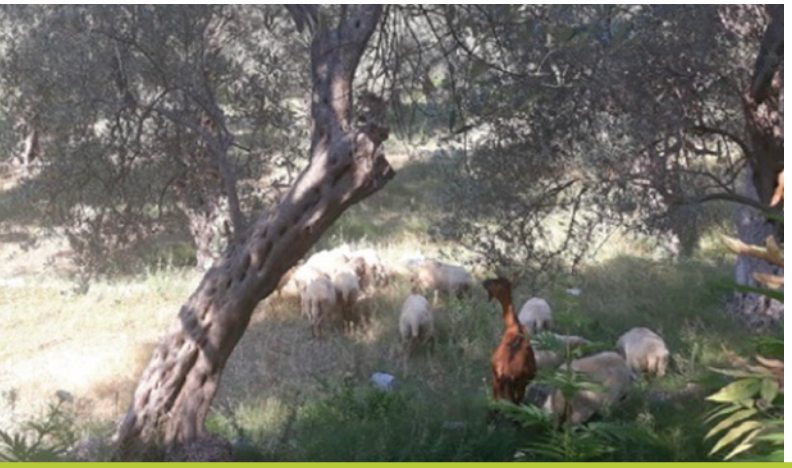


**Photo 12.**
Sheep farming as one of the best practice examples in Dzidzarin





irrigation and, of fertilizers with it is also neither possible, nor economical without a proper project.

For locations such as Dzidzarin, it is recommended to administer the basic nutrients by injection and micronutrients by foliar application.

One of the best practice examples is **sheep farming**. It is very advisable that sheep flock be present within olive orchards since they maintain herb canopy, prevent fires by eating middle size shrubs that are considered to be highly flammable, and eat the olive fruit contaminated by the olive fruit fly pest.

**Photo 13**
Sheep farming as one of the best olive growing practices in Džidžarin.

**Table 3. Agrochemical soil analysis from Dzidzarin**

| Depth | pH | | $CaCO_3$ | Humus | $P_2O_5$ | $K_2O$ |
|---|---|---|---|---|---|---|
| cm | $H_2O$ | KCl | % | % | mg/100g soil | |
| 0-6 | 7.65 | 7.08 | 8.5 | 7.87 | 57.6 | 39.1 |
| 6-29 | 7.7 | 7.16 | 10.8 | 2.96 | 3.6 | 14.9 |
| 29-59 | 7.48 | 6.9 | 16.1 | 1.45 | 1.4 | 7.4 |
| 59-78 | 7.61 | 6.99 | 14.2 | 1.13 | 0.7 | 8.9 |
| 78-100 | 7.58 | 6.95 | 11.8 | 0.96 | 1.2 | 8.2 |

**Table 4: Soil management activities in Džiždarin**

| Agronomic practices | |
|---|---|
| Frequency of fertilization each growing season | 1-2 times |
| Form of fertilization | Organic manure and NPK fertilizer |
| Application of green manure by planning legume cover crops | Not used |
| Chopped pruning branches used as fertilization sources | Not used |
| Olive groves protected by terraces | Yes, often elongated and sometimes semi-circle |
| Weeds cut each season | Yes, few times |
| Application of mulching | Not used |
| Implementation of tillage | Autumn: tillage on 30-60 cm depth; Early spring: Shallow soil conservation |
| Soil analysis to check soil fertility | Rare in ancient groves; regularly in young orchards (soil analysis at Biotechnical Faculty) |
| Irrigation of olive trees | Only in young orchards, micro-irrigation systems ("drip") |





## 4.3 PEST AND PATHOGEN MANAGEMENT

Olive trees are vulnerable and susceptible to numerous pests and diseases. The most common are Olive fly (*Bactrocera oleae*), Olive moth (*Prays oleae Bem*), Olive black scale (*Saissetia oleae Olivier*), Peacock's Eye (*Spilocea oleagina*) and others. On the other side, maintaining a good balance between beneficial insects that reside in the nearby vegetation and agro-biodiversity is crucial to promote a friendly way of pest and pathogen management.

