Ecosystem Services

Far larger is the capital provided by nature and not by man – and we do not even recognize it as such.

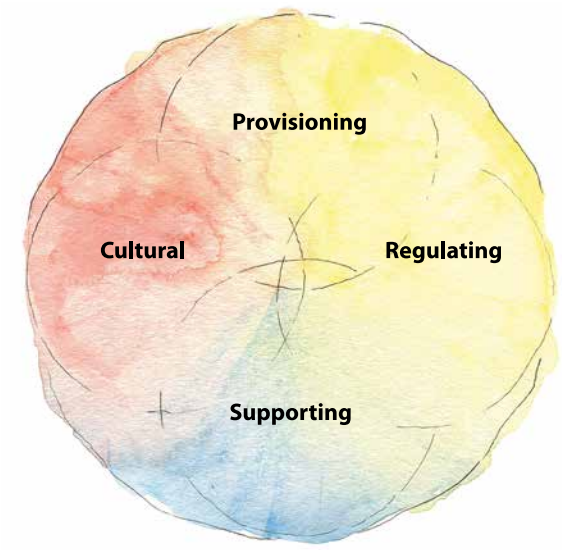
— E.F. Schumacher

Humankind has always benefited from surrounding ecosystems. *Ecosystem services* is the name given to all benefits we receive from the interaction of the living and non-living entities and forces of Earth. Their nutrient cycles and energy flows sustain us in many ways.

It is easy for us to see some ecosystem services. A forest for its production of lumber, a mountain for its minerals and rivers for hydroelectricity. Looking deeper there are so many more services revealed. We must also learn to farm for the enhanced services it provides.

Four Types of Services

- Provisioning: Relating to the production of resources (food, water)
- Regulating: Relating to the control of disease, weather
- Supporting: Good examples include nutrient cycling, or crop pollination
- Cultural: We have fun in the sun and peace in the woods (recreational and spiritual benefits)



Farm Ecosystem Services

Let's look at some of the services farmers receive.

Energy flows are all around us.

Provisioning: Soil life interacts with heat and moisture to provide the service of decomposition and provisioning of soil organic matter. Many plants, animals, fungi, etc. provide us with food.

Regulating: Trees and other plants provide microclimates, sheltering against extreme rain, sun and flood.

Supporting: Mycorrhizal fungi form symbiotic relationships with plants and allow increased access to nutrients and water in exchange for sugar. They contribute to the cycling of nutrients and water in the soil.

Cultural: Healthy diverse food systems provide habitat, beautiful spaces and research/educational opportunities.

Assigning Economic Values

We need to start to understand the value of ecosystem services. Let us consider the questions:

- What is the value of biologically active soil?
- What is the value of topsoil retention against erosion?
- What is the value of habitats that sustain healthy predatory insect populations?
- What is the value of a beautiful and functional landscape that inspires farmers?
- What is the value of a tree that regulates moisture, holds and builds soil and provides nuts, lumber and mulch?

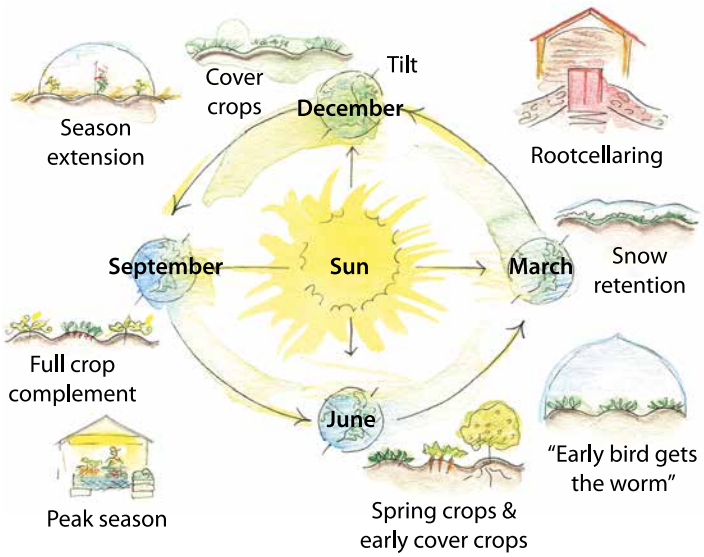
Trees provide many services: release oxygen, sequester carbon, build soil organic matter, stabilize soil, provide habitat for beneficial organisms, etc. They are the biggest organism on our planet, connected together through mycorrhizal fungi.

Just geocaches!

Do you take credit?

Pando is the name given to a 104-acre clonal colony of a single male aspen in Utah whose root system is estimated at 80,000 years old.

Seasonal Rhythms

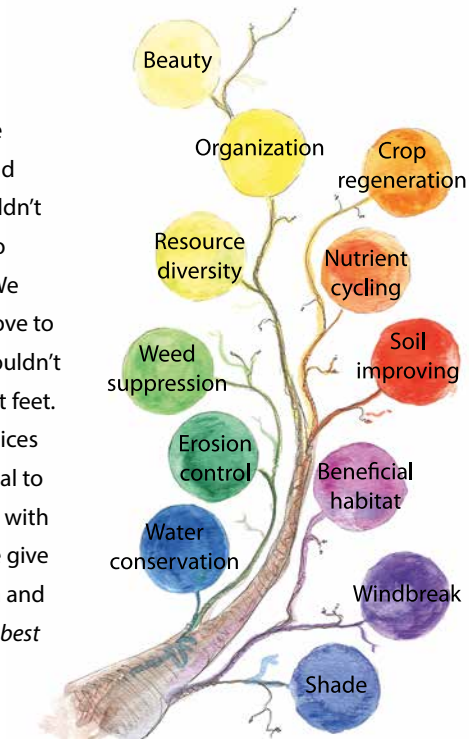


Do You Know?

