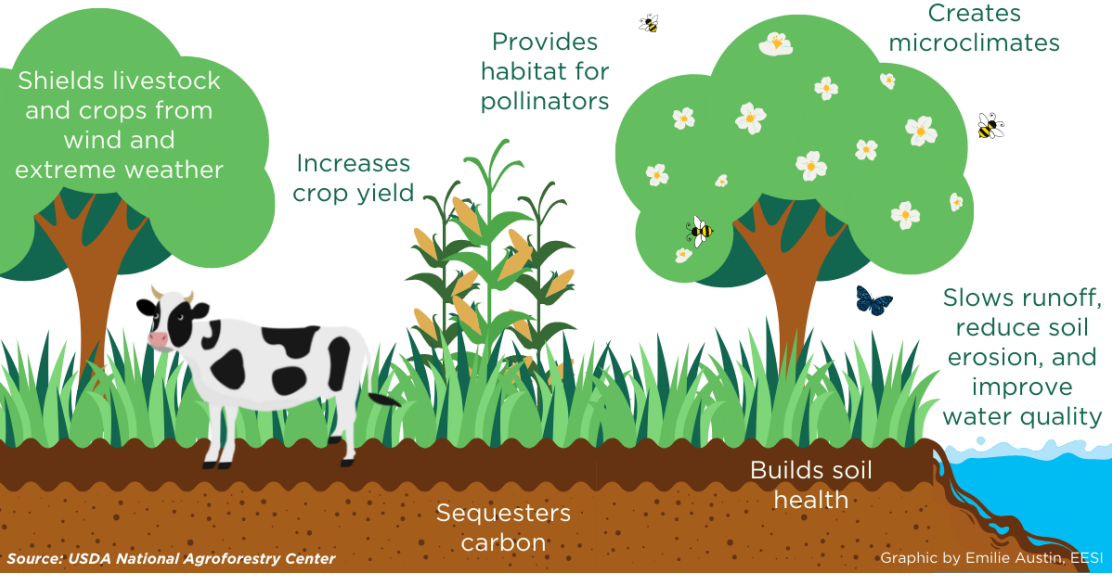
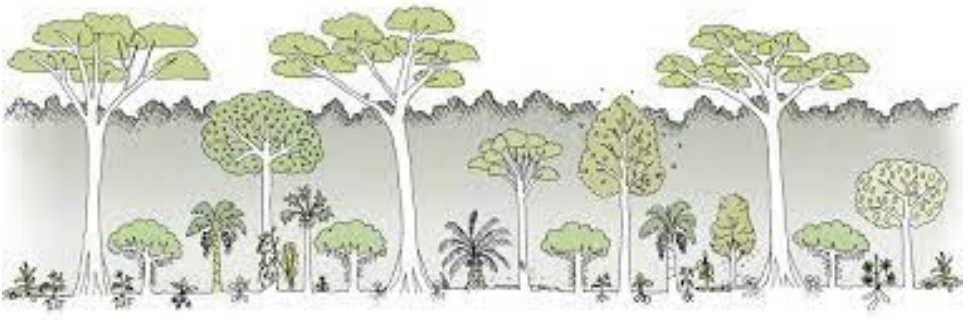
# The Benefits of Agroforestry




**Distributed by the Dartmouth Agroforestry Short Course, as part of the Ong Agroecology Lab**

# The Relationship Between Agroforestry and Agroecology

**Agroecology** is the study of the relationship between plants, animals, and the environment in an agricultural context. Research surrounding agroecology is often used to make farming practices more efficient for farmers.



