olive4climate

CLIMATE CHANGE MITIGATION THROUGH A SUSTAINABLE SUPPLY CHAIN FOR THE OLIVE OIL SECTOR

LIST OF SUSTAINABLE PRACTICES FOR OLIVE CULTIVATION IN ARID AREAS

Contract Number: LIFE15 CCM/IT/000141
Duration: 01/07/2016 - 31/12/2019
www.OLIVE4CLIMATE.eu

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

The project OLIVE4CLIMATE was developed observing the great impact of the agricultural sector in the total emissions produced by human activities. The attention was then focused on the olive groves since this cultivation is an essential part of the agricultural sector of the European Union, especially in the Mediterranean area.

On this context, the project wants to highlight the strong connection between sustainable agricultural techniques and climate change mitigation through the evaluation of the Carbon Footprint (CF) associated to the production of 1 liter of extra virgin olive oil. This process is going to be tested in the Mediterranean countries with heterogeneous environmental conditions and with significant olive cultivation records, in three heterogeneous geographical contexts: Italy, Greece and Israel.

With a few additional data, also the carbon sequestration (sink) realized by the olive groves will be evaluated. This allow to determine the break-even point after which the amount of carbon sequestered exceeds the emissions related to human activities and, therefore, the corresponding carbon credits generated by this system. From this perspective, the Carbon Footprint and the evaluation of the Carbon sequestration can become important "green" marketing tools for the olive cultivation that could be included in the voluntary carbon market.

In this document, several strategies for creating a sustainable olive oil sector and promoting products deriving from integrated and organic cultivation methods will be presented. The objective of these techniques will be the improvement of the net balance between absorbed and emitted CO2 and then determine the capability of the olive groves as an instrument for climate change mitigation.

2. GENERAL INFORMATION AND BACKGROUND

Arid and semi-arid areas are characterized by pronounced water scarcity and recurrent droughts due to limited, irregular and unpredictable rainfall, high temperatures, high rates of evapotranspiration, modest grass covering and poor soil quality.

As a consequence, food production is limited in these areas due to failed plant growth, irregular production, low plant density, lack of tolerant crop species.

Environmental degradation and loss of natural resources are exacerbated by climate change, that emphasizes the depletion of the organic matter of soils, creates water emergency conditions, deteriorates water quality and further reduces water availability.

Numerous agronomical strategies have been developed in order to guarantee a reasonable agricultural production under arid conditions.

Since 1948, Israeli agricultural production has risen more than 12 times, while in the same period water use has increased by only three times. Today, Israel, one of the most arid areas in the world, uses the most technologically advanced irrigation methods and counts on the highest percentage of reuse of waste water.

The approaches to face olive cultivation into arid areas take advantage from this experience, proposing traditional and new high-technological strategies.

3. THE PROJECT ACTION: CLASSIFICATION AND DETAILED ANALYSIS OF THE AGRICULTURAL COMPANIES INVOLVED

Aim

To demonstrate the possibility to use olive groves as an instrument against desertification caused by climate change, a sample of Israeli companies was selected and studied during OLIVE4CLIMATE project.

In particular, olive trees may tolerate and produce fruits in areas with less than 100 mm total year rainfall, they can be irrigated with medium saline water (3200 mg/L NaCl) and can survive under high irradiance, high temperature and high vapor pressure deficit.

In compliance with the project aim, all agronomic technologies implemented in desert environments has been collected, analyzed and selected to improve the ability of the olive crop to deal with adverse weather and soil conditions. In particular, through this action it was possible to:

- Collect and organize into a repertoire of protocols a list of sustainable practices for olive cultivation that can be used in areas with adverse weather and soil conditions.

The method

The activities has been organized as follow:

- Task 1: collection of all information, about the companies selected, available in the documents supplied by the association involved to: elaborate a briefly description of the olive groves (i.e. dimension and location, total number of trees, cultivar, age and size of the trees, planting distance, management techniques) and the olive mills; collect ancillary data about meteorological characteristics.
- Task 2: analysis of the companies through site surveys and first data elaboration to confirm the data elaborated in task 1 and collect other information, about the companies, not directly available from the schedules supplied by the trade associations.
- Task 3: sharing of the knowledge acquired between the beneficiaries involved.

4. IRRIGATION

Microirrigation

Microirrigation is an irrigation system that releases micro-quantities of water close to the plant root system. This method has been exploited and studied mainly in Israel since the 1960s. Over time, the method has dramatically improved and increased efficiency. The main benefits include the limited dispersion of water, because it is brought as close to the roots as possible, with frequency and quantities specially studied according to each crop system. Furthermore, leaves remain dry, thus reducing the pathogen settlement and need of fungicide and insecticide spraying.

Irrigation with waste water

Agricultural activities are the ones most responsible for water consumption which has led to a progressive depletion of those easily accessible water resources and a decrease in aquifers' levels.

