



NDN COLLECTIVE

# INDIGENOUS REGENERATIVE AGRICULTURE

BY

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# INTRODUCTION



Regenerative agriculture is a farming practice that regenerates the Earth's ability to continue to give life. Indigenous agriculture, developed over hundreds of generations' careful experience, observation and knowledge building, is inherently a regenerative practice. Indigenous nations hold a precious gift given to us by our ancestors in the diversity of seeds, agricultural knowledge, and wild food understandings we still hold, knowledge that is rooted in ancestral experience and spiritual relationships. This knowledge ties us to our land, histories, the vitality of the present, and is key to our thriving futures. Work is happening across our Nations to recover our traditional foods and our unique farming, hunting, and harvesting techniques. We are also working to heal disrupted ecologies, helping our wild foods flourish, and create new Indigenous culinary expressions. We understand that the recovery of our traditional foods is central to recovering not only our physical health, but our well-being as a whole. Our nations are also adapting contemporary agricultural tools and techniques, developing approaches to meet the needs of our peoples in alignment with our values and care of our homelands. Our Indigenous food movements are powerful and worldwide!

Agriculture that ensures the continuous regeneration of life is centered in being in good relationship. We can look to the living natural ecology of our homelands, our stories, and both traditional and scientific knowledge to guide these relationships. As in all things, mirroring the patterns and processes of Creation, and engaging in intimate observation and learning is the foundation for good relations. How we practice agriculture in a good way depends on the nature of our homelands, the soils, the shifting weather, water, and sun energy, and the way that our plant and animal relatives interact with all of these elements. It shifts and changes from one place and time to another, so remaining engaged in these living relationships is key. Our Mother the Earth, the soil where we all begin, is central.





# NURTURING SOIL



## What is Soil?

Soil consists of five primary parts: mineral solids, water, air, organic matter, and microbial life. Mineral solids, ground from the parent rock of the Earth, come in the forms of sand, silt, and clay. These minerals are mostly silicon, oxygen, aluminum, potassium, calcium, and magnesium. The water in the soil contains dissolved nutrients and is the main source of water for plants. The air in the soil provides roots with oxygen and helps remove excess carbon dioxide from respiring root cells.



Organic matter is created when soil microbes degrade formerly living beings, incorporating them into the soil. When mineral and organic particles clump together, aggregates are formed. They create a soil that contains more spaces (pores) for air exchange, water storage, and healthy microbial life.

## Soil pH

Soil acidity or alkalinity is described with a pH number ranging from 1.0 (extremely acid) to 14.0 (extremely alkaline). A pH of 7.0 is neutral, neither acid nor alkaline. Most plants grow best in slightly acidic to neutral soil (a pH between 6.0 and 7.0). Soil pH affects the chemical form of some nutrients like phosphorus and iron and makes them more, or less, available for roots to absorb. When the pH is too high or low, plants may develop a nutrient deficiency even in a nutrient rich soil.

pH is a measurement of the free hydrogen ions in the soil solution. When more hydrogen ions are present, the number is lower (more acidic), when the number of hydrogen ions decreases, the pH increases (more alkaline).

It is good to test your soils before planting, in any case but particularly on larger scale gardens or farms. Soil testing is offered out of most land-grant University extension offices. A list of these [is compiled here](#). Soil testing home kits can also be purchased online.

Soil texture, whether sand, silt, or clay, can impact soil pH amendments. Clay soils are more difficult to adapt the pH in, and while sandy soils are easy to shift, it is also easy to drop the soil pH too much. Both clay and sandy soils can be slowly brought to desired pH through steady additions of compost, as a balancing 'adaptogen' for the soil.



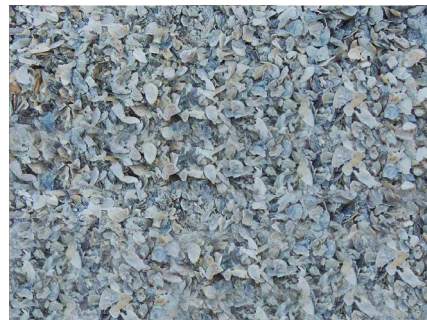
## To reduce pH:

Sulfur pellets are sold by most organic agricultural amendment providers. Lowering the pH of the soil is more challenging than raising pH. Elemental sulfur reacts biologically with soil bacteria to lower the pH.



## To raise pH:

Raising the pH should happen before the soil pH value of 5, at which point it can develop toxicity. Some options are calcitic limestone, dolomitic limestone, hydrated lime, burned lime, and wood ashes. Wood ashes are a very common recommendation to add to soils, and many gardeners do this yearly. This will raise the pH, but without actually testing the soil, this may present a problem, creating alkaline soil. Wood ash is the least effective compared to the other amendments listed. Gypsum also raises the soil pH and can impact it deeper in the soil than other amendments. A traditional Northeast Turtle Island Indigenous practice for raising soil pH is adding oyster and other ground shellfish shells.



## What is Needed for Healthy Agricultural Soil

We want the soil to have good tilth so that plant roots can fully develop in a strong way. A soil with good tilth is spongy, contains more aggregation of organic matter and minerals, and is less compact than one with poor tilth. This kind of porous soil structure supports rainfall infiltration and water storage for plants to use later, and creates a good home for thriving soil life. Most soil organisms are beneficial to plants, so if the soil organisms are thriving, they will support plant health and resilience. For good root growth and drainage, we also look for soil with a good depth before a compact soil layer or bedrock is reached. Soil health is improved using agricultural practices that mirror the processes and patterns of Creation, including composting, using no or low-till practices, as well as caring for the water, energy, plant and animal relationships through polyculture, cover cropping, agroforestry, and more.



# COMPOST

Compost is fully decomposed organic material. Composting is the action of controlled aerobic (oxygen-using) biological decomposition of moist organic matter, producing compost, an enriching offering for the soil. Compost is the result of biological decomposition of organic materials. Anything organic can turn into compost. The bodies of plants, animals, us, are all composed of atoms and molecules that come together to form our bodies. Decomposition is literally the de-composition (taking apart) of those molecular structures, allowing that energy to be returned to the Earth.

## The Decomposers

Our Mother Earth has many helpers, whose purpose includes supporting this decomposition and returning beings back into the living soil.



### Physical Decomposers

These include large visible creatures, macro-organisms you can see in or around your compost pile, such as mites, centipedes, sow bugs, snails, beetles, ants and earthworms, are physical decomposers; they grind, tear, and chew materials into smaller pieces in the process of digestion.



### Second Level Physical Decomposers

The second level decomposers, like springtails, nematodes, beetle mites, mold mites and protozoa, eat the organic matter and the organisms that make up the first level decomposers. These tend to be smaller and the use of a hand lens or stereoscopic microscope is useful to observe them in detail.



### Chemical Decomposers

Micro-organisms such as bacteria, fungi, and actinomycetes—even though they go unnoticed in your compost pile—are responsible for most of the organic material breakdown. They are chemical decomposers because they use chemicals in their bodies to break down organic matter. The most abundant type of chemical decomposer in a compost pile is aerobic bacteria. When they break down organic material, they give off heat. Billions of aerobic bacteria working to decompose the organic matter in a compost pile causes the pile to warm up. As the temperature rises, different organisms thrive.

## Why Is Compost So Good?

Compost improves the soil, which in turn supports healthier and more abundant plants. Compost provides virtually all of the essential nutrients for healthy plant growth, and it almost always releases those nutrients over time to give plants a slow, steady, consistent intake of the elements essential for growth. Compost also improves the soil's structure, making it easier for soil to hold and use the right amount of moisture and air. Compost will improve the texture of both clay and sandy soil; compost is the best additive to make either clay or sandy soil into rich, moisture holding, loamy soil. Compost-rich soil also infiltrates water more easily, and can reduce erosion. And, as an added benefit, compost improves plant vigor and provides for improved immunology from diseases. Life thrives in the presence of diverse communities of supportive connections. Compost carries these networks of diverse life.

## Compost is different than humus

Humus is what is left over when all (or at least most) of the organic matter has decomposed. It no longer is actively releasing nutrients into the soil, but is still precious, as it helps maintain a spongy, porous soil structure in which microbial soil life can thrive.

## The Phases of Composting

In the process of composting, microorganisms break down organic matter and produce carbon dioxide, water, heat, and humus, the organic end product. Under best conditions, composting occurs through three phases:

1. The **Mesophilic**, or moderate-temperature phase, which lasts for a couple of days,
2. The **Thermophilic**, or high-temperature phase, which can last from a few days to several months, and finally,
3. A several-month **Cooling and Maturation** phase.

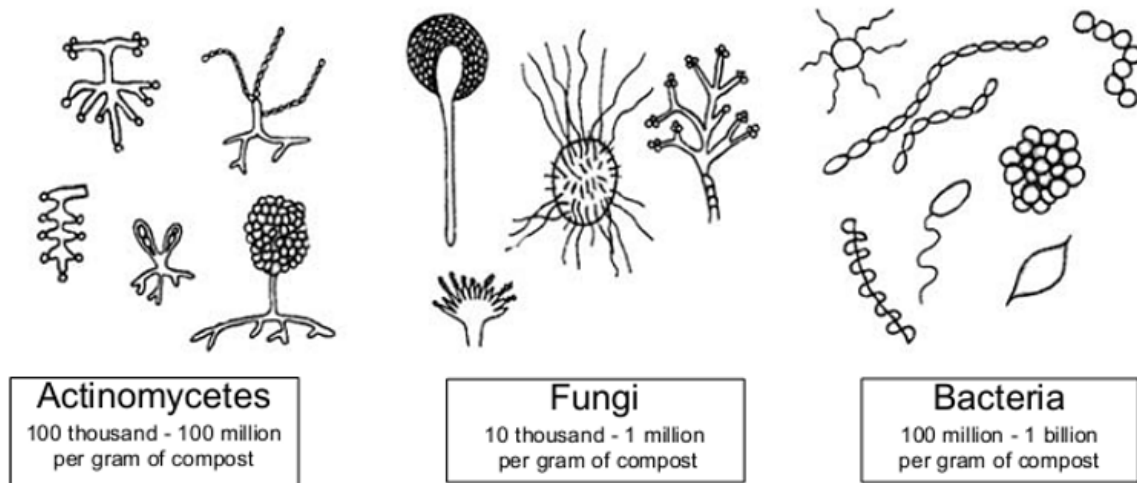
Different communities of microorganisms predominate during the various composting phases. Initial decomposition is carried out by mesophilic microorganisms, which rapidly break down the soluble, readily degradable compounds. The heat they produce causes the compost temperature to rapidly rise.

As the temperature rises above about 40°C, the mesophilic microorganisms become less competitive and are replaced by others that are thermophilic, or heat-loving. At temperatures of 55°C and above, many microorganisms that are human or plant pathogens are destroyed. Because temperatures over about 65°C kill many forms of microbes and limit the rate of decomposition, compost managers use aeration and/or mixing to keep the temperature below this point.

During the thermophilic phase, high temperatures accelerate the breakdown of proteins, fats, and complex carbohydrates like cellulose and hemicellulose, the major structural molecules in plants. As the supply of these high-energy compounds becomes exhausted, the compost temperature gradually decreases and mesophilic microorganisms once again take over for the final phase of “curing” or maturation of the remaining organic matter.



## COMPOST MICROORGANISMS MAGNIFIED 1,000 TIMES



## Successful Factors for Composting

- 1. Love your Microorganisms!** Make sure there is a large population of bacteria, actinomycetes, fungi, yeast, algae, and other organisms. This can easily be accomplished by adding a couple of handfuls of sifted compost from a warm outdoor compost pile. A scoop of rotting forest leaves or prairie vegetation is another good way to bring these precious little beasts into your compost.
- 2. Aeration.** If there is an oxygen deficit, the aerobic bacteria will die and anaerobic bacteria will replace them. These critters produce hydrogen sulfide, ammonia, and methane gas (smelly stuff). So, the system must be aerated. There are many ways and means of doing this. Ways to ensure this include adding 'brown material,' described below, to increase pore space, and the addition of earthworms. It is a balance, because too much air flow can remove too much heat and moisture.
- 3. Moisture Content:** Ideally, the composting material would have the moisture content of a wrung-out sponge – 45 to 70% moisture. If the moisture level drops too low, the material will dry out, but not decompose, leaving active pathogens. If the moisture content is too high, the microbes will drown, once again leaving anaerobic bacteria.
- 4. Temperature:** The temperature needed for efficient effective decomposition is 68 to 112 degrees. The decomposition process releases heat, so often compost piles create their own heat source. Steaming compost piles can be found surrounded by snow in the winter time, and people have even found ways to capture this to heat the water for their homes!
- 5. The right Carbon to Nitrogen ratio.** Microorganisms require digestible carbon as an energy source for growth, and nitrogen as well as small amounts of phosphorus and potassium, for protein synthesis to build their cell walls.  
The optimum C:N ratio is 30 to 1.



## Carbon (Browns) and Nitrogen (Greens)

‘**Green**’ materials are high in **nitrogen**, while **brown** materials are high in **carbon**. The green materials provide protein for the microorganisms, while the brown materials provide energy.



### Typical green materials are:

- Fresh (green) Grass clippings
- Fresh manure (horse, chicken, rabbit, cow, human)
- Kitchen scraps (fruit, vegetables, coffee grounds, tea bags)
- Weeds
- Green leaves



### Typical brown materials include:

- Brown, dry leaves
- Dried grass
- Cornstalks
- Straw

If you have more browns, you’ll still get compost, it’ll just take a little longer. If you are on the side of too much green, you’ll typically end up with a smelly garbage heap.

### The Sugar Trick:

If you have a smelly garbage heap, or for that matter, animal pens that are getting stinky, sprinkle white sugar on the heap or ground. Why sugar? The two bacteria responsible for converting urea into nitrate fertilizer are *Nitrobacter* and *Nitrosomonas*. These bacteria need carbon for their functioning. That white sugar is a high intensity carbon source, and will help bring composting about in a balanced way.

## "Hot" vs. "Cold" Composting

Decomposition occurs naturally but doesn't necessarily occur quickly.

### Hot Composting

When we provide the microorganisms with a good mixture of browns and greens, as well as some water and air, decomposition can be very efficient. This is known as "hot" composting, sometimes called "aerobic" composting, because the microbes that require air have sufficient air to live, eat, and reproduce quickly. The compost pile can attain temperatures as high as 160 degrees Fahrenheit, which will kill some weed seeds, make most of the microbes very active, but will deter worms and some other critters. As the pile cools, the worms will return to assist in the decomposition. Hot composting is fast, to the point that an intensively cared for compost heap can fully decompose in several weeks.

