CRPV soc. coop. CENTRO RICERCHE PRODUZIONI VEGETALI

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FRUTICULTURE

IN EMILIA-ROMAGNA SEQUESTERS ORGANIC CARBON IN THE SOIL

FRUTTIFI_CO

EXTRACT FROM THE PAMPHLET: "FRUTICULTURE IN EMILIA-ROMAGNA SEQUESTERS ORGANIC CARBON IN THE SOIL"

The complete version in Italian is available at the following link: https://www.pedologia.net/it/FRUTTIFI-CO/cms/Pagina.action?pageAction=&page=InfoSuolo.51&localeSite=it

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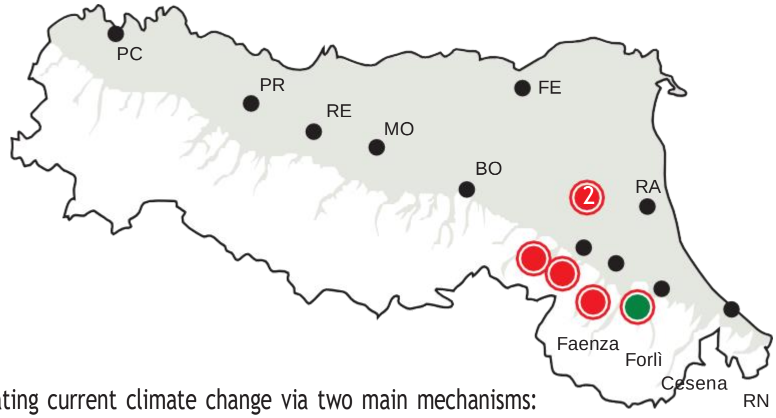
The FRUTTIFI-CO Project



Modern agriculture can significantly contribute to mitigating current climate change via two main mechanisms: increasing the absorption of atmospheric carbon dioxide into the plant-soil system and reducing the emission of greenhouse gases (GHG). The former is tied to agricultural practices which are careful to maintain/improve organic matter and is based on agricultural systems' ability to capture carbon from the atmosphere for fairly long periods, "sequestering" it in the form of plant biomass and/or organic matter in the soil. The latter, is based on reducing the use of nitrogenous fertilizers and limiting all agronomic practices, including the use of machinery, which can cause greenhouse gas emissions.

On the basis of these considerations, the Operational Group FRUTTIFI-CO (Fruit Growing Aimed at Carbon Footprinting) came into being, composed of research institutions (CRPV, I.TER and Bologna University) and five farms belonging to the main fruit and vegetable-producing organizations (Apofruit Italia, Agrintesa and Granfrutta Zani), who all shared an interest in starting to monitor the carbon footprint in the fruit and vegetable sector, paying particular attention to the ability of the soil to sequestrate carbon.

The partner farms are located in pedologically diverse environments, both in the hills and on the plain, and are representative of the different types of production: integrated, organic and biodynamic.

KEY	PARTNER FARM	TERRAIN	BOROUGH	SPECIES CULTIVATED	TYPE OF PRODUCTION	REFERENCE ORGANIZATION
1	MASSIMO BIONDI'S FARM	PLAIN	CESENA	PEACH, PERSIMMON, APRICOT, PLUM, PEAR	BIODYNAMIC	APOFRUIT
2	MONICA AND MAURIZIO ZANI'S FARM	PLAIN	FAENZA	APRICOT, PEACH, APPLE, PEAR	INTEGRATED	GRANFRUTTA ZANI
3	M. LUISA TURILLI SPADA & SONS FARM	HILL	BRISIGHELLA	CHERRY, PLUM, APRICOT, PEACH, KIWI, POMEGRANATE	INTEGRATED/ORGANIC	AGRINTESA
4	MAURIZIO SAVORANI'S FARM	PLAIN	BRISIGHELLA	KIWI, VINE, OLIVE	INTEGRATED	AGRINTESA
5	FLAVIO MERCURIALI'S FARM	HILL	PREDAPPIO	APRICOT, PEACH, PLUM	ORGANIC	APOFRUIT

After a preliminary study to collect information about company organization, soil management and the characteristics of the fruticulture systems, the project started specific monitoring activities to evaluate the content and quality of the organic matter in the selected fruit-growing plots inside each partner farm.

The specific objectives of the project FRUTTIFI-CO are described below.

