SUSTAIN OLIVE

D-2.5

MANUAL OF GOOD PRACTICES IN THE OLIVE GROVE

SUSTAINOLIVE

(SO D 2.5- T 2.4- WP 3)

TECHNOLOGICALLY SOLUTIONS FOR SUSTAINABLE OLIVE GROWING

(SO D 2.5- T 2.4- WP 3)

ENGLISH

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PRIMA
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Manual of Good Practices

SUSTAIN OLIVE

Version 4
D 2.5 Booklet on STSs for olive farming (T2.4)

Deliverable D 2.5 Booklet
WP2. *Synopsis of olive grove farming models, including conceptual approaches, methods and STSs identification*

Novel approaches to promote the SUSTAINability of OLIVE cultivation in the Mediterranean

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Executive Summary

This document is a basic manual for the implementation of Technologically Sustainable Solutions (STS) that allow initiating a transition to a sustainable olive grove. In the previous tasks, and with the collaboration of the partners involved, a meaningful description of the agroecology concept was developed at the taxonomic level, as well as the concepts related to olive grove sustainability and STS with value for stakeholders beyond the scope of the project. TKV reformatted and reorganized the results into a small manual on sustainable solutions that are applicable to the cultivation of olive groves and olive oil production, but with a value that can be extended to other crops of economic interest in the Mediterranean context (Almond or vine). A discussion with project partners representing farmers and oil mills has been essential to modify the content and language aimed at a wider audience. The manual will finally be translated into the national languages of the 6 countries involved.

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1. Introduction

The increased demand for olive oil and the agricultural community policy's have acted as catalyst for the intensification and expansion of olive groves. This intensification involves the systematic use of chemical fertilizers and pesticides, as well as the implementation of more aggressive weed control practices, soil management, increased olive trees density, mechanization of harvesting, and the abuse of water irrigation.

These intensification processes have resulted in simplified landscapes with low natural value olive groves, generating greater negative environmental impacts, particularly soil erosion, surface runoff, higher loss of soil fertility, degradation of habitats and landscapes, and the overexploitation of scarce and vulnerable water resources.

The progressive disappearance of biological elements in intensive olive groves has led to the inefficiency of ecological regulatory mechanisms, potentially providing ecosystems with resistance and resilience to constantly changing environmental conditions.

We are faced with the paradox that, despite having recognized benefits for our health, olive oil production is based on an increasingly unsustainable production model.

Fig. 1.1 Representation of the progressive change of our cultivation systems

1850

The central concept of SUSTAINOLIVE is to contribute to a more sustainable and eco-innovative olive sector by promoting the design and implementation of a set of Technologically Sustainable Solutions (STS) that are based on agroecological principles and methods, on knowledge and cooperation between the different project partners.

When we speak of technologically sustainable solutions, we refer to the processes in which we combine technology and sustainable development, and where such technology is focused on the sustainability of an agricultural system. In our project, we aim to the sustainability of the olive groves to be able to maintain the available resources in the best conditions for future generations, and the quality of the environment where this activity takes place.

Is not anything new, for millions of years farmers have adapted to their environment and have developed technologies to improve their productivity, diversify crops, as well as protect and properly nourish the soil.

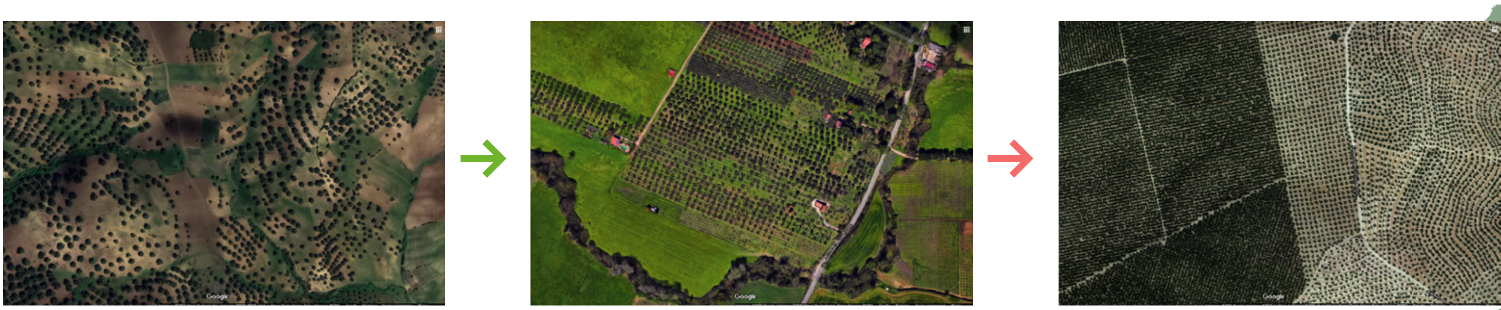


Fig. 1.2 Representation of the progressive change of our cultivation systems, within the olive grove, and its intensification

We will address in this manual different key concepts to improve the sustainability of our cultivation and the associated good practices that can help us achieve these sustainability goals.

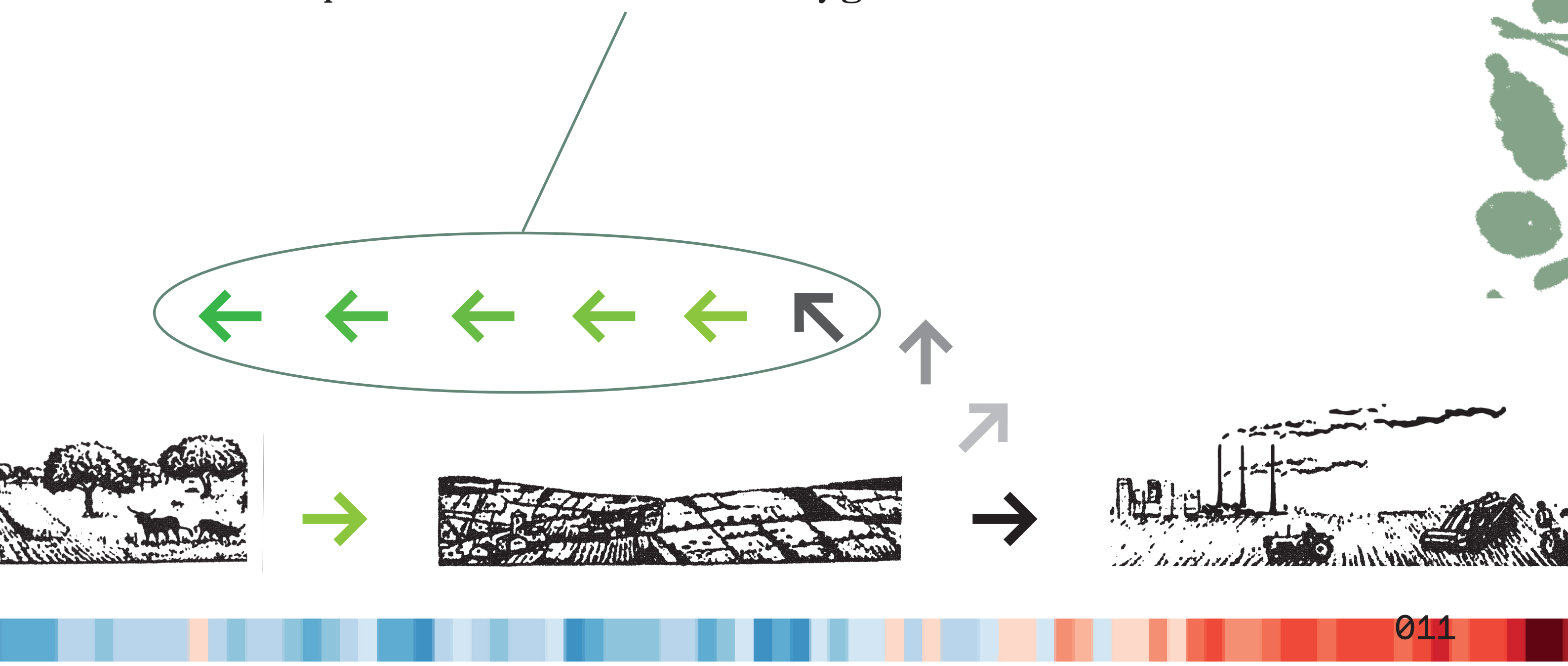
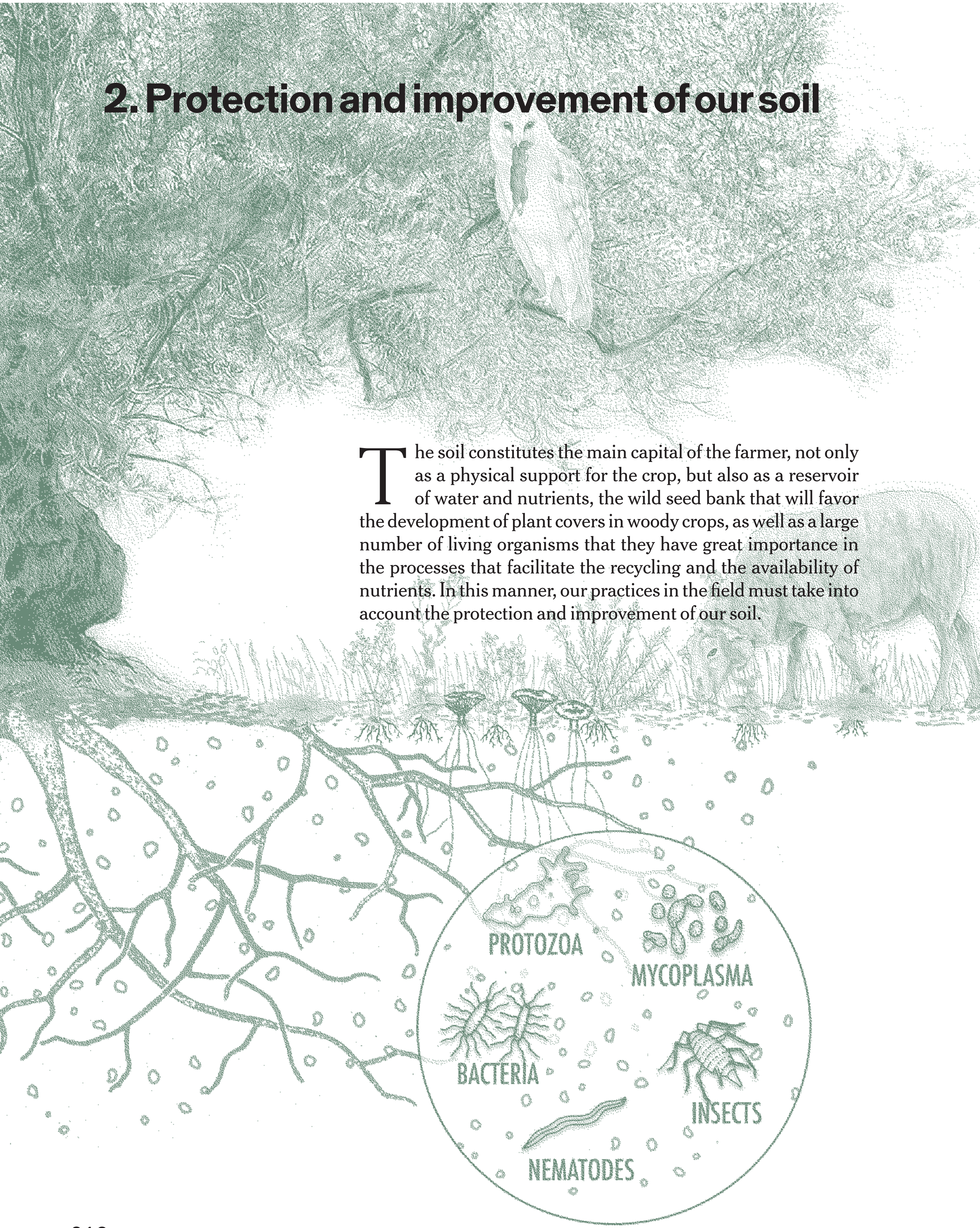


Fig. 1.3 Graph that represents the rise in temperature from 1850 to 2017 due to climate change

2017

2. Protection and improvement of our soil

The soil constitutes the main capital of the farmer, not only as a physical support for the crop, but also as a reservoir of water and nutrients, the wild seed bank that will favor the development of plant covers in woody crops, as well as a large number of living organisms that they have great importance in the processes that facilitate the recycling and the availability of nutrients. In this manner, our practices in the field must take into account the protection and improvement of our soil.