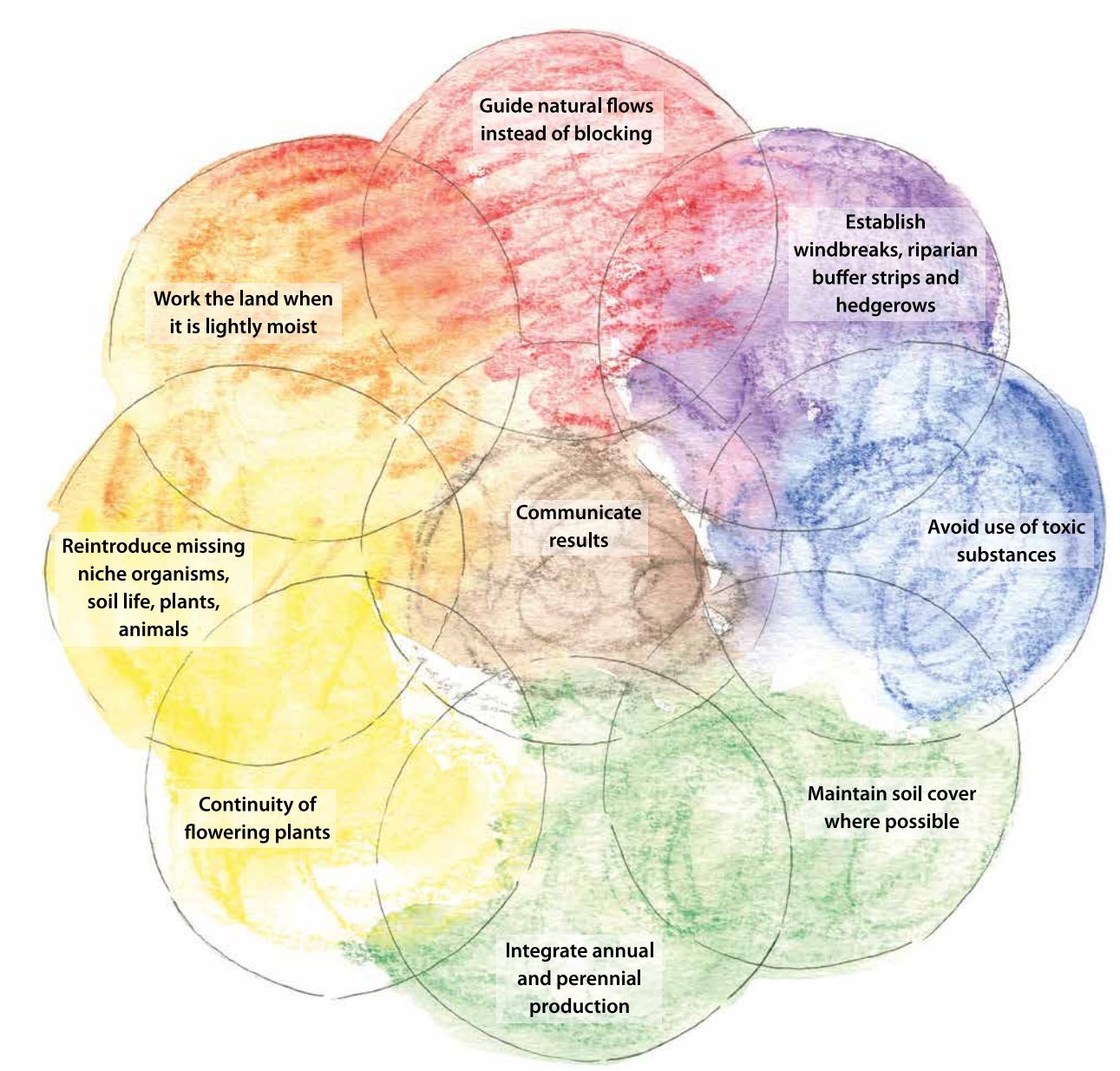
We need to value these functioning systems and support them. We wouldn't expect our mechanic to repair the car for free. We wouldn't expect the stove to run without gas. We wouldn't assume to walk without feet.

The ecosystem services that are already essential to farming can provide us with so much more once we give them space to function and support them through *best production practices.*