### Cold Composting

"Cold" composting is slower, the form of composting that almost always occurs in the forest, where the mix is often composed of dry leaves and dead wood. It will decompose over time, but the temperature never gets very high, and the process can take years.

Our goal is to create a composting environment that is "hot," at least during the late spring, summer, and early fall, completely decomposing to a finished state in the timescale of a few months to a year.



### Aeration/Turning

Turning is not necessary but, depending upon your ecology, turning the compost pile may make the process of composting more efficient. This is debated, as turning can upset the microbial ecology of the pile. Mixing your heap can help to keep the browns and greens in balance, will distribute moisture, and add essential air (oxygen) to the mixture. The core (the inside) of the compost heap is always hotter and is the center of activity. The outside is generally less active and much cooler. If you don't want to turn it, you can run a pipe with aeration holes through, or periodically add bigger sticks to break up the pile, or simply ensure that every time you add 'greens' to your pile, cover them with a clean layer of 'brown' cover material.





## Two Chambers, Piles, or Bins are Always Better than One

Because the composting process takes at least several weeks under the best conditions, you cannot add additional materials to the heap without “resetting the clock” to day one. To create an ideal batch of fully composted material, your mix needs to “cook” for at least several weeks; if you add additional material, you’ll have a mix of fully decomposed material, partially decomposed material, and fresh materials. It’s simply much easier, and much more desirable to use a consistent mixture of fully decomposed compost for gardening purposes.



## Curing and Maturation

### Curing is important.

While the thermophilic stage of composting will kill most pathogens, an effective curing time will render the compost healthy. Also, immature or uncured compost can carry phytotoxins that can harm your plants, and it will absorb oxygen from the soil to fuel continued composting, also damaging to plants.

The best approach for a compost guarantee is to buy a compost thermometer. They are very affordable and can guarantee your compost is cured. When your compost pile is full, push it into the center of the pile and leave it. When the temperature reads the same as the ambient air temperature, your compost is finished.



## Be Careful with These Ingredients!

### Sawdust

Because of its very high carbon content, and very small particle size, sawdust can overwhelm a compost pile. Avoid using sawdust that came from Black Walnut wood, as it contains a chemical that will stunt or prevent the growth of some plants, tomatoes in particular. And, NEVER use sawdust from processed or treated wood. It is full of carcinogens.



### Wood Shavings, Chips, and Bark

Like sawdust, the carbon content can overwhelm, and shut down, an otherwise good compost mix. Set them aside, if possible, and let them decompose the old fashioned way, over time (“cold” decomposition).

### Chemically treated paper

Eventually, the fungi and biological activity will break down the harmful chemicals in standard inks, but it will take longer and more specific care. Best not to add this to your pile, and advocate against toxic inks in general.

## When and How to Use Compost

### Soil Building

Compost is the single best additive for amazing garden soil. It improves tilth, fertility, water retention for sandy soils, water drainage for clay soils, and improves your soil’s disease fighting characteristics. Add compost in spring and fall, and till it in.

### Garden Fertilizer

Compost can be used throughout the season as a garden fertilizer. Simply side dress vegetables and flowers for a slow-release food source and improved disease prevention.

# COMMERCIAL, COMMUNITY, OR NATION-SCALE COMPOSTING

Composting can be done on large scales! This supports the care and management of ‘waste,’ as well as producing soil enriching compost. Any homes, schools and businesses that throw away manure, ash, paper, landscaping waste, food waste, sewage, coffee grounds, seaweed, or animal wastes from butchering are a source of compost material.

## Large Scale Approaches

### Windrows

Windrows are long rows of composting ingredients, no more than 4.5 – 5 feet high. If they are too high, the material may compact and become too heavy to properly aerate, and if the material is too small, the right amount of moisture and heat may not be produced. These rows are piles of ‘browns’ and ‘greens,’ and can be turned periodically with tractors or other equipment. Some use passive or active aeration methods to support the aeration of windrows. Passive methods include 1., using a mix of bulky materials to create spaces in the compost pile, or 2., staking in perforated pipes that the compost rows are constructed around.

Active aeration is the construction of the windrows on top of perforated pipes through which pumps circulate air.

### Bin systems

Large bins, or a series of bins, can also be constructed to handle large composting operations. If the bins will be expected to efficiently compost, mixing the browns and greens ahead of time before placing in the bin, and passive or active aeration will support that process.

### Piles/Heaps

Compost piles or heaps can be formed, also no more than 4.5-5 ft tall.





## Important Factors for Large Scale Composting

Whether using windrows, enclosed bins, or heaps, the following considerations are helpful for garden scale composting, but absolutely necessary for large scale composting.

1. Create a 4-6 inch layer of coarse browns, like wood chips or straw, at the bottom of your pile. This layer will filter odors that attract pests, soak up liquid from the material (the greens and browns) being used, and allow air into the pile.
2. Chop, shred or grind the material. Shredding the materials creates more surface area for the biological activity to take place and will greatly accelerate the composting process. Over the years folks have used everything from shovels to lawnmowers to wood chippers to shred materials, but there are also shredders made particularly for this purpose that may be a good investment for a community or tribal scale project. The ideal particle size of 1/8 inch to 2 inches.

Commercial and midscale shredders, grinders, and sifters for the end products are widely available online

3. Cover with an additional layer of browns to minimize odors and pests.

## Components of a Community Composting Site

- An enclosure or designated space to store brown materials, ready to mix with incoming green materials. This enclosure should be protected from animals that may want to nest, either through enclosure or ensured continuous activity.
- Compost materials receiving and mixing areas
- Storage for tools or equipment for moving, measuring, and mixing
- Pest-resistant composting system
- Enclosures or designated space for curing and finished compost
- Sifter for screening finished compost if it will be offered to the public
- Scales for weighing finished compost if it will be offered to the public
- Informational signage with clear instructions and contact info
- Source of electricity (if needed) and access to water

## Large Scale Site Selection & Design

*Source: Institute for Local Self Reliance*

Attentive design of your composting site and processes should be central. Keeping the site organized so that the work is done simply, keeping things neat and uncluttered, and creating a beautiful space where the public will visit are all important considerations. Additionally, there are health, safety, and effective composting considerations.

Consider where materials to be composted will enter the site, where they will be stored, where compost will be cured, and where finished compost will be stored or used to make space for more incoming material.



## Other considerations for designing your site:

### Consider Slope

If your site is sloped, finished or curing piles should always be upslope from any active piles to keep water from flowing through unstable material and contaminating more stable compost. If using windrows, run them downslope, so that they do not block the flow of water.

### Avoid Standing Water

Ideally, nothing involved in the composting process – tools, feedstocks, composting systems, active composting piles, curing or finished compost piles – should sit in standing water. Water that directly contacts actively composting materials should never run directly into surface water.

### Shade trees or Roof Cover

Shaded spaces, such as beneath a tree or a roof, will help your composting piles and compost stay moist by limiting evaporation.

### Cover your Compost

Lids, or impermeable tarps can keep your composting pile and compost from getting anaerobic and smelly. There are also selectively permeable fabric covers or biocovers that can reduce moisture loss from piles, keep odors down and animals out of your compost. Selectively permeable covers are fabric covers used to protect actively composting piles, curing piles, and finished compost piles by shedding rainfall but still allowing piles to breathe. Biocovers are thick layers of finished compost or carbon-rich material, such as wood chips, straw, or forest leaves used as natural air filters to cover actively composting piles. Using a nice thick layer of wood chips, mulch, or other carbon-rich material at the base of your pile will also help soak up any extra moisture and keep your site cleaner and drier. Managing odors and never leaving any exposed food scraps are key to avoiding pests.

Covering can be done with all residential, farm, or large scale operations relatively simply when using a biocover.



**It's important to keep your site well-organized, and attractive.**

Consider using fencing, existing trees, vegetation, or buildings to create a visual screen around the composting area. This will avoid drawing unwanted attention.

**Are you allowing community compost drop-offs?**

If so, provide clear rules and instructions for participation, and easy access to drop off zones. It is recommended to allow drop offs during certain hours, to ensure staff presence and well-managed drop offs.

# CHINAMPAS

By Alvaro Mena, with contributions from PennElys Droz

Chinampas are made up of an articulated set of artificial floating islands in shallow marshy lake areas and is unique in the world, which is why it is considered an Indigenous legacy of Mexico for the world. The soil is continuously enriched by fine sediments from the lake, plant remains and animal waste. The ahuejote ( a native willow) fences around each island prevent erosion, and protect the chinampa against wind and pests, while providing natural trellises for vine crops. It has been documented that in the early 16th Century, Nahuatl people could grow up to seven different crops in a year that resulted in 13 times as much produce as dry land farming. Chinampas, being rich in porous and organic matter, absorb water from surrounding canals and retain it, while the chinampa layers are designed to allow deep-rooted crops to draw groundwater, eliminating the need for supplemental irrigation. Some of the moisture loving vegetables produced through this crop are: spinach, chard, radishes, parsley, cilantro, cauliflower, celery, mint, kohlrabi, chives, rosemary, lettuce and purslane, among many others.



## Low or No-Till Approaches

Tilling is the turning of the soil with a plow or other machinery. Tilling has been a common practice, as it reduces weed pressure and makes planting seed easier. It also breaks up the precious aggregate in the soil, leaving the soil vulnerable to erosion by wind and water, nutrient runoff, moisture loss, and causes disrupted microbial relationships in the soil. The Dust Bowl in the colonial US in the 1930s was largely caused by massive tillage and monocropping of wheat. We should always look to the natural processes of Creation to learn how to care for the continuance of life. In the non-human world it is rare to find bare soil. Our Mother Earth covers herself with vegetation and rock, creating places of water retention and nurturance for life. Low or no-till approaches recognize the need to mirror the ways of Creation, while creating conditions for our food plants to thrive.

## No-Till Considerations

In no-till farming, farmers do not till their fields before planting. Instead, just enough soil is disturbed to allow seed to be planted. Larger scale farmers use specialized equipment to dig a small channel wide enough for seeds to be planted. Cover crops are often used in this method, to protect from weed establishment, maintain porous soil, and enrich the soil.



## No-Till Implements

### Roller Crimper

An implement called a roller crimper can be utilized to kill the cover crop before planting. Roller crimpers come in a broad diversity of sizes for a variety of farm scales. They can be a large implement attached to a tractor, or come in manual form, for smaller fields. Small farmers can also use tarping to reduce tillage.



### No-Till Seed Drill

No-till seed drills are also extremely helpful for mid to large scale farmers. A no till seed drill is a heavy drill with specialized discs that cut through plant residue, place the seed at the correct depth and then presses the soil back over the seed.



### No-Till Transplanters

For mid to large scale vegetable crops utilizing no-till approaches, there are mechanical transplanters available. These also come in a broad range of sizes, from manual walk-behind tools to stand-alone machines, to tractor implements as large as in the photo shown, allowing three rows to be planted simultaneously.

\*Implements as large as in the photo shown, allowing three rows to be planted simultaneously.

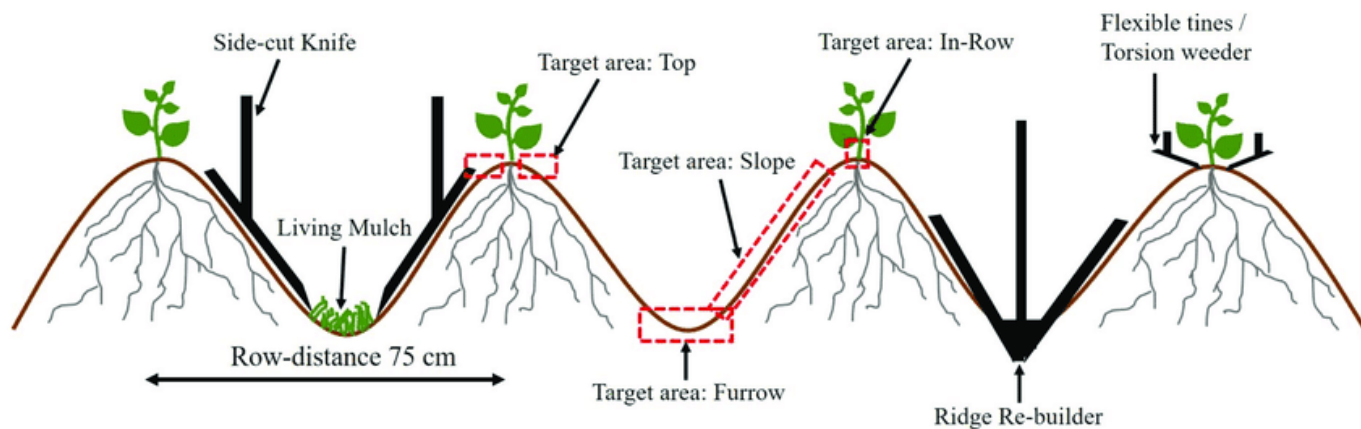


## Conservation (Low) Tillage Considerations

No-till may not work for all farmers, all fields, all the time. There are a variety of approaches to use to reduce tillage and protect the life in the soil.

**Seasonal no-till farming**, in which tilling is used every two years or less, is one approach.

**Ridge tillage**, in which a farmer builds ridges or raised beds and then tills the top zone, is another. Ridge tillage has the added benefit of providing better drainage and warming cold spring soils more rapidly.



## Strip tillage

Involves the plowing of narrow strips where seeds will be planted. The soil between strips is undisturbed. Strip tillage pairs the benefits of conventional tillage, including enhanced soil drying and warmth, with the benefits of no-till, including reduced soil erosion and nutrient runoff.

## Mulch tillage

Involves the use of conventional tillage, with the spreading of thick mulch between the planted rows.



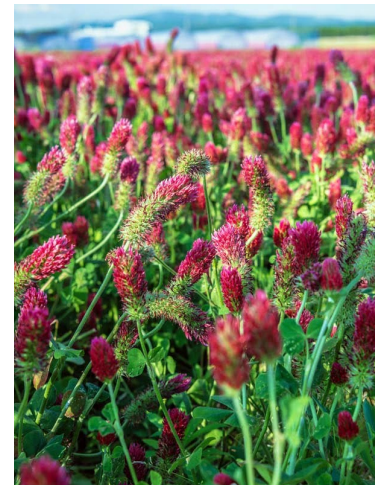
# PLANT RELATIONSHIPS



Interrelated to the life of the soil is the tending to and maintaining of good relationships with the plants themselves. The relationship of different plants to different soils, as well as the relation of plants with each other, the elements, and the seasons is important to learn and be mindful of. Each different type of plant has their own needs, preferences that should be thought of and planned for in our agriculture. The ways we care for the plants we have cultivated also incorporate lessons from the ways that Mother Earth creates healthy and resilient ecologies. The natural world does not leave bare soil for long, or produce one type of plant over vast regions. Diversity is important to maintain healthy vibrancy and there are many ways we can cultivate diversity, regardless of the size of our farms. Cover cropping, crop rotation, intercropping, and polyculture practices are common approaches.