Source: Ernst Götsch ideas - Medium.com

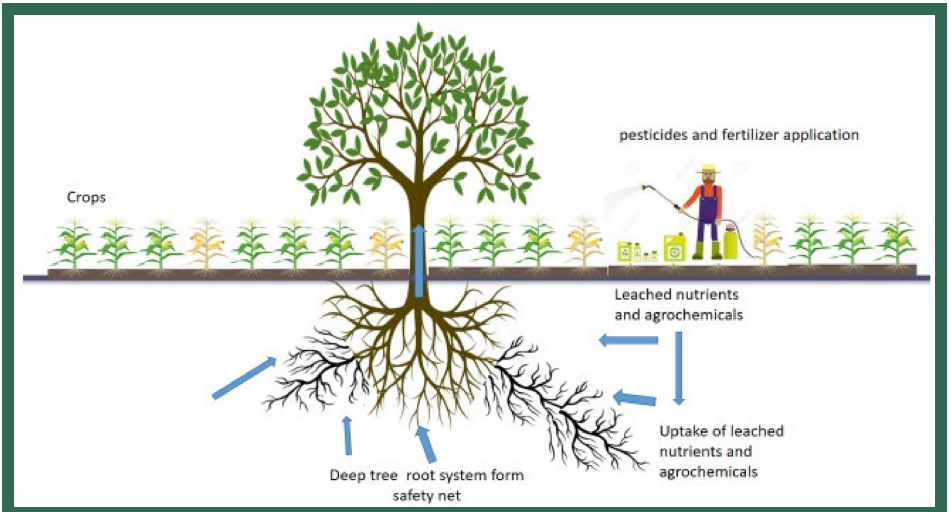
**Agroforestry** is a powerful facet of agroecology; implementing trees on agricultural systems can provide several benefits, including diversification, wildlife conservation, and climate resilience. The objective of most agroforestry systems is to optimize the beneficial effects of the interactions that occur among the woody components and the crop or animal components in order to obtain more diversity of products, lessen the need for outside inputs, and lower the negative environmental impacts of farming practices.

Source: What is agroforestry - Ecomaster

Trees and crops will interact above and belowground as well as across the landscape. Trees make water and nutrients to crops and provide shade, but can also compete with crops depending on their spatial orientation.

# Benefits of Agroforestry

## Water quality



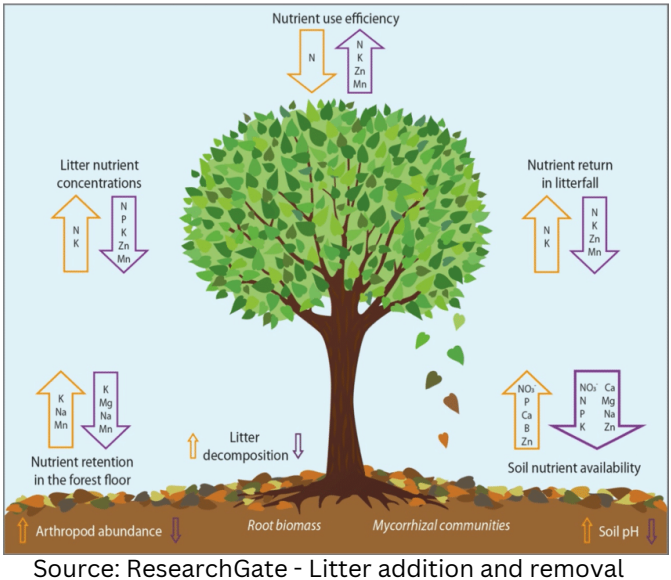

*Source: ResearchGate - Absorption and immobilization of leached chemicals in agroforestry*

- **Nutrient uptake:** The flow of nutrients into streams is a significant environmental concern and can result in pollution and eutrophication. Trees along streams help mitigate runoff, as their roots can uptake nutrients and promote nutrient cycling, particularly of nitrogen.
- **Erosion mitigation:** Trees also help prevent sediment erosion caused by stormwater runoff by physically slowing water movement through surface roughness and soil aggregates. This not only prevents sediment from entering waterways, but it also prevents gully formation and promotes water infiltration for crops.