Ecosystem Services

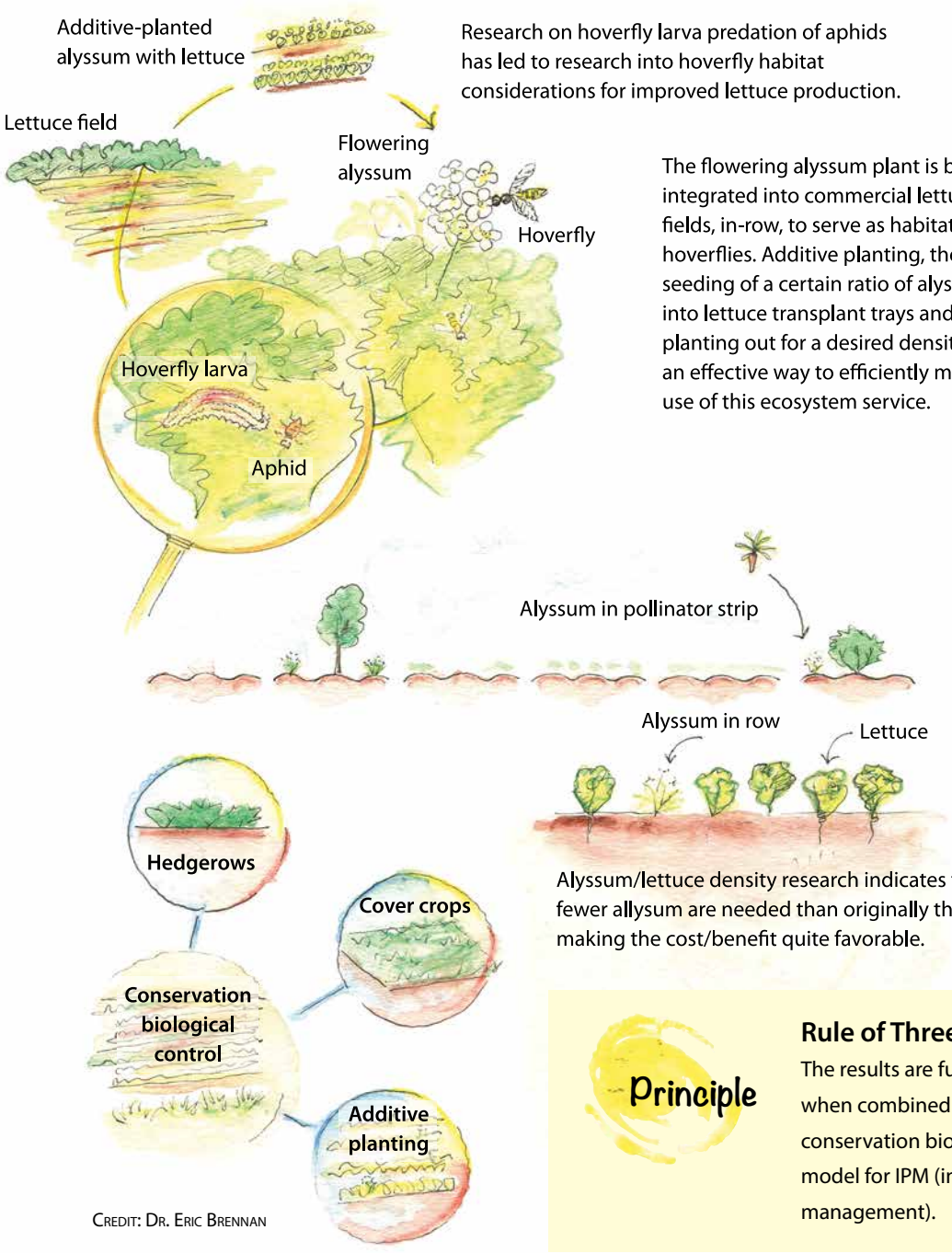


Support Ecosystem Services on the Farm



CASE STUDY

Ecosystem Services: Hover Fly Larva Predation of Aphids in Lettuce Production



CREDIT: DR. ERIC BRENNAN

Research on hoverfly larva predation of aphids has led to research into hoverfly habitat considerations for improved lettuce production.

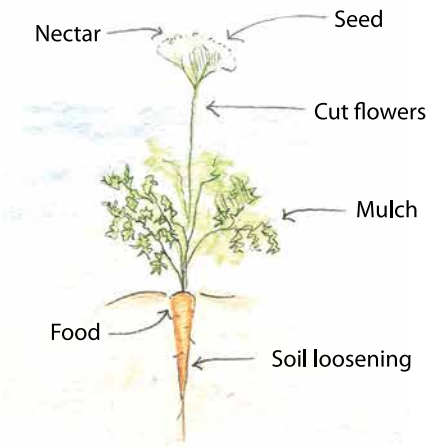
The flowering alyssum plant is being integrated into commercial lettuce fields, in-row, to serve as habitat for hoverflies. Additive planting, the seeding of a certain ratio of alyssum into lettuce transplant trays and so planting out for a desired density, is an effective way to efficiently make use of this ecosystem service.

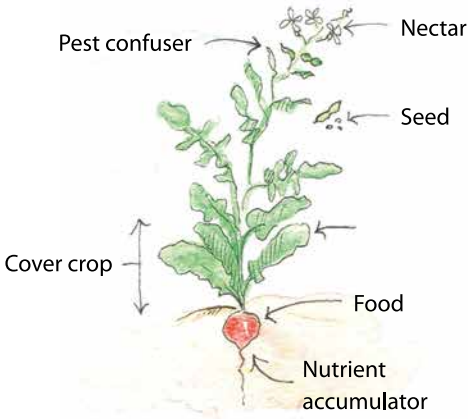
Alyssum/lettuce density research indicates that fewer allysum are needed than originally thought, making the cost/benefit quite favorable.

