



AGRIFUTURES

REGENERATIVE FOODSCAPES

PERMACULTURE
ORCHARD

PERMACULTURE EBOOK



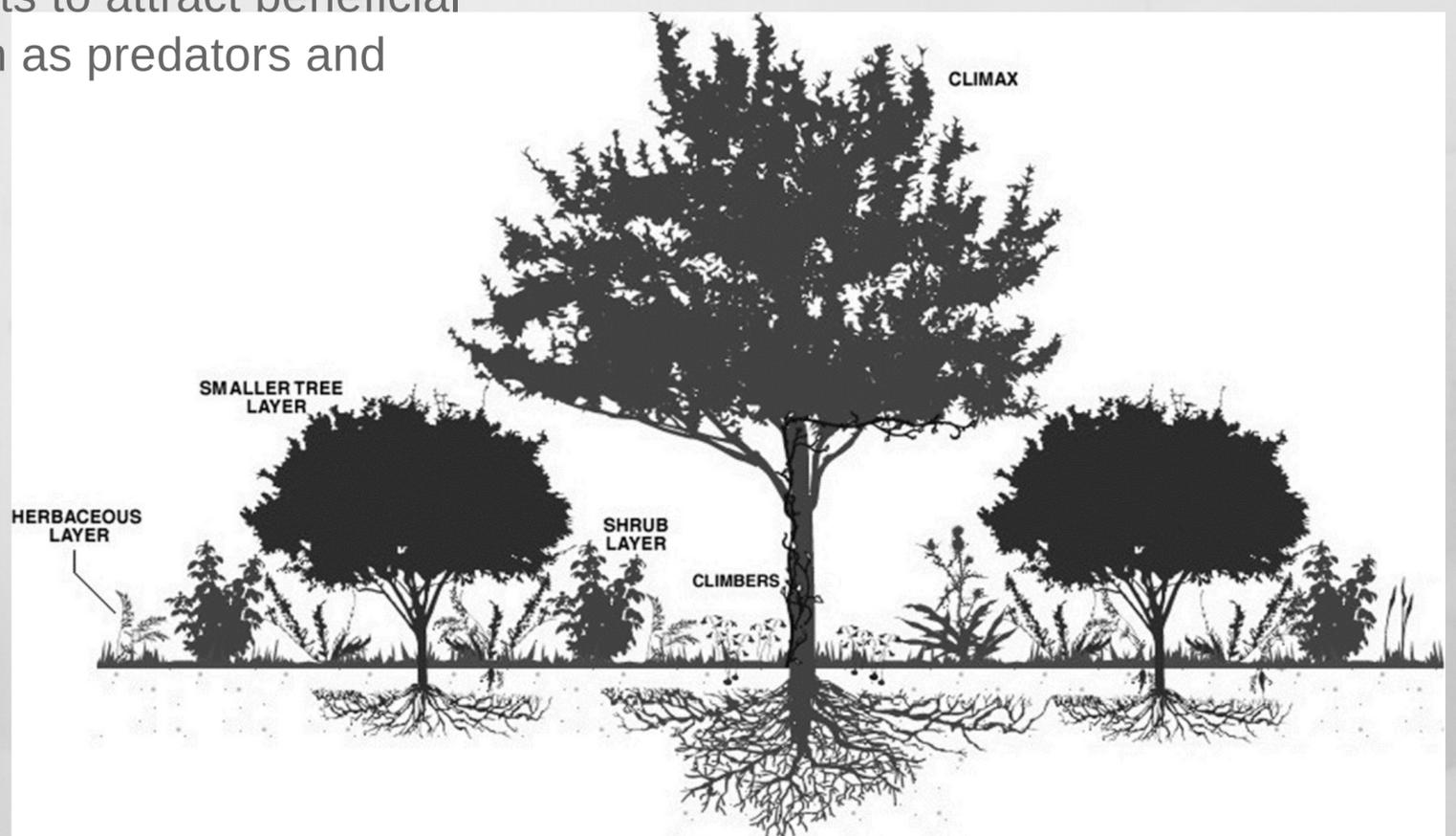
What makes a permaculture orchard different

Within a permaculture orchard a designer seeks to replicate some of the ecological complexity found in a forest edge ecosystem to arrive at a more biologically stable state than found in a conventional orchard and thereby reduce the dependency upon sprays and intensive management through relegation of ecosystem services to compatible plants and animals incorporated in support of productive species.

Some of the support plants that may be incorporated into a productive planting may include living green mulch plants that will suppress weeds, plants to attract beneficial insects such as predators and

parasitoids or pollinators, or plants that help enrich the soil through accumulation of nutrients with deep tap roots or nitrogen through an association with mycorrhizae fungi.