## Cover Cropping/Green Manuring

Cover cropping is the practice of planting crops specifically for the covering and enrichment of the soil, that are not necessarily a core food crop. Cover crops limit the establishment of weeds in the field, and limit erosion and water loss that results from a bare field. Cover crops also contribute organic matter to the soil to support good soil structure, enhance microbial activity, and produce nitrogen and other nutrients. Cover crops are also important for organic agriculture as the practice reduces pest pressure. Healthy natural ecologies are diverse, and growing cover crops contributes to diversity, providing pollen, nectar, and a home for beneficial insects. Green manures are a cover crop that is tilled under while still in young, 'green' stage.



## Nutrient Enhancement

In addition to nitrogen from legumes, cover crops help recycle other nutrients on the farm. Nitrogen (N), phosphorous (P), potassium (KB], calcium (Ca), magnesium (Mg), sulfur (S), and other nutrients are accumulated by cover crops during a growing season. When the green manure is incorporated, or laid down as no-till mulch, these plant-essential nutrients become slowly available during decomposition. Certain broad-leaved plants are noted for their ability to accumulate minerals at high concentrations. For example, buckwheat, lupine, and sweetclover are noted for their ability to extract phosphorus from soils. Alfalfa and other deep-rooting green manures scavenge nutrients from the subsoil and move them upwards to the surface rooting zone, where they become available to the following crop. The breakdown of green manures in soil influences mineral nutrient availability in another way. During decomposition of organic matter, carbonic and other organic acids are formed as a byproduct of microbial activity. These organic acids react with insoluble mineral rocks and phosphate precipitates, releasing phosphates and exchangeable nutrients.



## Winter Cover Crop

A winter cover crop is planted in late summer or fall to provide soil cover during the winter. Often a legume is chosen to support nitrogen fixation, such as clovers, vetches, medics, and field peas. They are sometimes planted in a mix with winter cereal grains such as oats, rye, or wheat that will winter-kill, to provide a dead mulch over the winter.

## Summer Green Manure Crop

A summer green manure occupies the land for a portion of the summer growing season. These warm-season cover crops can be used to fill a niche in crop rotations, to improve the conditions of poor soils, or to prepare land for a perennial crop. Legumes such as cowpeas, soybeans, annual sweetclover, sesbania, guar, crotalaria, or velvet beans may be grown as summer green manure crops to add nitrogen along with organic matter. Non-legumes such as sorghum, millet, forage sorghum, or buckwheat are grown to provide biomass, smother weeds, and improve soil tilth.



## Living Mulch

A living mulch is a cover crop that is interplanted with an annual or perennial cash crop. Living mulches suppress weeds, reduce soil erosion, enhance soil fertility, and improve water infiltration. Examples of living mulches in annual cropping systems include overseeding hairy vetch into corn at the last cultivation, no-till planting of vegetables into clover, sweetclover drilled into small grains, and annual ryegrass broadcast into vegetables. Living mulches in perennial cropping systems are simply the grasses or legumes planted in the alleyways between rows in orchards, vineyards, berries, windbreaks, and field nursery trees to control erosion and provide traction.



## CROP ROTATION

Crop rotation involves shifting the type of crop planted on the same plot of land throughout the years. You can shift crops every year, or have two or three year long crop rotation schedules. Some insect pests and disease-causing organisms are host plant specific. For example, the rice stem borer feeds mostly on rice. If you don't rotate rice with other crops belonging to a different plant family, the problem continues as food is always available to the pest. However, if you plant a legume as the next crop, then corn, then beans, then bulbs, the insect pest will likely die due to absence of food.

Different plants also have different nutrient needs and contributions they make to the soil, so offering diverse plant experiences to the soil can contribute to soil health. For example, grass and legume crops (such as wheat and beans) have root systems that constantly die off and regenerate, contributing good organic matter to the soil. Other crops, such as alfalfa and clovers, have strong taproots that are able to pull nutrients from deep in the soil. Radishes and potatoes create spacious gaps in the soil for deeper water penetration. Each crop has its own benefit to the soil, other plants, and us.

### Advantages of crop rotation

- Prevents soil depletion
- Maintains soil fertility
- Reduces soil erosion
- Controls insect/mite pests.
- Reduces reliance on synthetic chemicals
- Prevents diseases
- Helps control weeds



It is important for crop rotation planning to know the larger family the plants belong to (see table).

### Tips for Crop Rotation:

- Rotate annual crops every year, making sure you are alternating plant families
- Follow a legume crop with a nitrogen loving crop
- Follow a legume crop with a high nitrogen-demanding crop.
- Grow less nitrogen-demanding crops in the second or third year after legume planting.
- Grow annual crops for only one year per location
- Don't follow one crop with another closely related plant
- Use longer periods of perennial crops on sloping land.
- Try to grow a deep-rooted crop as part of the rotation.
- Grow some crops that will leave a significant amount of residue.
- When growing a wide mix of crops, group into blocks according to plant family, timing of crops, (all early season crops together, for example), type of crop (root vs. fruit vs. leaf), nutrient needs, or crops with similar cultural practices.

## FAMILY GROUPS FOR COMMON CROPS

FAMILY	COMMON NAMES
Allium	Chive, garlic, leek, onion, shallot
Cucurbit	Gourd, cucumber, chayote, melon, pumpkins, squash
Crucifer (Brassica)	Bok choy, broccoli, Brussels sprouts, cabbage, Chinese cabbage, cauliflower, collard, kale, kohlrabi, mustard, radish, turnip, watercress
Aster	Lettuce, artichoke
Solanaceous (nightshades)	Potato, tomato, pepper, eggplant
Grains and Cereals	Corn, rice, sorghum, wheat, oat, barley, millet
Carrot Family	Carrot, celery, dill, parsnip, parsley
Root Crops	Cassava, sweet potato, taro, yam, water chestnut
Mallow	Cotton, Okra

### Intercropping/Polyculture

Intercropping is the technique of planting different, mutually beneficial crops in the same space. This technique brings much of the same benefits as crop rotation, and is a practice highly developed by our ancestors and practiced by our people today. Growing multiple plant species together in a synergistic manner, mimicking the patterns observed in natural ecosystems, encourages diverse interactions between plants, soil, and animal life. That diversity supports thriving agricultural ecosystems.





## Reduces Pest Pressure

Diverse plant species attract a wide range of beneficial insects, birds, and microorganisms, creating a natural balance that helps control pest populations. Additionally, when there are diversely interplanted crops, it limits the ability of a plant species specific pest to proliferate.

## Structural and Multistory Support

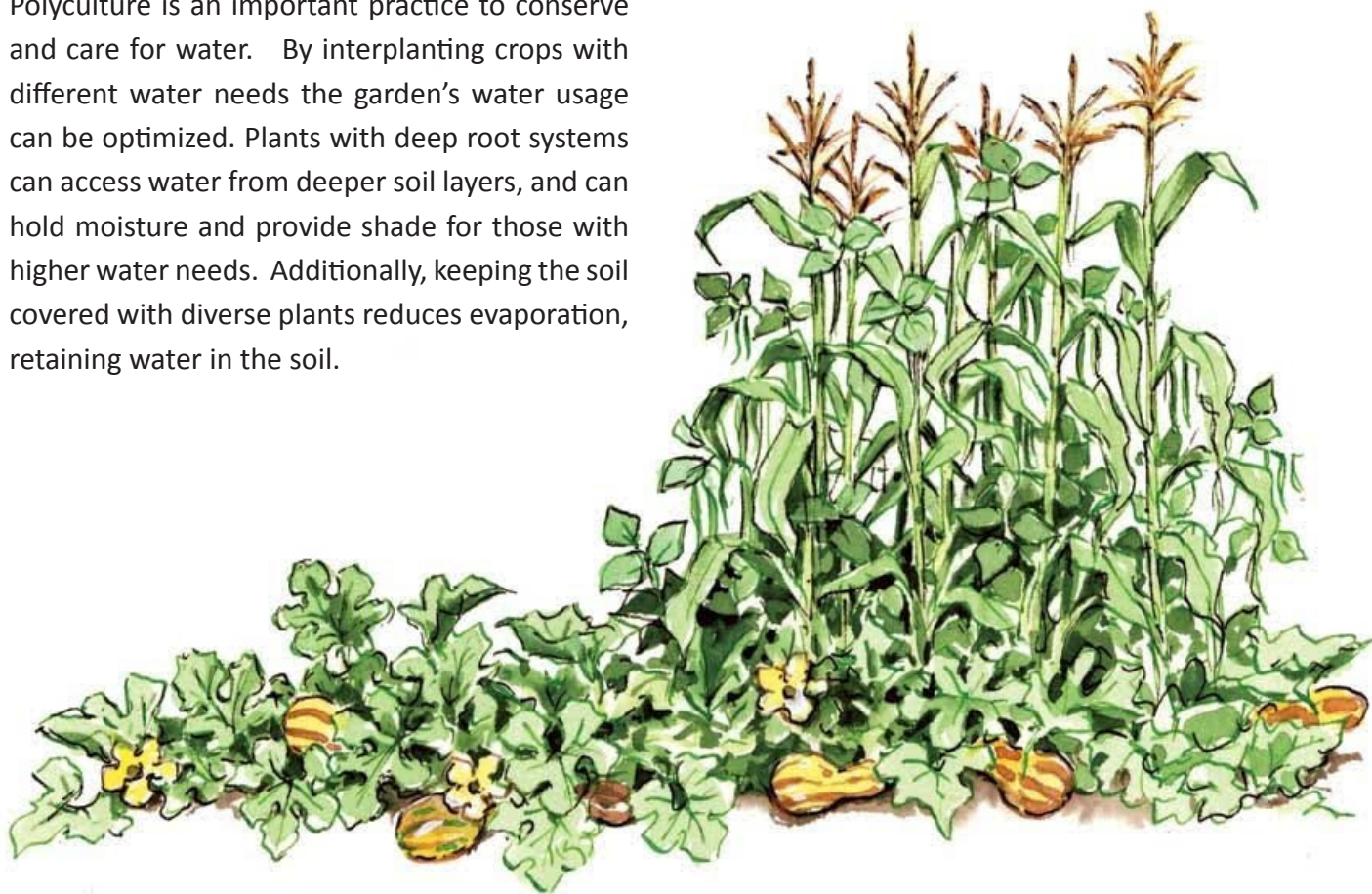
In a well-planned intercropped system, large plants provide shade for smaller plants that need sun protection. For example, corn can shade lettuce. Tall plants, like corn and sunflowers, can support lower-growing, sprawling crops such as cucumbers and peas. Planting tall crops in low growing sprawling crops can also suppress weeds that can take over in open areas.

## Improving Soil Fertility

Different plant species have different root structures and nutrient requirements, so planting them together can help prevent nutrient depletion and soil erosion. Some crops, like beans, peas, and other legumes, help to make nitrogen more available in the soil. Similarly, plants with long taproots, like burdock, bring up nutrients from deep in the soil, enriching the topsoil to the benefit of shallow-rooted plants.

## Water Care

Polyculture is an important practice to conserve and care for water. By interplanting crops with different water needs the garden's water usage can be optimized. Plants with deep root systems can access water from deeper soil layers, and can hold moisture and provide shade for those with higher water needs. Additionally, keeping the soil covered with diverse plants reduces evaporation, retaining water in the soil.



## Companion Planting

Certain plants, because of their natures and needs, will thrive with some plants and will not thrive with others. Planting with consideration to these preferences, alliances, and dislikes can support the health of your garden or farm.

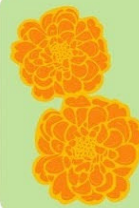
# COMPANION PLANTING GUIDE

Growing the right plants together can make a huge difference in your success as a gardener. Effective companion planting can save space, suppress weeds, manage pests, improve yields, and create better soil. Use our companion planting guide to pair your vegetable plants with the best companions to create a mutual support system with incredible results.



### THREE SISTERS

**Corn** grows up straight and tall, providing support for beans to climb. **Beans** enrich the soil with nitrogen, helping all 3 sisters. **Squash** provides shade, repels insects, and suppresses weeds.



### MARIGOLDS

An excellent all-purpose companion to all garden crops, marigolds encourage vegetable growth and repel many pests and insects.



### TOMATOES

Pair well with herbs like **basil** & **cilantro**, which may repel pests with their scents and also attract pollinators. To repel nematodes, plant **marigolds** nearby. *Don't plant near corn, potatoes, or kohlrabi.*



### BEANS

Good all-around companion plants to most of the garden. They are nitrogen fixers, improving the soil. They love tall stemmed plants to climb, like **sweetcorn** or **sunflowers**. *Don't plant near onions.*



### CUCUMBERS

Pair with **nasturtiums** for pest control. Cucumbers also pair well with **peas**, **radishes**, **celery**, **corn**, **marigolds**, and **sunflowers** (as a trellis and shelter). *Don't plant near potatoes.*



### BRASSICA

Cabbage, cauliflower, kale, and broccoli: these cole crops are friendly with **tomatoes** and **celery**. Marigolds and nasturtiums also provide good pest control. *Don't plant near strawberries.*



### RADISHES & CARROTS

These two root crops go together nicely. Radishes & carrots don't compete in the soil and mature at different rates, so they can be effectively intercropped and even succession planted.



### FENNEL

Although delicious, fennel is a bad neighbor to most, inhibiting growth or even killing many other plants. Dill, however, can be a good companion for fennel. Grow them together in a separate area.

SOW RIGHT SEEDS 



## THREE SISTERS

### Turtle Island Indigenous Intercropping

The most well known of our Indigenous intercropping is the planting of our three sisters together; corn, squash, and beans. This ancestral technique is widespread across our Nations, and is often accompanied by the planting of fish, as well, in the mounds. Each farmer or gardener carries their own teachings and techniques, but the following is one approach to this interplanting. Approaching planting with good heart, prayers, and song supports the welcoming in of the helpers and the spirit of the plants, and are not described in these 'steps.



#### STEP 1:

Till the soil with a shovel or rototiller. Spread 1 to 2 inches of organic matter, such as compost or manure, over the area and work it into the soil with shovel or rototiller.

#### STEP 2:

Plant the corn, pushing kernels 1 inch deep in heavy soils, such as clay, or about 2 inches deep in sandy soil. Press soil over the planted seeds. Space the kernels about 10 inches apart and the rows 3 feet apart. Keep the soil moist. Sprouts should appear in one to two weeks.