Despite the fact that these organisms that inhabit the soils are more numerous than those that live on the surface, they are truly unknown to most of us. A soil in good condition contains one billion microorganisms per gram, housing most of the planet's biomass, and these living organisms are the basis of all biological processes, making the earth and organic waste enter the lifetime cycle.

SOIL EROSION DAMAGE WITHOUT VEGETATION COVER

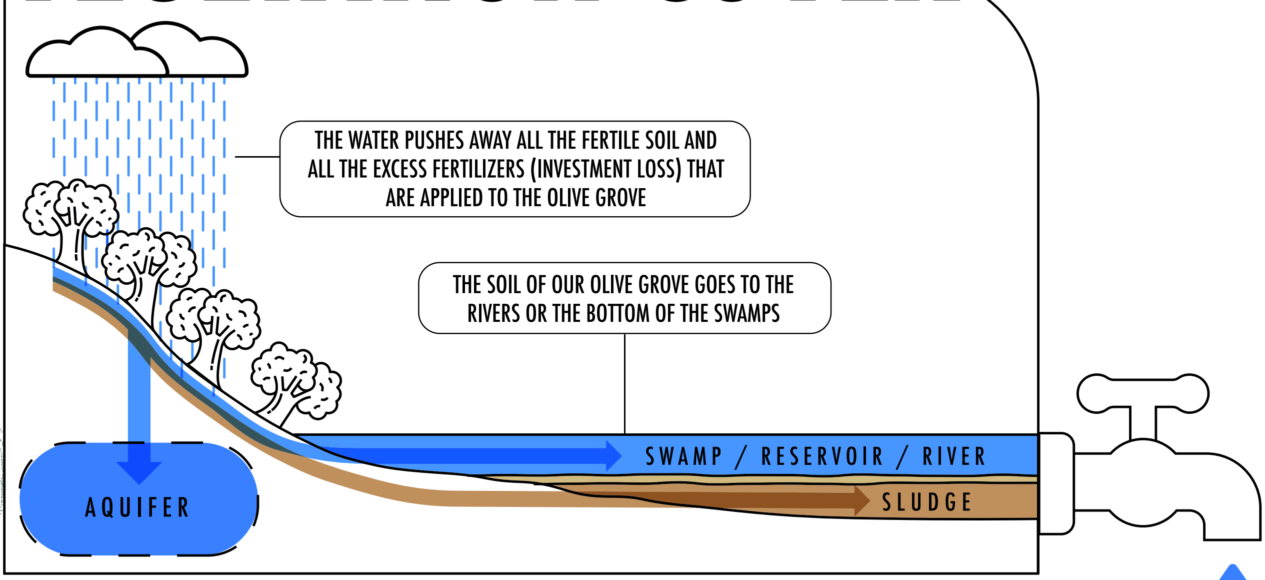
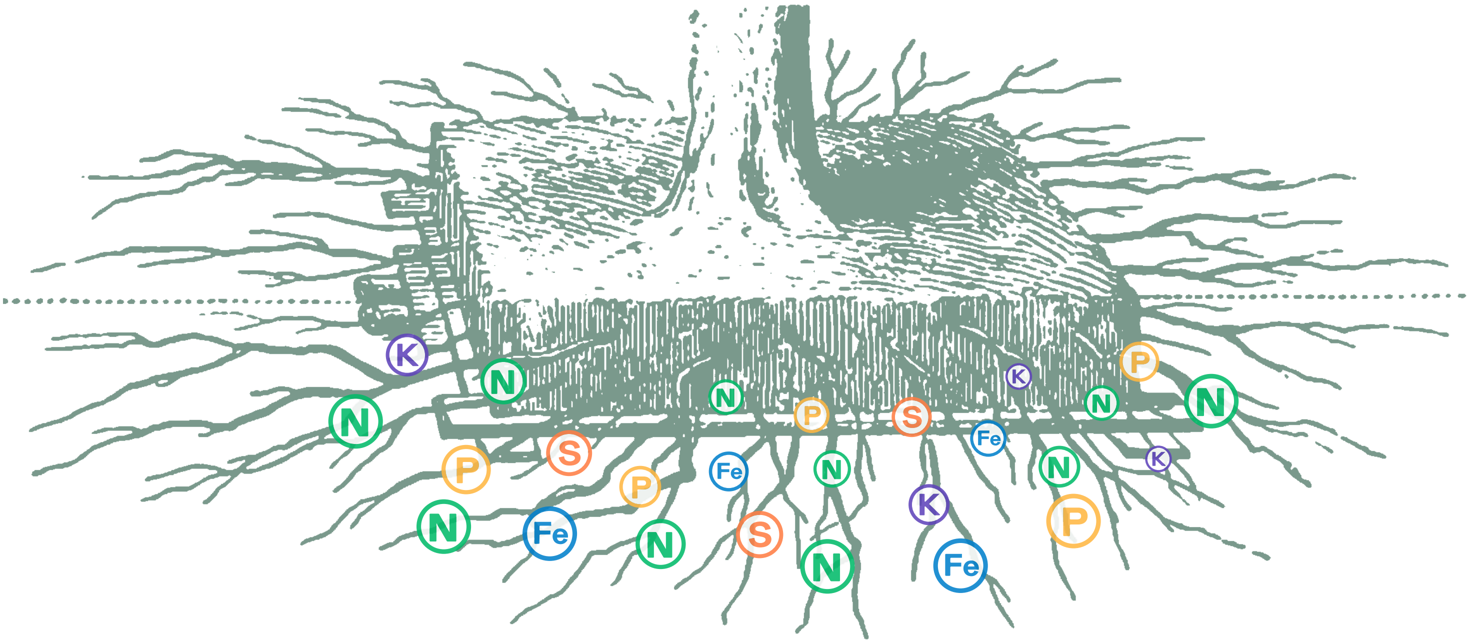


Fig. 2.1 Erosion process in soil without vegetation cover. All the soil coming from erosion, which is generally loaded with herbicides and remains of fertilizers and phytosanitary products, waisting them, and ending up in rivers and reservoirs mixing together and contaminating them

It is very important to know the relationships between our cultivation and the life that exists in the soil. When we talk about our cultivation, we will not only take into account the olive trees, but also the green cover that exists between the rows and the bushy plants of the non-productive areas (boundaries and others).

In the first 30 cm of soil, the roots absorb the nutritive elements solubilized by the microorganisms and, in return, secrete carbon-rich radical exudations to nourish some of these microorganisms. The roots can exude up to 50% of the carbohydrates fixed in photosynthesis in the form of sugars, proteins, amino acids and vitamins. These compounds feed a specific group of microorganisms related to each plant. When the plant dies, the roots become part of the organic matter again. Bacteria and fungi participate in the decomposition. The galleries formed during root growth will serve to facilitate the circulation of water and gases. The lumpy appearance of the earth that surrounds the roots reminds us the interest of not leaving a bare soil. The structures of the microorganisms that surround the root retain a large amount of nitrogen, phosphorus, potassium, sulfur, iron and other micronutrients, preventing them from infiltrating deeper layers or being leached. Fungi and bacteria produce enzymes and acids necessary to break down inorganic minerals and convert them into stable organic forms capable of feeding plants

Apart from these functions related to the nutrition of our crop, soil microorganisms compete with populations of other pathogenic microorganisms (such as the well-known Verticilium or Xylella Fastidiosa) and form a protective layer on the surface of the roots. These pathogenic species only take advantage when the



beneficial species of fungi and bacteria are killed by the continuous application of toxic agrochemical substances. Fungi are able to bind soil particles into fine mycelium webs, ensuring structural stability. Their most important role is the action they exert on the lignin of the plants, for which they require an aerated soil. Without fungi you cannot start the humus cycle. Mycorrhizal fungi are especially effective in providing nutrients to the root; these fungi colonize the outer cells of the roots, but also extend their long filaments (mycelia) into the rhizosphere, thus forming the basic junction between the roots of the plant and the soil. Mycorrhizae produce enzymes that decompose organic matter, solubilize phosphorus and other nutrients that come from inorganic rocks, and transform nitrogen into assimilable forms for plants; in return they receive significant amounts of sugars and other nutrients.

The macrofauna groups are the animals we can see (mammals, arthropods, mollusks and worms). Earthworms are the group of most interest for us inside the macrofauna group, due to the many tasks they perform in favor of the soil. Among the mechanical actions, stands out the network of galleries that they build, aerating the floors in every way, mixing and transferring soil horizons. In its intestine, soil and organic matter mix, forming the humic clay complex that improves soil fertility. On the other hand, the resulting soil absorbs moisture better and is more resistant to erosion, contains a greater number of nutrients and becomes more permeable to the passage of roots that cross the galleries created by worms, with humid walls and rich in microbes, and organic matter.

Mammals, where we highlight rodents, create immense galleries where they shelter and reproduce, allowing water and air to enter the ground in a massive way. The construction of galleries also facilitates the rise of deep soils and a good mix of soil horizons.

The arthropods group: crustaceans (mealybugs), arachnids (spiders and mites), myriapods (centipedes and insects) and collembola. Their fundamental action is to chop up the organic matter that falls to the ground and with their excrement produce an adequate support for microbial life. These animals live far from the light of the ground and under the leaves and stones, they do the first job of digestion.

We have just given a brushstroke about the importance of soil in our cultivation, but there are multiple threats that endanger it throughout the Mediterranean area, mainly erosion, which causes the loss of millions of tons of fertile soil each year, the progressive loss of organic matter due to intensive agricultural practices, and contamination by the inappropriate use of herbicides, pesticides and synthetic fertilizers.

What can we do to solve these problems?

Good agricultural practices to protect and improve our soil.

2.1 Favor vegetation covers

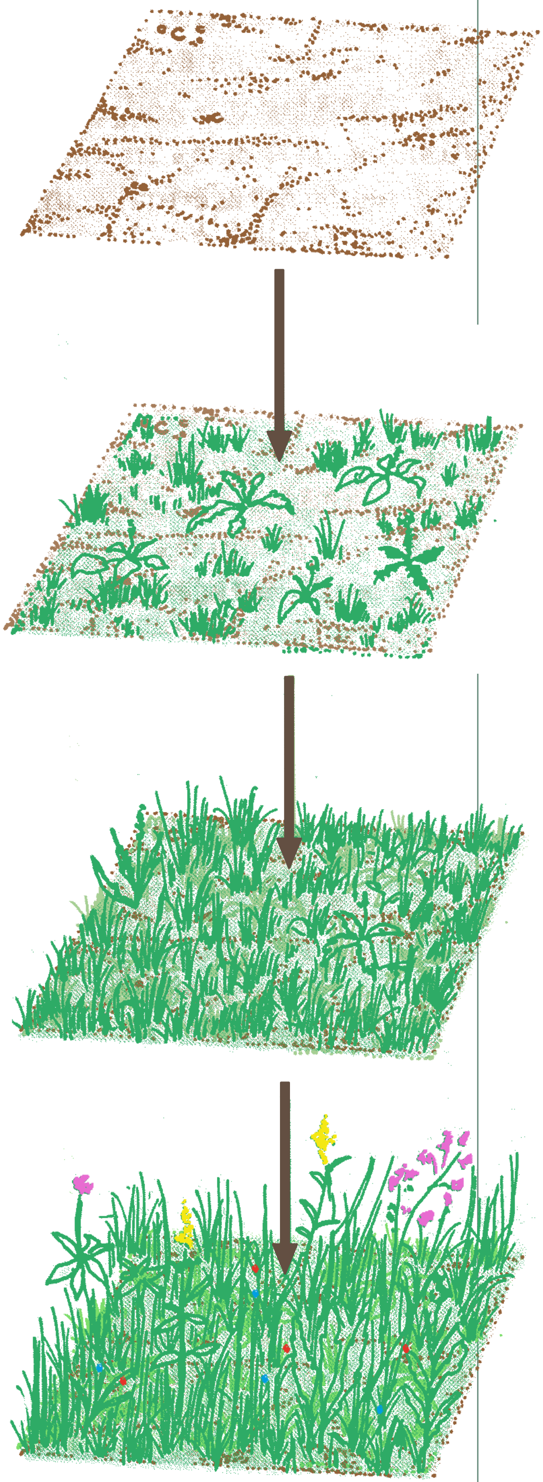


Fig. 2.2 Progressive growth of the vegetation cover

We call vegetation cover to the mantle of herbs that covers the ground surrounding the olive trees. It is the most important measure for the protection of the soil against erosion, one of the main problems of the olive grove throughout the Mediterranean basin. On the one hand, it protects the soil from the direct impact of raindrops (soil disintegration), and on the other it acts as a filter against the sun's rays, preventing the evaporation of water. It constitutes a physical barrier for the flow of surface water when there is a slope, which causes gullies where there is no grass cover on the surface of the crops.