Incorporating this greater diversity of plant species in a design helps replicate some of the ecological balance found in a forest edge ecosystem where plants have evolved complex associations with other plants and benefit greatly from the presence of these plants which in cohort provide different and complimentary roles for building soil fertility and in support of other plants.





Traditionally orchards have neat rows of choice cultivar trees, grafted onto dwarfing root-stock to decrease age of production and make the trees easier to manage. They are also heavily pruned to increase quality of fruit and sprayed to control pests, diseases and weeds all in an effort to produce a great looking product that in New Zealand is largely destined for export to overseas markets. Due to the rigorous standards of exported fruits, which could see entire consignments of fruit discarded if pest damage was evident. The production (including sprays) has been intensive to meet these demands. Commercial orchards seek to maximize economic return by planting a large concentration of fruit trees on dwarf root stock in neat rows in accordance with the dimensions of the farm machinery used to manage the plantings. The model adopted in a traditional orchard is one that seeks maximum economic gain through closely planted, highly productive trees.

An organic orchard largely follows the production method of a conventional orchard, but may substitute some of the cultivars that are commonly favoured with those that require less spraying to control pest damage and / or are less vulnerable to diseases. With the organic approach, more care is placed in looking after the health of the soil and practices such as mulching under-story grasses and grazing sheep are sometimes employed to help return some sources of nutrients back to the soil naturally to reduce the dependence upon chemical fertilisers.

With the organic approach, there is also more restriction on the range of chemical that can be used and growers may be more likely to adopt practices like using pheromone traps on sticky bases and biological controls to control pests to reduce the requirement for use of insecticides.

With the design of a Permaculture orchard there is an emphasis on functional diversity within plantings and inter-connectivity with other systems to introduce into an orchard system some of the complexity found within a natural ecosystem that helps manage pests and diseases and maintain the health of plants naturally. In essence within a permaculture orchard you are trying to provide to the productive plants of interest an environment that can most closely represent the habitat it has evolved to thrive in, within a modified context that allows for good yields to be obtained.



This is a starkly different way of looking at production, which conventionally is focused around maximum yield, ease of harvesting and simplicity of design. The commercial orchard design represents a system out of balance that will become vulnerable to pests and diseases and will represent an environment unfavourable to the healthy growth of the crop of interest. In such an environment, the trees will never thrive and production will be reliant upon the input of chemical fertilisers to stimulate growth and various fungicides, pesticides and herbicides to battle a system out of balance.

By providing optimal conditions for healthy growth, selection of robust disease and pest resistant plants adapted to local conditions and supported by a complex and diverse assembly of supporting plant and animal species, the productive trees within a permaculture orchard will thrive and reward the grower with an abundant harvest.







Orchard Design

The design of a food forest can take on many different forms depending on the size, resources, expected yield and management of the orchard. Some points to consider in the design of an orchard include:

- **Minimize Competition.** Minimize light, water, and nutrient competition by spacing trees and shrubs so their crowns do not touch at maturity. A patch should have much less than 100% canopy cover so that sunlight reaches lower vegetation layers and maintains the health and productivity of plants near the ground.
- **Cover the Ground.** Establish thick ground covers composed of lush, diverse plants to ensure no one disease or weed can get a foothold. Fill weed niches by planting at least one clumping and one running variety.
- **Include Support Species.** Include plants that perform one or more of the following support functions so that we do not need to perform this work: Fix nitrogen to feed other plants (clover, New Jersey tea, huang-qi) Dynamically accumulate nutrients (comfrey, yarrow, dandelion). Provide nectar and pollen to attract helpful birds and insects (bee balm, anise hyssop) Suppress weeds with low-growing ground covers (thyme, oregano, violet, strawberry)
- **Consider Harvesting Issues.** To ease harvesting, place edibles with similar harvesting periods in close proximity. Species with frequent harvests should be placed near frequently visited areas. Provide pathways into beds and allow adequate space around the plants to ease harvesting.
- **Aesthetics.** As a general rule, place shorter plants near the front of the patch and taller plants near the back—in this configuration, the front of the patch would ideally face south to capture as much sunlight as possible. Use a taller plant as a focus element. Group plants in odd numbers to avoid the subconscious tendency to divide even elements into smaller groups.



- Sunlight. All fruit trees thrive the best in full sunlight (minimum of 6 to 8 hours of sunlight a day) but some (paw paws, native persimmons, serviceberries, red mulberries) can survive in partial sunlight.
- Water issues. Access to water, proper drainage
- Soil quality. Test soil, may need to amend soil if poor quality or if hazardous, the soil will need to be replaced.

