

ECOLOGICAL ASPECTS OF AGROFORESTRY SYSTEMS

AUTHOR:
IACOPO BENEDETTI

MODULE 3



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AIM OF THE MODULE



- Influence of agroforestry systems on soil
- Nutrient cycles and carbon sequestration in agroforestry systems
- Water use and water productivity in agroforestry systems
- Influence of agroforestry systems on biodiversity

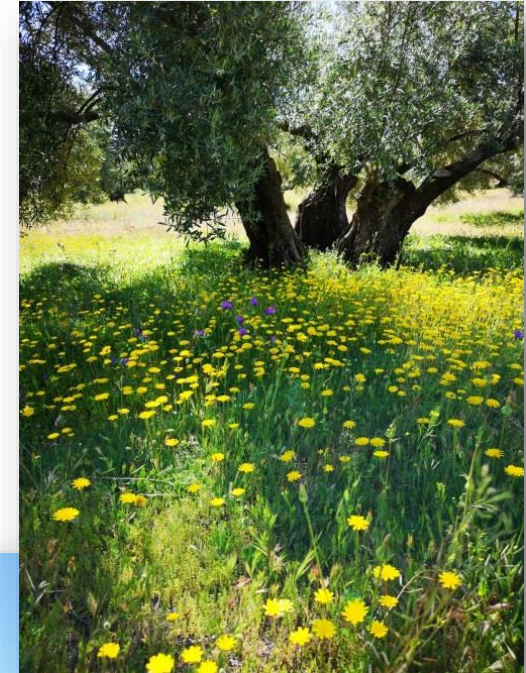


A) INFLUENCE OF AGROFORESTRY SYSTEMS ON THE SOIL



FARMING CONTRIBUTES TO SOIL CONSERVATION BY

1. Reduction of erosion and soil degradation.
2. Improvement of water infiltration capacity and reduction of surface run-off.
3. Increase in soil fertility.
4. Improvement of soil structure.
5. Increased retention and efficiency of nutrient use.
6. Increase in the diversity of soil microorganisms: micro-meso-macro fauna and microflora.
7. Reduction of pests and diseases.



The image on the left shows a traditional olive grove, with no vegetation cover or pasture, which means that the soil can suffer from erosion. The image on the right shows an olive grove in which no herbicides are used, favouring natural pastures that encourage the creation of soil, the infiltration of rainwater, which stops erosion and generates a resource that can be used by livestock. Therefore, the image on the right represents an agrosilvopastoral system.



A) INFLUENCE OF AGROFORESTRY SYSTEMS ON THE SOIL



AGROFORESTRY increases the levels of organic matter through alternative management (agro-ecological) based on the maintenance of biological diversity, reduces consumption of fossil fuels, chemical fertilizers and agro-toxins, increasing the input of organic matter (compost, manure, green manure, polyculture, etc.) and reducing the loss of organic matter through management that reduces erosion and surface runoff, minimizing the loss of nutrients, perform no or minimal tillage and incorporate the remains of the crops.





A) INFLUENCE OF AGROFORESTRY SYSTEMS ON THE SOIL



ORGANIC MATTER IS RESPONSIBLE FOR A GOOD PART OF THE PHYSICAL-CHEMICAL PROPERTIES OF THE SOIL THAT CONFER FERTILITY

- It is a storehouse of nutrients both in terms of total nutrients (C, N, P, K and micronutrients) and in terms of the ability to supply available nutrients.
- It increases water infiltration and retention.
- Improves soil structure by increasing the aggregation and stability of soil aggregates and porosity.
- Increases temperature, water, pH buffering, etc.
- Increases the presence and quantity of microorganisms.
- It is the energetic and structural support of the edaphic trophic network.

STRATEGY:
Those that increase the levels of organic matter.



OBJETIVE:
Sustainable production
Resource conservation
Environmental health
Control of pests

Reference: Photograph by Julie Major 2003, (nationalgeographic.org).