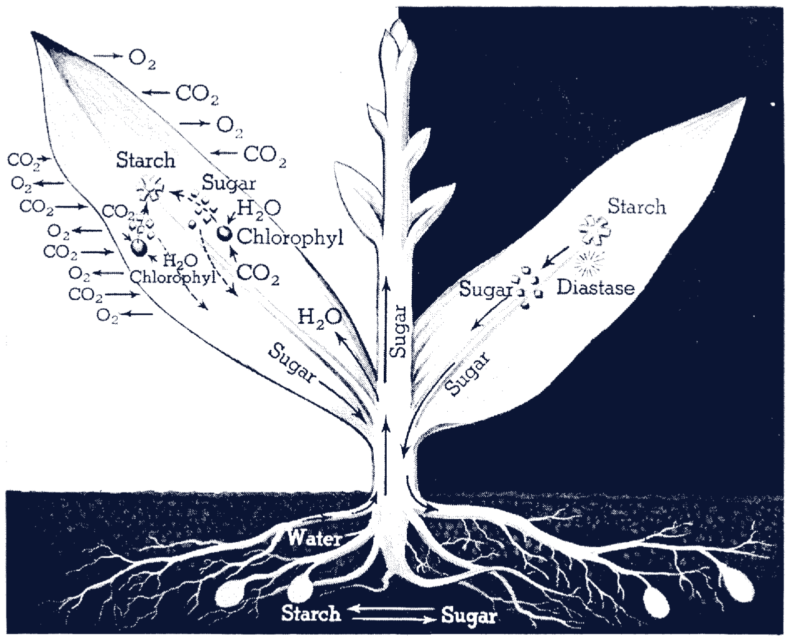


Fig. 2.3 Detail of the biological process of a plant

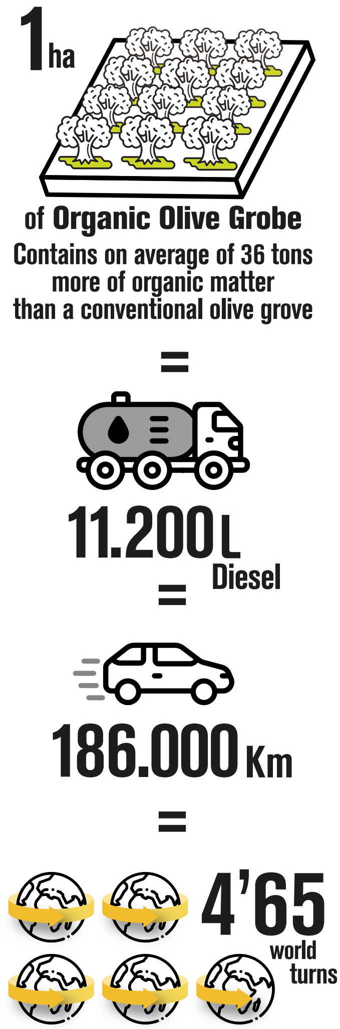
The vegetation cover has many other benefits for growing and protecting our environment:

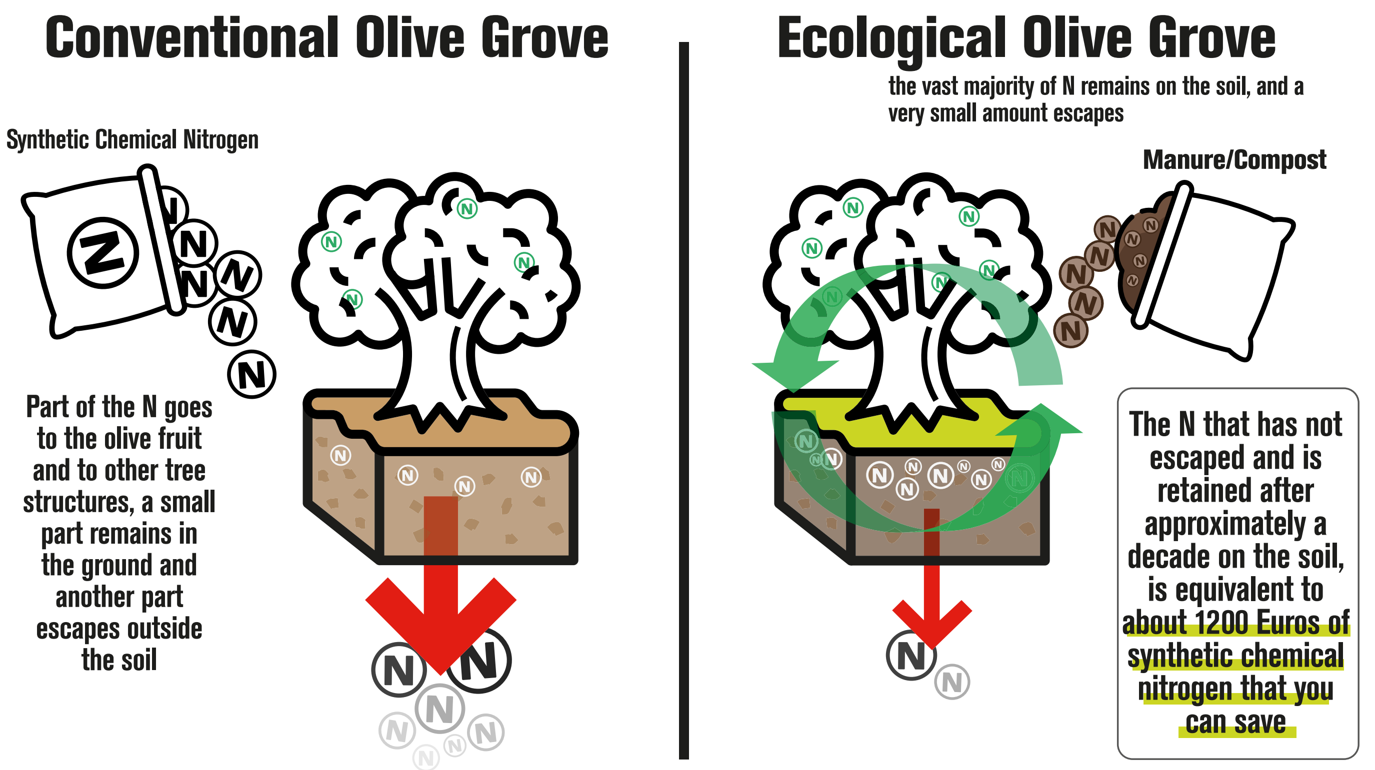
→It is an important contribution of nutrients and organic matter to the crop when this superficial flora dies.

↘In the case of crucifers such as dandelions, so abundant in our olive groves, they extract nutrients from the deep layers of the soil, such as potassium.

↘Legumes will extract nitrogen that will also benefit the crop, another macronutrient of great importance.

↘The remains of grasses (Poaceae) will slowly be incorporated into the soil and, as they have shallow roots, they do not consume water from the deep areas.





→ The roots of the vegetation cover improve the physico-chemical structure of the soils, building channels conducting water and air to the soil, fundamental elements for cultivation and the existing life in the soil.

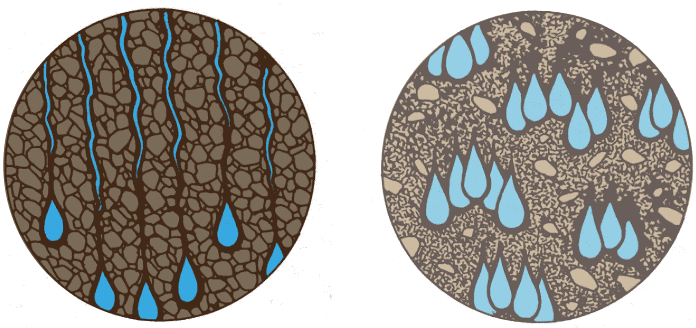


Fig.2.4 In the left image you can see a good physical-chemical structure, where channels have been created where the water passes through, not like the opposite image on the right

→ Limits the runoff of rainwater and favours the maintenance of water reserves.

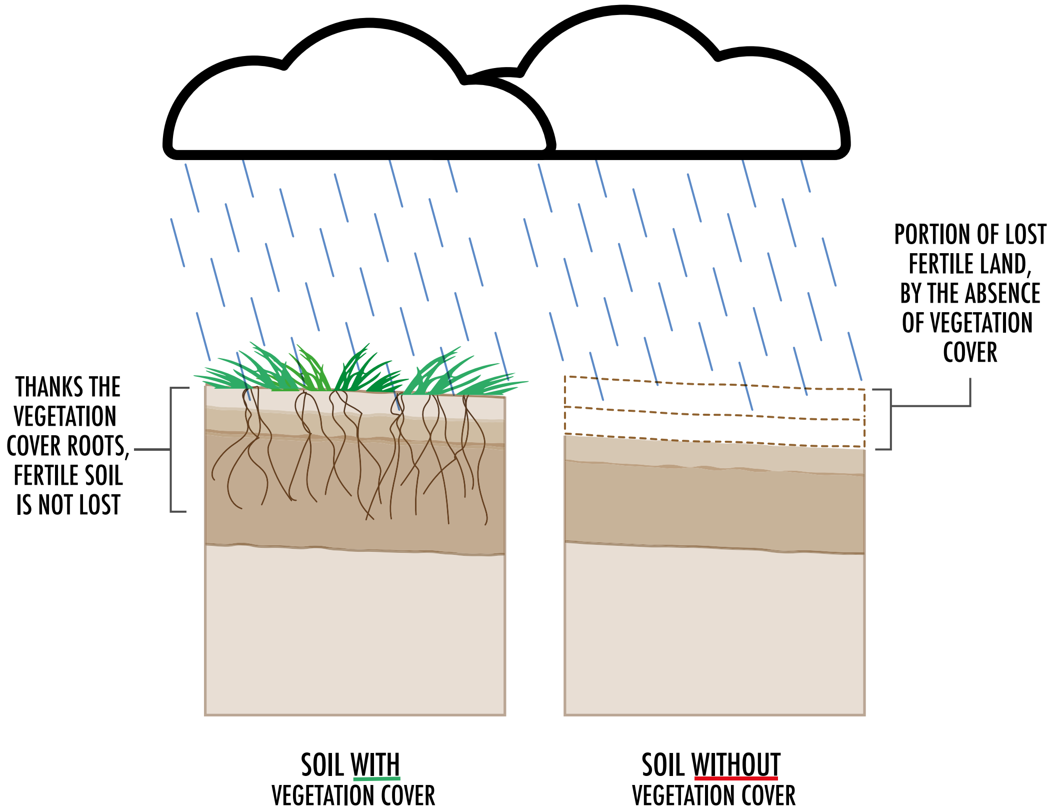
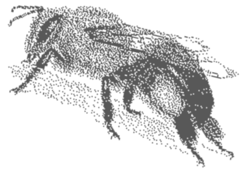


Fig.2.5 You can see the erosion produced by water in a soil without vegetation cover, where great part of the money invested in fertilizers... Is lost with the eroded soil

→ The grass cover itself constitutes an excellent habitat, where a large number of living beings take refuge and feed, they also maintain the balance of our olive groves, such as auxiliary insects that contribute to the prevention of pests and diseases.