In many desert areas, fossil water has become a fundamental resource for agriculture but its use is associated with salinisation and desertification problems. In addition, the exploitation of this non-renewable resource can only be guaranteed in the medium to long term.

Waste water, if appropriately treated, can be returned to the soil in irrigation mode and can be used in olive orchards in order to promote plant growth and fruit production.

The use of treated waste water can also help for ferti-irrigation and to enrich the amount of organic matter of impoverished soils and thus increase carbon storage on the soil.

Olive milling wastewaters (OMW)

The new oil extraction technologies envisage a reduction in crude water volumes.

OMWs are rich in organic matter, in particular mucillaginous polysaccharides (complex sugars) derived from the olives pulp, and polyalcohols such as mannitol. Nitrogen compounds such as amino acids and proteins are also abundant. Among the inorganic substances, potassium and magnesium phosphates prevail in the OMWs. The most characteristic component of OMWs are polyphenols (1-5%). Polyphenols are a very diverse and heterogeneous class of naturally occurring substances, playing important biological roles also in soil microorganisms.

OMWs severely alter soil C/N ratio, making it very high and damaging microflora and microfauna aerobics.

The use of OMWs has been tested on olive groves and some parameters have been monitored, such as energy consumption, soil conditions and the amount of olive oil produced. The results show a reduction in energy costs, an increase in the organic matter of the soil and a consequent increase in product yield. Soils irrigated by OMWs may fully recover fertility and productivity.

Salt water

Another unconventional water resource is salt water. As regards to moderately or highly saline waters, recent research has shown that plant tolerance is generally higher than expected.

Many factors are involved, such as varieties, climate, land and management, that, if appropriately coordinated, may allow to considerably extend the conventionally adopted limits.

Soil degradation is undoubtedly the most known negative effect of irrigation with salt water, and is directly manifested on agricultural soils. Salts tend to accumulate in the soil unless they are diluted by a certain amount of water permeating the profile. Salt leaching can be used when the salinity of the soil is about to reach guard levels, depending on the tolerance of the cultivated species.

5. FERTILIZATION

Fertilization techniques can be distinguished into:

- fertilization: modification of the soil's chemical properties with the purpose of meeting the nutritional needs of crops;
- correction: pH adjustment;
- amendment: improvement of physical properties.

New fertilizers have been developed able to simultaneously act on two fronts: plant nutrition and increased water retention, i.e. soil capacity to retain water and hence nutrients essential to the plant growth. Fertilizers that may increase soil water retention capacity by creating a microclimate around plant roots, will enable the development of agriculture even in the arid areas.

Fertilizers: - Livestock effluents - Ameliorants - Soil fertility and availability of nutrients - Soil control - Organic soil balance - Fertilization of fruit growing systems.

Biofertilizers with native bacteria

Biofertilizers are being posed as possible alternatives to chemical additives, fertilizers or pesticides, and among these, the formulations containing native bacteria are particularly interesting.

Bacteria play an important role since they may help plants absorb those nutrients already present in the soil but not normally usable as insoluble. In addition, bacteria compete with other microorganisms in the soil and can therefore also hinder the growth and development of harmful organisms for crops.

This type of biofertilizers could therefore not only lead to a decrease in the use of synthetic fertilizers, but also of pesticides.

These bacteria have proven able to:

- increase the availability of nutrients present in the soil (making them assimilable by plants);
- produce hormones that stimulate plant growth;
- stimulate the development of the radical apparatus;
- prevent the development of other harmful micro-organisms for the plant.

This type of bacteria is normally present both in the soil and in the plant tissues.

Foliar fertilization

Foliar feeding is used in agriculture to have a quick and accurate control of plant nutrition.

Foliar fertilization can lead to an increase in nitrogen content in the plant. All products are positive but urea has the best absorption quotient, followed by ammonia, glycine and then nitrates. The species studied may adsorb foliar intact glycine.

This fertilization method is an effective tool for completing the fertilization regime, especially in the presence of poor nutritious or arid soils.

Plant growth promoter bacteria

Plant growth promoter bacteria are a valuable resource and opportunity for agriculture in arid areas, as well as an important sustainable strategy against desertification.

When water is the limiting factor, plants tend to increase their root system to try to overcome the water deficit. Some plant species in arid soils succeed in adopting strategies to maximize the benefit of the little water available to them and it has been shown that plants grown in arid soils have the potential to develop a particular alliance between roots and bacteria present in the soil: this is how they can support plant growth even in conditions of severe water scarcity.

The agricultural practices implemented in agriculture in arid and desert regions is a crucial factor in the selection of beneficial micro-organisms in the soil that can support plant growth in drought.