Source: Mississippi River Basin Conservation Network

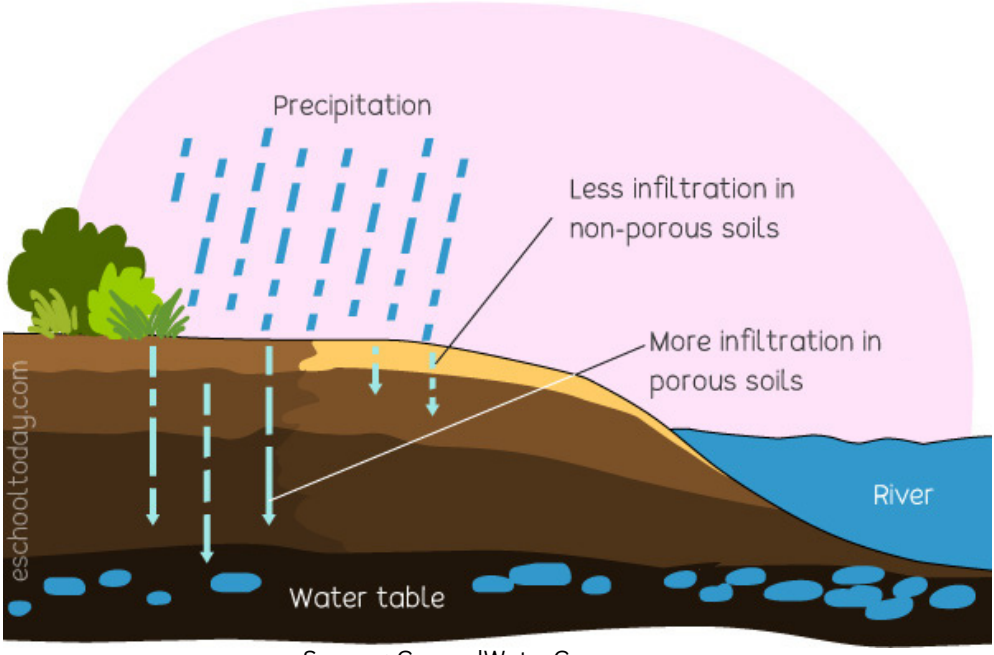
- **Establishing trees along streambanks:** The area bordering a stream is called a riparian zone, and Agroforestry systems in these areas are called riparian forest buffers. Having a riparian forest buffer introduces many benefits for erosion mitigation and flood management.
- **Wildlife Protection:** In addition to preventing algal blooms, trees in riparian zones shade aquatic and terrestrial wildlife , protecting them from intense sunlight and heat. Vegetation also provides habitats for insects and microbes that are food sources for fish.

# Soil Health




Source: ResearchGate - Litter addition and removal

- **Increased soil organic matter (SOM):** Trees increase the SOM in an agricultural system through the decay of litterfall. This increase in SOM promotes microbial activity, aiding in the decomposition and mineralization of nutrients, which makes nutrients available for uptake by plants.
- **Deep soil nutrient uptake:** Trees are also able to bring water and nutrients from deep soil profiles to the shallow soil layers, using these nutrients for the growth of the agricultural crops on these shallow layers. The roots of trees absorb nutrients that are deep underground, and convert these nutrients into leaf litter, which eventually decomposes on upper soil layers.