→ It allows us to integrate domestic livestock, where the farmer benefits from a free maintenance of the vegetation cover due to the animals grazing, plus the fertilization of the soil with the livestock manure, and the shepherd benefits from quality pastures, where they both benefit from.

→ It also facilitates the access of the machinery, allowing to carry out tasks such as harvesting without fighting against the mud.

As we can see, they are all advantages. One of the main concerns of the farmers that stops the development of this practice are based on the competition between the olive tree and the grass cover in terms of the availability of water and nutrients. For this reason, it is essential to have an adequate control of the vegetation cover with the use of animals (mainly sheep, equids or fowl), or with mechanical brush cutters in low rainfall season.

We understand that the best plant cover is the one that grows naturally on our land, but unfortunately the continued use of herbicides has been depleting the natural seed banks.

There are also grass covers created with harvest remains, pruning and other plant based materials that, although they cannot be compared to natural plant covers, are a good alternative to avoid leaving a bare ground.

2.2 Adding organic matter to our soil

The soil shows more resistance to eroding when its physical properties improve, and this occurs if organic matter is added to the soil, it also makes a difference the less you till the soil, and if you eliminate the use of pesticides, mainly herbicides, since they create soil compaction.

2.2.1 Use of by-products

Current olive waste management practices in the olive oil sector produce environmental problems such as soil contamination, underground seepage, contamination of water bodies and emissions of bad odours. Currently, the search for environmentally friendly and economically viable solutions for the elimination of by-products, including agricultural use, is a priority in the producing countries and, therefore, it is considered a key challenge for SUSTAINOLIVE. In the last chapter of this document we will delve into the composting of alperujos (olive waste) for the fertilization of the soil and the closing of the nutrient cycle.

2.2.2 Creating a vegetation cover with the chopping remains of pruning in the the olive grove rows

These so-called inert covers fulfil several essential functions for the good management of our olive groves. On the one hand, they provide soil protection against water erosion by reducing the speed of water circulation on the surface, improving water infiltration and reducing water losses due to evaporation. On the other hand, it improves the physical properties of the soil by slowly decomposing, providing organic matter and improving the structure in the most superficial layers of the soil.

For the creation of this type of vegetation roof there are a large number of special made shredders or mincers that act by breaking branches and pruning remains with a diameter of up to 10 cm.

3. Increase and favor biodiversity in cultivation

Biodiversity: The word biodiversity has the meaning of "biological variety" and comes from joining the words bio- (life) with the word "diversity" which comes from the Latin *diversitas* = "variety". In two words: variety of life.

In an ecosystem, the organisms that inhabit it are in balance thanks to the mechanisms that allow the continuous renewal of natural elements. The movements of energy and nutrients are also in balance, governed by natural or ecological principles.

Light energy and carbon dioxide are taken up first by plants to make their food (sugars) through photosynthesis. That is why plants are considered the producers of an ecosystem. Energy flow refers to its initial fixation, it transfers through the system along a food chain and its final dispersion by respiration.

Nutrient recycling is the continuous circulation of elements from an inorganic to an organic form and vice versa, that is, the circulation of materials through the structural components of the ecosystem. When the human being modifies these ecosystems to produce food, it alters these balances and simplifies the structure of the ecosystems, this alteration will bigger, the more we simplify the starting ecosystems. For Margalef (1979), "the exploitation of crops involves a simplification of the ecosystem, compared to its pre-agricultural state". This exploited ecosystem are made up of a smaller number of species and also a smaller number of biotypes (grasses, weeds, trees, etc.). The structure of the soil is simplified and the diversity of the populations of soil microorganisms and animals decreases. The circulation of nutrients outside the organisms acquires more importance. Annual rhythms are accentuated, not only in cultivated species, but also in species associated with crops, such as weeds or pests. Agroecology applies the concepts and principles provided by Ecology for the design of sustainable food production systems. In this way, it is the farmers' task that the less simplification of the ecosystem should be done. In the Mediterranean olive grove, tillage practices and the use of herbicides to eliminate the weed flora in the olive grove have directly affected the diversity of flora and fauna in the crop. The farmers objective is to avoid competition for water and nutrients, but these practices have led to a general impoverishment of vertebrates and invertebrates that were directly associated with plants and that, in many cases, were a natural control tool of the olive tree pests and diseases. They have also impoverished the contributions of organic matter to the system, fundamental for the natural processes that occur in the soil, these practices aimed at controlling the flora they've added the chemical fight, which accelerates the imbalances in our crop making it even more vulnerable and dependent of periodic treatments, polluting the soil, air and surface and underground waters.

When the system is balanced and there is shelter for the different animal species, the benefits of biological control of pests and diseases become apparent.

Insects have natural enemies, mainly other insects, but also birds, fungi, bacteria and viruses, which help limit their spread, so measures that are favourable for the multiplication of these organisms should be used if they exist, in the environment in which we have our crops, and in some cases we can incorporate

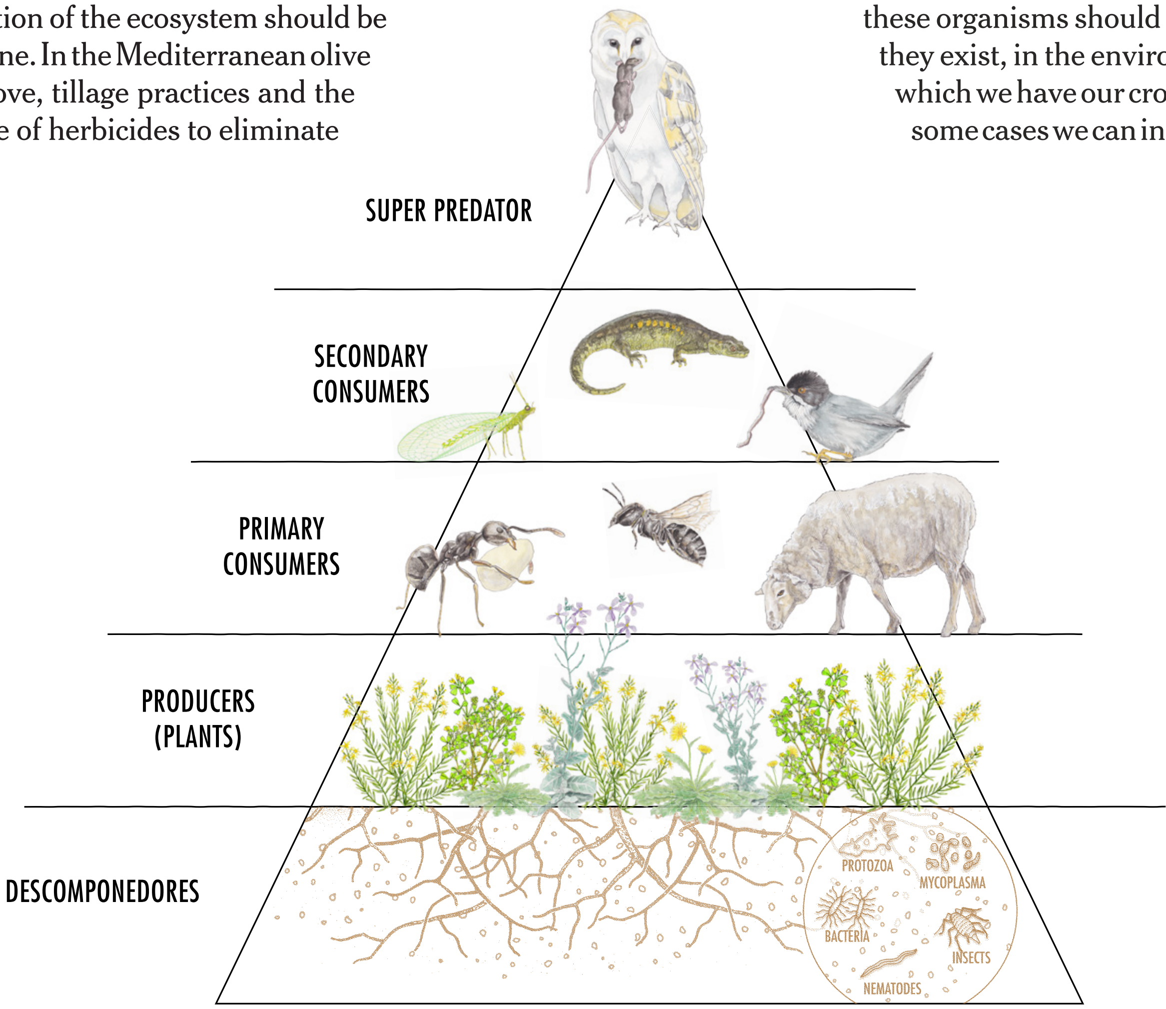


Fig. 3.1 Trophic chain

them artificially (seeds of weed plants, shrubs in non-productive areas or the spread of useful fauna).

Starting with bacteria, a well-known case is that of Bacillus Thuringiensis, which produces a disease in the larvae of certain insects, due to toxins produced by the bacillus, a solution is prepared and applied by spraying it.

Insects that live at the expense of others can be predators or predators and parasites. Firstly are those that feed on eggs, larvae or adults of the species that are pests in the crop. There are predators that feed on several species (polyphagous) and predators that only feed on a specific species (specific). Among the most important predators we have within the Coleoptera family, the Coccinellidae, commonly called ladybirds, in the Neuropterans family the genus Chysopa, in the Dipterans family the genus Syphus, and the family of Mantidas are also predators.

Trapping: Using traps, certain pests are attracted by the color yellow or blue, which is why gummed plates of these colours can be placed as a means of reducing the plague, or to evaluate existing populations. On other occasions, food-type or light-type traps are used.

What can we do to increase the biodiversity of our crop?

Favorable practices, to increase biodiversity.

3.1 Favor organic fertilization of our crops

The use of organic matter to fertilize our crops favors biological activity in the soil, allowing the transformation of this organic matter into humus and mineral nutrients for the crop. This practice is essential if we want to maintain the life of the organisms that live in the soil and the services that they offer to the sustainability of the crop.

3.2 Vegetation covers and shrub planting in unproductive areas

In previous sections we have talked about the need to maintain a vegetation cover to facilitate an adequate habitat, in which useful insects for the farmer can take refuge, we also must avoid altering and polluting the environment to maintain a diversified agroecosystem.

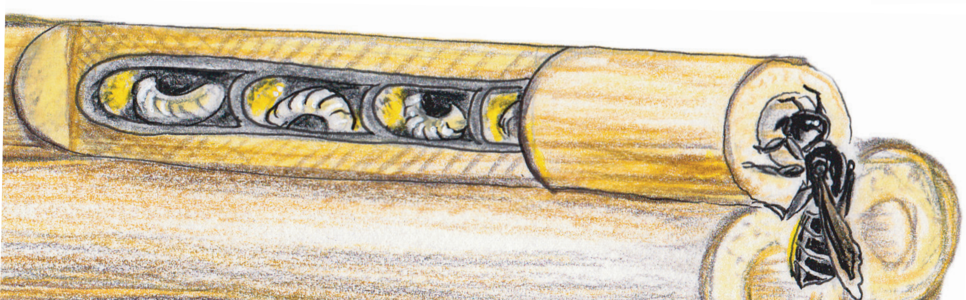
The planting of perimeter hedges or unproductive (uncultivated) areas facilitate the development of biodiversity. There are certain insect-related plants that regulate pest insects: for example, the false yellowhead (Dittrichia viscosa).