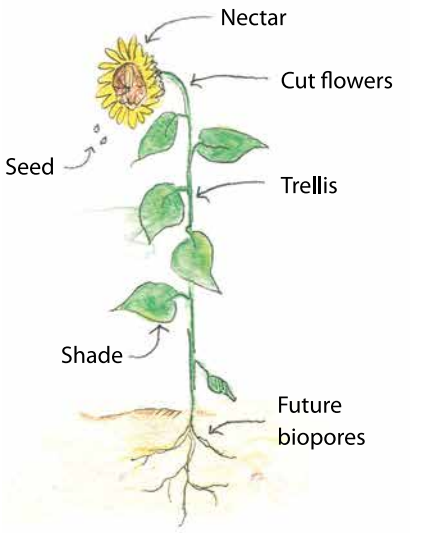
Principle

Rule of Three

The results are further enhanced when combined in a three-prong conservation biological control model for IPM (integrated pest management).







Crop Life Cycle and Services

Crop Services

Taking any crop we grow — carrot, radish or sunflower — we begin to observe its services. We often think of crops as having one service: food, when in fact they have many. To truly comprehend the service potential, consider its morphology, habit, niche and life cycle. These give clues to how it fits into our agricultural designs. Now that we have looked at crop life cycles, let's look closer at crop services.

Time is often the missing ingredient for insight .

Ask Some Questions!

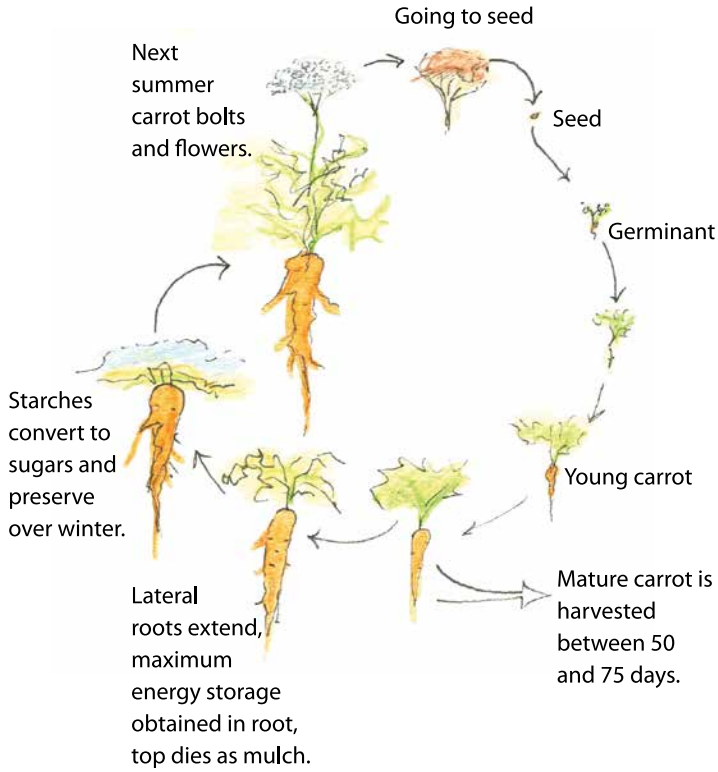
Crops are more than just food, they are plants in their own right with their own character, and plant character reveals service potential.

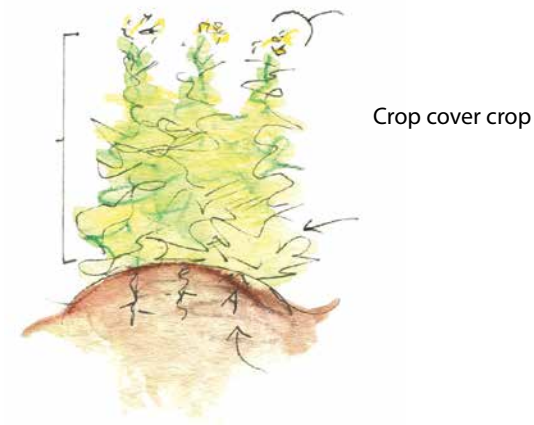
Ask these questions. Is this plant an annual, biannual, perennial? What are the characteristics of its roots, stem, leaves, flowers, fruits? How would it disperse its seeds in nature? What plants might we find in association with this plant in a natural system? How much organic matter does it produce? What weeds does it out-compete? What other products can it produce?

Hidden yields are the overlooked services provided by a crop, such as organic matter accumulation or windbreaking.

Life Cycle Consideration

A crop is not a stagnant entity, existing only as the mature food-producing unit. Farmers will be familiar with many of the stages of growth up to the production of the edible portion of the plant. Yet, it is the full understanding of a crop's *complete life cycle*, when left on its own, that is of interest here. This cycle allows us a view of potential crop services that may be overlooked when considering only plant germination, growth and production of the food part.