Quantify the organic matter content and carbon sequestration in the soil of the selected plots: over the last 15-20 years turfing has become a consolidated practice for managing inter-rows in orchards in Emilia-Romagna. Therefore, specific monitoring was set up to quantify the organic matter content, and consequently organic carbon, to verify the potential increase compared to management in the past when inter-rows were tilled. In each selected plot monitoring involved specific sampling and analyses connected to the study of the soil with a Dutch auger and the opening of designated pedological profiles in order to estimate the quantity of organic matter present and the ability of the soil to store carbon in the first 100 cm of soil.

Verify the quality of the organic matter using indices which provide indications of the soil's ability to store or disperse the organic carbon present. After specific sampling and analyses, the microbial biomass, metabolic quotient (qCO_2), microbial quotient (qMic), mineralisation quotient (qM) and biological fertility index (BFI) were evaluated. In particular, the biological fertility index of the soil highlights optimum situations and/or situations of alarm of pre-alarm regarding the supply of organic matter and the possible loss of mineralization.

Evaluate the environmental impact of cultivating fruit trees in terms of greenhouse gas emissions through the process of Life Cycle Assessment by specific interviews and the use of special software.

Define and share appropriate "guidelines" for agronomic management of orchards aimed at sequestering organic carbon in the soil identifying the agricultural practices directed at mitigating emissions of greenhouse gases and favouring carbon sequestration in the soil.

The Environment and Agriculture: the important role of soil management

Soil is one of humanity's most precious resources. It is not renewable, and therefore it is necessary to understand, protect and respect it. In nature there is not just one type of soil. Just as rocks, plants and animals differ from one place to another, so does the soil. Diverse types of soil exist, which differ in origin, colour, depth, and fertility.

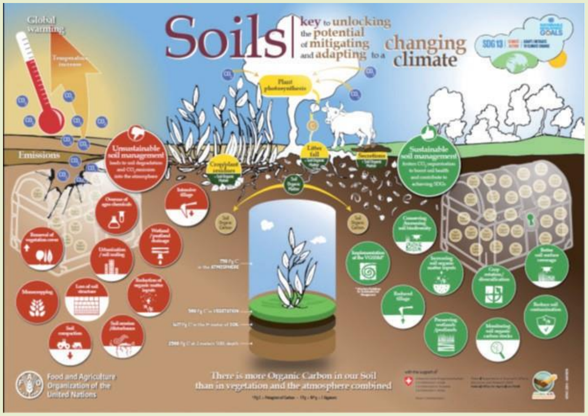
Soil covers the uppermost part of the Earth's surface, and permits plants, animals and humans to live. It is a living, dynamic, productive organism. To allow sustainable production the soil must be healthy; the UN Agency has established that heathy soil is recognized by "the ability to sustain productivity, diversity and the environmental services of the Earth's ecosystems". Therefore, good agricultural practices and agronomic management of the soil play an important role in the production of healthy, nutritious high-quality food.

FAO Poster showing the importance of good agronomic management for preserving soil fertility in order to obtain healthy, nutritious high-quality food.

Fruticulture in Emilia-Romagna, with its 50,000 hectares of orchards, produces high-quality fruit, including PGI registered pears and peaches. It provides an interesting example of soil management practices which contribute not only to producing high-quality food, but contrasting climate change by favouring the storage of organic Carbon in the ground. Studies and the research by FRUTTIFICO have shown that orchards with inter-rows which are turfed or treated with green manure are an excellent example of sustainable management, keeping organic Carbon in the soil.

But what does storing, accumulating, sequestrating Carbon in the soil mean? They all revolve around simple ecological principles. Through photosynthesis plants "capture" carbon dioxide (CO_2), one of the main greenhouse gases, and accumulate it in their tissues as organic Carbon. The community of soil microbes decompose plant residues which land on the soil. Organic Carbon is stored in the form of complex polymers in the soil, of secondary origin, since they originated from the metabolism of the microbial community, through the process of humification. It has been recognised worldwide that "in the first metre of soil on the planet there is more Carbon than in the atmosphere and all the plants on land"

Good practices must sustain the Carbon available for the life of the microbial community so that it can carry out ecological functions and keep the soil healthy.



FAO poster showing how soil constitutes one of the potential ways of mitigating and adapting to climate change

Considering that carbon sequestration is a medium-long term process, the loss of organic Carbon from the soil, must be prevented, through the use of sustainable practices. Increases which result from the adoption of sustainable practices can only be measured years later. The basic process of Carbon sequestration also depends on the "quality" of the organic matter formed during humification.