The flora favours the shelter of insects while they also contribute to the pollination.

3.3 Placing insect hotels, bird poles, nest boxes and ponds

There are different natural or artificial structures that provide shelter for insects, birds and mammals that are essential to maintain the balance of our agroecosystem: Eroded rocks, stone walls, ponds that serve as habitat for amphibians also as drinking fountains for birds and mammals, perches and elevated nest boxes for different types of birds and bats, and "insect hotels" that facilitate solitary wasp layings, for example.

As we have already said before, the more our cultivation resembles a natural ecosystem, the more easily imbalances will be corrected.



4. Conclusion

Good soil management in the olive grove is the pillar on which the success of the olive grower rests in the short, medium and long term. Obtain and maintain a soil with high natural fertility, healthy and capable of adequately nourishing the crop. And all of this in an affordable way, is the key to olive growing, and we must focus our efforts in the olive grower who begins the transition, towards a more sustainable olive grove.

5. Sustainable solutions to the common problems of olive growing

In this section we propose different techniques to address the main problems that farmers encounter in their evolution towards more sustainable management models. If our practices have been related to the use of synthetic chemical inputs, the transition to more sustainable models will be accompanied by production losses and imbalances of all kinds, both at the soil level and in the flora and fauna of the crop. It will generate the progressive loss of organic matter and environmental pollution.

5.1 Pests and diseases

Tuberculotsis

Pseudomona savastanoi pv. savastanoi

Olive tree tuberculosis is a disease caused by bacteria. It is detected by the appearance of tumors in the branches of trees and, to a lesser extent, it can affect roots, leaves, olives or the trunk. The tumors of the previous year harbour house the bacteria that in the presence of humidity spreads to the rest of the tree, more easily if there are wounds such as those caused by frost, hail, pruning, falling leaves, etc.

The most frequent attack of tuberculosis occurs on the branches, mainly when they are still green. In the first stages, the tumors are green, with the same tone as the branches, although more spongy and softer. As they evolve they become rougher and harder, and the color darkens until it has the coloration of the trunk. The most affected branches lose vigor and can even dry out.

The disease is closely linked to the presence of humidity, so the most favorable periods for infection are spring and autumn, and its control is mainly based on preventive measures such as those detailed below:

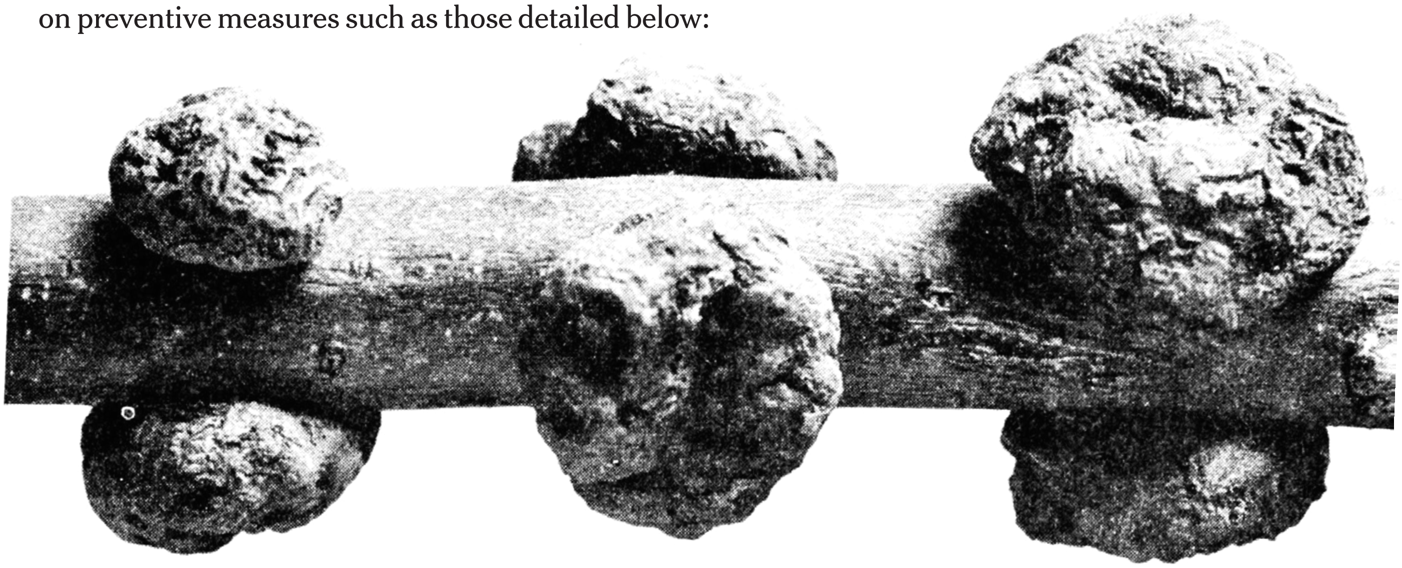


Fig. 5.1 Olive tree branch affected by Tuberculosis

— Carry out the pruning of the olive grove in dry periods, eliminate the branch tissues affected by the bacteria, and properly disinfect the tools used.

— Avoid injuries during harvesting and do not harvest when it is raining.

— Avoid excess nitrogen fertilizers.

Olive fruit fly

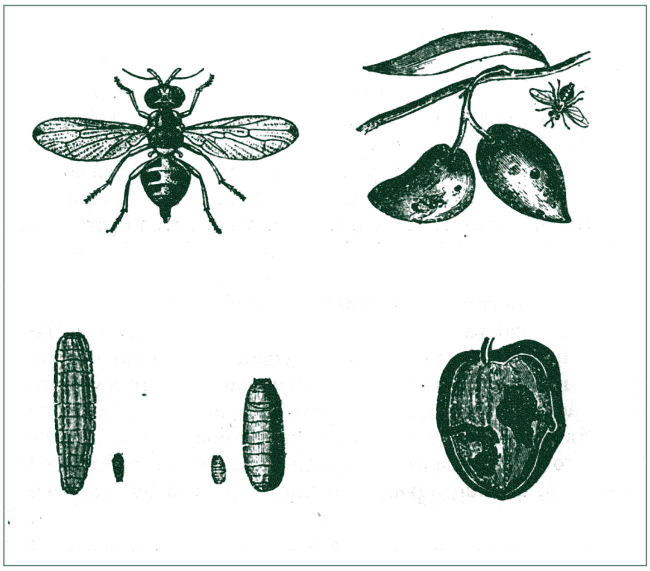
Bactrocera Oleæ

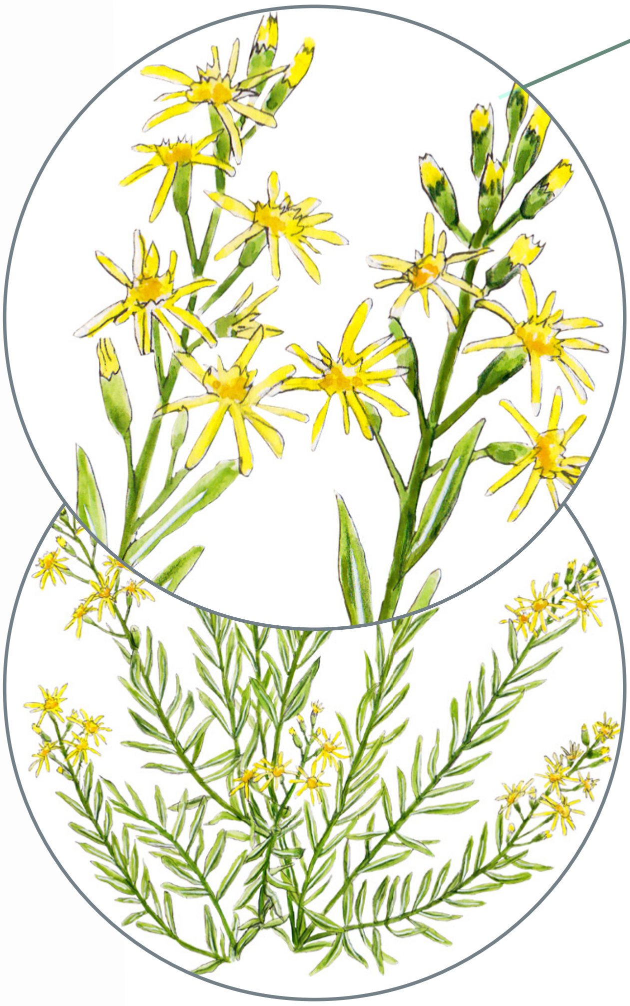
Considered the most problematic pest of the olive grove, its larvae are responsible for the damage done to the olive fruit, by feeding on its pulp. It is characterized by a whitish triangle located on the thorax, a black spot at the end of the wings, and the extension of the anal cell, narrow and elongated. The adult measures between 4 and 5 mm. The female is capable of laying more than 20 eggs a day in olive fruits. The damage is not so much related to the decrease in production as to the appearance of table olive fruit, or the decrease in the quality of the oil (the galleries created by the larvae allow the entry of fungi that give the oil a bad taste), it also makes the premature fruit fall of.

To evaluate the incidence of this pest, control traps are used that attract the fly by its color (yellow) and by a natural attractant, when the adult fly flies.

Its control is very complicated and it is greatly affected by the weather.

Fig. 5.2 Olive fruit fly





Yellowhead

Inula viscosa o Dittrichia viscosa

Some plants have a special role in reducing natural enemies. Thus the dipteran Myopites stylata causes the formation of flower galls in the plant known as olivarda, or mosquera grass (Dittrichia viscosa). These galls play an important role in the biological cycle of the parasitoid hymenopteran Eupelmus urozonus, which uses them as a safe haven during its hibernation, being one of the main natural enemies of the olive fly.

Maintaining Dittrichia viscosa hedges helps to better control the Olive fly.

The olive fly has a high number of natural enemies, highlighting a small wasp (Opius concolor), or beetles of the genus Cicindela. Maintaining a diverse vegetation cover and the so-called "insect hotels" favor the presence of the fly's predatory wasps.

Another effective method is mass trapping with the so-called Olipe traps, which are plastic bottles hung in the trees, facing south, with some perforations of about five millimeters. **These bottles are filled with 1 liter of water and 30 grams of bammonium phosphate.**

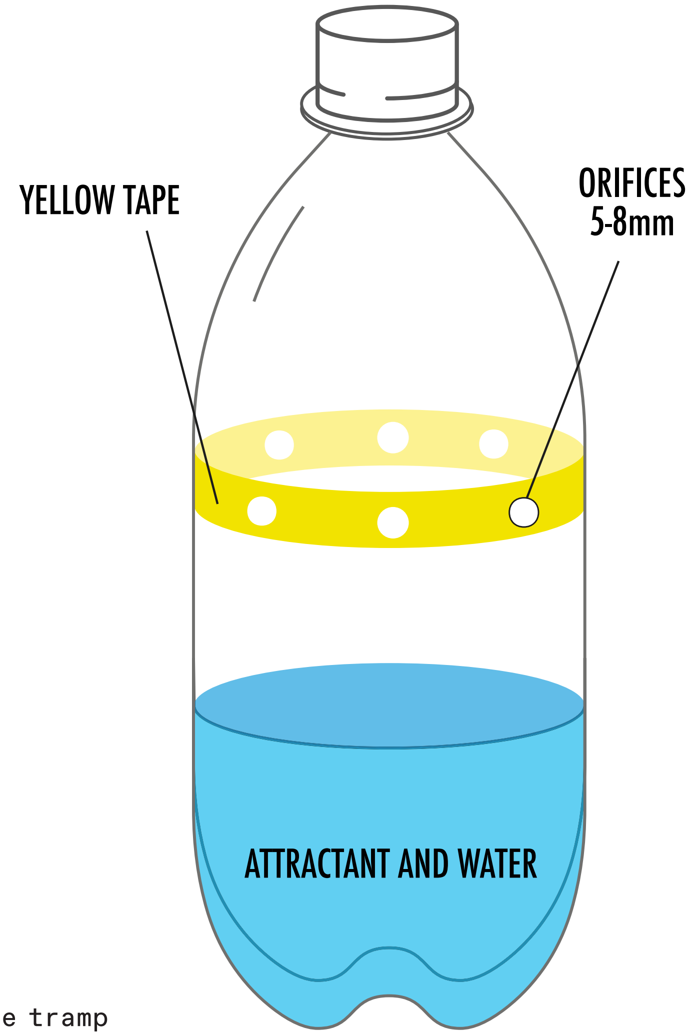


Fig. 5.3 Olipe tramp

Olive moth

Prays Oleæ

Is another notorious pest of the olive grove that causes damage mainly in the phase in which the larvae feed on the fruit (carpophagous generation). The adults lay their eggs on the underside of the leaves and shelter there in the winter, in the form of pupae that are easily identifiable, and in spring the larvae enters the leaves where we can see the galleries that they create as they feed (generation phyllophagous). When flowering occurs we can also see the larvae feeding on the flowers or the silk threads they leave in them (anthophagous generation). It is in summer when most of the damage appears due to the fall of the olive caused by the entry of the larvae into the fruit pit.