*What type of treatment is implemented to combat pests and diseases?*

Major problem in the cultivation of old olive trees is their protection. It is carried out to a negligible extent, and damages by olive flies and other diseases and pests are very high. For several years in the

**Photo 14.**
Elongated and semi-circle terraces

**Photo 15.** Terracing as an ancient anti-erosion measure

past, airplane protection of olives was carried out and quality and quantity of olive and olive oil was significantly better.

However, due to environmental pollution, this protection has been abandoned. The owners themselves perform protection, but not regularly due to poorly accessible terrain for mechanization. Since the Olive fruit fly is the most dangerous pest for the local olive growers, each year Mc Phail traps and yellow plates are used for monitoring this insect. After precise monitoring and consultation with national institutions (Biotechnical Faculty and Ministry of Agriculture, Forestry and Water Management), notifications are sent to the farmers with recommendation on how to efficiently and successfully combat the main pest in our area, by using chemical protection (*Imidan 50 WG, Perfektion, Cromogor, Buminal*).





## 4.4 OLIVE HARVESTING

Harvesting time must coincide with the ripening of the fruits to produce the very best quality of olive oil. Generally speaking, early harvesting produces green color oil with higher level of bitterness and pungency due to high level of phenol content. Late harvesting results in oil yellowish in color but less bitter and tastier for many consumers. Hence, there are various considerations to be taken into account when establishing the right moment to harvest, including olive varieties and climate conditions. In case of late attacks by the olive fly, it is advisable to anticipate the harvesting to avoid both oil quality and quantity reduction. Harvesting methods are very important to avoid bruising and damaging of olive fruits compromising the production of the coming year. Olive fruits have to remain undamaged and should be collected without touching the ground and brought to the oil mill soon after harvest .

*Olive harvesting in Dzidzarin:*

By hand: Yes, mostly

By harvest tools: Yes, as auxiliary tools

By mechanical shakers: No

By tractor shakers: No

**Table 5: Calendar of works to be implemented in orchards**

| Month | Agro-technical measures | Pests and diseases occurrence |
|---|---|---|
| **January** | Pruning is allowed only during the dry period; preparatory works for new plantation; fertilization only if it was not done the previous year after harvesting | Scale insects (*Hemiptera, Sternorrhyncha*) Peacock spot (*Spiloceae oleagineae*) |
| **February** | Planting, pruning and/or olive tree rejuvenation only during warm and dry period; shallow soil tillage recommended | Peacock spot (*Spiloceae oleagineae*) |
| **March** | March is the right time for planting, pruning, tillage, fertilization and other agro-technical works | Peacock spot (*Spiloceae oleagineae*) Sooty mould of olive (*Capnodium elaeophilum*) |
| **April** | Grafting can be started from April 20th, fertilization and weeding are recommended | Olive bark beetle (*Hylesinus oleiperda*) Olive fruit Curculio (*Hynchites cribripennis*) |
| **May** | Grafting from April 20th, initial start of irrigation if water scarcity occurs; monitoring of flowering for foliar fertigation and nutrition; second nutrition should be implemented when 10% of flowers are open | Peacock spot (*Spilocea oleaginea*) Sooty mould of olive (*Capnodium elaeophilum*) |
| **June** | Soil tillage and irrigation. Third nutrition when 70% of flowers are open, fourth with 100% of open flowers and fifth time when olive fruit is size of wheat grain | Olive moth (*Prays oleae*), Scale insects (*order Hemiptera, suborder Sternorrhyncha*) |
| **July** | Removal of unnecessary green branches; irrigation and foliar nutrition | Occurrence of the first generation of Olive fruit fly (*Bactrocera oleae*) at the end of the month |
| **August** | Irrigation when needed together with foliar nutrition; shallow tillage recommended for preservation of soil humidity | Olive fruit fly (*Bactrocera oleae*) of the second generation |
| **September** | Removal of green branches; addition of organic manure if there was no heavy rain in the previous period | Olive fruit fly (*Bactrocera oleae*) of the third generation; Peacock spot (*Spilocea oleaginea*) |
| **October** | Olive harvesting and olive oil processing Pruning, fertilization; trunk disinfection | Olive fruit fly (*Bactrocera oleae*) |
| **November** | Olive harvesting and addition of manure | Peacock spot (*Spilocea oleaginea*); Black scale (*Saissetia oleae*) |
| **December** | Harvesting of late olive species; pruning; deep soil tillage; addition of manure; preparation for planting | Peacock spot (*Spilocea oleagina*) |

