

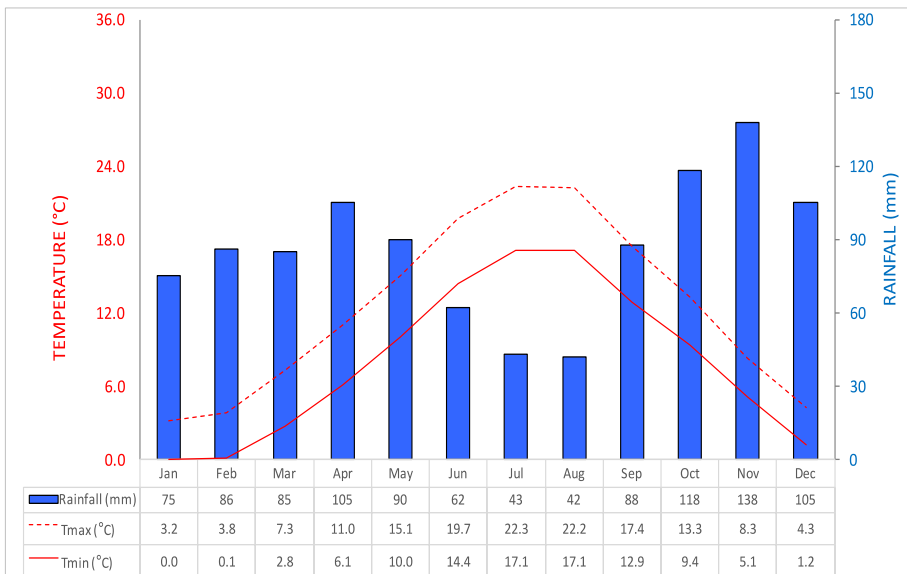
Testimonial video and associated training material

4. Cover crops

Testimony by Lorenzo Tanini, who uses both winter and summer cover crops on his farm in Italy



Lorenzo Tanini is the owner of the Il Piano farm, located in Rufina, in the province of Firenze. In his farm, Lorenzo grows mainly arable crops, as well as olives and vines. Since 2020, rising fertilizer prices have prompted him to look for alternatives to limit their use, and cover crops came up as the best solution. Soon after Lorenzo adopted this agro-ecological practice, he realized that the benefits brought by cover crops are not just limited to the reduction in fertilizer use, but also led to an improvement in the physical and chemical characteristics, as well as the overall fertility of the soil.



The climate in Rufina is warm and temperate. There is significant rainfall throughout the year. The temperature averages around 12°C and the annual rainfall exceeds 1000 mm.

Soils develop on argillites and marls, sometimes with intercalations of fine sandstones, which characterize a hilly landscape with gentle slopes, rounded relief, and terraced, gently sloping slopes generally cultivated with vineyards and olive groves.

Cover crops benefits

Cover crops have gained recognition for their diverse range of advantages, including the control of soil erosion, the prevention of nutrient leaching losses, and the enhancement of soil functions and biodiversity. As a result, the use of cover crops represents a Nature-based Solution to improving ecosystem services within agroecosystems. The most important benefits of cover crops are:

Ø *Control of soil erosion*

Cover crops provide a physical barrier that reduces the impact of raindrops and prevents soil aggregates from breaking. In addition, their presence makes the soil surface rough, a feature that severely limits surface water run-off on sloping ground. Lastly, the root systems of cover crops play a crucial role in aggregating and retaining soil particles, making them less susceptible to erosion transport.

Ø *Improvement of soil fertility*

Cover crops, when incorporated into the soil, serve as a significant source of organic matter. This brings numerous benefits to the soil. Cover crops enhance porosity, helping to maintain an optimal balance of air and water, and providing a more hospitable environment for root systems. They supply carbon and nitrogen, which are essential elements for plant nutrition and support the growth of microorganisms. Additionally, cover crops promote a favourable soil structure that positively influences the chemical, physical, and biological properties of the soil.



Ø *Microclimate regulation*



Cover crops help regulate the soil microclimate, particularly regarding moisture and temperature. The presence of cover vegetation significantly lowers the soil temperature, thereby mitigating potential stress on the subsequent or coexisting crops. Moreover, when the soil is covered by a crop, the loss of non-productive water is greatly reduced. In fact, in a covered soil, the evaporative component of the evapotranspiration process, which is lost directly to the atmosphere, is lower compared to the transpirational component, which instead contributes to biomass accumulation. This mechanism is also highly beneficial in areas prone to salinization, as reduced evaporation prevents the accumulation of soluble salts (especially sodium) on the soil surface.

Ø *Nutrient regulation*

Cover crops play an important role in nutrient regulation through various mechanisms. Firstly, they can take up nutrients when the main crop is not present in the field, and transfer them to the subsequent crop in the rotation through the incorporation of the cover crop residues. In this instance, nutrient availability varies depending on the carbon-to-nitrogen (C/N) ratio of the incorporated residues. A second regulatory mechanism involves capturing mobile elements, such as nitrogen, which are often not fully utilized by the main crop. In this instance, the cover crop acts as a catch crop, preventing the leaching of these elements into groundwater thus improving the resource use efficiency of the system.