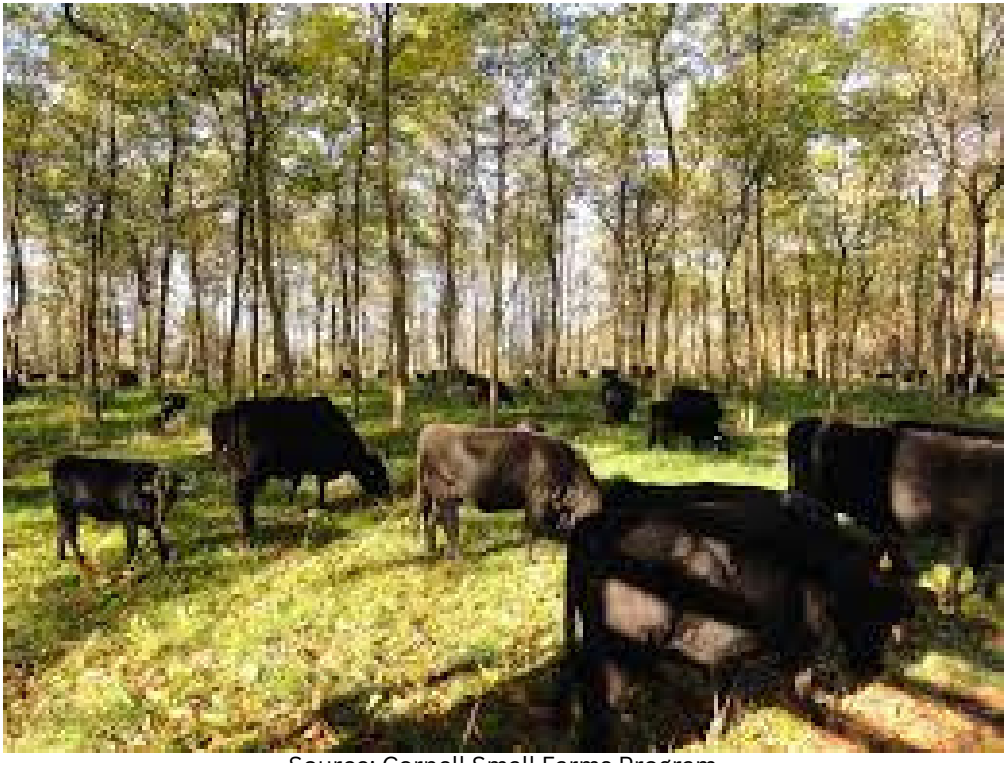
Source: GroundWaterGovernance

- **Limiting Erosion:** In addition to protection from water erosion, trees can physically slow airflow and fine roots and fungi help stabilize soils, reducing the wind's ability to dislodge soil particles.
- **Increasing water infiltration:** Trees can increase water infiltration and holding capacity. Tree roots break up compacted soils, creating channels that allow water and air entry. Increasing water infiltration can decrease nutrient runoff, and thus increase nutrient availability. Moreover, the organic matter that trees shed can clump together in soil, forming aggregates that increase water holding capacity.

# Support for Livestock

Agroforestry systems benefit not only crops and forages - they can directly support  livestock. Systems where cattle, forages, and trees are intentionally integrated are called silvopasture systems.

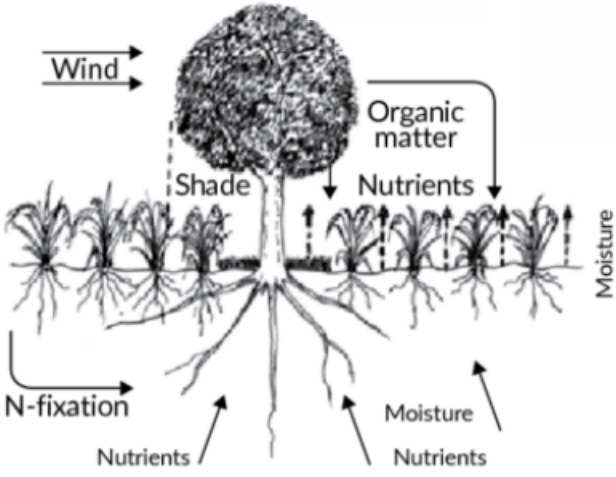
Source: Silvopasture - Earth Overshoot Day