# 5 Conclusions

Despite the great number of challenges, the most important potentials of Montenegro remain favorable agro-ecological conditions, long tradition of olive growing, autochthonous varieties of olives, increased interest in olive production and olive products, complementarity with tourism and great potential for organic production. However, weaknesses such as fragmentation of the plots, market disorganization, inadequate level of knowledge and unwillingness for investment risk greatly limit the accelerated development of olive growing. There is an evident need for changing the awareness of all the stakeholders (e.g. producers, competent authorities, consumers, media, etc.) for modern sustainable olive growing. Undoubtedly, pioneer steps are made in this direction and Montenegrin olive growing in the last decade experienced positive trend (planting new olive trees, restoring old ones and increasing production of olives and olive oil). Also, work is intensified in terms of education for both producers and consumers, which are encouraging signals for the future of olive growing in Montenegro.

**Photo c.**
Government of Montenegro invested one million euros for the construction of House of olives, located within Old Bar. This facility is equipped with processing units and exhibition areas, suitable for both presentations and tourist purposes. House of olives serves as center for National association of olive growers

# MONTENEGRO

**PROJECT DELIVERABLE**

| | |
|---|---|
| Project Partner | **PP 6 Association for Sustainable Development, Regional Collaboration and olive farming, Valdanos, Montenegro** |
| Work Package | **WP T 1 Identification and conservation of landscape with ancient olive trees and orchards (AOOs)** |
| Deliverable Code | **DT1.3.1** |
| Deliverable Title | **Common report on best practices to be applied by farmers for AOOs conservation and valorisation** |
| Date of submission | **Period 3** |
| Expert | **Arben Elezaga, Fjolla Cakuli, Cemal Hidrio** |

# 1 Introduction

Cross Border Olive project is funded by the Interreg Italy Albania Montenegro Programme under the Priority Area "Smart management of natural and cultural heritage for the exploitation of cross border sustainable tourism and territorial attractiveness". Its main objective is to promote sustainable tourism development based on the natural asset of the landscape with Ancient Olive Orchards (AOOs). The project will contribute to promote sustainable tourism activities and to conserve and protect natural resources in areas with AOOs and to raise the awareness of local populations on their own cultural heritage linked to traditional olive growing, activating a process for setting local development strategies.

Work Package 1 (WP1) deals with the identification and sharing of best practices for conservation of the landscape of ancient olive orchards and aims to identify and characterize the existing natural heritage of the involved countries in terms of landscape and biodiversity richness in AOOs. WP1 should fulfil three deliverables, notably I) mapping olive trees and groves (A.T.1.1), II) characterization of biodiversity of AOOs (A.T.1.2), and III) Identification and sharing of best practices for conservation of the landscape of ancient olive orchards (A.T.1.3).

We provide below the results of the third deliverable related to best practices of olive orchards in Montenegro, more specifically in Ulqin/Ulcinj.

Best Practices or good farming practices in Montenegro are sup-

posed to be applied by farmers in two selected areas, namely in the municipalities of Bar and Ulqin. They will be made available to at least 30 local farmers, extension service agents and technicians and will be disseminated to other stakeholders through extension services and other means of communication. The Ministry of Agriculture of Montenegro will support their implementation in future years by validating and promoting them to a larger number of farmers and land users dealing with management of ancient olive orchards. This report is related to the olive orchards and farmers in the municipality of Ulqin.

The activity aims at facilitating the identification and sharing of best practices with low environmental impact for the conservation of the AOO areas through a set of good agriculture practices such as planting, soil cultivation, soil fertility management, irrigation, spontaneous flora and pest management, pruning, and harvesting. Processing of olive oil is considered for the impact both on landscape quality/attractiveness and on olive oil products and on the wine and food offer.