∅ Weeds suppression

The presence of cover crops helps in weed control through both resource competition (such as nutrients, water, and sunlight) that would otherwise benefit the weeds, and physical reduction of available space, preventing or delaying their germination. The direct effect is a significant reduction in herbicide application, resulting in evident economic and environmental benefits.

Cover crops: which ones to choose?

The choice of species depends on many factors: meteorological conditions, the duration of the intercropping period between successive cash crops, the tillage system, and the timing and methods of cover crop seeding. The cover crop species commonly cultivated belong to three main families: brassicaceous, legumes, and graminaceous. These families have distinct characteristics.

BRASSICACEAE

These plants are characterized by rapid initial growth, high above-ground biomass, and a fibrous taproot root system. Some of them have biocide effect on nematodes and fungi.

The most common species are:

- White mustards (*Sinapsis alba*)
- Tillage radish (*Raphanus sativus*)
- Canola and turnip (*Brassica napus* and *B. rapa*)



LEGUMINOSAE

Legumes are typically used in nitrogen-deficient soils, prior to crops that have a high demand for this element, or on farms that do not have access to livestock manure or in organic farming systems. The most common species are:

- Clover (*Trifolium spp*)
- Vetch (*Vicia villosa*)
- Broad bean (*Vicia faba*)
- Alfalfa (*Medicago sativa*)



GRAMINACEAE

These plants are commonly used as cover crops because the fibrous and well-developed root system allows for the retention of nutrients, thereby limiting their leaching (catch crops). The most common species are:

- Oat (*Avena sativa*)
- Rye (*Secale cereale*)
- Barley (*Hordeum vulgare*)
- Ryegrass (*Lolium multiflorum*)
- Wheat (*Triticum aestivum*)



Agronomic management of cover crops

In general, the main purpose of cultivating cover crops is to produce abundant above-ground and below-ground biomass, allowing it to perform all the aforementioned beneficial functions.

There are both summer and winter cover crops. Winter crops are often self-terminating during winter when temperature drops and environmental conditions are no longer suitable for vegetation. In this case, in late winter the cover crop dies and leaves the fields free for the subsequent spring sowing (maize, soybean, sunflowers, etc.). For this type of cover crops, the sowing date is extremely important as it determines the phenological stage at which the plant is when the cold effect occurs. If the cover crop has been sown in late summer, it will be already in the reproductive phase and will be more sensitive to cold compared to a crop sown later. In this way, the termination will be optimal.

Summer cover crops are sown just after the winter crop harvest (commonly cereals) and left in the field during summer. In this case, the cover crop is generally terminated mechanically before the sowing of the next cash crop. The main drawback of summer cover crops is that it may be necessary to intervene with emergency irrigation or fertilization, which represent an additional cost for the farmer.

Termination of cover crops

The purpose of termination is to prevent cover crops from being an impediment to the creation of suitable conditions for the germination and growth of successive cash crops.

ROLLING

- ✓ Maximum effect at flowering stage.
- ✓ Suitable for cereals at the milk-dough stage.
- ✓ When executed during frost, rolling provides a very effective termination.

MOWING

- ✓ The effectiveness greatly depends on the phenological stage of the crop.
- ✓ The optimal mowing time is during flowering especially for species like vetch, clover, wheat, and rye.

DISK HARROWING

- ✓ Good decomposition as plant tissues are mixed into the soil (10-15 cm).
- ✓ Multiple passing is necessary if plant biomass is high.
- ✓ If executed in vegetative phase, the effectiveness of termination can be below optimal.

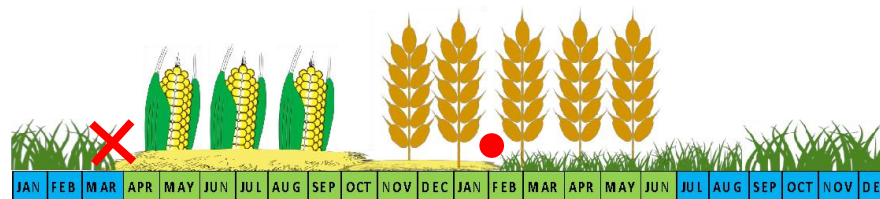
Mulching with cover crops



Spring-summer monocropping



Autumn-winter monocropping



Crop rotation

Cover crops deliver the expected results if they produce abundant aerial and root biomass. However, they are often cultivated at times of the year that are unsuitable for cash crops, when the climate is unfavorable and the growing season relatively short. Hence, cover crop management must be aimed at the best utilization of available resources (solar radiation, temperature, water and nutrients). The purpose of sowing is a good establishment and initial rapid growth.

The purpose of termination is to prevent cover crops from being an impediment to the creation of suitable conditions for the germination and growth of successive cash crops.

Cover crops have multiple uses, providing several opportunities for inclusion in crop rotation. Cover crops may be used as green manures, living mulches, residue mulches or catch crops which share multiple benefits, but they can be used to best meet certain specific needs.