Source: Cornell Small Farms Program

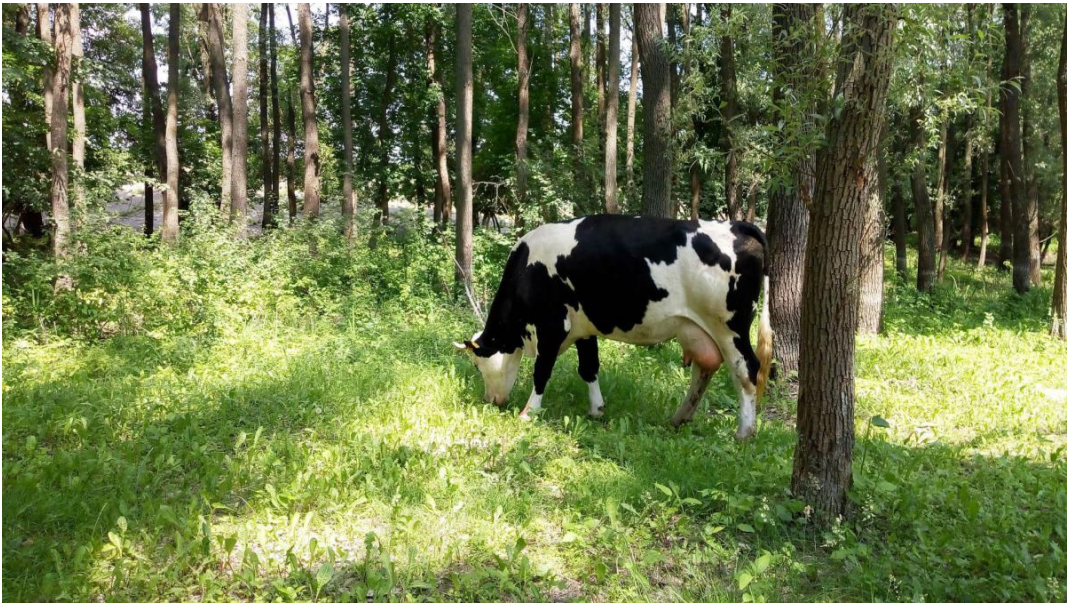
- **Temperature regulation:** Cattle can face heat stress, and use a lot of energy to keep cool in hot conditions. Trees are able to provide sources of shade in warm months, and can block wind in cool months.

- **Nutrients for cattle:** Due to the improvement in nutrient uptake and retention that trees provide in soil, both crops and forage are more nutrient-rich. Forage grown under partial shade tends to have a higher protein content than forage in the open pasture.




Source: ResearchGate - Nutrient Cycling in Agroforestry systems

- **Diverse fodder for animals:** The diversity in environmental structures and resources that trees bring allows for the survival of several different species of forage for cattle. Different plants have different concentrations of nutrients, meaning their diversification allows for a more balanced nutrient intake in cattle. Additionally, having diverse fodder can makes cattle more interested in eating. Special attention should be cared to the quality of fodder different trees may offer.