The exchange and sharing of best practices among the farmers is based on a first stage of identification and collection of agricultural practices already applied in AOOs, and in a second stage whereas best practices are applied or not by local people, and if yes, how they could be disseminated by other stakeholders. The purpose of the project is to stimulate the interest of local and foreign tourists to visit these areas, promote valorisation of typical products and enhance overall sustainable and integrated rural development.



# 2 Overview of Olive Growing in Montenegro

Montenegro has a total area of 13 812 km$^2$ and a total population of around 650 000 people. Its coastline has a length of 293,5 km and it is precisely along the coast that the olive growing zone is located, particularly in the south.

Olive orchards cover about 3200 ha, or about 1/3 of total surface under fruit trees in Montenegro. Olives are grown along a coastline, influenced by the Mediterranean climate. The average temperature is 15,5ºC; with absolute minimum of -8,5ºC and absolute maximum of 40.0ºC. Average annual rainfall is 1652 mm. The olive growing area is mainly hilly. A total number of about 420 000 trees is estimated at present. The average age of olive trees is 150-200 years. Tree height is 7-10m or even up to 15m, which is not suitable for intensive agricultural practices, such as pest control and harvesting. Thus, the majority of olive trees need rigorous pruning and lowering of the tree height, as part of best practices to be applied in order to preserve the ancient olive trees.

Most olive groves are between 0.2 ha and 2.0 ha, while relatively large areas exist in the area of Luštica (20 000 trees) and in Ulqin – Valdanos (80 000 trees), which are protected by law. About 95% of olive groves are under private ownership. Mass migration and expropriation issues resulted in olive abandonment and devastation. The Montenegrin coast can be divided in two sub-areas of olive grow-

ing: Bar sub-area (municipalities of Ulcinj, Bar, Budva, where *Vajuk/Žutica* variety predominates with 95-98%), Boka-Kotorska sub-area (municipalities of Tivat, Kotor, Herceg Novi, where besides *Vajuk/Žutica*, there are other varieties like *Crnica, Lumbardeška, Sitnica, Šarulja* etc.). Foreign varieties such as *Picholine, Leccino, Coratina, Itrana, Ascolana tenera* are present and account for about 3% of the total. Depending on the year, the total production of olive oil in Montenegro is estimated at 400-500 tons.

Olive farmers are grouped into four olive growers' associations that provide a wide range of services to olive farmers, such as information and assistance in applying for grants from the Ministry of Agriculture, extension services, pest control support, and so on. In addition to this, these associations already organize traditional events related to olive growing and consumption, with the aim of boosting tourism.

**Figure 1.** One of the activities of Valdanos Association



# 3 Overview of Olive Growing in Ulqin/Ulcinj

The Municipality of Ulqin is home to around 80 000 trees, with 18 000 trees only in the Bay of Valdanos, which was declared a natural monument in 1968. The cultivation of olives and olive oil production is an integral part of the culture of the people who live in this region and is proudly preserved from generation to generation. The tradition of olive growing in Ulqin is over 2000 years old.

Production is carried out mainly in a traditional manner, but recent years have seen an increase in more modern ways of carrying out the whole process of olive oil production. The most represented varieties are the local *Vajuk, Frang*, and *Ullaster* (*Olea Oleaster*). In the last few years, there has been a tendency of planting introduced varieties such as *Picholine, Arbequina, Leccino, Coratina*. These varieties should compensate for the lack of table varieties (for canning olives) in the domestic assortment and allow for cultivation of olive trees in critical areas due to winter frost. Olive growing in Ulqin (and Montenegro) is characterized by noticeable variations in annual yields, and one of the reasons is inadequate, irregular and incomplete implementation of agro-technical measures, making the communication of best practices to farmers ever more significant.

Olives are mainly processed into oil in oil mills (both cold pressed and traditional stone mills), not all of which meet international stand-

ards. However, recent years have seen an improvement in terms of implementation of agro-technical measures and modernization of olive processing technology, which directly affect the quality of the final product.