#### STEP 3:

Mound soil around the corn stalks when the corn is about 10 inches tall. The mound should be about 3 inches high around the stalk and extend out about 6 inches. The mounded soil encourages the corn to extend its roots out for additional stability.

#### STEP 4:

Plant about 12 pole beans in the mounded soil around each stalk of corn. Push the bean seeds into the soil about 1 inch deep and 6 inches from the stalk, and pat the soil over the seed. Keep the soil moist. Sprouts should appear in one to two weeks. As the beans grow, train the vines to wrap around the corn stalk.

#### STEP 5:

Plant squash down the center of the rows one week after planting the pole beans. Push the seeds into the soil about 1 inch deep and at 3-foot intervals. Water well. Sprouts should appear in one to two weeks.

#### STEP 6:

Keep the soil moist, which may mean watering more than once a week during hot and humid weather if there is no rainfall.



# THE MILPA

By Alvaro Mena

## The Milpa in Mexico

The milpa is a regenerative agriculture system that has an important relationship with the territory. In addition to being a system of diverse crops in which corn, pumpkin and beans play an important role, it is also a diverse system at the landscape level. The milpa is used throughout all the Indigenous peoples' communities of Mesoamerica and has at least six thousand years demonstrating its viability. In sowing, the bean, pumpkin and corn seeds are deposited at the same time, so that they emerge at the same time as mutually beneficial plants. The bean is a seed that fixes nitrogen, the pumpkin covers the soil, maintains humidity and prevents the emergence of unwanted grass, and the corn supports the bean. In addition, within the milpa, space is left for planting other vegetables, and an area of forest is preserved around it, protecting the milpa. This to protect the cornfields from the winds. Medicinal plants are also left in the cornfield and quelites are harvested, which are plants that grow naturally among the cornfield and are part of the diet of our people.



## Agroforestry

Agroforestry is a kind of integrated planting approach that integrates trees and forest into production of crops. There are a variety of ways farmers may practice agroforestry.

**Alley cropping** involves planting crops between rows of trees, or agroforestry intercropping, when not utilizing row planting.



**Forest farming** is the practice of growing food, herbs, or flowers under a forest canopy that is cared for to provide an ideal ecosystem for the crops. Forest farming is also called multi-story cropping.

**Silvopasture** integrates trees with livestock and forage. The trees can be a resource for timber, fruit, fodder, or nuts as well as shade and shelter for the animals.





Trees can also be planted as windbreaks to provide shelter to crops, animals, buildings, and soil from wind, snow, and dust. Windbreaks can also support wildlife, and can be interplanted with crop and forage trees to offer multiple uses. The creation or restoration of riparian forest areas around rivers, streams, and ponds is also considered part of agroforestry. The restoration of trees and diverse plant life around waterways can support the filtering of any farm runoff and stabilize the banks of streams, rivers, lakes and ponds to prevent erosion. These areas can also create habitat for our animal relatives and useful wild plants.

Again, the most resilient and regenerative farming systems are designed to mirror Creation and the natural order of life. Integrating particular crops and animals with trees supports the inter-relational health of all of them. Trees protect strongly against soil erosion, and can uptake farm runoff. Trees, depending on the type, can also add an extra crop that gives the farmer income source protection against poor ground crop harvests. It creates habitat for diverse wildlife, including predators such as raptors who can help keep other crop-eating wildlife at bay. And, trees are a strong support for climate resilience, holding carbon, moisture, and offering shelter.



## Organic Production

Our people have always used organic methods. Organic growing refers to farming with no synthetic chemical inputs, whether fertilizers, pesticides, fungicides, genetically modified organisms (GMOs) or herbicides. Organic farmers rely on natural processes, cultivation of healthy soils, and biodiversity, with natural pesticides, fertilizers, and fungicides used if necessary. Healthy soils, and soil care, as described earlier, is critical for organic production. Healthy soils produce healthy plants, who often can ward off disease and insect pests themselves.

You can often tell which nutrients your soil may need based on the look of the plants themselves.

## Nutrient Deficiency Treatments

If your plants are showing signs of deficiency, there are simple soil amendments available to support plant and soil health.

### Potassium (K) Deficiency:

Kelp meal, Greensand, Wood Ash, Kitchen Compost

### Calcium:

Eggshells, oyster shells, dolomite lime, bone meal

### Iron:

Typically soil ph is too high, and there is too much clay. Compost and peat moss

### Nitrogen:

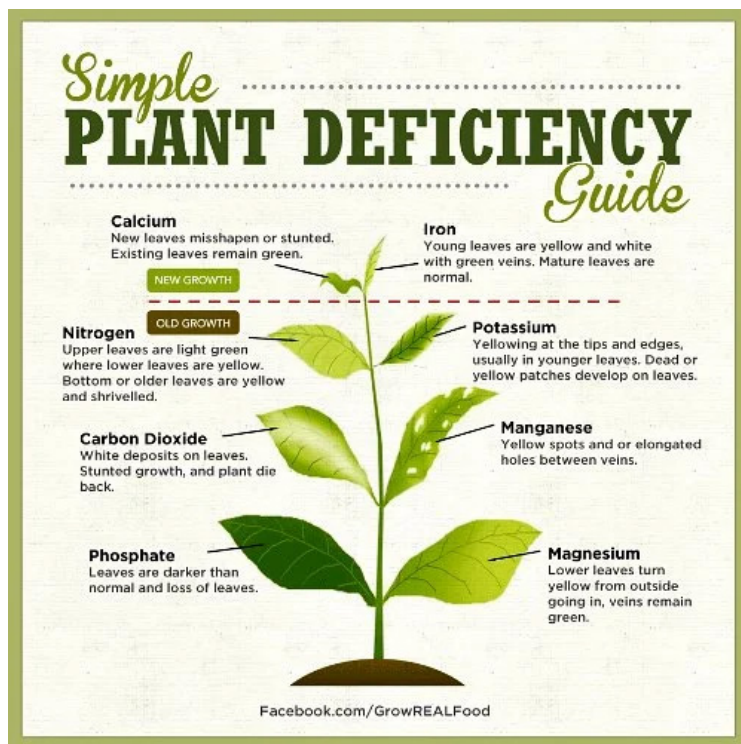
Diluted urine, composted Manure, Blood meal, Fish Emulsion, Cottonseed, soymeal, or alfalfa meal, Cover crops of alfalfa, vetch, peas, or beans

### Phosphorus:

Bone meal, Fish emulsion, Wood ashes, Cottonseed meal, Phosphate rock

### Magnesium:

Epsom Salts, 1-2 tsps salts in 1 gallon water.  
3 applications, 6 weeks apart. Fish meal, greensand





# INTEGRATED PEST MANAGEMENT



Integrated Pest Management is an organic pest management practice based on intimate knowledge of the life cycles of both beneficial and pest insects, and the creation of a healthy garden habitat based on this knowledge. Use of organic or biodegradable pesticides is used as a last resort. This approach, as in all regenerative agriculture, is centered in good observation, and awareness of the connections and relationships across the ecosystems in order to cultivate a balanced, healthy farm ecosystem.

## Good Pest Management is Based on Healthy Soils

Healthy soils contain many different organisms that compete with pest organisms, keeping them in check. Maintaining diversity and fertility in the soil is accomplished by the soil care practices described earlier; composting, use of cover crops and green manures, crop rotation, and polyculture practices. Creating habitat for beneficial wildlife and insects, such as hedgerows, trees, or creating bat and bird houses are helpful practices, as are having a variety of flowering plants to provide pollen, nectar and refuge for numerous beneficial insects. Learning what beneficial insects eat, and where they live, can help you intentionally create habitat for them.

## Beneficial Insects to Support your Crops

### Lady Bugs

#### What They Eat:

Aphids, Mealy bugs, Mites, Soft scale, Eggs of insect pests.

#### Where they live:

In plants of the carrot family; fennel, dill, Queen Anne's lace. Also yarrow and sunflowers. Deergrass and other clumping grasses are excellent habitats for overwintering ladybugs.



### Lacewings

#### What they eat:

The larvae eat soft-bodied insects including aphids, thrips, mealy bugs, soft scale, worms, and mites.

The adults eat pollen & nectar.

#### Where they live:

In plants of the carrot family; fennel, dill, Queen Anne's lace. Also yarrow, sunflowers, buckwheat, California buckwheat, corn, amaranth, holly leaf cherry, alyssum, coyote brush.



### **Syrphid Flies**

#### **What they eat:**

The larvae eat aphids. The adults eat pollen & nectar

#### **Where they live:**

In plants of the carrot family; fennel, dill, Queen Anne's lace. Also yarrow, sunflower, buckwheat, alyssum, coyote brush, and other flowering plants



### **Damsel Bugs**

#### **What they eat:**

Aphids, Mites, Thrips, Worms, Lygus bugs, Leafhoppers

#### **Where they live:**

Yarrow, Alfalfa, Goldenrod, Plants of the sunflower family



### **Big-Eyed Bugs**

#### **What they eat:**

Aphids, Mites, Thrips, Worms, Flea beetles, Insect eggs

#### **Where they live:**

Cool season cover crops (berseem clover & subterranean clover) and common knotweed



### **Tachinid Flies**

#### **What they eat:**

The larvae parasitize many worms, Japanese beetles, and some bugs.

Adults eat pollen & nectar

#### **Where they live:**

In plants of the carrot family; fennel, dill, Queen Anne's lace. Also yarrow, sunflowers, buckwheat, alyssum, coyote brush



### **Pirate Bugs**

#### **What they eat:**

Thrips Mites Leafhoppers Small worms Insect eggs

#### **Where they live:**

In plants of the carrot family; fennel, dill, Queen Anne's lace. Also yarrow, sunflowers, buckwheat, alyssum, coyote brush, alfalfa, corn, clover, & vetch



### **Assassin Bugs**

#### **What they eat:**

Many insects including large insects and worms

#### **Where they live:**

In permanent plantings such as hedgerows, which provide shelter and food



## Spiders

### What they eat:

Spiders eat a great variety of pests, including aphids, flea beetles, cucumber beetles, leafhoppers, & many others

### Where they live:

One of the best ways to increase the number of spiders is to use straw mulch and maintain undisturbed habitat strips, such as hedgerows



## Common Pests and Organic Approaches to Managing Them

### Cucumber Beetles

- Set aside or create habitat for beneficial insects and bats.
- Delay planting to avoid the time when the beetles lay their eggs
- Use row covers or paper cones to protect the young plants.
- Thick mulch prevents pest insects from laying their eggs in the soil at the base of the stems.
- Trellis the plants to get them up off the ground.
- Cultivate and eliminate crop residues.
- Monitor the pest populations twice a week when the plants have less than five leaves: Check five plants in five different parts of the field. If you find more than five beetles per plant, some treatment is called for.
- Use trap crops, bait, and sticky traps.



### Lygus Bugs

- Create habitat for beneficial insects
- Monitor plantings for beneficial insects
- Plant trap crops (alfalfa & radish)
- Botanical pesticides as a last resort
- Beneficial Organisms that Attack Lygus
  - Fungus: *Beauveris bassiana* (Mycotrol™)
  - The parasitic wasps *Anaphes ioles* & *Peristenus* sp.
  - Damsel Bugs, Big-Eyed Bugs, Assassin Bugs, Lacewings, Spiders
  - Caterpillars
- Create habitat for beneficial predators and parasites.
- *Bacillus thuringiensis* (Bt)
- Botanical pesticides
- Repellents: dilute garlic, onion or chilis with water





## Aphids

- Create habitat for beneficial insects
- Control ants
- Use garlic, onion, or chili repellent
- Insecticidal soaps
- Diatomaceous earth
- Vegetable oil spray
- Botanical Insecticides, such as Neem.
- Natural enemies: Lacewings, syrphid, flies, and ladybugs.



## Leaf Miners

- Parasitic wasp (*Diglyphus isaea*)
- Row covers
- Use sticky traps
- Don't plant next to infected crops
- Use botanical pesticides (on adults)
- Use "Neem" (for larvae)
- Sanitation
- Mulch



## Flea Beetles

- Row covers
- Beneficial nematodes
- Sticky traps located every 15 to 30 feet along the rows
- Dilutions of garlic, onion, or chilies with water
- Botanical Insecticides



# WATER CARE



Caring well for water is a central part of farming with love for our descendants.

In standard industrial agriculture, 40% of irrigation water goes to waste through evaporation and poor irrigation practices, while agricultural runoff contaminates water bodies. Much of our soil care practices are also important for the protection of water. Keeping the soil covered and enriched with compost helps soils hold water. The creation of forest areas around water bodies protects them from runoff. And, shaping the land to help retain or drain water, depending on your soils and weather, can support the adaptability of your farm to shifting weather patterns, including the creation of contours, swales, and infiltration basins. NDN Collectives' [‘Caring for Water’ book](#) explores these techniques further.

Traditional agriculture, growing specially adapted regional foods with rainwater or ancestral ditch systems, is a critical part of our future food security, and is undergoing a powerful revival in our communities!

When we irrigate, it is good to invest in water-efficient irrigation systems. The most efficient system is drip irrigation.

## Drip Irrigation

Drip irrigation is an irrigation method which saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters.

The advantages of drip irrigation are:

**It saves water!** Studies show that drip irrigation systems use 30 - 50% less water than conventional watering methods, such as sprinklers.

**Improves growth.** Smaller amounts of water applied over a longer amount of time provide ideal growing conditions. Drip irrigation extends watering times for plants, and prevents soil erosion and nutrient runoff. Also, because the flow is continuous, water penetrates deeply into the soil to get well down into the root zone.

**Discourages weeds.** Water is only delivered where it's needed.

**Saves time.** Setting and moving sprinklers is not required. A timer can be added to the system for automatic watering.

**Helps control fungal diseases,** which grow quickly under moist conditions. Also, wet foliage can spread disease.

**Adaptable.** A drip irrigation system can be modified easily to adjust to changing needs.





The very low flow of water from outlets on a drip system also enables you to water a much larger area from a single water source. Less water usage equals a larger single watering zone.

Another advantage of using a low flow drip system is that you do not need high water pressure to supply the drippers. Most drip systems are recommended to run at about 15 to 30 PSI (pounds per square inch). For comparison most houses have water pressure of anywhere from 40 PSI to 60 PSI. Because of this low pressure, drip systems can use tubing and other components that do not require glue, clamps or hard-to-connect components. Drip irrigation supplies are commonly found in any garden supply store, and can also be ordered online.