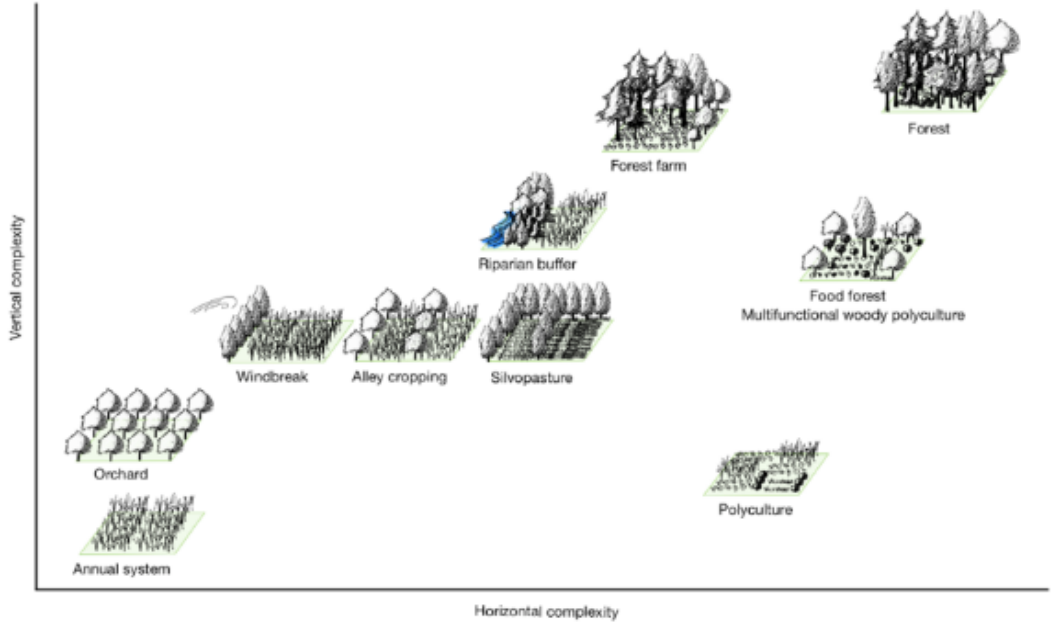


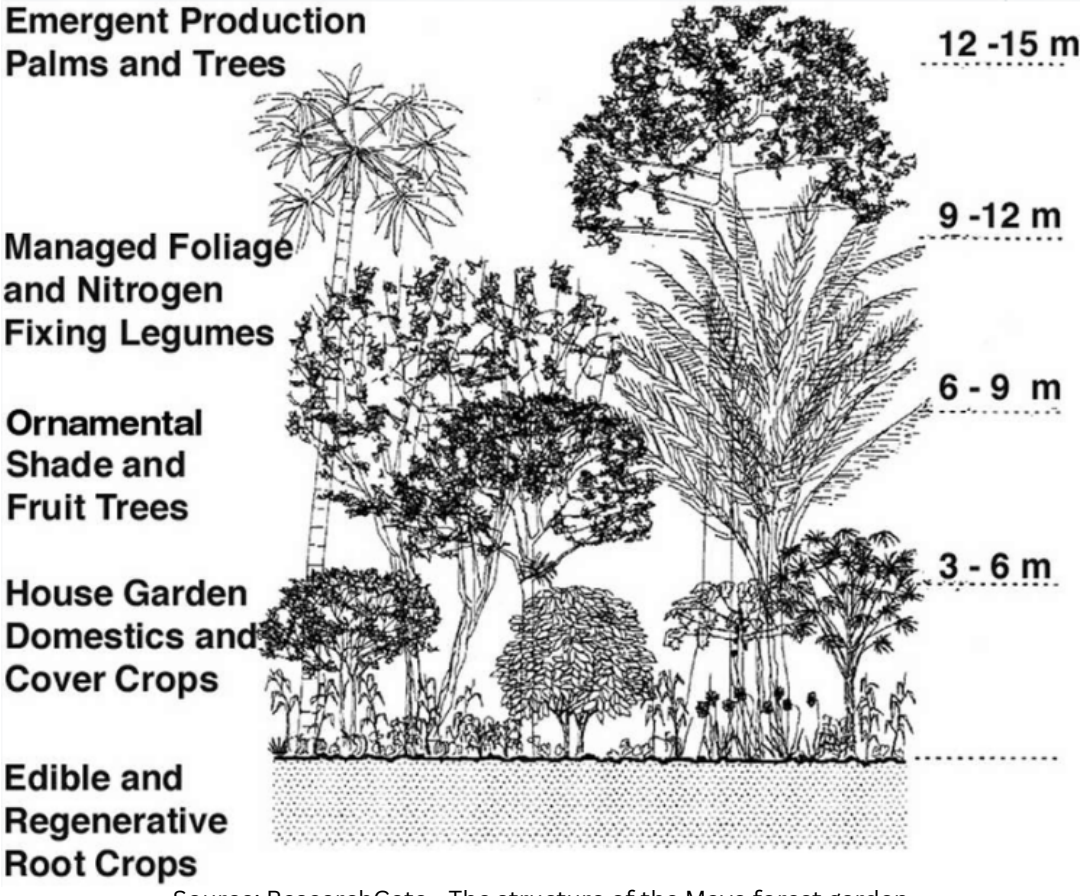
Source: Silvopasture - UNH

- **Improved growth for certain forage:** Silvopasture systems are often seen as a relationship between trees and forage - one must place lots of thought in the types of forage and trees they choose to maximize benefits. In general, the shade that trees provide can limit the amount of evapotranspiration that occurs in forage, which can lengthen the feed production cycle with a certain foraging material. Yet, this shade may not be compatible with all plants - cool season plants are able to thrive with this system.