In a wider context, the Ministry of Agriculture and Rural Development has started a project entitled "One million olive trees", which plans to plant the largest number of new olive trees in the area of Ulqin municipality.
Most of the olive orchards currently in Ulqin are AOOs. The project "Enhancing the competitiveness of local SMEs in Montenegro through cluster development" funded by the EU, co-funded and

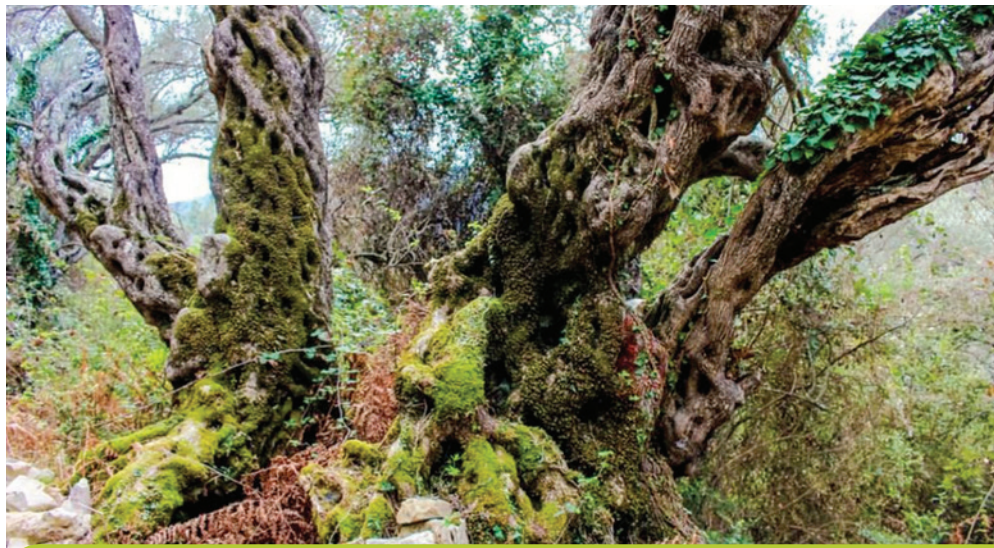
**Figure 2.** Bey's fountain in the olive grove in Ulqin dating back to the Ottoman Empire





implemented by the United Nations Industrial Development Organization (UNIDO) in cooperation with UNDP, was carried out by the Ministry of Economy of Montenegro with the objective of strengthening the competitiveness and market access of four selected clusters. Within this project in 2015 the official results were obtained on the age of the olive trees. The determination of olive tree age was done in cooperation with the University of Istanbul (Faculty of Forestry). During this project, samples were taken and the age of 25 olive trees in the municipality of Ulcinj was determined (and 25 olive trees in the municipality of Bar). From these olives, exclusive oil can be produced intended for specific markets.

**Figure 3.** 2000-year-old olive tree in Valdanos



# 4 Good Farming Practices for Olive Management

## 4.1 Pruning

Pruning is an indispensable management practice for all olive groves and in particular for AOOs, as it helps balance the relationship between vegetative and reproductive systems, adjust the plant to light and solar conditions easing the penetration inside the canopy, provide suitable canopy aeration since an insufficient aeration accelerates the spread of fungal diseases, helps cultivation operations. Production pruning should be carefully planned not to be either too hard (over-pruning) or too light; it should be carried out every year and, if this is not possible for many reasons, at least every two years and when this is the case it is advisable to cut back at least the suckers inside the canopy. The same practice of cutting sucker shoots should be applied when pruning is made every 4-5 years or more. Care should be taken during pruning not to disturb the bird nests and the birds since they provide natural protection to olives from a number of dangerous insects that attack olives. Therefore, in a common AOO area, a yearly rotation of pruning should be implemented to allow for birds to nest and thrive. Finally, pruning must be done during dormancy and after late frosts. In case of vigorous trees, late pruning around April is advisable as this provides equilibrium between growing and reproduction of the trees; however, suckers inside the canopy must be cut off during summer to avoid competition for water and nutrients with the productive part of the trees.

*Frequency of pruning in Ulqin:*

Neglected for a long time: 30%

Performed 2 to 5 years: 29%

Performed 1 to 2 years: 41%. Pruning is performed regularly in the majority of orchards. However, the remaining groves shall be pruned as well, given the risk of fires also for those that are pruned. Moreover, the average tree height is 7 to 10 meters, which needs to be lowered, even in most of the orchards where pruning is performed regularly.