# SEED SAVING



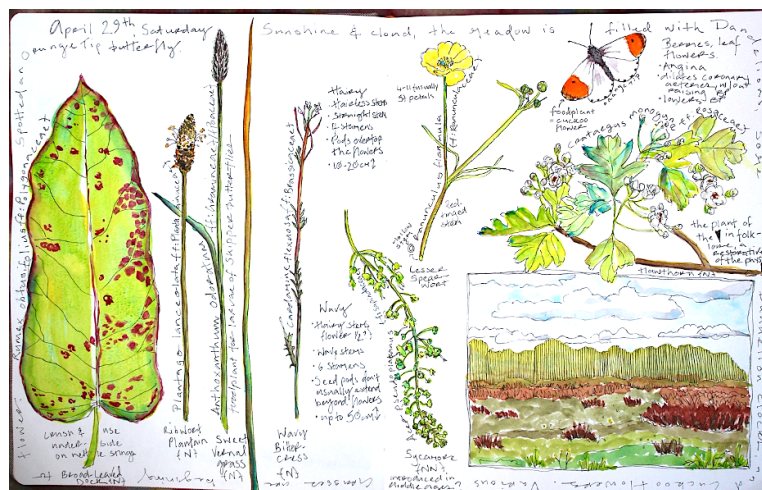
Our seeds are part of the living thread tying us both to our lands and our ancestors. Our ancestors were brilliant plant breeders and seed savers, creating an unparalleled number of food plants adapted to the climates and microclimates of the Americas. Today, farmers and gardeners are under pressure to preserve seeds from potential contamination of local genetic pools by GMOs (genetically modified organisms) carried in wind and insect-borne pollen. As small seed companies are absorbed by the corporate seed industry, the tradition of specialty varieties declines and heirloom crops are lost in a mire of corporate hybrids. Thankfully, there are many Native and non-Native peoples and organizations working to re-implement our traditional farming practices and revive the use of our old seeds.



## Art and Attention for Seed Saving

Learning how to observe slowly and attentively is a critical skill for good seed savers.

This is an example of a 'naturalist journal' approach to documentation of the observed world. Keeping a seed saving notebook is a critical part of the process and it can include art, or simply be a documentation of your observations and selection choices.



# BASIC SEED SAVING HOW-TO

Adapted from the International Seed Saving Institute

## Understanding Flowers

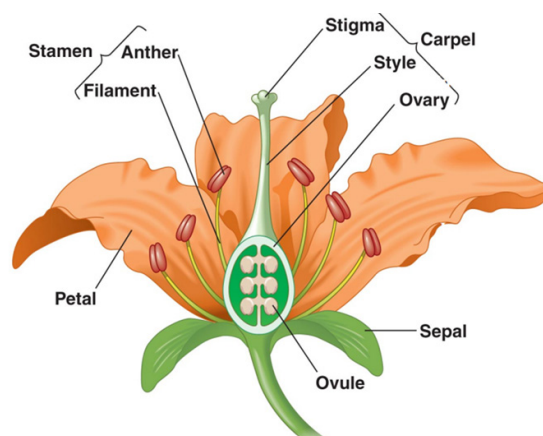
**Flowers** are the portions of plants where reproduction takes place and seeds are produced.

**Pistils** are the female reproductive organs in flowers made up of the stigma, style and ovary. The stigma is the opening in the pistil through which the pollen passes on its way to the ovary. The style contains the pollen tube between the stigma and the ovary through which the pollen is carried. The ovary contains ovules. When fertilized, ovules develop into mature seeds.

**Stamens** are the male reproductive organs in flowers. They consist of the filament, anther and pollen. A filament is the tube that supports the anther where pollen is produced. Pollen is the equivalent of sperm in plants. Pollen grains fertilize plant ovules.

**Monecious** plants produce single plants with separate male flowers and female flowers on the same plant.

**Dioecious** plants produce separate male flowers and female flowers on different plants.



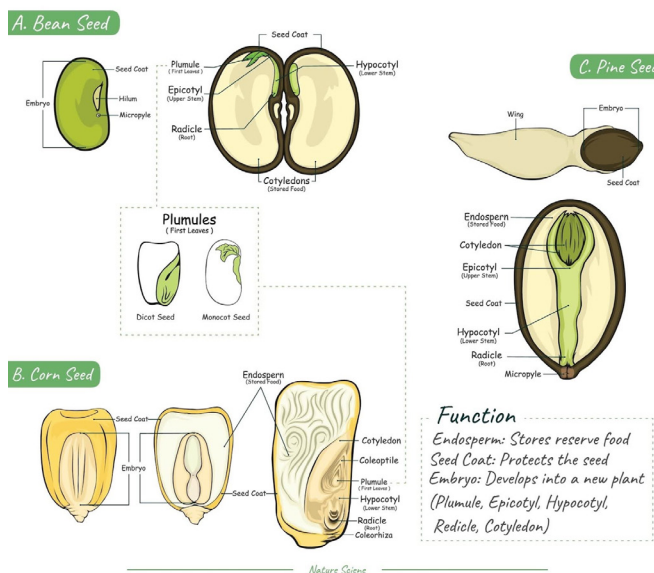
## Seeds

**Seeds** are living, hibernating embryos. They have a life span and survive longest if kept cool, dark and dry.

Most of our food plants and their seeds are either dicotyledons or monocotyledons (dicot or monocot).

The cotyledon is the nutrition reserve that a seed uses to power germination. Monocots have one cotyledon, and Dicots have two, as illustrated by the bean and corn seeds in the diagram[PD1].

### Structures of a Seed

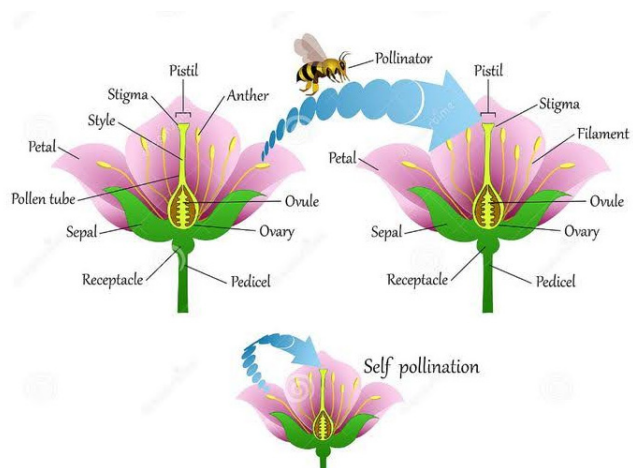


## Pollination

**Pollination** is the process of sexual fertilization in plants. The different methods a flower uses for pollination will determine how you care for seed saving, and the spacing or isolation necessary for plants to produce dependable seeds.

**Self-pollination** occurs without the need for other flowers or plants because it takes place within the flower before it opens. Isolation distance to prevent cross-pollination is not necessary unless insects invade the flowers.

**Perfect flowers** contain the stamens which produce pollen and the pistil which receives the pollen. Some self-pollinate. Others are self-incompatible, meaning they will not receive their own pollen.



## Pollination Considerations for Seed Saving

**Cross-pollination** takes place when pollen is exchanged between different flowers on the same or different plants. Cross pollination within the species you are seed saving is good and maintains genetic diversity. Cross pollination between different types of plants may cause unwanted characteristics and traits may result in the offspring.

- **Wind pollination** is pollen exchange caused by wind.
- **Insect pollination** is pollen exchange caused by insects, primarily bees.

Depending on the pollination strategy of the plant, different strategies to prevent or encourage cross-pollination are used.

**Isolation distance** to prevent unwanted cross-pollination is the distance between two different flowers necessary to prevent pollen from being exchanged. Isolation can be physical, in the case of caging or bagging, or time isolation, in which plants are stagger-planted to avoid the crossing of different varieties.



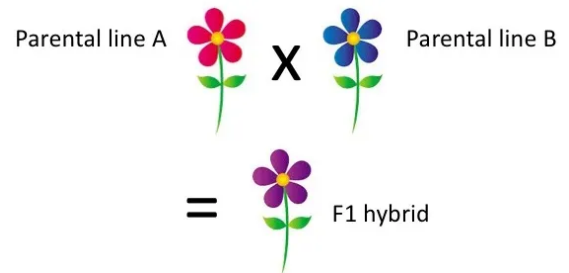
**Caging or bagging** is a separation technique where insects that might cause cross-pollination are prevented from reaching flowers by a fine net supported by wire or wood. If flowers in the cage are not self-pollinating, several plants must be included in the cage and pollinating insects introduced. Alternate day caging allows two plants or two groups of plants to be naturally pollinated by insects. Unwanted cross pollination is prevented because one plant or group of plants is caged one day and the other plant or group is caged the next.



**Inbreeding** can result from self-pollination or pollination between a small number of close relatives. Some vegetables show no signs of inbreeding depression even when self-pollinated for many generations and others show signs of inbreeding depression in first generation offspring.

## Hybrids vs. Open Pollinated Seed

**Hybrids** are varieties resulting from pollination between genetically distinct parents. The “F” in F1 hybrid stands for filial, another name for offspring. F1 means the first generation offspring after pollination. Depending on their genetic complexity, F1 Hybrids can be sterile or produce a majority of offspring unlike themselves.



**Open-pollinated** varieties are stable varieties resulting from the pollination between the same or genetically similar parents. Not hybrid.

We encourage you to check out some of the following resources to learn more about the differences between these types of seed.

**Seed Savers’ Blog on Hybrid, Heirloom, and Open Pollinated seed.**

<https://blog.seedsavers.org/blog/open-pollinated-heirloom-and-hybrid-seeds>

**High Mowing’s Blog on Hybrid and Open Pollinated Seed**

<https://www.highmowingseeds.com/blog/how-to-choose-open-pollinated-vs-hybrid-varieties/>

**Small Footprint Family’s clip of open pollinated, hybrid, and GMO seed**

<https://www.youtube.com/watch?v=p0jDXBcqRv4>

## ‘Root to Seed’ Seed Saving Strategy

**Root to seed** describes a technique used to produce seed for biennial crops, or ones that produce over a two year period. Biennial plants include carrots, parsley, hollyhocks, and more. The roots of the biennials are harvested in the fall, trimmed and stored for the winter. The following spring, the best roots are planted for seed production that season. When roots to biennials are left in the ground in the fall to produce seeds the following summer, the term seed to seed is used.



## Seed Selection

We make a distinction between selection characteristics and selection traits.

**Characteristics** are general features attributed to unidentified complexes of genes. Complex and hard to define, characteristics are often ignored by commercial breeders and offer the most rewards for home gardeners.

Characteristics can include:

*but are not limited to*

- Freeze tolerance, cold tolerance
- Regional adaptability
- Winter hardiness
- Early maturation
- Vigor
- Flavor

**Vigor** is a desirable characteristic that describes strong, vibrant germination and plant growth. Each home gardener can create his or her own list of selection characteristics.

**Traits** are specific features traceable to identifiable genes. For example, pea traits traceable to single genes include vine growth (bush or tall), seed texture (smooth or wrinkled) and disease resistance (fusarium, enation mosaic and powdery mildew resistance).

There are so many qualities to consider when selecting seeds it can be difficult to track. One thing you can do to mark a specific plant is to loosely tie a bright colored piece of yarn around it. This will allow you to remember which plants displayed traits like vigor when it's time to harvest seed. Be sure to keep an eye on the yarn as the plant grows so it doesn't get too tight and harm the plant. Alternatively, you can place small stakes in front of plants to mark them.

## Timing of Seed Harvest

**Viable** seeds are seeds that germinate and produce vigorous plants. Seeds should not be harvested before they have matured enough to be viable. Learning the life cycle of your seeds well enough to understand their timing is important.

**Dehiscent seed capsules** are open and discharging seeds. Seeds must be harvested before this stage takes place and seeds are lost. Seed capsules in some varieties literally explode at the point of maturity. It is not uncommon to have only a few capsules out of hundreds, mature at any one time.



## Processing and Cleaning Seed

Cleaning and separating seeds from chaff is not difficult for small, home garden needs. Often, a little extra time taken during harvest to shake seeds out, one capsule at a time, results in completely clean seeds that need no processing. For home garden needs, separating seed from chaff may not even be necessary. The **wet processing method** is used for seeds that are embedded in the damp flesh of fruits, or berries, and **dry processing** is used for seeds that emerge from pods or husks.

## Wet processing

Wet processing involves three steps; removal of seed from the fruit, washing the seed, and drying. Large fruits are cut open and seeds are scraped out. Small fruits are crushed or mashed. Some seeds need to ferment in their fruit for best germination.

During fermentation, microorganisms such as bacteria and yeast kill many of the seed-borne diseases that can affect the next generation. *Do not add water* to the fermentation mix.



### Cleaning

For most fruits, add seeds and pulp to a large bucket, adding twice as much water as the volume of seeds and pulp. Viable seeds tend to be denser and sink to the bottom. The debris and hollow seeds can be poured off. Repeat until clean, then strain.

### Drying

Dry the seeds on a non-stick surface. It is important to dry them relatively quickly, to avoid germination or mold. Spread the seeds as thinly as possible and stir several times during the day. Seeds should not dry above 95 degrees, or 85 degrees for dark colored seeds.

*Window screens can be an excellent choice to dry seed, depending on the size of the seeds.*



## Dry processing

It is best to let the whole plant dry in the garden, although sometimes in cold climates the whole plants are harvested before the first hard frost and hung in a shed that doesn't freeze. The seeds can continue to mature.

**Flailing or threshing** is the process of fracturing or crushing seed pods in order to free the seeds. This can take the form of everything from simply rubbing broccoli pods between hands to walking over bean vines.

**Winnowing** is an ancient technique used to clean seeds. Seeds and chaff are poured through moving air which blows the lighter chaff aside, allowing the heavier seeds to be collected below.

### Cleaning Screens

Screens with different-sized openings are used to separate seeds from chaff. The screen number denotes the number of openings that will cover a one inch line. A screen is selected with openings just large enough to let seeds drop through without the chaff or as in the case of larger seeds, a screen selected to allow the chaff to drop through without the seeds.





# HOT WATER TREATMENT TO MINIMIZE DISEASE

From Suzanne Ashworth, Seed to Seed

Hot water treatment can prevent the seed-borne phases of some diseases, such as black rot, black leg, and black leaf spot in the cabbage family, bacterial canker and target spot in tomato, downy mildew in spinach, and Septoria spot in celery.

## TOOLS

- Accurate thermometer
- Frying pan
- Saucepan
- Sieve



## Instructions

Heat water in the saucepan to 50 C, 122 F. Pour a little water into the frypan, leaving the saucepan about 2/3 full. Set the saucepan into the water in the frypan.