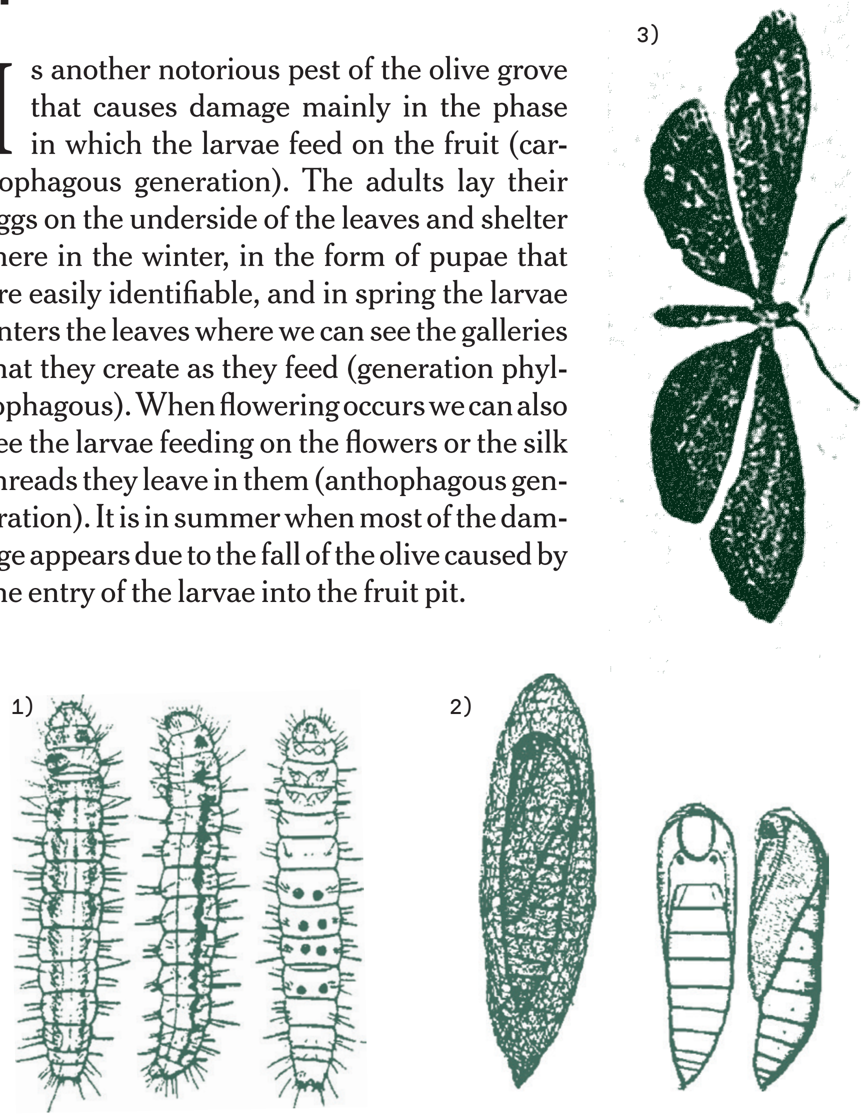


Fig. 5.4 Prays Oleae in its different phases, 1) Larvae, 2) Chrysalis, 3) Adult (De Silvestri)