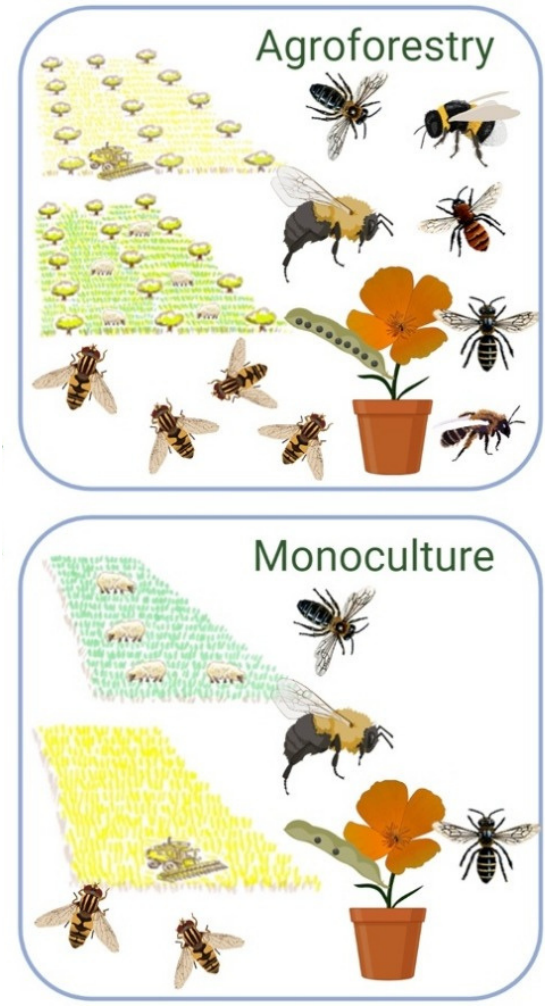
# Biodiversity

Agroforestry systems are able to promote biodiversity in agricultural lands, as they provide vertical and horizontal structural complexity and resource heterogeneity that provides for a wide range of plants, microbes, and animals.





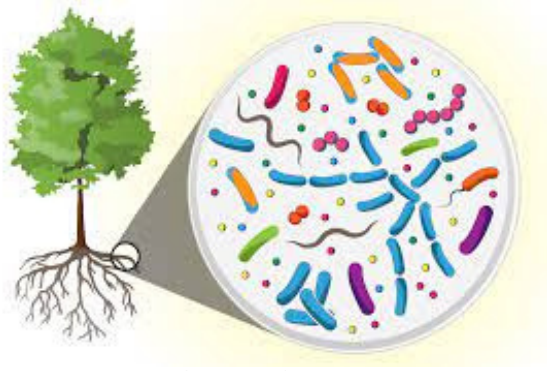

Source: ResearchGate - The structure of the Maya forest garden




Source: ScienceDirect

- **Structure for pollinators:** A diverse landscape allows for habitats that support different pollinating birds and insects, which allows for greater quality and quantity of agricultural crops. Diverse pollinators allow for pollination complementarity, in which the different types of contributions of the pollinators reduce possible factors that may harm pollination effects (i.e. climate change).

- **Management of pests and pathogens:** Resources brought by trees can support the presence of organisms that act as natural enemies to pests and pathogens. With more habitat diversity, there can be more diversity in these enemies, meaning there are different enemies to prey upon a single pest species as well as more likelihood that different pest species' will be preyed upon.