The formation of stable organo-mineral complexes of the organic matter in the soil, which provide good soil structure, depend on the intrinsic characteristics of the soil (e.g., depth, texture, mineral composition), the characteristics of the site (e.g., morphology, position, aspect and drainage), soil management (e.g., turfing, cover crop, nutrient management, irrigation, manure/organic compost) as well as the use of and type of soil conditioner (e.g., biochar, organic composts). All of these factors also influence the speed, the cumulative quantity, and the period required to reach maximum capacity of Carbon sequestration in the soil. For this reason, it is essential to know not only the quantity of organic matter and Carbon present, but also the quality and the metabolic state of the microbial community. Studies and research by FRUTTIFICO have demonstrated that the biofertility index is an excellent indicator to understand the quality of the organic matter and its "stability" to remain in the soil and store Carbon over time.

Therefore, if the 50,000 hectares of soil dedicated to fruticulture in Emilia-Romagna are managed well and sustainably, the potential to accumulate Carbon in the soil reaches interesting quantities which can undoubtedly have an impact on contrasting climate change.

It is therefore essential to appreciate and recognise the important role of fruit-producers. They not only produce high-quality produce, but safeguard, preserve and protect the territory promoting the enormous potential of the soil in the struggle against climate change.

Guidelines for best soil management to maintain organic matter and sequester carbon in fruticulture

The definition of “Guidelines for best soil management to maintain organic matter and sequester carbon in fruticulture” is the conclusive objective of the project FRUTTIFI_CO.

The guidelines, shared by the farms and research institutions in the operational group, aim to promote and give value to the role of fruit-producers in carbon sequestration and therefore as custodians of environmental sustainability in fruticulture.

The “Voluntary guidelines for sustainable soil management” (FAO 2015) which clarify the important role sustainable soil management plays in the collective efforts to mitigate and adapt to climate change, fight desertification and protect biodiversity, were a fundamental reference.

Sustainable soil management is designed to preserve, maintain or improve the ecosystem services and functions of the soil. The key points of good agronomic practices are:

- Reduce water and wind erosion of soil to a minimum;
- Maintain good soil structure by avoiding compaction;
- Maintain sufficient surface coverage to protect the soil, such as permanent turfing or a cover crop during wet seasons;
- maintain or improve the organic matter content for example by adding organic material, limiting tilling, favouring coverage of inter-rows with permanent turfing or green manure;
- maintain or improve the fertility of the soil using fertilizing plans;
- apply good water management to favour the infiltration of water from precipitation and guarantee drainage of any excess water as well as working towards efficient use of water to meet the plants’ needs: drip irrigation plants typically used in fruticulture perform these functions well;

- preserve the biodiversity of the soil to sustain all biological functions;
- reduce the impermeabilization of the farm soil to a minimum;
- not contaminate the soil;
- contain soil salinity and sodification.

Furthermore, good practices must aim at reducing greenhouse gas emissions in order to limit the carbon footprint and favour:

- sequestration of atmospheric carbon in the soil: carbon sequestration techniques are all agricultural practices which tend to conserve soil fertility because they increase the organic matter content, for example inter-row turfing
- increase productive efficiency: sustainable intensification which improves production through more efficient use of resources.
- Reduce emissions: optimize first and foremost fertilization with nitrogen (doses, periods, types of fertilizer, precision technology, distribution methods above all for farm sewage) and the use of other technical means (water, phytosanitary defense).
- Produce and save energy: all interventions which save energy or increase the energetic efficiency of the machines used can contribute, as well as installing renewable energy production plants (e.g., solar panels).

In particular, for fruit production the following practices contribute to reducing the emission of greenhouse gases (GHG), in order of importance:

- Use techniques to optimize the use of fertilizers to reduce not only the emissions derived from their industrial production but also their use in the field, particularly synthetic nitrogen fertilizers, (N_2O emissions);
- Adopt nutrient balances, supported by decisional systems and analysis of soil fertility, to limit the dose of nitrogen, how it is fractioned and the choice of fertilizer;
- Adopt more efficient distribution techniques such as fertirrigation;
- Adopt practices to reduce the loss of N_2O into the atmosphere (avoid soil compaction, ensure good surface drainage and more generally, respect the good agronomic practices for soil management which favour the microbial function of the soil).
- Use renewable energy sources for example to run the irrigation plants and farm machinery (electric harvester).
- Use local sensors and information systems to back up decisions to optimize irrigation.
- Use renewable material in the supporting infrastructure of the orchards, for example wooden posts instead of reinforced concrete.
- use agrochemical products (pesticides) more efficiently and substitute them whenever possible, with alternative techniques (e.g., sexual confusion).
- Leave cuttings from pruning in the field and shred them, if there are not particular plant health problems.

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