A) INFLUENCE OF AGROFORESTRY SYSTEMS ON THE SOIL



PRACTICES IN AGROFORESTRY FOR SOIL CONSERVATION AND INCREASE OF ORGANIC MATTER:

1. Green fertilisers: when the soil is deficient in elements such as nitrogen, herbaceous covers are cultivated with legumes that incorporate this element naturally. This management helps in the provision of nutrients and the incorporation of organic matter, as well as the control of pests and diseases. Legumes such as vetch, beans, alfalfa and clover are used.



Beans are arable crops that fix nitrogen to the soil.

2. Incorporation of manure: it is incorporated either directly into the soil from nearby farms (to promote the closing of cycles at the local level) or by contribution from the livestock itself.



The livestock incorporates the manure that benefits soil conservation.

3. Compost: the farmer creates this product by mixing organic matter rich in nitrogen (slurry and manure) and materials rich in carbon such as straw, woody waste, etc. The difference between manure and compost is therefore that the former is of natural origin and the latter is man-made.



The compost is a product created by the farmer to improve the soil.



A) INFLUENCE OF AGROFORESTRY SYSTEMS ON THE SOIL



4. Crop associations: agroforestry promotes polyculture. Attempts are made to mix crops with fruit and/or forest trees, incorporating animals and other vegetation such as aromatic or medicinal plants. It favours the closing of the cycle of nutrients, the availability of nutrients, the fertility of the soil and the structure and formation of the soil itself.

5. Crop rotation: with the succession of different crops over time we manage to improve the physicochemical properties of the soil, improve fertility and reduce erosion, while promoting the development of soil microorganisms.



Crop association, in which horticultural species are interspersed with forest and fruit trees



A) INFLUENCE OF AGROFORESTRY SYSTEMS ON THE SOIL



6. Minimize or eliminate the consumption of fossil fuels, synthetic-chemical fertilizers and agrochemicals (pesticides, herbicides, pesticides, etc.).

7. No tillage or minimum tillage:

- Reduces the loss of organic matter.
- It "protects" the available forms of organic matter.
- Protects "habitats" for the establishment of natural predators of pests.
- Reduces (soil) compaction by increasing water infiltration and deep root system development.



Cereal cultivation under holm oak



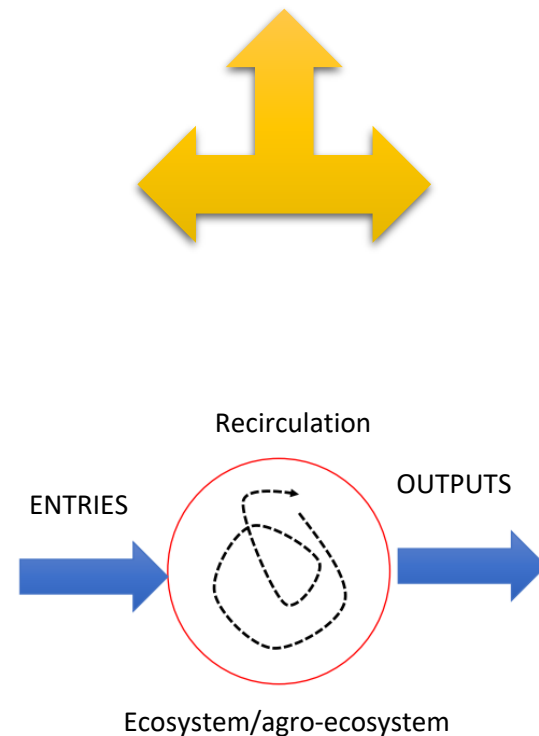
B) NUTRIENT CYCLING AND CARBON SEQUESTRATION IN AGROFORESTRY SYSTEMS



THE NUTRIENT CYCLE IN AGROFORESTRY SYSTEMS

Conventional cultivation systems

If the **NUTRIENT BALANCE SHEET** is **significantly negative** (more is withdrawn than is incorporated), then, in Theoretically, the levels of nutrients available in the soil are would reduce (in the short, medium or long term) leading to decreases in the productions.