Establishment Steps

1. Outline beds with flags, hose, or string and cut existing vegetation as close to the soil as possible.
2. Mark locations of all plants using stakes or flags.
3. Plant trees and shrubs: see publication Hand-Planting Guidelines for Bareroot Trees and Shubs. Set plants 1-2 inches higher than normal to allow for mulch.
4. Sheet mulch the entire area: see publication Create a New Garden Bed.
5. Plant herbs by moving back mulch and carefully cutting an “X” into the cardboard or newspaper with a utility knife. Dig into the soil, set the plant, and cover lightly with mulch.
6. For 3-4 months, test soil moisture and water heavily when dry. Water the soil, not plant foliage.
7. Weed and carefully tend the bed as you would a vegetable garden for the first year. As ground covers get established, maintenance should decrease each year.



Plant Guilds

The plant guilds incorporated into a permaculture orchard are based around plants that would naturally share a similar habitat and would have adapted to similar conditions. Almost 80% of all plants that share a habitat benefit from the interactions of the other plants in that system through the various specialty roles each plant performs that has a complex set of beneficial interactions throughout that system. Within a productive orchard many of these plants are selected for specific beneficial properties such as being nutrient accumulators, nitrogen fixators, soil stabilizers, shelter, scaffolding, pest deterrents or pollinator attractors. In addition to the species visible on the surface there is an extensive soil biology working in unison under the surface.

- A mixed species edible plant guild has the following features and benefits:
- A diverse yield of produce over a greater part of the year.
- Inclusion of nitrogen-fixators to increase nitrogen content in soil.
- Diversity confuses pests, resulting in less pressure.
- Diversity avoids spreading diseases between compatible vectors.
- Increased habitat for wildlife.
- Focus on perennials results in long term yield and low maintenance.

Most tree species have evolved with a forest environment shared with many other plants. While competition exists between these trees and shrubs for light and soil nutrients, beneficial relationships have also developed where growth is improved by interaction with other plants. With many farmers transitioning off monoculture crop production due to problems with pests and soil fertility, more are looking to the benefits of a plant guild plantings to achieve sustainable and diverse production more in balance with natural systems.



Some of these benefits include:

- Sharing nutrients and minerals through a fungal hyphae network.
- Collectively producing exudates (mostly sugars from photosynthesis) that promote a fungal dominated micro-fauna in the soil.
- Creating a diversity that avoids build up pests and diseases.
- Benefitting from flowering of other plants to keep pollinators within area.
- Benefitting from habitat provided by other plants for predators of pest insects.