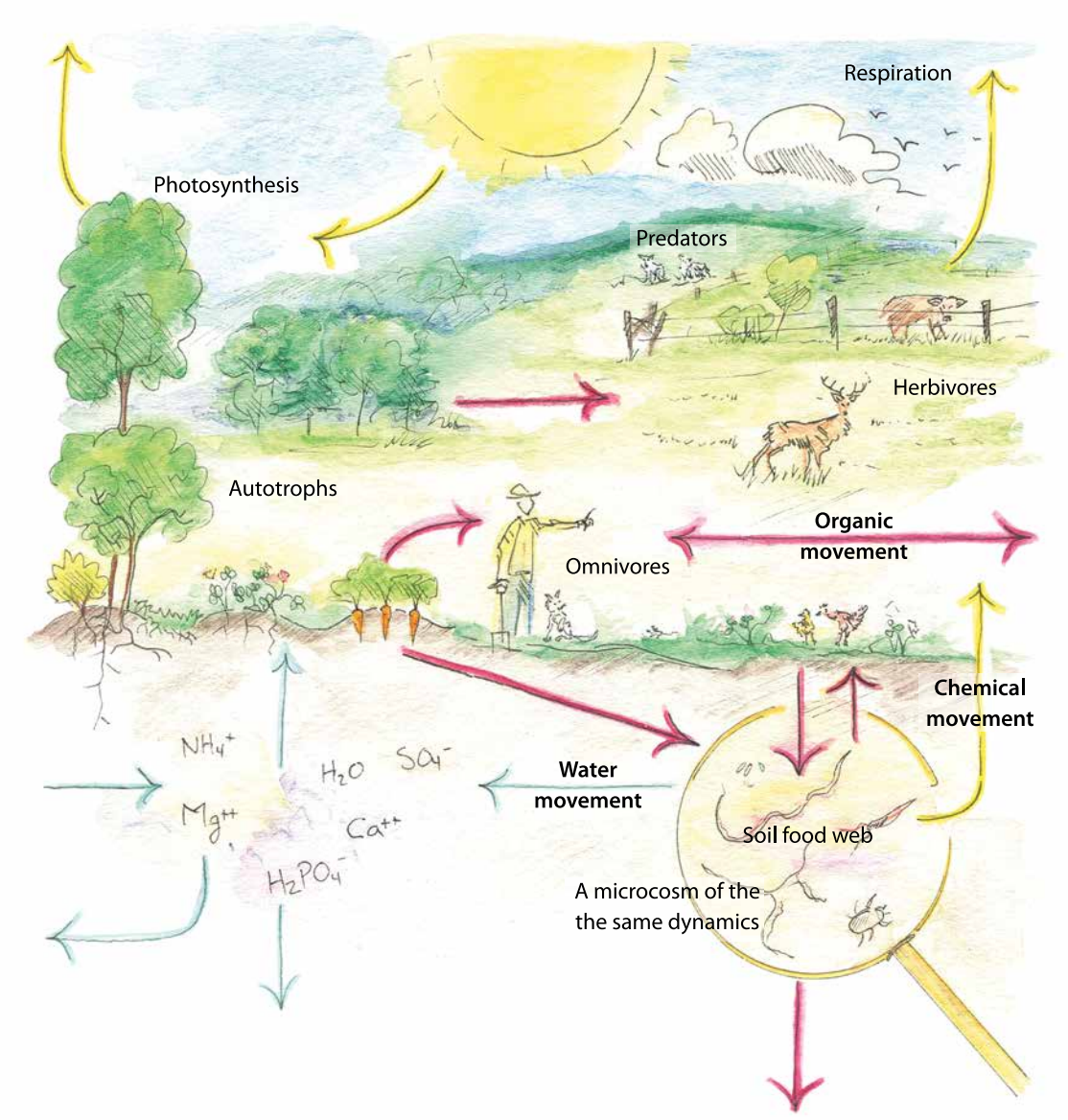
It is the missing stages that are needed for a full comprehension of a plant's *services* and *hidden yields*. For instance, only by observing a plant going to seed did humans realize they could collect the seed and bring it near to their homes for cultivation. Furthermore, even though we don't collect lettuce seed on our farm, the process of letting it bolt and flower has become an invaluable tool. We use it as a *crop-cover crop*, *habitat hotel* and *in situ* mulch production. Observing the organic matter production, habitat buzzing and weed eradication potential of an overgrown bed of greens gave us perspective into the easy service of giving the plant a little more time to grow.

Crop-cover crop means a crop that is left to build organic matter, fix nutrients and provide cover.

Agro-ecosystems

Because ecosystems are efficient at converting and moving energy, mimicking them is key for market gardens. Consider the fact that your garden is already an ecosystem and look for ways to make it function more like one. What are the inputs to our food systems and what are the outputs? Do the different species fit together? How do the species serve each other and the greater production? Our

Ecosystem Dynamics



Agro-ecosystem, agro-ecology, ecosystem farming. In other words, growing like an ecosystem: a layered and diverse agriculture allowed to evolve and regenerate for multiple services, including food, and maybe fodder, fiber, fuel, or even soil function-support, community beautification and water purification.

biggest question being what ecosystem do we want to mimic? We decide we want a woodland market garden; now, with an intended agro-ecosystem in mind, we can begin to design.

Managing an Ecosystem

An ecosystem is complex, yet, for the market gardener, this must be more organized and more controlled. There has to be profit, and we don't want to farm a permaculture market garden mess. We should find a balance of diversity, maximize crop services and manage specific situations in a standardized way. We talk about this in our *permabed system* and the way we use permanent raised beds to help manage diversity. We also will look at *organizational land patterning* and how we can find various solutions to dividing up our land for better management of diversity throughout the farm.