## 4.2 Soil Management and Fertilization

Soil management is crucially important for the growing and production capacity of olives tree and for maintaining and increasing soil fertility level over long periods. Sustainable soil management protects soils from erosion and helps maintain the vegetation cover always along the slopes thus increasing soil fertility and conserving biodiversity.

**General rules for fertilization:**

- Nitrogen is absorbed throughout the growing season but should more intense from blossoming to stone hardening;
- Phosphorus is absorbed in the first part of the growing season, but phosphorus requirements for olives are rather low;
- Potassium uptake begins with growth recovery after dormancy but should be used in higher doses during the oil accumulation period in the fruits.

It is very important that fertilization is carried out on the basis of soil analyses, status of the trees, available soil moisture and tree response to fertilizers. In general, for a planting with 278 plants/ha (6x6 meters distance) that produces about 41 kg/ha of olives, it is advisable to use 50 kg/ha phosphorus, 170 kg/ha potassium, and 95 kg/ha nitrogen. Since the number of trees in AOOs areas is much lower (usually 120 plants/ha), these recommendations should be adjusted accordingly.

## Questions and issues

*Are olive trees fertilized each growing season?*
Yes, 3-4 times a year.

*Which form and amount of fertilization?*
Usually organic in November-December, 2-3 times in spring with chemical fertilizer (27-54% potassium +nitrogen). Phosphorus is





applied at end-April. Around 2kg/tree.

*Is green manure applied by planning legume cover crops?*
No, but it is used to be applied in previous generations.

*Are chopped pruning branches used as fertilization sources?*
No.

*Are olive groves protected by terraces? Which type, elongated or semi-circle?*
Yes, both elongated and semi-circle.

*Are spontaneous plants cut each growing season?*
Yes, but only around 20%.

*Is mulching applied?*
No.

*Is tillage implemented?*
Yes, in the autumn and spring 10cm-12cm.

*Are soil analyses made to check soil fertility?*
No, mostly because it is not a tradition and the farmers don't have enough knowledge about the importance of soil analyses.

*Are olive trees irrigated?*
In very rare cases, during extreme drought.

**Figure 4.** Terraces in the olive orchard in Ulqin

## 4.3 Pest and pathogen management

Olives are vulnerable and susceptible to a number of pests and diseases. The most common are Olive fly (*Bactrocera oleae)*, Olive moth (*Prays oleae Bem*), Olive black scale (*Saissetia oleae Olivier*), Peacock's Eye (*Spilocea oleagina Cast Hugh*) and others. On the other side, maintaining a good balance between beneficial insects that reside in the nearby vegetation and agro-biodiversity is crucial to promote a friendly way of pest and pathogen management. Therefore, maintaining a high biodiversity is very important.





### Questions and issues

*What type of treatment is implemented to combat pests and diseases?*
Explain the frequency. They are treated with deltamethrin (maximum 2 times per year) in order to not create resistances and leave residues.

## 4.4 Olive harvesting

Harvesting time must coincide with the ripening of the fruits to produce the very best quality of olive oil. Generally speaking, early harvesting produces green colour oil with higher level of bitterness and pungency due to high level of phenol content. Late harvesting results in oil yellowish in colour but less bitter and tastier for many consumers. Hence there are a number of considerations to take into account when establishing the right moment to harvest, including olive varieties and climate conditions. In case of late attacks by the olive fly, it is advisable to anticipate harvesting to avoid both oil quality and quantity reduction. Harvesting methods are very important to avoid bruising and damaging of olive trees compromising the production of the coming year. Olive fruits must not be damaged either and they should be collected without touching the ground and brought to the oil mill soon after harvesting.