The main alterations caused by "conventional agriculture" in the biogeochemical cycles are related to the **CARBON, NITROGEN AND PHOSPHORUS** cycles.



B) NUTRIENT CYCLING AND CARBON SEQUESTRATION IN AGROFORESTRY SYSTEMS



THE NUTRIENT CYCLE IN AGROFORESTRY SYSTEMS

Thanks to the fact that **AGROFORESTRY** combines different crops that correspond to different strata (tree, shrub and herbaceous) the nutrient cycle is improved, as each plant takes advantage of certain soil resources.





B) NUTRIENT CYCLING AND CARBON SEQUESTRATION IN AGROFORESTRY SYSTEMS



AGROFORESTRY SYSTEMS ARE SUSTAINABLE IN TERMS OF NUTRIENTS BECAUSE:

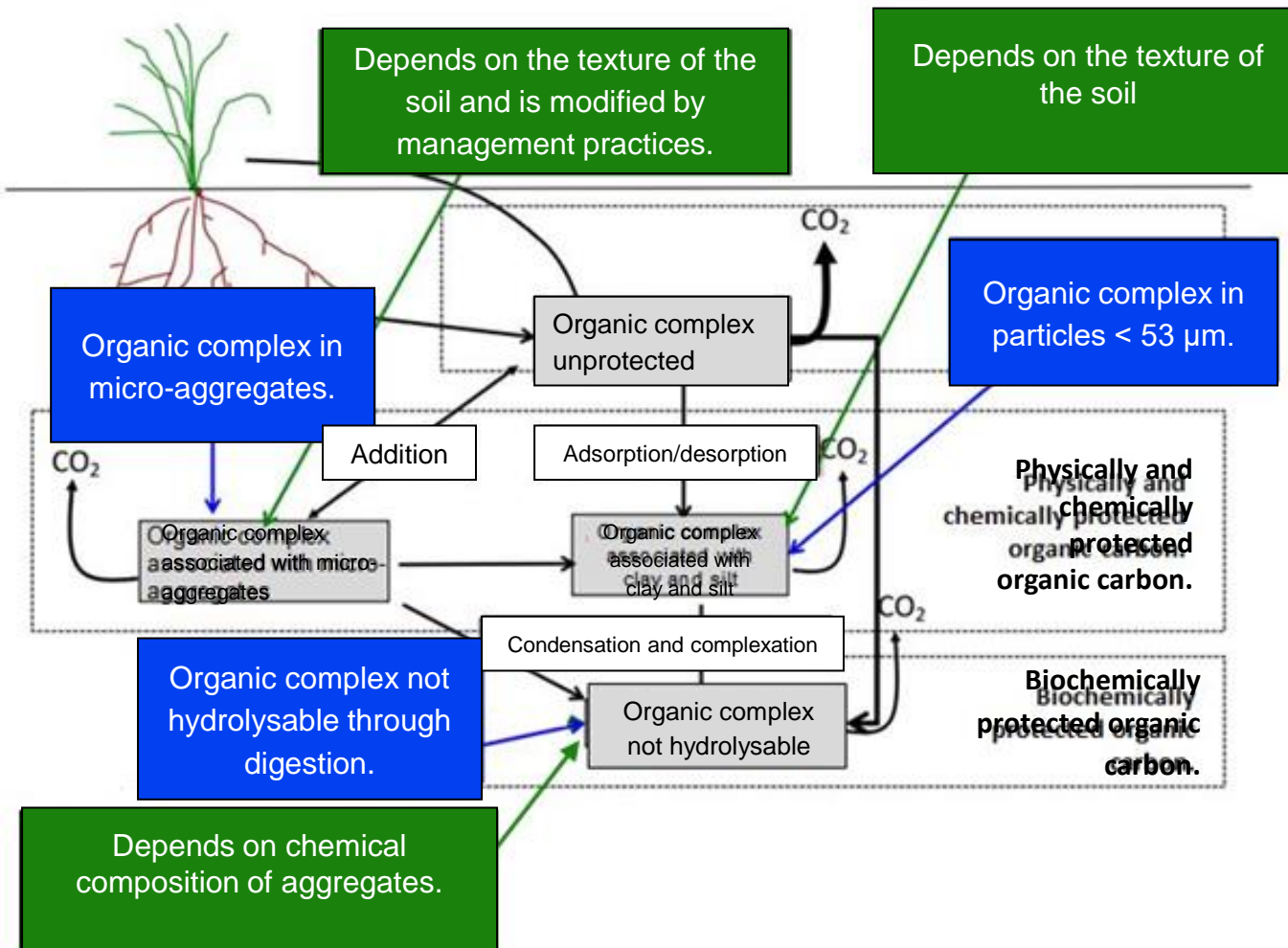
BARBECHO, the introduction of **LEGUMINOSES** and **STERCOL** from livestock preferably fed from nearby pastures or from the farm itself, increase productivity with almost neutral or slightly positive balances of nutrients such as nitrogen, phosphorus and carbon.