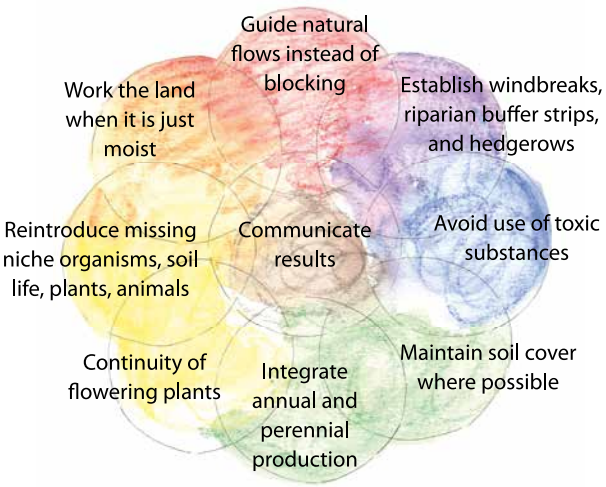
It is critical, however, that we choose the initial species that make up our ecosystems. Species with benefits we are willing to manifest. For example, in a savannah market garden, grass would be an asset as it is eaten by the herds of animals that are rotated through. On the other hand, if your primary production is vegetables and mixed fruits and berries, many grasses are less beneficial and more an invasive weed. In an agro-ecosystem where regeneration is encouraged, choose species that you won't mind going wild.

Agro-ecosystems, ecosystem farming, agro-ecological production…growing like an ecosystem!

Support Ecosystem Services

We operate as though Earth's bounty is endless. Yet, the soil can be lost, and we cannot recreate the wealth of nature in our lifetimes. Soil is formed on a geological time frame. We must understand the ecosystems that perpetually create wealth and harness their services to maintain our soils, waters and biology so they can serve our needs.

However, we cannot reject our current agricultural models completely. We must evolve, as nature does, in the direction of connectivity. Understanding and valuing ecosystem services is not enough. Now let's design them into our market gardens and fuel them as we would a tractor. Sow cover crops for winter so soil life can sustain spring production. Support the systems that would support us. Work the land carefully because it is precious.



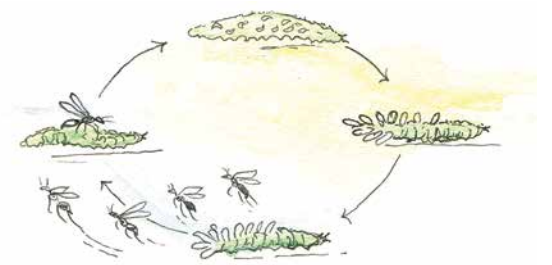
Principle

Organizational land patterning is the concept of dividing space into well-defined places. Defining land into fields, hedges, plots and raised beds can help integrate the diversity needed for ecosystem farming. Once space becomes place, we can pattern it for better management of diverse production.

Support Farm Ecological Succession and Agro-ecological Evolution

More than anything, permaculture farmers should work to support farm ecological succession. Instead of constantly keeping our farm in a perpetual state of disturbance, brought by constant tillage of all parcels of land, we should set aside land through organizational land patterning to continue down a more natural ecological trajectory toward woodlands. For instance, designating a regular pattern of beds in the garden for perennials is a powerful tool.

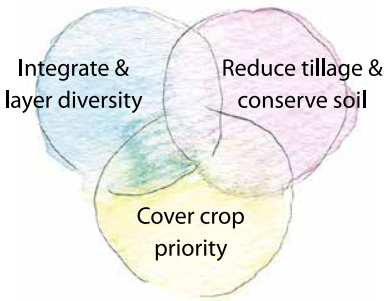
Life Cycle of Parasitic Wasps



Out of the long list of nature's gifts to man, none is perhaps so utterly essential to human life as soil.

— Hugh Hamond Bennet

Key Ways to Support Garden Ecosystem Services

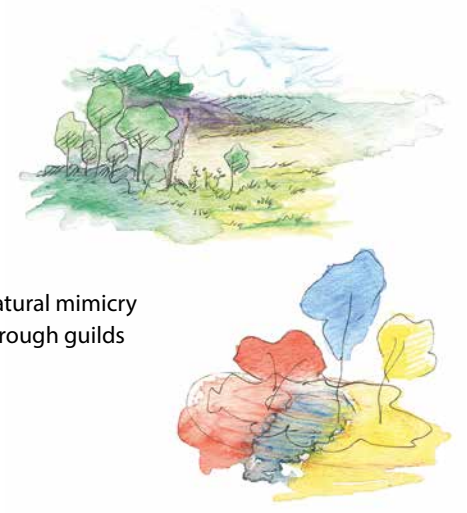


1. **Integrate Diversity**
   - Integrate annuals and perennials, cover crops
   - Integrate crops and cover crops
   - Integrate crops into guilds
     - Creates garden microclimates, shade/shelter/protection
     - Improves nutrient cycling with healthier soil
     - Improves intercrop services like pest deterence

2. **Reduce Tillage**
   - Put garden into permanent raised beds
   - Practice conservation tillage techniques
   - Till shallow, seldom, softly and stratified
     - Reduces loss of carbon from excess soil aeration
     - Protects mycorrhizal and other soil life
     - Reduces plow pan and improves soil structure

3. **Cover Crop Priority**
   - Allow crops to become cover crops
   - Cover crop spent beds soon and often
   - Ensure cover crop over winter and spring
     - Builds organic matter and nutrients
     - Protects crops, soil life and soil tilth
     - Reduces erosion and nutrient loss

These three simple ways of supporting ecosystem services will pay you back quickly. We have seen much higher yields by reducing tillage, creating shelter and increasing beneficial insect habitat.