Food Forest Layers

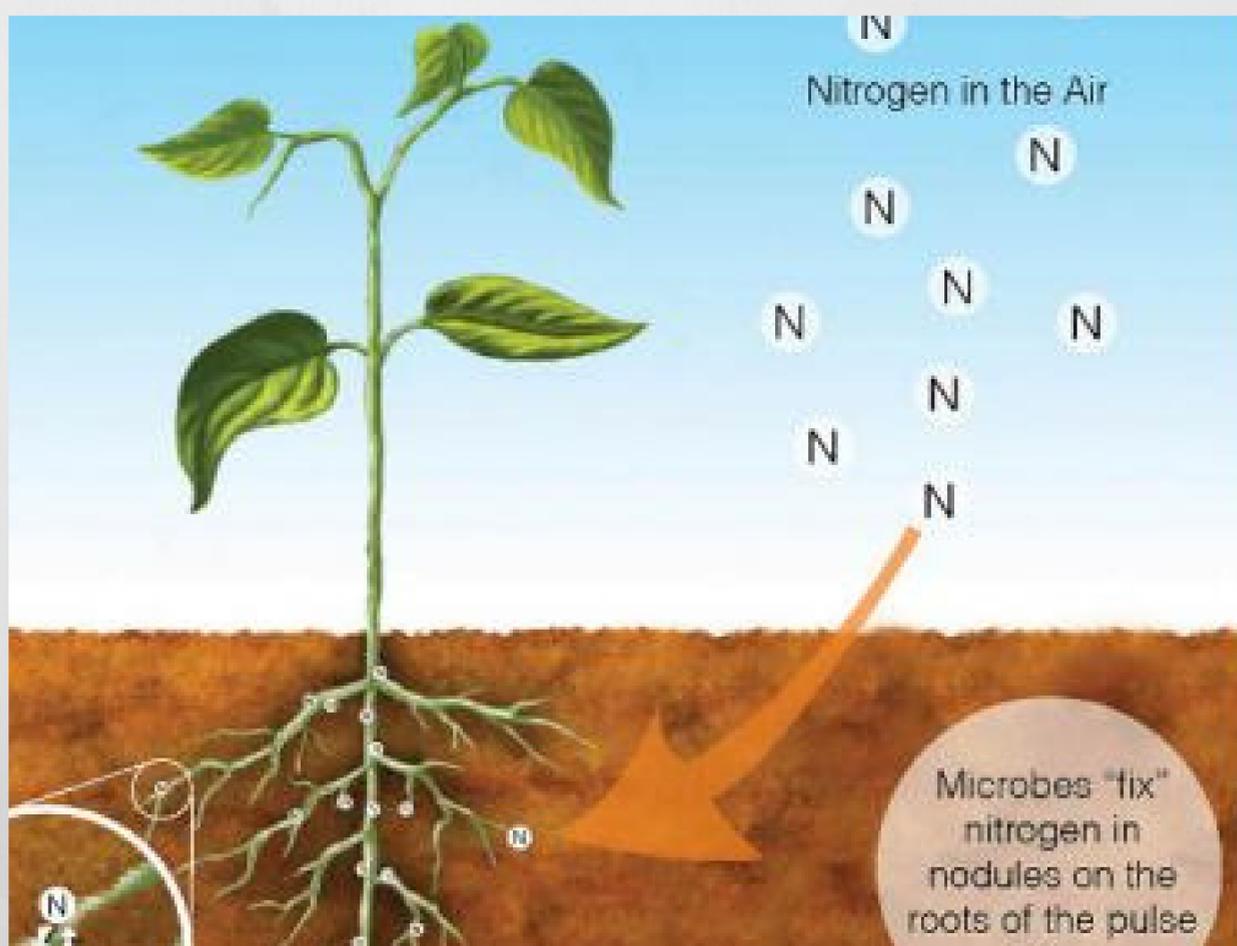
Within a forest there are multiple layers from the canopy trees, down through sub-canopy, shrubs, vines and ground cover. Plants within each layer are species that have adapted to fill that niche within a forest edge environment and perform best when located within that environment and supported by the plants filling the other niches. In a permaculture design, we therefore try to locate a species within its correct context in relation to other plants that would share that habitat. By filling all these available niches the impact of weeds is also reduced because there are fewer niche openings for those plants to occupy.

The other benefit to incorporating a multi-layered planting into an orchard design is that there are then multiple photosynthetic layers of plants all making use of the same area of land all busy using the same light that falls on a particular area to produce multiple products

Nitrogen Fixing Plants

Nitrogen fixing plants have a mutually beneficial relationship with bacteria living in nodules within their roots. These bacteria are able to fix atmospheric nitrogen into nitrates that can be absorbed by the plant roots and used by the plant to manufacture proteins important for plant growth. In exchange, the plant shares some of the sugars produced through photosynthesis with the bacteria. Some of the nitrates produced by the bacteria are also leached into the surrounding soil and can benefit neighbouring plants, especially when those plants are linked by fungi hyphae under the soil, which can share nutrients between plants. By cutting back nitrogen fixing plants some of the root system will also die, also providing a source of nutrients for neighbouring plants. By containing nitrogen fixators into a guild planting a natural source of nitrogen for plant growth can be obtained.

Most plants in the pea or bean family (the Fabaceae, more commonly referred to as legumes) fix nitrogen, as do ceanothus, mountain mahogany, buffaloberry, and *Elaeagnus* species such as goumi and autumn and Russian olive. Nitrogen fixers come in all sizes, from ground covers such as clover, to shrubs, to trees such as black locust, alder, and acacia. These fast-growing plants can be slashed down or trimmed to provide a rich stock for mulch or compost.





Nutrient Accumulating Plants

Many deep-rooted perennial plants act as nutrient accumulators by mining minerals found deep in the subsoil and bringing it to the surface to build plant tissues. By pruning back these plants the minerals and other nutrients they contain are returned to the top soil where via decomposition of soil microbes they are made available for plant growth. A quick method for this is called chop and drop where nutrient accumulators are cut off at the base when leaf growth is at its peak and before seeds are produced the cut leaves provide a nutrient source to the soil and also act as a mulch to protect the soil from erosion and drying.

Certain species draw specific nutrients from deep in the soil and concentrate them in their leaves. The long taproots of these plants dredge up important nutrients such as potassium, magnesium, calcium, sulfur, and others. As these plants lose their foliage in fall, the nutrients build up in the topsoil. Such plants are obvious candidates for the ecological garden because they keep nutrients cycling within the yard and reduce the need for purchased fertilizers. Nutrient accumulators include yarrow, chamomile, fennel, lamb's quarters, chicory, dandelion, and plantain.