Regulate the temperature of the water in the saucepan by either turning up the heat on the frypan or taking the saucepan out of the frypan. When the desired temperature can be steadily maintained, pour in the seeds, stir until they are all wetted, not floating, then stir gently through the whole process.

## Treatment Times

Cole crops (broccoli, brussels sprouts, kale, Chinese cabbage)	20 minutes at 50 C
Eggplant, Spinach and turnip	25 minutes at 50 C
Cauliflower	25 minutes at 52 C
Tomatoes	25 minutes at 55 C

Sieve, dry away from direct sunlight and store.

## Seed Storage

The successful storage of seeds requires cool, dark, and dry conditions. Put seeds in plastic bags for separation and labeling before putting the plastic bags into air-tight, glass jars to be stored. Note: plastic bags alone do not protect against moisture, especially in potentially moist locations like refrigerators or freezers. Allow jars that have been stored in the refrigerator or freezer to warm to room temperature before opening to prevent moist air from condensing on the inside walls of the jar.

**Keep Them Cool:** Storage conditions are best if seeds are kept below 50° F.

**Dark:** Absolute darkness is best. However, seed storage is adequate if direct sunlight or bright, artificial light is avoided.

**Dry:** Dryness is the most important factor in the long-term storage of seeds. Optimum levels should be below 9% moisture. Most vegetable and flower seeds will store more than one year without special protection. Silica gel can be purchased for prolonged storage in humid climates.

If your seeds have ‘flex’ they are not dry enough. They need to break or shatter, indicating that they are dry enough.



## Your Seed Saving Journal

It's important to keep good records of your seed saving efforts. Note the dates planted, days to maturity, and days of harvest, as well as other observations. This will help you select the traits and characteristics you want to carry on to the next generation. This information should be on the label of your stored seeds. Traits you may want to note in your journal:

- |   |                            |                         |
|---|----------------------------|-------------------------|
| • Vigor                                   | • Stockiness               | • Flavor                |
| • Earliness                               | • Hardiness                | • Flesh Characteristics |
| • Trueness-to-type                        | • Lateness to Bolt         | • Size and Shape        |
| • Disease and Insect Resistance           | • Color                    | • Productivity          |
| • Tolerance to Drought or Excess Moisture | • Uniformity or Lack of It | • Storage Ability       |

There are so many qualities to consider when selecting seeds it can be tough to keep track. One thing you can do to mark a specific plant is to loosely tie a bright colored piece of yarn around it. This will allow you to remember which plants displayed traits like vigor when it's time to harvest seed. Be sure to keep an eye on the yarn as the plant grows so it doesn't get too tight and harm the plant. Alternatively, you can place small stakes in front of plants to mark them.

## Reacquiring Genetic Diversity:

If your plants are not as strong or not producing as well as they have been you may need to bring in more genetic diversity. Purchase more seeds or reach out to the Seed Savers Exchange or the last known seed company to carry that type.

## THE FESTIVALS OR FAIRS OF NATIVE SEEDS

By Alvaro Mena

In Mexico, many towns have been working for several decades on Native Seed Festivals. They are events organized by communities that have their deep roots in the importance that these celebrations and gatherings have for the towns. They are organized with various objectives, but they all share the objective of conserving native seeds through exchange, and the diversification of the cornfields. In this way the seeds are strengthened and diversification is kept alive.

These events are the prelude to rebellion against an agri-food system that seeks to impose its industrial production techniques, its patented seeds, its chemical fertilizers and herbicides, its way of extracting water, and its lack of respect for the soil, the skin of the Mother Earth. After being at the seed festival, the farmers return to their communities and in open rebellion to that system, they sow their own seeds, with their own techniques and their inherited wisdom. In this sense, the Native Seed Festivals become a public demonstration of a political position, a grassroots demonstration of anti-capitalist Indigenous community building and power.

These meetings are also to remember the importance of the relationship of respect with Mother Earth, to practice and commit to the ceremonies that shelter the cornfield, the ceremonies that are the relationship of respect with what surrounds us, a reciprocal respect, a respect that honors the community of nature and ourselves.

At the beginning of the seed festivals, a ceremony is held to ask the four cardinal points that they fulfill their function of generating life.

At the same time, it is a commitment that the necessary care will be given to make it so. And, like every cycle that begins, it must be closed

When you exchange a seed at these festivals, you not only exchange the grain, but with it you take the wisdom about when to plant it, in what type of soil, if it requires a lot or little rain, if you have to put the seed in a particular position. These are also technical, productive exchanges. In the end it is food and if there is enough of it, there is life in abundance.





# INDIGENOUS FIRE IN AGRICULTURE



Across Turtle Island, we have always used fire to cultivate abundant food systems, recognizing Indigenous Fire in Agriculture

Across Turtle Island, we have always used fire to cultivate abundant food systems, recognizing the renewal of life that fire creates. After generations of colonial fire suppression, our people are renewing our responsibilities to bring fire back to the land. It is challenging, often involving educating colonial land ‘management’ institutions, and ensuring that our position as original and primary caretakers is honored, but our people are unrelentingly carrying this important work forward. Organizations such as the Cultural Fire Management Council and the Indigenous Peoples Burning Network have been leading the way, offering training and support to other Nations as well as fire departments and the US Forest Service. Across Turtle Island, people are renewing their homeland ecologies and responsibilities by returning fire to the land.

Cultural burning encourages diverse native plants to thrive, and it creates a landscape that is more resilient to wildfire, which is becoming more common due to climate change. Damon Panek, Wildland Fire Program Manager for the Fond du Lac Band of Lake Superior Chippewa shared, “Bringing fire back to this landscape isn’t just about the ecological benefits. For us, burning is about fulfilling our role in the relationship we have with the land. We’re doing this for our culture, our identity and our way of life.”



Traditional burning is not only done to encourage the growth of berries, basket plants, herbs and shrubs, and renew the forage for animals, it is also done to prepare the land for planting. Burn regimens reduce weed pressure, manage parasites and plant diseases, and add immediately available nitrogen, phosphorus, and other nutrients into the soil.



Indigenous farmers are exploring the use of fire once more to support traditional agriculture. The Giiwekii Project, an intertribal effort organized by the Great Lakes Lifeways Institute, is working to bring Anishinaabe flint corn back to Madeline Island, while breeding a new, climate adaptive flint, guided by traditional teachings and responsibilities. Damon Panek, now with the Red Cliff Band of Lake Superior Chippewa, is contributing knowledge of fire and strategy to support the Giiwekii Project’s future plans to return fire to the land as a part of the revitalization of corn agriculture on the Island, working with traditional fire to create healthy agricultural landscapes.

# ANIMAL RELATIONS



Traditional rangeland management relied on fire to open pasture for many reasons, including creating new growth and forage for our animal relatives. As Madeline Theriault, Anishinaabe from Bear Island, wrote:

*“White man makes a farm to grow hay to feed his animals...Indians also feed their animals, only in a different way. Around the middle of April, the Indian looks around to find a bare spot, mostly up on the rocks where the snow goes first, where there is still a lot of snow at the bottom of the hill. They set a match to this bare spot and only burn where it is dry and bare, so there’s no danger of a big forest fire because the fire stops when it reaches the snow. Two years later you would find a big patch of blueberries in amongst the bushes. And you would see all the hungry animals feeding on those blueberries....After a few years, young trees would grow...then the rabbits would get to feed from those young bushes. In later years, the little trees would get bigger. Then the moose and deer get to feed from it. So, you see the setting of these small fires can go a long way in feeding many animals.”*

People of the prairies and grasslands in Turtle Island would also set fire to renew the forage, to attract bison, deer, and others to the fresh plant growth that would bloom in the wake of the fire. People, fire, plants, and animal relatives have always supported one another. When colonial forces sought to destroy the bison, the prairie ecosystem suffered due to their loss. Bison grazing dramatically increases the biodiversity of the grasslands. Bison graze in mosaic patterns, and as they do, allow for the slower growing, flowering plants to thrive and provide food for others. Their waste fertilizes the soil, and their hooves aerate it, resulting in stronger plant growth and richer soil. They also wallow, creating depressions in the earth that create damper microclimates in the prairie, cultivating even more diversity. Researchers have noted that simply restoring bison to prairie ecosystems begins the restoration of native grasses and biodiverse prairie life.

Today, our Nations all across Turtle Island are working to restore relations with bison and the other animal relatives we rely upon; a slow restoration of our people and the balance of life. The Intertribal Buffalo Cooperative supports much of this work within the colonial United States. They are a cooperative of 80 tribes in 20 different states that facilitates the management of over 20,000 buffalo over a million acres of land. They support Tribes to establish and care for herds, engage in contemporary trade, including technical assistance, cold storage, processing, marketing, youth development, and land restoration, among much more. The Rosebud Sioux Tribe, through the Sicangu Community Development Corporation, has developed the Wolakota Regenerative Buffalo Range. They have a herd of over 1,200 plains bison on 28,000 acres of prairie, providing not only food for the people, but spiritual, cultural, and ecological restoration. Wizipan Little Elk, project manager, shared,

*“We are going to ensure the buffalo are taken care of in a way that is culturally appropriate. Part of our instructions are to treat buffalo as buffalo. Don’t treat them like cattle.... We have to make sure they have big open spaces to use the land how they need to. It also means our buffalo will never see a feedlot. When we harvest them, it will be done in a culturally appropriate manner where we pray with them, honor who they are in their spirit and make sure that we are not wasting anything.”*



This work is bringing the world back into balance, and is a strong part of building the seeds for our renewed, spiritually responsible Indigenous economies.

## **Caring for Our Relatives Well**

Honor of our animal relatives and the land can be carried into how we raise domestic animals as well. Industrialized agriculture has created a system in which animals are often raised in abusive conditions; not afforded freedom, care and honor. This system not only is harmful to the spirits of the animals themselves but also our own. Cattle, sheep, goats, and poultry can be raised as relatives in the circle of life with us, and can be raised in a way that contributes to the health of our Mother Earth. Indigenous design practice mirrors Creation and the balance of the natural world to cultivate healthy systems that contribute to the regeneration of life. This is applied to our animal relationships as well. Domestic animals have ancestral homelands and habitats that should be re-created in order to raise vibrant, healthy animals. Chickens, for example, come from woody forested habitats with diverse plant life, and thrive when this environment is re-created for them. Rabbits live naturally in family warrens, with tunnels and burrows; an environment that can be created in a domestic context. And, of course, grazers such as cattle naturally belong on open pasture.





## Regenerative Grazing

Grazing of livestock can be done in a manner that is damaging, or in a way that contributes to the health of a thriving ecosystem. Regenerative grazing (also called rotational or prescribed) grazing is a method that, unlike allowing Indigenous grazers to roam extensive lands, contains and rotates domestic animals through different pastures to improve soil, plant and animal health. This practice allows lands to rest, more groundcover to be maintained, and plants to regenerate between grazings, while distributing manure spread throughout the pastures to establish deeper roots. Deep rooted plants improve soil health, structure, and fertility, while also creating resistance to erosion, drought, and climate shifts.

This method also lowers expenses for farmers, increasing the availability of feed through forage rather than needing to rely on purchased feed, and also is known to sequester carbon by keeping it in the ground.

Regenerative grazing does take more care, and awareness of ecological life. In order to plan a grazing pattern that enhances and regenerates the life in the land, the farmer needs to be aware of the amount of leaf production at different times, and managing grazing to maintain a good groundcover, to support full recovery of grazed plants before the next grazing period. The farming decision makers take an adaptive and flexible approach to grazing, managing for positive changes and noting feedback from the animals and the land. It is an approach that supports the engaged and living relationship between people, land, and all life.



Changes that can be adapted include, among other considerations:

- Shape of grazing pasture or paddock
- Size of grazing pasture or paddock
- Stock density (number of animals grazing an area)
- Duration (length of time an area is grazed)
- Intensity (amount of plant remaining after grazing)
- Frequency (how often it is grazed)
- Time of year

Other considerations, based on what type of farm you have, include what type of grazing animal to rotate (cattle, sheep, goats, etc.) and the age and stage of the animals themselves, whether they are young and growing, mature, pregnant, or lactating

## The Importance of Planning

In the adaptive work of regenerative grazing, journaling and planning is important. A regenerative grazing management plan should include: needing to rely on purchased feed, and also is known to sequester carbon by keeping it in the ground.

### Goals

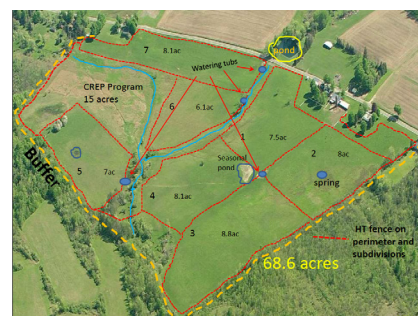
- It is important to identify your purpose in the work. These goals can serve as guideposts and points of encouragement.

### Support System

- Who can you reflect with about this work, as thought partners and as supporters?

### Maps

- It is important to have aerial and soil maps, in order to design and plan. You can sketch in your ideas on infrastructure, note forage types, and more.
- Google Maps, and Google Earth are good sources of aerial maps. Your local USDA Natural Resources Conservation Service offices can also help provide maps.
- Soil maps are helpful, as soil differences often explain why some areas of land are more productive than others. The USDA Web Soil Survey is a good source for soil maps.



### Infrastructure

- What is your existing infrastructure, such as fences, corrals, ponds, etc.?

### Existing forage types and production seasons

### Grazeable acres

### Potential stocking rates

- How many animals can be rotated on different pastures?

### Any additional equipment or infrastructure needs

- With the practice of rotating animals used in regenerative grazing, temporary fences are typically required. Temporary electric fencing, using a few geared reels with polywire, fiberglass or step-in posts, and a fence charger can be a simple solution. fences are typically required. Temporary electric fencing, using a few geared reels with polywire, fiberglass or step-in posts, and a fence charger can be a simple solution.

### Identified limiting factors

- What are potential challenges and what are some thoughts of how to manage those challenges?

### Scale (remember to start small, learn, and grow from there!)

## Poultry

Poultry (chickens, turkeys, and ducks) thrive in a canopy of trees and woody perennials. The trees protect them from the elements and predators, and they return fertilizer to the soil. Combine this with working with fruit and nut producing trees and the cycle of regeneration and farm abundance is created.

### Tree-Range Farms and the Regenerative Agriculture Alliance

Reginaldo Haslett-Marroquin is a visionary Indigenous Mayan farmer, originally from Guatemala, now living in the northern region colonially named Minnesota. He and a team of supporters over many years, developed a model regenerative practice based on Indigenous understandings for larger scale poultry production. This work launched as [Tree-Range Farms](#), and expanded to include [Salvatierra Farms](#).