Natural mimicry through guilds

GREEN THUMB TECHNIQUE

Many predatory insects feed on pollen and nectar in their adult stage; provide this by designing continuous bloom into your garden.

Primary services include shade/shelter/protection, especially of soil tilth, growing crops and soil life. We fight to keep the top 2" of our soil wet in summer to germinate carrots. In a woodland market garden, the evaporation would be less, the organic matter higher and the water needs for germination better met. We could achieve better stands of fall carrots.

Unnatural Operations that Counter Ecosystem Services

- Constant soil disturbance
  - Although disturbances occur in ecosystems, they don't occur every single year on as grand a scale as agriculture employs. often, this causes *succession stagnation* and prevents any building of complexity needed for *farm ecosystem functions.*
- Focused eradication of select pest species
  - Regular and full eradication of species is ecologically abnormal and leads to the very scary outcome of super bugs!
- Incomplete life cycles of species and imported genetics of dominant species
  - Such large tracts of land populated by communities that have no local adapted genetics are abnormal. Working to slowly reintroduce seed saving into every farmscape at multiple scales is critical.

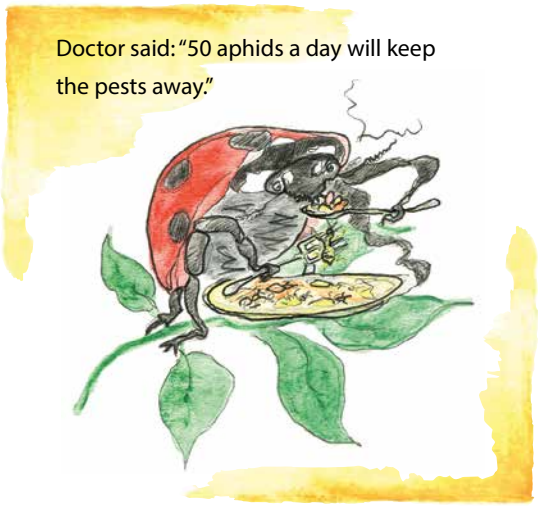
Soil erosion is as old as agriculture.
— Hugh Hammond Bennett

Succession stagnation occurs when disturbance, such as plowing occurs annually. As you can see, most agricultural fields are perpetually kept in the earliest stages of natural succession: bare exposed earth and annuals.

EXAMPLE: Provide for the Needs of Beneficial Insects

Beneficial insects require food, shelter and water like other creatures. Through cover cropping, shelter belts, hedgerows and polyculture, we provide a reliable source of pollen, nectar and protection. However, many *beneficials* are predators, requiring quantities of herbivorous insects as food. I guess that is what makes them beneficial — they eat those guys that eat our plants.

Let's switch perspective and regard pests as a reliable food for the *beneficials*. It is when we achieve economic yields of crops without upsetting this natural prey/predator relationship that we build a stronger insect defense on the farm. Use of pesticides upsets this balance by both accidentally killing beneficials and removing the food source they need for population cycles.



That being said we shouldn't let our crops be destroyed. Using row cover, trap crops, delayed planting and other IPM techniques helps keep crops healthy while engaging in *insect husbandry* (that purposeful feeding of pests with trap crops to raise them as food for their predators). We let a bed of kale over winter on the complete opposite side of the field from where we plan to plant early brassicas. This is very effective at trapping flea beetles!

In Conclusion

Many ecosystem services will not be immediately apparent but will reveal themselves through key strategies that enhance garden ecology. By reducing tillage, integrating diversity, and prioritizing cover crops, we build ecological integrity. Through observing crop life cycles and gaining a better understanding of a crop's character, we gain insight into their hidden yields and can begin to design them for increased service. A solid basis of natural sciences can help us in our inquiry and design of the ecosystem farm.

GREEN THUMB TECHNIQUE

Old seed with unreliable germination can be used for a *pest cocktail* to build habitat hotels. This mix can be broadcast on a bed to attract a range of organisms. The mix is conveniently an assortment of most vegetables you grow and so will attract a range of pests. As this is seeded early and left exposed, it is an ideal feeding frenzy. The pests are happy to stay here and be eaten. It is tempting to go spray the heck out of them as they are concentrated, but I would discourage this as it interrupts the beneficial organism husbandry and will result in collateral damage.

Habitat hotel

ETHICS

Once we understand and accept farms as within nature and begin to put value and even ($) on *all* of Earth's wealth, direct and indirect, we can begin designing the *ecosystem farm*, managing it with *design management* so it may evolve as it is only right for a living production. Understanding that we need to support the ecosystem so it can serve us, and maintaining it like any other tool.

However, we must not only recognize, understand and value ecosystem services, but also show appreciation. This closes the loop between profiteering and *profit resilience*. The permaculture ethic — people care, earth care and surplus share — are an inspiration to us. They ask us to remember our place within our communities and ecology and share with each other to grow forward.