You'll note that many of these plants are considered weeds. In nature's more tolerant scheme, most weeds make their living as pioneer species: tough, sun dependent, fast growing, and short lived. These early colonists invade bare or depleted soils, where one of their roles is to accumulate nutrients in their roots and leaves. Each fall, these plants die and rot, pumping a fat load of minerals into the soil. The enriched earth is then ready for the next successional phase of less ephemeral, more fastidious plants, such as perennial herbs, shrubs, and trees. Ecological gardeners turn the features of pioneer plants to their advantage, letting them draw nutrients from deep in the earth to create fertile, balanced soil. As the soil improves, nutrients will begin to recycle from leaf to soil and back again. No longer will deep roots be required to tug scarce nutrients from the depths. The accumulator plants will then be redundant and will begin a natural decline that the gardener can accelerate by pulling them up and replacing them with other varieties.



Mulch Makers

Plants build soil in many ways, and one is by the continual rain of leaves, flowers, twigs, and bark that patters on the earth as the seasons turn. All this debris quickly composts into rich humus. Every plant drops litter, but some are truly prodigious mulch makers, and it is these that we especially welcome when the soil is young or has been abused. Mulching is simply composting in place, but it brings other benefits, such as moisture retention, soil cooling, and habitat creation.

Soft-leafed plants make mulch the fastest. These include artichoke and its relative cardoon, rhubarb, comfrey, Jerusalem artichoke, ferns, reeds, and nasturtium. Many varieties used for “green manure” cover crops can be used for mulch, such as the clovers (especially sweet clover, which grows five feet tall), vetches, many grasses and grains (such as oats, wheat, and barley), mustard, croton, and buckwheat. These plants and many others can be slashed or mowed down, often several times a season, and used as mulch wherever needed. Mulch plants should be cut before they go to seed unless you want mulch growing in your beds. Some gardeners interplant mulch makers among their crops and simply chop-and-drop the whole plant to deliver its benefits right in place. If the mulch looks too messy, it can be tucked under a layer of straw or wood shavings.

Woody plants can also make great mulch. Many shrubs, especially nitrogen fixers such as alder, *Elaeagnus*, Scotch broom, and ceanothus, break down very quickly. Trimmings from shrubs and trees that have small branches (pencil-thick or thinner) are fine for mulch. There’s no need to send them through a chipper as long as they’re in contact with the soil, which greatly speeds rotting. A tall pile of brush won’t break down nearly as fast as some stomped-down branches that get ground contact. Again, if aesthetics are a factor, brush can be mulched out of sight or under a more attractive top layer.

Then there are living mulches. A soft undercover of greenery offers many of the same benefits as dry mulch, plus those of living plants (flowers, habitat, and so on). Living mulches include dwarf yarrow, thrift, *Ajuga*, wild strawberry, stonecrop, yerba buena, and white clover.



Perennial Vegetables

Perennials can replace many (though not all) annual plants. Fruit and ornamental trees; bushes for berries, blossoms, and wildlife; shrubs, vines, herbs, edible greens, and flowers—all come in perennial varieties. Hundreds of books describe perennial plants. But one niche is tough to fill with perennials: vegetables. Most fruits are perennial, and perennial greens abound, but not many temperate-climate veggies return each year. Some commonly are asparagus, rhubarb, and artichoke. Egyptian or walking onions, which set shallot-like bulbs above ground on stalks, can be added to the list. A perennial broccoli exists, called Nine-Star, that must be picked before it sets seed or it may die. Another that I've already mentioned is bamboo, with its edible shoots. Scarlet runner beans are perennial in mild climates.

Perennial Herbs

To expand the list of edible perennials yet further, we can include several herbs, especially those that can be used in quantity. Some examples are chives, fennel, parsley, various mints, and garden cress. Many other herbs are perennial, such as oregano, sage, marjoram, and other culinary herbs, but as they are never eaten in substantial amounts, it might be stretching things to include them.

Roots and Tubers

We can sneak a few roots and tubers into this list. I consider them almost-perennial foods because you must disturb the soil to harvest them, and if you harvest the entire root, it doesn't matter if it's a perennial—the plant is gone. But by leaving a section of the root, or allowing the plant to grow large enough to send out smaller roots, some species can be perennialized. They include Jerusalem artichoke, salsify or oyster root, Chinese artichoke, horseradish, shallots, garlic, cinnamon vine or Chinese yam, American groundnut, burdock, and chicory.