### Questions and issues

*How are olives harvested:*
By hand: Yes
By harvest tools: Yes
By mechanical shakers: Yes
By tractor shakers: No

## 4.5 Thickening and replacing dead plants and branches

Since in many cases AOOs have a lower number of trees per hectare (sometimes even 40-50 trees/ha), farmers often increase their number by planting new trees; however, it is not advisable to have more than 120 trees/ha. It is important to consider that during the thickening process, the trees should not be in touch with each other. This means that planting should be done at regular spacing of 10x10 m or minimum 8x8 and no more because too many trees/ha above 120 in AOOs will create the conditions for increased competition for nutrients from the soil but will also compromise the traditional AOO landscape. Therefore, the number of young plants should not be more than 40% of the whole AOO area. Care must be taken also for the chosen varieties of the young trees not to jeopardize the centuries-old germplasm that has resisted for centuries.





Finally, removal of the dead plants and branches inside the AOOs is very important to avoid the risk of fire and spread of pest and diseases and should be done frequently.

### Questions and issues

*Are new trees planted in the AOO area?*
No, as they are already more than recommended, on average 250-300 trees per hectare in AOOs.

*Are dead plants and branches removed regularly?*
Yes, once a year.

*Are basal shoots removed?*
Most don't remove them.

# 5 Conclusions

The very long tradition of olive harvesting in Ulqin, the emotional attachment people have with this tradition, the tourism industry, and the favourable agro-ecological conditions, ensure that AOOs will be incorporated successfully in the tourism offer of the town. However, the fact that there are around 80 000 ancient olive trees in Ulqin is both an opportunity and a challenge. The biggest threat to the AOOs of Ulqin is abandonment, especially for the 18 000 trees in the Valdanos Bay, which have been abandoned for 40 years and are now in a long process of ownership dispute. There is a high risk of fires in the area, which could spread to the other part of the AOOs, as they are a continuation of each other, especially due to the difficult access and very little access to water. Moreover, some of the other threats or weaknesses are the fragmentation of the orchards, illegal construction, lack of knowledge of modern technologies, and lack of investments. Greater awareness of all those involved in olive growing, but also of stakeholders in tourism and other industries, such as commerce, is essential. Moreover, more modern and sustainable olive growing techniques need to be implemented. This has already started and there is a positive trend in that regards, with more olive trees planted, better care towards old olive trees, and increased production. Furthermore, a lot of work is being done by both the Ministry of Agriculture, as well as by local NGOs, in education, promotion of AOOs and of good olive growing practices.



This project is co-financed by the European Union under the instrument for Pre-Accession Assistance (IPA II)
This document has been produced with the financial assistance of the Interreg Interreg IPA CBC Italy-Albania-Montenegro Programme. The contents of this document are the sole responsibility of Agricultural University of Tirana and can under no circumstances be regarded as reflecting the position of the European Union and of the Interreg IPA CBC Italy-Albania-Montenegro Programme Authorities.

**Agricultural University of Tirana - AUT**
www.ubt.edu.al
info@ubt.edu.al

**CIHEAM Bari**
www.iamb.ciheam.org
iamdir@iamb.it

**Urban Research Institute - URI**
www.uri.org.al
info@uri.org.al

**Park Authority of Venafro**
www.parcodellolivodivenafro.eu
info@parcodellolivodivenafro.eu
progetti@parcodellolivodivenafro.eu
PEC: info@pec.parcodellolivodivenafro.eu

**Municipality of BAR**
www.bar.me
ana.zivanovic@bar.me

**Association for Sustainable Regional Groves - Valdanos**
www.valdanos.org
valdanos@t-com.me

## NOTES

Interreg - IPA CBC
Italy - Albania - Montenegro
EUROPEAN UNION
CROSS BORDER OL

# CROSS-BORDER COOPERATION FOR SUSTAINABLE DEVELOPMENT AND TOURISM, THROUGH VALORIZATION OF RURAL CULTURAL HERITAGE AND CONSERVATION OF NATURAL ASSET OF AREAS WITH ANCIENT OLIVE GROVES

crossborderol.italy-albania-montenegro.eu

cbo.interreg@gmail.com

Interreg_CROSS-Border-OLIVE

olivemaps_cbo

Agricultural University of Tirana - AUT

CIHEAM BARI

URBAN RESEARCH INSTITUTE

Park Authority of Venafro

Municipality of Bar

Association for Sustainable Regional Groves - Valdanos