They combine **STRATEGIES aimed at reducing outflows and increase the entries.** Maintain the quality of the background elements (structure of the agro-ecosystem) requires minimizing energy inputs and materials of fossil origin and strengthen internal flows and nutrient inputs (legumes, waste recycling, etc.).

- 1.- Only those nutrients that are removed with the harvest should leave the agroecosystem: manage adequately to reduce nutrient losses through erosion, surface runoff, denitrification, ammonia volatilization and leaching.
- 2.- Reinforce the mechanisms of retention/recirculation of nutrients.
- 3.- Recycle locally/regionally everything containing nutrients and organic matter.



B) NUTRIENT CYCLING AND CARBON SEQUESTRATION IN AGROFORESTRY SYSTEMS



Nitrogen cycle in an olive and sheep silvopastoral farm. The sheep provide organic matter in the form of manure, the remains of pruning and pomace add other organic compounds that through the processes of ammonization and nitrification are transformed into nutrients for the olive grove. Closing the cycle at farm level.

Source:
The forms of organic carbon in the soil
Roberto García Ruiz, 2019. University of Jaén.



C) WATER USE AND WATER PRODUCTIVITY IN AGROFORESTRY SYSTEMS



WATER AND PRODUCTIVITY IN AGROFORESTRY SYSTEMS

The **AGROFORESTRY** where trees predominate prevents water and wind erosion by encouraging water infiltration and plant cover, but also improves the structure of the soil by the roots and the return of organic matter to the soil (by decomposing leaves and roots or using their remains for composting).



Aloe Vera, herbs and olive groves. The proliferation of species with diverse functions and characteristics increase the infiltration capacity of soil water and reduce water erosion. Vegetation cover and tree and herbaceous strata with different roots help to capture water at different depths.



C) WATER USE AND WATER PRODUCTIVITY IN AGROFORESTRY SYSTEMS



AGROFORESTRY SYSTEMS FAVOUR WATER INFILTRATION:

- ❑ The presence of trees, shrubs and herbaceous plants reduces the force with which water drops impact the soil and therefore reduces water erosion.
- ❑ The presence of organic matter in the soil, characteristic of agroforestry systems, increases the greater porosity and infiltration of water into the subsoil. Facilitating its availability for the flora.
- ❑ The existence of channels, natural ponds and other systems of accumulation of surface water favor not only the productivity of the agroforestry system, but also the proliferation of wild fauna.