Each poultry flock or “unit” includes 1,500 chickens, a barn and 1.5 acres of land divided into two fenced-in areas, or paddocks. The birds spend days outside in paddocks filled with rows of hazelnut trees and perennial shrubs such as elderberry and comfrey. At Salvatierra Farms, this environment features an understory of hazelnuts and elderberries, an overstory of oaks, maples, and basswood, and a ground level covered with forages. The birds are fed outside to encourage them to spend time roaming the paddock eating plants and insects. The farms produce tree crops and healthy, vibrant poultry, while building the soil and the ecological balance.



Understanding that healthy transformations require ecosystem like networks, Reginaldo also founded the [Regenerative Agriculture Alliance](#), (RAA) which designs, deploys, and manages a regenerative poultry-centered ecosystem to bring wealth back into the hands of farmers, entrepreneurs, and workers. They also offer [regenerative poultry production training and consulting](#). The RAA is a connecting hub for over 40 farmers, funders, government agencies, non-profits, and operating partners, providing business development, technical assistance, and poultry processing services. As a collective ecosystem, the farms all operate under a standardized regenerative agriculture design, publicly branded as Tree-Range®.

As a regenerative design, it is able to be adapted to the ecologies and specific environments of each farm. The birds go to their small poultry processing facility, and the farmers then choose whether to offer them under the Tree-Range label or not. If they opt to sell them under the Tree-Range label, storage, distribution, and marketing are taken care of. This shared infrastructure helps small farmers survive and thrive, and the collective wealth-sharing model is inspiring large and small farmers across the country to re-envision the way that we engage with all our relations within the food system.





# OUR COMMUNITY RELATIONSHIPS



Caring for one another as people in good relation to our food ecosystems is also central to regenerative agriculture. This includes caring for your heart, mind, and body, honoring our sources of life and the balance of Creation. This also includes caring for our traditional teachings and the new teachings we are bringing in, and the agreements we make with each other about how food production, trade and distribution should happen. The work at the Regenerative Agricultural Alliance is a clear demonstration of how we can re-vision our community food ecosystems. All of this work is ultimately in service of supporting the re-development of our food sovereign Indigenous Nations, healing from the disruption and disconnection caused by colonial violence.

## Food Sovereignty

Food sovereignty is simply the right to determine our own sustainable food systems. The term was originally created by the powerful agricultural movement organization [La Via Campesina](#). Food sovereignty refers to our ability to determine what foods are available for our communities, how those foods are grown, processed, and distributed, the way that food trade happens, and the well being of workers. Restoring our food sovereignty must be a focus as we build decolonial and just economies. The First Nations Development Institute has put together a [Food Sovereignty Assessment Tool](#) for Indigenous communities and Nations to guide food sovereignty strategy mapping.

Food Sovereignty mapping can include:

1. Uplifting traditional foods, the health of traditional foods, and identifying what needs to be done to support these sources of life and keep our relationship with them strong? Is it protecting and preserving seed? Revitalizing traditional burn practices? Remediating contaminated land or water?
2. Identifying the local 'foodshed' or regional food sources and potential food sources. In the globalized economy, our foodshed is often a global foodshed. We can also map what foods necessary for healthy nutrition are or could be produced as locally as possible.
3. Identifying the value chain: In order to have self-determination of our food systems, we need to be engaged in every aspect. This includes:
  - Inputs: Healthy Land and Water, Seed, fertilizer, machinery, irrigation, energy
  - Production: Sorting, packaging, energy, materials
  - Processing/distribution: manufacturing, preparing, packaging branding, transportation, storage
  - Markets: farmers markets, Community Supported Agriculture programs, local shelf space, grocery stores, food services
  - Consuming: Homes, restaurants, institutions, events.



Food sovereignty requires working across the entire ecosystem of food, from cultivating ecologies, plants, animal, and humans relationships, to shifting policy, economic models, and structural barriers to allow self determination of our communities.

## The Oneida Example

The Oneida Nation has been working to build their food sovereignty for many years. They have established the Oneida Community Integrated Food Systems program, which integrates an orchard, cash crop farm producing wheat, soy, corn, and alfalfa, a buffalo herd and cattle operation, aquaponics, a farmers market, where local farmers, gardeners, and value-added producers can sell, a processing facility, cannery, Tsyunhehkwa, an 83 acre certified organic farm, raising traditional crops and organic produce, chickens, a cannery and retail store that focuses on making culturally important traditional foods and plant medicines available to the community. The Oneida are also restoring wetlands for wild rice beds.

A vision of many of our people across Turtle Island is the revitalization of not only our local and bioregional food systems, but the networking of our people together to create and manage and Indigenous food trade, from production, processing, packaging, distribution, as well as international trade. Our people have been working on planting the seeds for this both through the colonial food system as it is set up now, to gain advancements for our sovereignty, and on grassroots, community networked levels.

[Makoce Agriculture Development](#), out of the Oglala Lakota Nation, is one of those Indigenous organizations leading the way, building a networked ecosystem of innovative farmers, chefs, and educators who are re-indigenizing our food systems. Makoce hosts five programs, an Oceti Sakowin Food System Alliance designed to bring together community members to strategize and advocate, a regenerative production farm producing poultry and produce, a hemp production facility, creating a location for hemp materials processing and training facilities, a Food System Institute, ensuring that training and education are offered within the region, and lastly, a Food Hub, designed to support a processing facility and infrastructure to allow food system leaders to gather, grow, and distribute their products to communities across the reservation and beyond. Indigenous food hubs, centered within our unique bioregions, hold great promise to be an organizing model that can bring our diverse Nations together to build our power and abundance.

Indigenous people were also strongly organized within the colonial US to influence the 2018 US Farm Bill in ways that opened up new possibilities for our Nations. The 2018 Farm Bill was renewed for 2024. Many of the Tribal provisions in the Farm Bill reinforced and expanded our food sovereignty, acknowledging our right to manage federal food distribution, purchase traditional and locally grown food for federally mandated food distribution, and manage our own forestry and rangeland. The Bill also supported opportunities for Tribes to expand trade internationally, expand traditional and local food production through training, financing, and policy support, and acknowledgment of the right of Tribes to grow, market and distribute hemp. The Native Farm Bill Coalition released a [2022 report on the impact of the bill](#).





# CONCLUSION



Our peoples' work to grow our unique Indigenous and sovereign food systems is building our power in remarkable ways. We are modeling what a thriving and spiritually responsible food system looks like, based on our traditional foods, while incorporating contemporary food relationships and techniques. Through centering our teachings and values, we are able to heal our hearts and spirits while tending to our food relatives. The powerful work we are doing to educate, network, and re-establish intertribal trade cooperatives across colonial borders, developing partnerships for the repatriation of resources back to our food systems is laying the groundwork for our future abundance as interconnected and renewed Nations.

# APPENDIX I: RESOURCES



## INDIGENOUS AGRICULTURAL SUPPORT

### **Intertribal Agriculture Council**

Hub for information, training, legal, networking and resourcing Indigenous producers, including producer maps.

<https://www.indianag.org>

### **Traditional Native American Farmers Association**

Seed bank, regenerative agriculture course

[www.tnafa.org](http://www.tnafa.org)

### **Native American Food Sovereignty Alliance**

Indigenous Seedkeepers Network, Native chef support, mentorship

[www.nativefoodalliance.org](http://www.nativefoodalliance.org)

### **Indigenous Food and Agriculture Initiative**

IFAI provides Tribal governments, producers, and food businesses with educational resources, policy research, and strategic legal analysis as a foundation for building robust food economies.

<https://www.indigenousfoodandag.com>

### **Native Farm Bill Coalition**

Native Agriculture policy advocate in the colonial US

<https://www.nativefarmbill.com>

### **Hopi Tutskwa Permaculture**

Indigenous Grower training program

<https://www.hopitutskwa.org/education>

### **Native Farm to School Planning and Development**

First Nations Development Institute

<https://www.firstnations.org/projects/native-farm-to-school/>

### **Indigenous Seedkeepers Network**

Indigenous Seedkeepers Network provides training in seedkeeping, developing a curriculum and toolkit, and actively working to rematriate our traditional seeds that have been taken out of our communities.

<https://sierraseeds.org/indigenous-seedkeepers-network/>

### **Makoce Agriculture Development**

<https://makoceag.org/>

## INDIGENOUS AGRICULTURAL SUPPORT

### Sovereign Seeds

Indigenous seed sovereignty, training, research, based in colonial Canada

[www.sovereignseeds.org](http://www.sovereignseeds.org)

### Food Sovereignty Assessment Tool

First Nations Development Institute

<https://www.firstnations.org/publications/food-sovereignty-assessment-tool-2nd-edition/>

### Soul Fire Farms' Food Sovereignty Action Steps

[Soul Fire Food Sovereignty Action Steps](#)

### Cultural Conservancy's Seed Rematriation Film Resource

<https://www.nativeland.org/seed-rematriation>

## COMPOSTING

### Composting Council

Resource on larger, community scale and commercial scale composting

<https://www.compostingcouncil.org/>

### Institute for Local Self Reliance

Resource on community/nation/commercial composting

<https://ilsr.org/composting/>

## HEIRLOOM SEED COMPANIES

There are many more than listed here. We encourage you to support your local seed company.

Alliance of Native Seedkeepers

<https://www.allianceofnativeseedkeepers.com/>

Seed Savers Exchange

[www.seedsavers.org](http://www.seedsavers.org)

Botanical Interests

[www.botanicalinterests.com](http://www.botanicalinterests.com)

Peaceful Valley Farm

[www.groworganic.com](http://www.groworganic.com)

Johnnys

[www.johnnyseeds.com](http://www.johnnyseeds.com)

Territorial

[www.territorialseed.com](http://www.territorialseed.com)

Migardener

[www.migardener.com](http://www.migardener.com)

Native SeedSEARCH

[www.nativeseeds.org](http://www.nativeseeds.org)

Bountiful Gardens

[www.bountifulgardens.org](http://www.bountifulgardens.org)

Heritage Harvest Seed

<http://heritageharvestseed.com/>

Nichols Garden Nursery

[www.gardennursery.com](http://www.gardennursery.com)

Ronnigers Potato Farm

[www.ronnigers.com](http://www.ronnigers.com)

Vermont Bean Seed Company

[www.vermontbean.com](http://www.vermontbean.com)

Victory Seed Company

<http://victoryseeds.com>



## PEST MANAGEMENT

Rodale Institute

<https://rodaleinstitute.org/why-organic/organic-farming-practices/pest-management/>

Beyond Pesticides

<https://www.beyondpesticides.org>

## INDIGENOUS KELP FARMING

Native Conservancy

[www.nativeconservancy.org](http://www.nativeconservancy.org)

Shinnecock Kelp Farmers

[www.shinnecockkelfarmers.com](http://www.shinnecockkelfarmers.com)

## ANIMAL RELATIONSHIPS

Regenerative Agriculture Alliance

Tree-Range Poultry Training

[www.regenalliance.org](http://www.regenalliance.org)

Rodale Institute

[www.rodaleinstitute.org](http://www.rodaleinstitute.org)

The Pasture Project

Regenerative Grazing Support

<https://pastureproject.org/about-us/our-work/>

## US FUNDING

Native American Agriculture Fund

<https://nativeamericanagriculturefund.org>

Regenerative Agriculture Foundation

<https://regenerativeagriculturefoundation.org/our-grants/#grantmaking>

Ambrook List of Ag Funding for Native Americans

<https://ambrook.com/funding/audience/native-americans>

USDA Indigenous Animals Grant

Designed to support the priorities of Tribal Nations in meeting the needs of traditional harvesting methods and indigenous animals. This project intends to fund projects which invest in Tribal Nations' supply chain resiliency, indigenous animals, restoring local indigenous food systems, and indigenous processing methods, and expanding local capacity for the harvesting, processing, manufacturing, storing, transporting, wholesaling, or distribution (communal or commercial) of meat, poultry, seafood, and other animals that provide culturally appropriate food and food security to tribal communities

<https://www.usda.gov/iag>

## CANADA FUNDING

FCC Canada

<https://www.fcc-fac.ca/en/financing/agriculture/indigenous.html>

Investment Agriculture Foundation

<https://iafbc.ca/ifsap/#:~:text=The%20IFSAP%20program%20provides%20funding,the%20agriculture%20and%20food%20sector.>

Indigenous Peoples' Resilience Fund

<https://communityfoundations.ca/initiatives/indigenous-peoples-resilience-fund/>

Manitoba Indigenous Food Systems Fund

<https://www.gov.mb.ca/scap/indigenouagri/indigenous-food-systems.html>

Indigenous Agriculture and Food Systems Initiative

<https://agriculture.canada.ca/en/programs/indigenous-agriculture-food-systems-initiative/guide#:~:text=AAFC%20has%20developed%20the%20Indigenous,who%20want%20to%20build%20their>

## RESOURCES FOR MEXICO

Programa de Producción para el Bienestar

<https://www.gob.mx/agricultura/acciones-y-programas/convocatorias-avisos-y-documentos-del-programa-produccion-para-el-bienestar>

Programa de Fomento a la Agricultura, Ganadería, Pesca y Acuicultura

<https://www.gob.mx/agricultura/acciones-y-programas/programa-de-fomento-a-la-agricultura-ganaderia-pesca-y-acuicultura-292335>

Programa de Precios de garantía a Productos Alimentarios Básicos

[https://www.dof.gob.mx/nota\\_detalle.php?codigo=5639906&fecha=31/12/2021](https://www.dof.gob.mx/nota_detalle.php?codigo=5639906&fecha=31/12/2021)

Programa de Abasto Rural

<https://sidof.segob.gob.mx/notas/5639067>

Redes Alternativas Alimentarias (Conabio)

<https://www.biodiversidad.gob.mx/diversidad/alimentos/consumidor-responsable/want%20to%20build%20their>

# APPENDIX II



## SEED SAVING

These vegetables are the simplest to achieve successful seed saving. They produce seed the same season as planted and are mostly self-pollinating, minimizing the need to be mindful of preventing cross-pollination.

### BEANS

**PLANT:** Although, ideally, different varieties should be separated by 150 feet or another crop flowering at the same time, we rarely observe cross-pollination even when two varieties are grown next to each other.

**FLOWER:** Beans produce perfect, self-pollinating flowers. Cross pollination by insects is possible but rare as pollination occurs before the flower opens. Because the anthers are pushed up against the stigma, automatic pollination is assured when the anthers open.