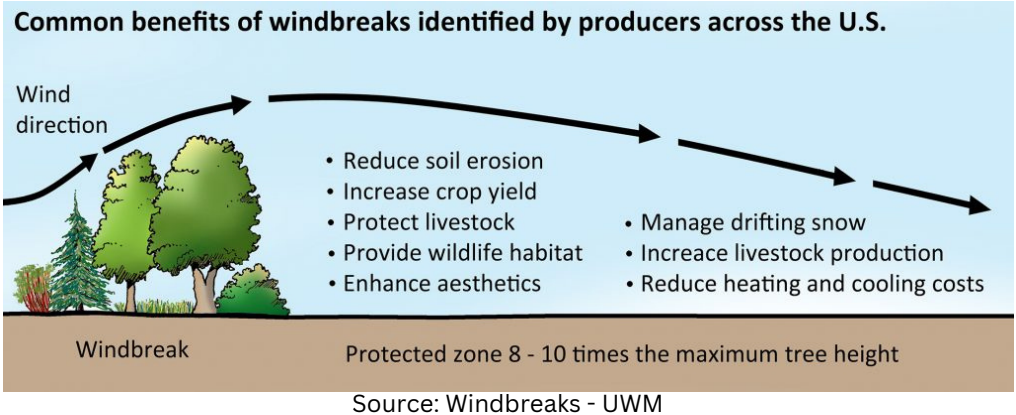


Source: ORNL

- **Further support to soil:** The diverse environmental conditions and resources brought by trees can support diverse species of microorganisms, which can serve unique benefits to soils. For instance, some microbes may be better suited for breaking down certain nutrients, and others may be more suited for aiding in the structure of soil aggregates. Lack of microbial diversity can result in an inability of plants to take up certain nutrients, resulting in less nutritious crops.

# Climate Resilience

Trees are able to create microclimates on farms, in which they are able to mitigate heat or are able to mitigate chill, among other properties. This allows for climate resilience on farms, as it protects from sporadic fluctuations in weather that can be caused by climate change.




Source: Windbreaks - UWM

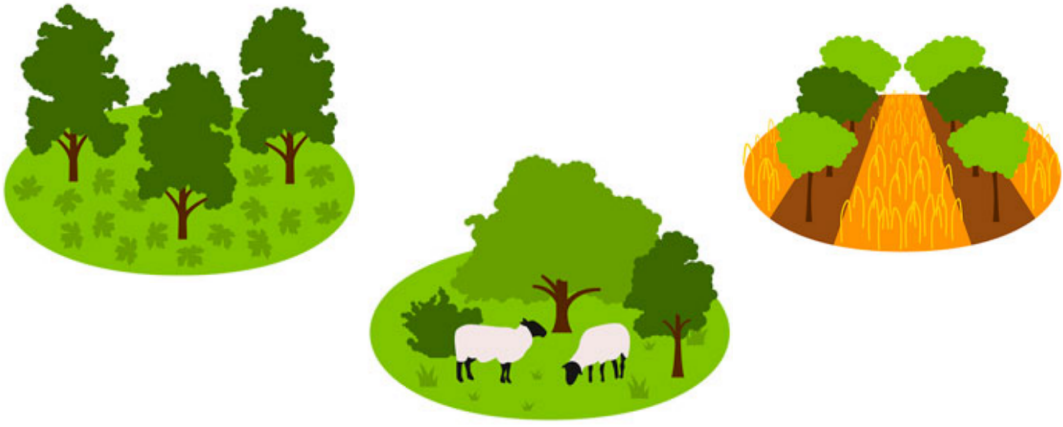
- **Protection against sudden cold spells:** Some agroforestry systems, particularly windbreaks, are helpful in mitigating the cold felt from sudden cold spells by slowing winds. These systems are also able to manage snowfall. Trees can be strategically placed to either evenly distribute snow - which may be favorable when wanting to take advantage of snow moisture - or to protect crops from snow - preventing the cold of snow from impacting crops.

- **Protection against sudden heat waves:** Trees can help mitigate heat via evapotranspiration. When evaporation of the liquid in tree leaves occurs, the transition from liquid to steam requires energy from the atmosphere, taking heat energy that results in a cooling for the air.
- **Reduce flood damage:** Trees, particularly in riparian areas, can improve bank stability in the face of flooding by physically slowing water flow, holding soil together with their root systems, and trapping debris that may contribute to further erosion.

Source: fao.org

**Carbon sequestration:** As another example of climate resilience, through photosynthesis, trees absorb carbon dioxide from the atmosphere, which helps mitigate the presence of greenhouse gasses, thus reducing the carbon footprint of farmers and supporting overall climate change mitigation.

# Closing: All Systems are different!



Source: A review of Agroforestry - Frontiers

Any trees included in your agroforestry system are going to become part of your interacting ecological community, and therefore a part of your management routine. Since trees and their potential benefits are governed by ecological principles, thinking about structural and functional diversity will help create more successful and resilient systems and promote the ecological, economic and social benefits desired during their implementation. There are no prescribed ways to implement agroforestry; there are infinite combinations and understanding the ecological underpinnings of your desired systems as they establish and develop will lead to the most successful and exciting systems.


Images from our first cohort!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