Thanksgiving to Ecosystem Services

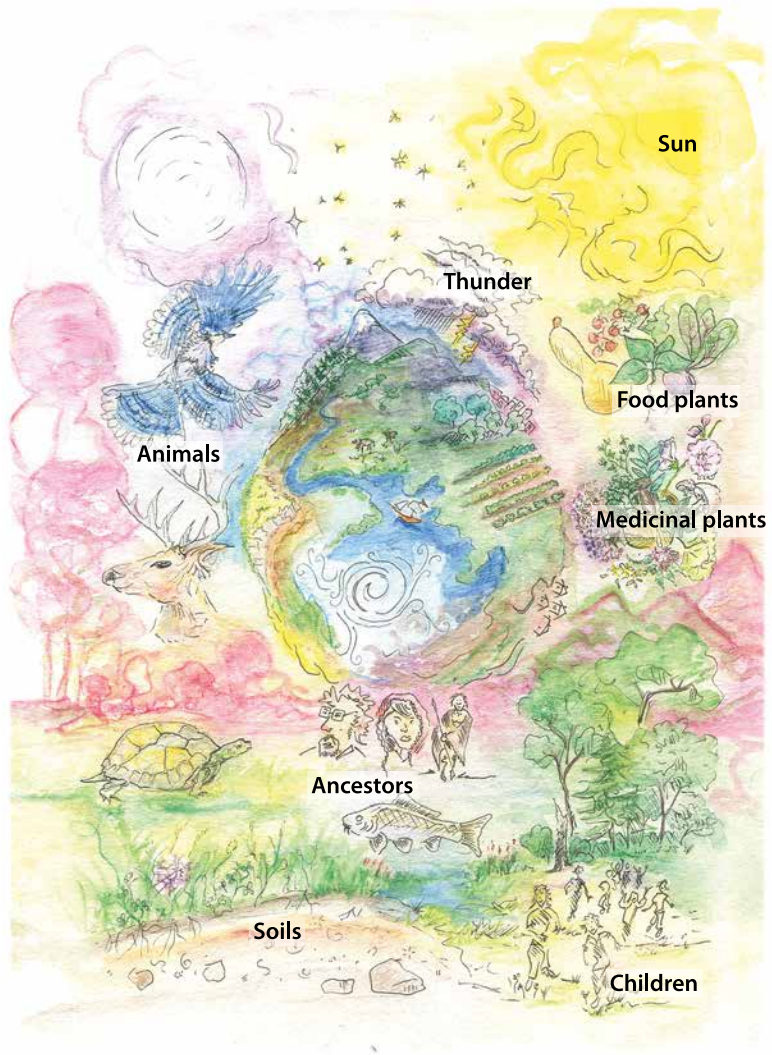
As a guiding way of regularly demonstrating appreciation, we use the thanksgiving address.

The Iroquois Nation, a confederation of Native American peoples, whose sociopolitical model contributed to modern North American democracy, has a ritual of giving thanks to all life.

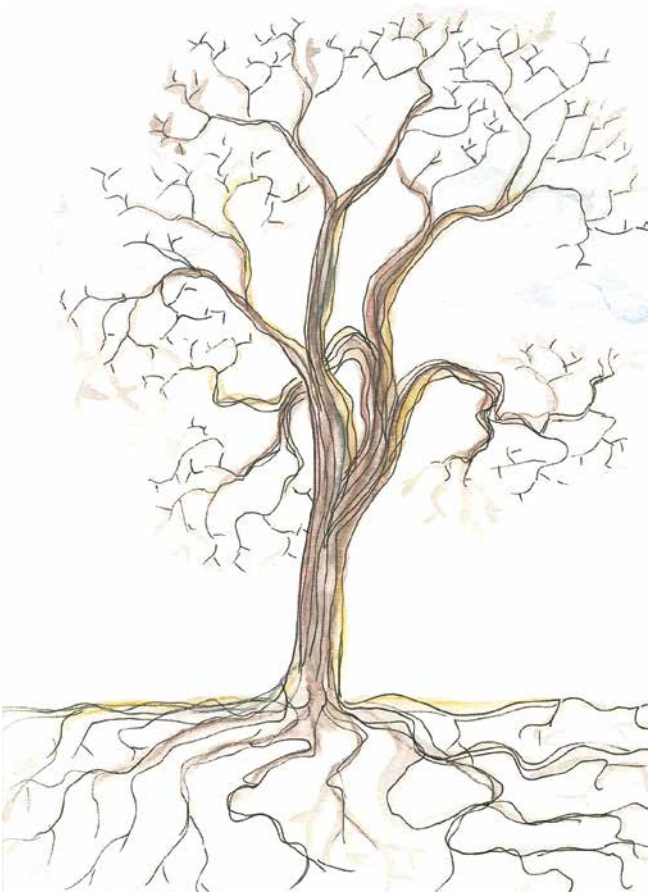
I have found that regular thanksgiving enhances my remembrance of the benefits of Earth's systems and connects me to the origins of my design management.

Our moon, sun, and Earth were here long before us, so it only makes sense that they be given the respect and familial titles that are traditional. However, we need not feel too hippy-dippy about this; it is a practical presentation of those entities that put money in the farmer's pocket and make our world enjoyable to live in.

Thank them, value them, support them, and design for their service.



THANKSGIVING ADDRESS



We now give thanks to:

Grandmother Moon
Grandfather Sun
Father Sky
Mother Earth
The stars
The four winds
The thunder clouds
The food plants
The medicine plants
The wild plants
The trees
The rocks
The soils
The waters
The fish
The animals
The birds
The insects
The elders
The children

If there is anything that I have not set in words, I hope the illustrations capture the grandeur; if there is anything unseen, please give thanks in your own way.

Now our minds are one.

*Inspired by the Haudenosaunee Thanksgiving Address