6. INTEGRATED MANAGEMENT OF RESOURCES

Aridity is generally associated with the lack of rain, but rain may be beneficial or destructive according to soil management. The way in which slopes are organized, vegetation cover, capture and retention methods, dynamics of urban aggression in the area determine the water availability and the degree of erosive processes. Traditional knowledge, which for centuries has guaranteed the environmental and landscaping environment by balancing climate alternatives and natural, seasonal or catastrophic adversities, ensuring resource renewal, are now lost due to a development based on the waste of natural resources, population migration and unlimited production growth.

The process of space usage and transformation was carried out through techniques and knowledge verified by long-term collective experience transmitted through generations and incorporated into the cultural complex of the people into the system of traditional knowledge. This knowledge perpetuates a set of good practices that realize the productive goals while safeguarding the environment and ensuring its continuous maintenance. Any traditional technique, in fact, is not just a challenge to solving a single problem, but it is always an elaborated, often multifaceted method that is part of an integrated approach between society, culture and economy closely linked to a world-based management concept. Terracing is at the same time a way to protect a slope, replenish the soils, collect water, create a usable space as a shelter for animals. And it is also something more, it has a high aesthetic and landscaping value.

Some tree crops, such as the olive tree, are used in association with horticulture to ensure the preservation of the soil and the shade in addition to the specific fruit. In the olive grove, an enlarged oasis model is created that can create livable situations in difficult and hostile environments thanks to the use of hydro-ecological knowledge: ecosystems made in close man-nature association trigger, in conditions of rare resources, vital cycles, autopoietic dynamics, capable of self-production and over time sustainability.

Further contribution may derive from environmental education and territorial planning involved in the fight against desertification.

7. DRY FARMING

Dry farming is practiced in arid areas where irrigation is not possible.

The key factors are two: the first is the meteorological weather that covers the average monthly rainfall amounts and their distribution during the various periods of the year. The other is the physical structure of the soil and its ability to retain water and mineral salts.

As far as the weather is concerned, permanent crops as olive may be established where precipitations, even at low levels, are evenly distributed throughout the year.

It is also important to take into account the temperature during fruit growth, as it is a determining factor for the ripening period.

Even the wind has its importance as it accelerates the evaporation of water present in porous soils and, in the presence of sand, forces farmers to build barriers to prevent crops being covered with sand.

There are three action strategies used in dry farming:

- increase water immersion by means of appropriate soil treatments and arrangements (store rain);
- reduce water leaks from the ground for surface sliding and evaporation;
- optimizing the use of water resources using arid-resistant species and appropriate agro-technics.

Avoid water dispersion by mulching, weeding, or increasing the amount of water in the soil at the disposal of the crops. Clay soils, which have great water storage potential, are better than sandy ones for arid cultivation.

The term "permaculture" was coined in the late 1970s, as a "permanent agriculture" contraction, to indicate a set of research aimed at enabling the cultivation of soil in any climatic condition.

One of the projects born in this area has created a hydrophobic waterproof sand that can be laid directly in the form of leaves beneath the sand of the desert. It allows plants to grow even in the most arid climates. In the southern regions of Israel, where the rainfall is very low and the average temperature in August is 50°C, a "permaculture" experiment has shown that fruit trees can grow in the desert.

8. RECYCLING PRUNING MATERIAL

The pruning material recycling is based on the on-site pruning of pruning residues. It allows:

- increase in organic matter content in the soil;
- improvement of the hydrological properties of the soil.

9. DIGITAL FARMING

The technological evolution of recent years has led to the development of computerized systems that allow to calibrate plant needs, managing culture nutrition in a fractional manner, with precision and balance according to the needs of the moment.

Agricultural management softwares are available that allow to easily plan, monitor and analyze all farm activities. Soil processing, treatments, fertilization, irrigation, harvesting and all other operations can be organized and managed through Decision Supporting System technologies.

These technologies act as an electronic brain to support farmers.

Satellite, drone or ground sensors may allow to monitor water and nutrient needs of each plot and each plant, to detect pathogen attack and to foresee fruit ripening.

Computerized systems may allow tractors to handle irrigation and plant remediation even remotely and with great precision, to the techniques of mechanical harvesting of olives.

Assembling and providing online information to the workforce with all useful information for their business, such as weather forecasts, information on the pathogens and parasites cycles, their spread and impact, guidelines on how and when to do interventions.

Consultation of information on smartphones or other mobile devices.

Availability of proximity information, directly related to the operating place, which can ensure the best harvest.

However, these systems require specific skills from users, which are not always available among the operators of a certain age.

But innovations can bring digital natives closer to agriculture, thus promoting generational replacement even in olive cultivation.

10. SELECTION OF TOLERANT GENOTYPES

New varieties derived from breeding and selection of the best performing genotypes under water, thermal or salt stress, may allow to extend olive cultivation into areas previously unusable.

Genomic assisted methods are now available that will make possible to deliver a panel of new varieties and rootstocks able to establish olive cultivation under severe environmental constrains.