Naturalized water raft in
agroforestry system of
Aloe Vera, herbs and
olive grove



D) INFLUENCE OF AGROFORESTRY SYSTEMS ON BIODIVERSITY



AGROFORESTRY SYSTEMS CONTRIBUTE TO THE CONSERVATION AND PROTECTION OF BIODIVERSITY THROUGH:

- The combination of woody plants in or near crops and pastures creates associated **FLORA AND FAUNA HABITATS** and therefore helps the proliferation of biodiversity both above and below ground.
- They provide **SHELTER** for domestic animals during bad weather or extreme heat.
- Trees help to **REGULATE THE TEMPERATURE** of the territory and therefore improve the environmental conditions for wild and domestic animals.
- It creates the ideal conditions for the proliferation of **POLLINIZERS** by providing habitats and energy.
- They promote the presence of species with different response characteristics to changes in the biotic or geological environment, contributing to the **RESILIENCE OF THE SYSTEM**.



D) INFLUENCE OF AGROFORESTRY SYSTEMS ON BIODIVERSITY



AGROFORESTRY SYSTEMS CONTRIBUTE TO THE CONSERVATION AND PROTECTION OF BIODIVERSITY



An example of stratification and diversity in a traditional orchard with high temperature and luminosity, in fertile soil. A wide variety of species and biological types are maintained, including tall walnut, herbaceous, shrub, perennial and deciduous trees. Each one fulfills different functions in an agro-ecosystem whose architecture imitates the potential forest.



D) INFLUENCE OF AGROFORESTRY SYSTEMS ON BIODIVERSITY



AGROFORESTRY SYSTEMS HELP INCREASE ECOLOGICAL RESILIENCE

AGRICULTURE encourages the presence of different species that have a similar role in the functioning of the ecosystem or similar responses to environmental factors, and the interactions between them are considered as one of the possible sources of **ECOLOGICAL RESILIENCE** (Peterson et al., 1998).

RESILIENCE has been defined as the ability of an ecosystem to absorb disturbances and reorganize itself while undergoing or after experiencing changes, so that it can maintain basically the same structure, functioning and self-regulatory mechanisms (Walker et al., 2004).



The preservation of the Iberian pig is indisputably linked to the preservation of the pastureland. The pasturelands are one of the most important agro-ecosystems due to their capacity to adapt to changing environmental and social conditions.



D) INFLUENCE OF AGROFORESTRY SYSTEMS ON BIODIVERSITY



AGROFORESTRY SYSTEMS CONTRIBUTE TO INCREASING FUNCTIONAL BIODIVERSITY

Agroforestry tries to reconstruct the **FUNCTIONAL BIODIVERSITY** of the agroecosystem, in such a way that they assume the basic processes of its functioning and respond to changing situations, achieving a greater degree of resilience.

MEASURES TO INCREASE FUNCTIONAL BIODIVERSITY:

- Natural or planted plant cover
- Polyculture
- Variety mix
- Stable ecological hedges-corridors
- Integration of livestock



Sheep grazing in an agro-ecological olive grove



D) INFLUENCE OF AGROFORESTRY SYSTEMS ON BIODIVERSITY



AGROFORESTRY SYSTEMS CONTRIBUTE TO THE MAINTENANCE OF NATURAL AND AGRODIVERSITY:

AGROFORESTRY is based on the maintenance of an adequate level of natural diversity (supported by semi-natural structures such as hedges, woods, unploughed land, sets of traditional fences, walls and terraces, trees of different years, areas of dense undergrowth, etc.) and agrobiodiversity (of cultivated species, varieties, species and livestock breeds, and functional diversity, different biological types in cultivated plants, trees of different heights, climbers, bushes, biannual, annual, semi-domestic, etc.).



The holm oak woodland and sheep cleaning a newborn calf



SUMMARY OF THE MODULE



LESSON LEARNED

- Agroforestry **increases the levels of organic matter** through agroecological management, based on the maintenance of biological diversity
- Organic matter **responsible for the physical-chemical properties of the soil** that grant fertility
- Forms for the **conservation of the soil and increase** of organic matter.
- It improves the **cycle of nutrients** in agroforestry systems
- Agroforestry **improves the soil**, as well as the environment in general, **providing numerous benefits**
- It **promotes the functional diversity of the ecosystem** acquiring a higher level of **resilience**