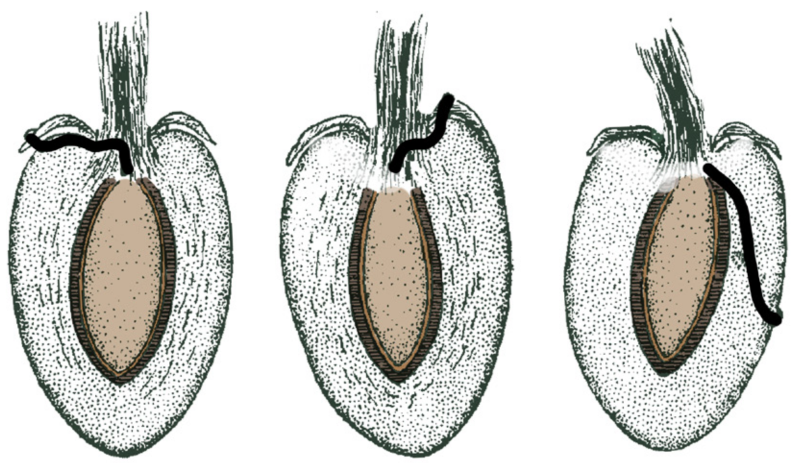


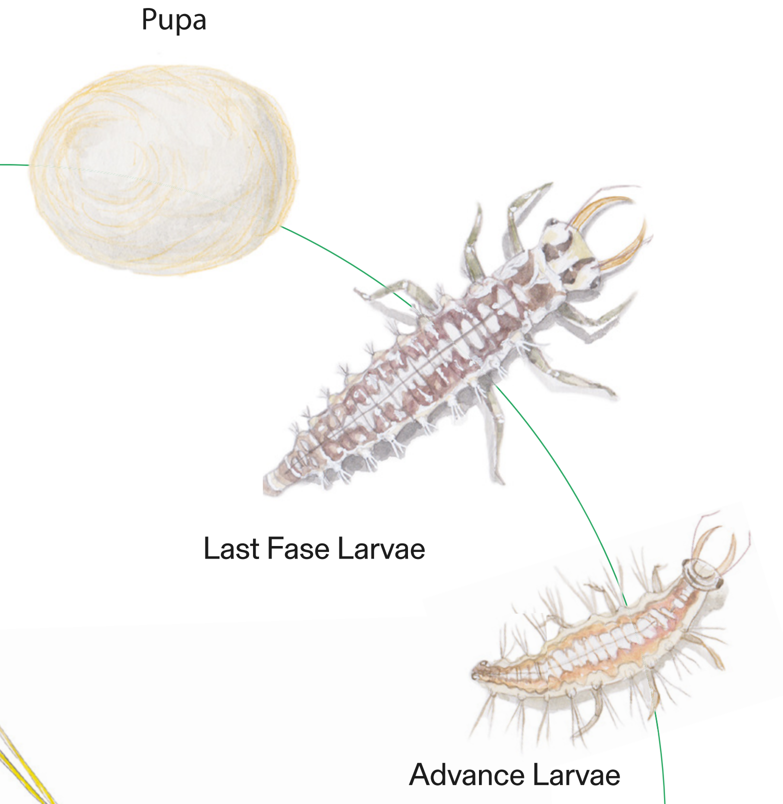
Fig. 5.5 Phyllophagous generation

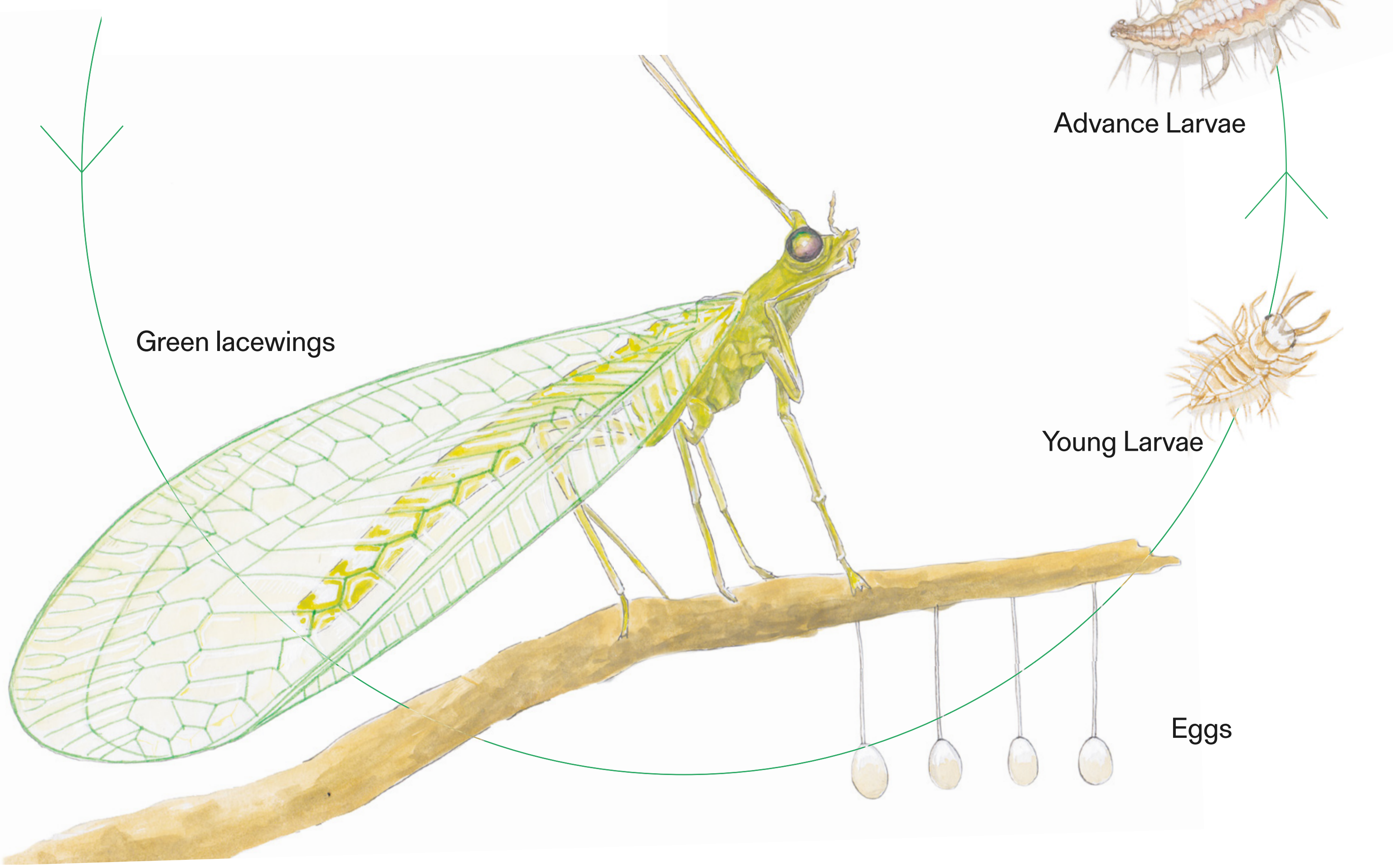
Fig. 5.6 Carpophagous generation

Green lacewings

Crhysoperla carnea

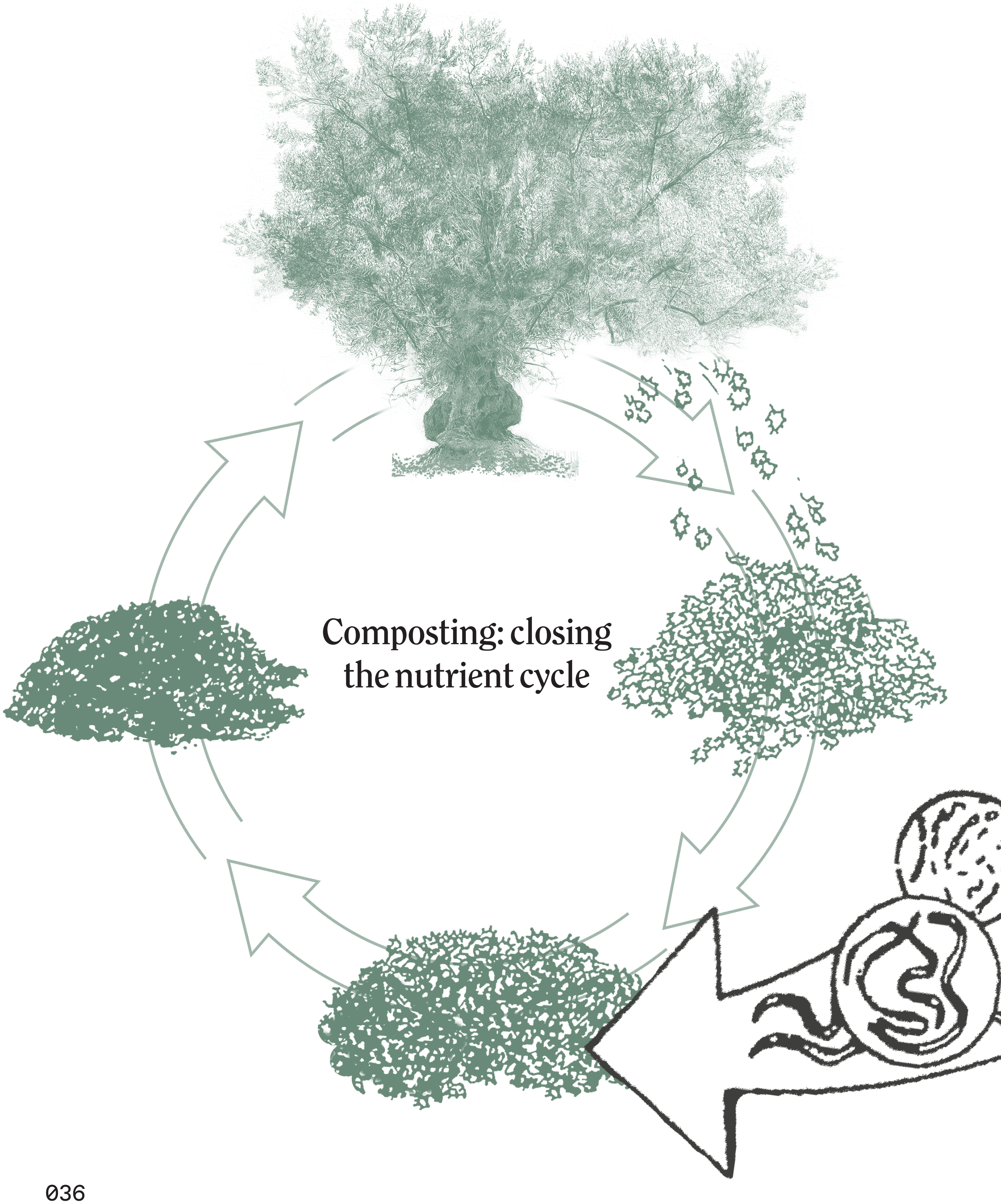
It is ideal to favor the conditions for Prays natural predators to combat them when it becomes a pest, among which the Green Lacewing (Crhysoperla carnea) stands out. In its adult phase, this insect feeds on nectar, so it is necessary to ensure the presence of a vegetation cover, and shrubs on the edges of uncultivated areas, rich in botanical diversity to favor the presence of this predator that can control the Prays very effectively. The egg laying of the Green Lacewing is easily identifiable by the unique way in which they do it, at the end of a filament, due to the voracity of their larvae when there born, which would end up eating the unhatched eggs.





In emergency situations we can use an insecticide based on a bacterium, Bacillus thurigiensis. It is a more selective treatment than synthetic insecticides and we must use it when the Prays larva is in the flowers.

5.2 Composting of alperujo (olive waste)



Composting is the process by which organic matter decomposes into humus. It is an aerobic biological process that we can accelerate if we control the humidity, aeration and temperature of the pile. All this will facilitate the intervention of the large number of macro and microorganisms that participate in the process. The final product will improve the quality of the starting elements used to make the compost, the possible toxic elements will have been eliminated, as well as fungi and bacteria harmful to the plants. In this way we improve the health of the crop, the nutrition of the soil, as well as closing the nutrient cycle of our farm.

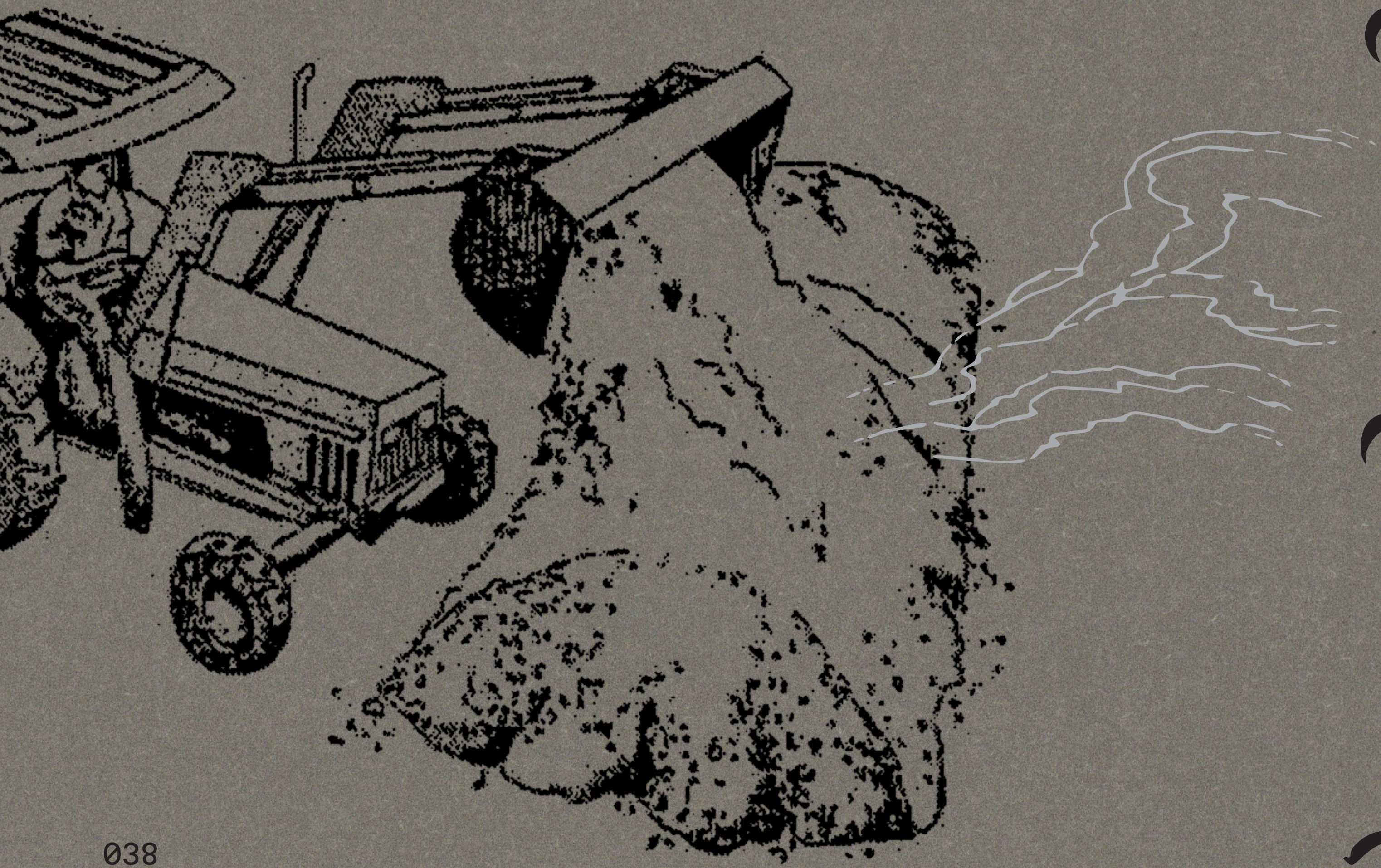
To obtain a quality product we must make sure to start the process with a balanced mixture of the starting components, which must have a carbon/nitrogen ratio close to 30, that is, 1 part of nitrogen for every 30 parts of carbon (there are tables to know the C/N ratios of different starting materials).

→ **a) Alperujo (olive waist)** is the main by-product of the olive grove, acting as the main component of our compost. It has a humidity close to 70%, and it is necessary to mix it with other elements that allow air to enter the mixture.The vegetation cover itself constitutes an excellent habitat where a large number of living beings feed and take refuge, that maintain the balance of our olive grove, also for auxiliary insects that contribute to the prevention of pests and diseases.

→ **b) Structuring.** The leafs are what is mainly used, that they are separated from the olives fruit when they enter the mill. In addition to olive leaves it also carries small branches that are detached during harvesting. This material is relatively abundant in the olive oil industry and can be supplemented or substituted by other agricultural, industrial or urban by-products: husks of different nuts, rice husks, sawdust, straw, greenhouses, chopped plant material, etc. In any case, the maximum size of the fragments should not exceed 3 cm.

→ **c) Nitrogen Source.** We are thinking mainly of manure although it can also be blood meal, liquid manure, etc. As the contents of C and N are highly variable depending on the material we have, we must analyze them to establish the proportions. As an approximation we can think of a mixture containing 65% alperujo, 25% structuring agent and 10% manure.

→ **d) Activators.** We use compost from previous heaps or forest soil because they contain part of the microfauna and macrofauna that will help us to activate the pile.



For practical purposes and following environmental regulations we must have a surface isolated from the ground that has a minimum slope to channel the leachate from the heap to an impermeable pond, it is also advisable that this surface is covered to provide shade and control humidity conditions. On the other hand, we must have a water access point and a thermometer with a probe to control the humidity and temperature of the pile throughout the process. To ensure the flipping of the mixture, a backhoe, a tractor with a shovel or an industrial turner is used that goes through the piles turning and watering the components.

We will start by building a pile by accumulating the starting elements in layers like in a lasagna, first the structuring material at the base, then the alperujo and finally the manure. The piles will have a maximum height of 3 m and a base with a maximum width of 4 m.

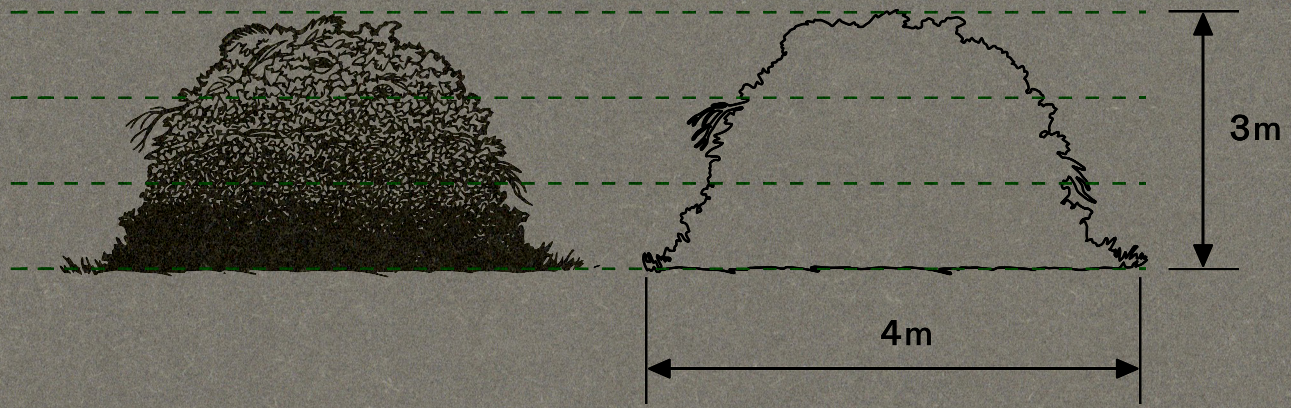
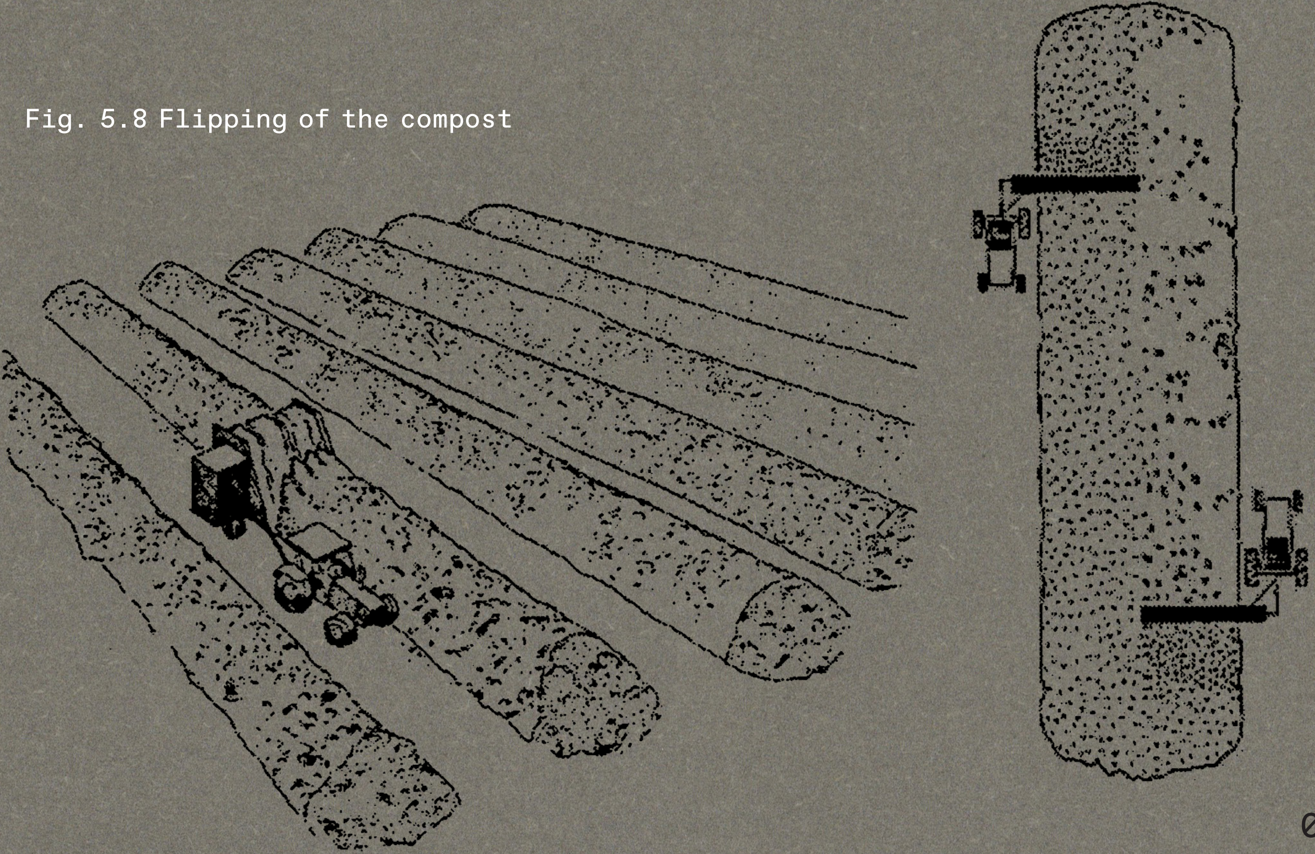


Fig. 5.7 Layers in which the compost is divided, and approximate measurements

Fig. 5.8 Flipping of the compost



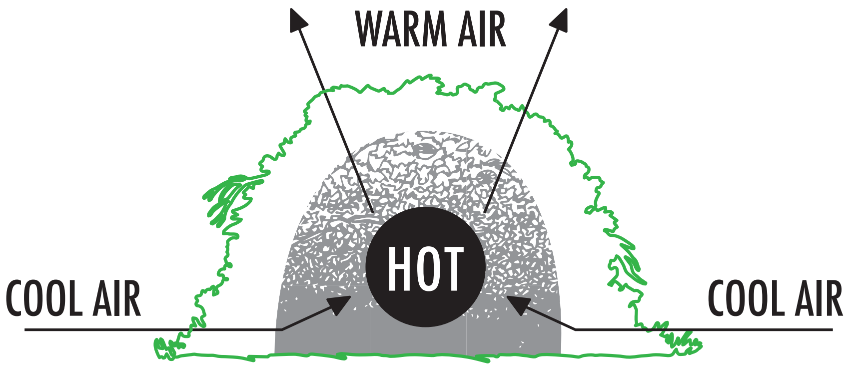


Fig. 5.9 Correct aeration process for composting

→Once all the components have been mixed by mechanical means so that they are perfectly homogenized, we will notice a rise in temperature due to biological activation.

→In the first phase, temperatures close to 60ºC are reached, which are essential to kill fungi and toxic bacteria, and eliminate seeds that are present in the heap. Temperatures from 70ºC cause the destruction of the fauna involved in composting and it will be necessary to turn over to lower the temperature down.

→As a rule, the pile will be turned over every time the temperature rises above 70ºC and when it drops below 40ºC, and we must ensure that it contains adequate humidity, around 40/50%. It is normally watered during turning to ensure moisture throughout the pile.

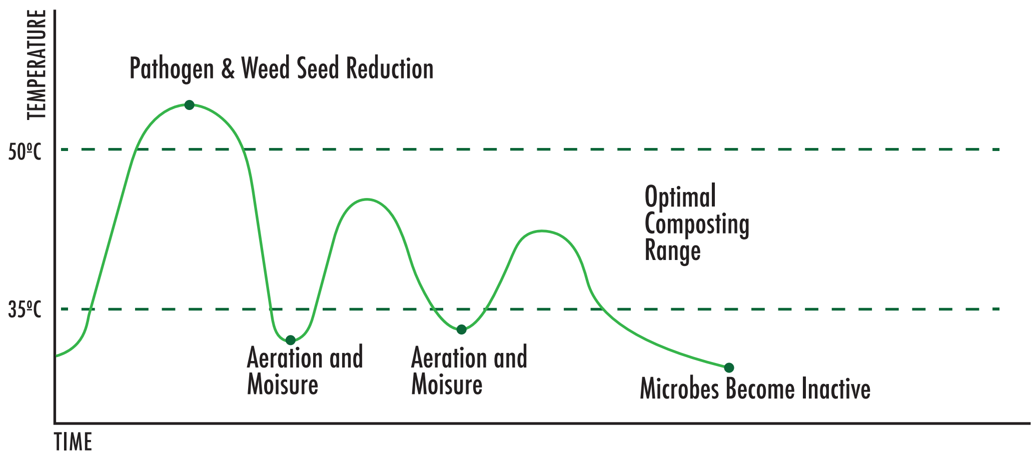


Fig. 5.10 Figura ilustrativa

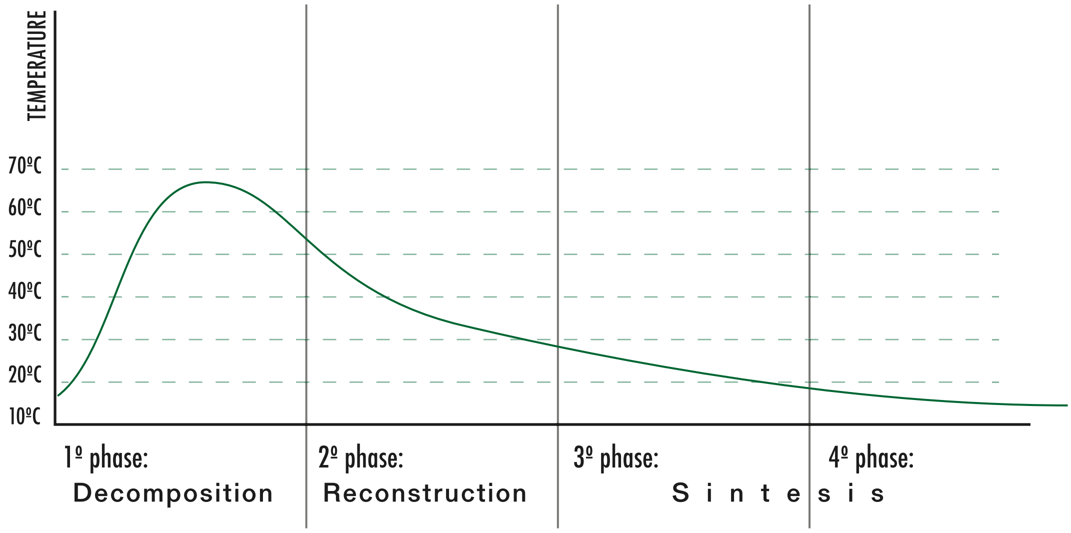


Fig. 5.10 Correct temperature phases for composting

→This process can last about 6-9 months, it requires us to measure the temperature at least once a week during the first months. There are between 6 flipping's in total.


Fig. 5.11 On this images you can see the hole process of composting alperujo (olive waist)





THERMOMETER
°C
TFA




COMMON MATERIALS FOR COMPOSTING

HIGH-NITROGEN MATERIALS These items should not be composted by themselves; they need some carbon materials to balance the high nitrogen levels.

MATERIAL	SOURCE OF	C/N RATIO	% NITROGEN
Alfalfa	N	13–20 to 1	2.5–3
Bone meal	N	3 to 1	L–2
Coffee grounds	N	20 to 1	2
Fish scraps	N	5 to 1	2–8
Grass clippings	N	12–25 to 1	1–2
Kitchen garbage, raw	N	12–25 to 1	2
Manure, chicken	N	7–10 to 1	3.2
Manure, cow	N	18 to 1	1.7
Manure, horse	N	25 to 1	2.3
Urine, human	N	8 to 1	15–18

MATERIALS WITH BOTH CARBON AND NITROGEN These materials will decompose effectively if mixed with some other high-carbon and high-nitrogen materials.

MATERIAL	SOURCE OF	C/N RATIO	% NITROGEN
Leaves	C/N	30–80 to 1	L–1
Manure, rotted	C/N	20 to 1	1–5
Seaweed, washed	C/N	19 to 1	1–2
Weeds, fresh	C/N	18 to 1	L–2

HIGH-CARBON MATERIALS These materials will decompose effectively if mixed with some high-nitrogen materials.

MATERIAL	SOURCE OF	C/N RATIO	% NITROGEN
Hay, timothy	C	58 to 1	.85
Paper	C	150–200 to 1	–
Newspaper, shredded	C	800 to 1	.05
Sawdust, aged	C	208 to 1	.25
Sawdust, fresh	C	500 to 1	1
Straw, wheat	C	128 to 1	.3
Straw, oat	C	80 to 1	1.05
Wood chips	C	700 to 1	L