**SELECTION TRAITS:** Most commercial breeders favor bush varieties which can be mechanically harvested and fibrous bean pods which hold up during harvest and shipment. Pole varieties are more suited to small, home gardens because they produce more beans in a smaller space. Because vines are off the ground beans are easier to pick and away from the settling cold air of unexpected frosts.

#### WHAT TO NOTE:

Pole or Bush	Pod edibility: Little or no fiber, Stringless
Seed color	Pod, foliage and flower color

**HARVEST:** Allow pods to dry brown before harvesting, about six weeks after eating stage. If frost threatens, pull entire plant, root first, and hang in cool, dry location until pods are brown.

**PROCESS:** Small amounts of pods can be opened by hand. Flail larger amounts. Remove large chaff by hand or fork. Winnow remaining particles.

### LETTUCE

**PLANT:** Separate varieties flowering at the same time by at least 20 feet to ensure purity.

**FLOWER:** Lettuce produces perfect, self-pollinating flowers. Each flower produces one seed. Flowers are grouped in little heads of 10-25 flowers all of which open at once for as little as 30 minutes. Anthers are fused together into a little cone that completely surrounds stigma and style. Style is pushed up through anther cone and is coated with its own pollen. Note: Mature head lettuce may need a slit (two or three inches deep) across the top to encourage flowering.

#### WHAT TO NOTE:

Leaf color	Leaf shape
Seed stalk formation	Bolt resistance
Seed color	



**HARVEST:** Some outside leaves can be harvested for eating without harming seed production. Allow seed heads to dry 2-3 weeks after flowering. Individual heads will ripen at different times making the harvest of large amounts of seed at one time nearly impossible. Wait until half the flowers on each plant has gone to seed. Cut entire top of plant and allow to dry upside down in an open paper bag.

**PROCESS:** Small amounts of seed can be shaken daily from individual flowering heads. Rub with hands to remove remaining seeds. If necessary, separate seeds from chaff with screens.

## PEAS

**PLANT:** Ideally, different varieties need to be separated 50 feet or with another crop flowering at the same time. However, in cool regions there is rarely cross-pollination even when two varieties are grown next to each other.

**FLOWER:** Peas produce perfect, self-pollinating flowers. Cross-pollination by insects is possible but rare because pollination occurs before the flower opens. Because the stigma does open before pollen is ready crosses theoretically could occur.

### WHAT TO NOTE:

Most commercial breeders prefer bush varieties with pods that ripen simultaneously in order to facilitate commercial harvesting. Tall varieties produce more peas in small, home gardens.

Plant Growth: Tall or Bush

Seed Shape: Round seeds germinate better in cold weather

Pod Edibility: lack of fibers on the inside of the pod

Pod shape

**HARVEST:** Allow pods to dry brown before harvesting, about four weeks after eating stage. If frost threatens, pull entire plant, root first, and hang in cool, dry location until pods are brown.

**PROCESS:** Small amounts of pods can be opened by hand. Flail larger amounts. Remove large chaff by hand or fork. Winnow remaining particles.

## CHILI PEPPERS

**PLANT:** Most home gardeners will get satisfactory results if different varieties are separated by 50 feet and another tall, flowering crop.

**FLOWER:** Peppers produce perfect, mostly self-pollinating flowers. Solitary bees will pollinate if a more desirable pollen is not available in the area.

### WHAT TO NOTE:

Flavor

Color of Pod

Heat

**HARVEST:** Harvest mature, fully-ripe peppers for seed. (Most bell peppers turn red when fully mature.) If frost threatens before peppers mature, pull entire plant and hang in cool, dry location until peppers mature.

**HARVEST:** Harvest mature, fully-ripe peppers for seed. (Most bell peppers turn red when fully mature.) If frost threatens before peppers mature, pull entire plant and hang in cool, dry location until peppers mature.

**PROCESS:** There are two methods, dry and wet, to process pepper seeds. The dry method is adequate for small amounts. Cut the bottom off the fruit and carefully reach in to strip the seeds surrounding central cone. In many cases, seeds need no further cleaning. To process the seed from large amounts of peppers, cut off the tops just under the stem, fill a blender with peppers and water and carefully blend until good seeds are separated and sink to bottom. Pepper debris and immature seeds will float to the top where they can be rinsed away. Spread clean seeds on paper towel and dry in cool location until seed is dry enough to break when folded.

## **TOMATO**

**PLANT:** Separate varieties with short styles (most modern varieties) by at least 10 feet. Varieties with long styles (heirlooms and older varieties) need at least 100 feet to ensure purity. If solitary bees are prevalent, separate all varieties at least 100 feet and place another flowering crop between.

**FLOWER:** Tomatoes produce perfect, self-pollinating flowers. Anthers are fused together into a little cone that rarely opens until pollen has been shed and the stigma pollinated. (Older varieties with wild tomatoes or *L. pimpinellifolium* in their genetic ancestry may have stigmas that stick out beyond the cone containing the anthers. Varieties with this trait can be identified by looking closely at mature flowers and need to be treated accordingly.)

**WHAT TO NOTE:** Tomato is the most popular vegetable in America and hundreds of the genes have been mapped. Those of immediate importance for home gardeners include:

Plant size Determinate, bush, or dwarf varieties

Leaf Shape

Disease

Ripening

Fruit color

**HARVEST:** If possible, allow tomatoes to completely ripen before harvesting for seed production. Unripe fruits, saved from the first frost, will ripen slowly if kept in a cool, dry location. Seeds from green, unripe fruits will be most viable if extracted after allowing the fruits to turn color.

**PROCESS:** Cut the tomato into halves at its equator, opening the vertical cavities that contain the seeds. Gently squeeze out from the cavities the jelly-like substance that contains the seeds. If done carefully, the tomato itself can still be eaten or saved for canning, sun-drying or dehydrating.

Place the jelly and seeds into a small jar or glass. (Add a little water if you are processing only one or two small tomatoes.) Loosely cover the container and place in a warm location, 60-75° F. for about three days. Stir once a day.

A layer of fungus will begin to appear on the top of the mixture after a couple of days. This fungus not only eats the gelatinous coat that surrounds each seed and prevents germination, it also produces antibiotics that help to control seed-borne diseases like bacterial spot, canker and speck.

After three days fill the seed container with warm water. Let the contents settle and begin pouring out the water along with pieces of tomato pulp and immature seeds floating on top. Note: Viable seeds are

heavier and settle to the bottom of the jar. Repeat this process until water being poured out is almost clear and clean seeds line the bottom of the container. Pour these clean seeds into a strainer that has holes smaller than the seeds. Let the excess water drip out and invert the strainer onto paper towel or piece of newspaper. Allow the seeds to dry completely (usually a day or two). Break up the clumps into individual seeds, label and store in a packet or plastic bag.

## EXPERIENCED SEED SAVER VEGETABLES

The experienced seed saver's vegetables produce seed the season they are planted but require separation to keep unwanted cross-pollination from taking place.

### CORN

**PLANT:** Female corn flowers are pollinated predominately by the wind, rarely by insects. Pollen is light and can be carried great distances. For purity, separate two varieties pollinating at the same time by at least 1 mile. Reasonable results are obtained with separation of 1000 feet.

**FLOWER:** Corn is monoecious, producing separate male and female flowers on each plant. Male flowers appear as tassels on the top of corn stalks and female flowers are pollinated via the silk emerging from each ear.

**INBREEDING DEPRESSION:** Corn is susceptible to intense inbreeding depression. If seed is saved from too few plants, subsequent plants may be short, mature late and produce few ears. Grow at least 200 plants and save the seeds from at least 100 of the best.

#### WHAT TO NOTE:

Kernel sweetness

kernel color

kernel starch: flint, dent, or sweet corn

**HARVEST:** Corn seed is usually ready to be harvested 4-6 weeks after eating stage. If growing season is not long enough, pick ears after husks turn brown. Pull back husks and complete drying in cool, dry location.

**PROCESS:** Process all but very large amounts of seed by gripping dried ears by hand and twisting allowing kernels to fall into container. Any remaining silk and chaff can be winnowed.

### CUCUMBER

*(All cucumbers except Armenian cucumbers)*

**PLANT:** Female corn flowers are pollinated predominately by the wind, rarely by insects. Pollen is light and can be carried great distances. For purity, separate two varieties pollinating at the same time by at least 1 mile. Reasonable results are obtained with separation of 1000 feet.

**FLOWER:** Cucumbers are mostly monoecious with separate male and female flowers on each plant. Female flowers can be identified by locating the ovary (a small looking cucumber) at the base of the flower. Cucumber vines will produce the greatest amount of female flowers when day length shortens to approximately 11 hours per day. Fruits will be aborted during dry spells and very hot weather.



**INBREEDING DEPRESSION:** Although inbreeding depression is not usually noticeable in cucumbers, seeds should be saved from at least 6 cucumbers on 6 different plants.

**HARVEST:** Cucumbers raised for seed cannot be eaten. They should be left to ripen at least 5 weeks after eating stage until they have turned a golden color. First, light frost of the season will blacken vines and make cucumbers easier to find. Undamaged fruits can be stored in cool, dry place for several weeks to finish ripening.

**PROCESS:** Slice fruit lengthwise and scrape seeds out with spoon. Allow seeds and jelly-like liquid to sit in jar at room temperature for 3 or 4 days. Fungus will start to form on top. Stir daily. Jelly will dissolve and good seeds will sink to bottom while remaining debris and immature seeds can be rinsed away. Spread seeds on a paper towel or screen until dry.

## MUSKMELON

Divided below into seven separate groups because of similar features. All *C. melos* varieties in all groups will cross with each other. They will not cross with watermelons which are *Citrullus vulgaris*.

Indorus: honeydew, crenshaw, casaba

Conomon: Asian, pickling melons

Dundaim: pocket melon

Cantalupensis: true cantelopes (without netted skin)

Flexuosus: Armenian cucumbers

Reticulatus: Persian melons, muskmelons with netted skin and orange flesh

Chito: orange melon, garden lemon melon

**PLANT:** Separate two different muskmelons by at least 1/2 mile to ensure purity. Experienced, home, seed savers grow more than one variety at a time in a single garden by using hand pollinating techniques. Muskmelon flowers are small and relatively difficult to hand pollinate.

**FLOWER:** Muskmelons are mostly monoecious with separate male and female flowers on each plant. (Some female flowers have stamens.) Female flowers can be identified by locating the ovary (a small looking melon) at the base of the flower. The early flowers are the most likely to be successfully pollinated and eventually produce seeds.

**INBREEDING DEPRESSION:** Not usually a problem with muskmelons.

**HARVEST:** Muskmelon seed is mature and can be harvested from ripe and ready to eat muskmelons.

**PROCESS:** Simply rinse seeds clean, dry with towel and spread on board or cookie sheet to complete drying.

## RADISH

Separate different varieties being grown for seed at the same time by at least 1/2 mile to ensure purity. Satisfactory results for home gardeners require no more than 250 feet of separation. As radishes cannot self-pollinate, pollen must be carried by insects from plant to plant. Seed to seed: Mulch in the fall to insure winter survival. The following spring, thin to 9" spacing, leaving those roots that showed no sign of bolting. Root to seed: Harvest roots in fall. Select desirable roots and trim tops to within an inch of the roots leaving small, new leaves. Store at 40° F. in humid location. Replant in early spring at 9" intervals and cover with 1" of soil. Note: Garden varieties of radish will cross with all wild varieties.

**FLOWER:** Radishes produce annual flowers which require pollination by insects, primarily bees.

**HARVEST:** Harvest 3' tall stalks containing seeds pods when pods have dried brown. Pull entire plant and hang in cool, dry place if all pods are not dried at the end of the growing season.

**PROCESS:** Open pods by hand for small amounts of seed. Pods that do not open when rubbed between hands can be pounded with hammer or mallet. Winnow to remove remaining chaff.

## SPINACH

**PLANT:** It is probably best to grow seeds for only one variety of spinach at a time. Commercial seed crops are separated 5 miles or more. Plant early in the spring to allow enough time for seed production which can take 4-6 weeks more than the time required to reach eating stage. Remove plants which bolt first, and thin remaining plants to 8" for seed production. Leave one male plant for each two females to ensure pollination.

**FLOWER:** Spinach is "dioecious", with male and female flowers on separate plants. Flowers are wind pollinated by spinach's dust-like, powdery pollen which can be carried for miles.

### WHAT TO NOTE:

Seed shape: prickly or smooth.

Leaf texture: flat, wrinkled.

**HARVEST:** Some outside leaves can be harvested for eating without harming seed production. If possible, wait until all plants have dried brown. Pull entire plant and hang in cool, dry place if necessary at the end of the growing season.

**PROCESS:** Strip seeds in upward motion and let them fall into container. Chaff can be winnowed. Use gloves for prickly-seeded types.

## SQUASH/PUMPKIN

Cucurbita maxima varieties with large, hairy leaves, long vines and soft, hairy stems and include: banana squashes, buttercups, hubbards and marrows

Cucurbita mixta varieties with large, hairy leaves, long vines and hard, hairy stems and include the cushaws

Cucurbita moschata varieties similar to C. mixta with flaring stems at the fruit and large, green sepals surrounding the flowers and include: butternuts

Cucurbita pepo varieties with prickly stems and leaves with a hard, five-angled stem and include: acorn squashes, cocozelles, pumpkins, crooknecks, scallops, spaghetti squashes and zucchinis

**PLANT:** Squashes from different species (see above) can be grown next to each other. Separate different squash varieties in the same species by at least 1/2 mile to ensure purity. Experienced home seed savers grow more than one variety in a single garden by using hand pollinating techniques. Squash flowers are large and relatively easy to hand pollinate.

**FLOWER:** Squashes are monoecious with male flowers and female flowers on each plant. Female flowers can be identified by locating the ovary (a small looking squash) at the base of the flower. (Some female flowers have stamens.)

**INBREEDING DEPRESSION:** Not usually noticed in squash and pumpkins.

**HARVEST:** Squash must be fully mature before harvested for seed production. This means that summer squashes must be left on the vine until outer shell hardens. Allow to cure 3-4 additional weeks after harvest to encourage further seed ripening.

**PROCESS:** Chop open hard-shelled fruits and scoop out seeds. Rinse clean in wire strainer with warm, running water. Dry with towel and spread on board or cookie sheet to complete drying.

## **BEET/SWISS CHARD**

**PLANT:** Grow seed for only one variety of beet or Swiss chard at any one time. Seed to seed: Mulch first year crop in the fall to ensure winter survival. The following spring, thin to 18" spacing. Root to seed : Harvest roots in fall. Select desirable roots and trim tops 1-2" above root. Store at 40° F. in humid location. Replant in early spring at 18" intervals with tops just showing above the soil.

**FLOWER:** Beets and Swiss chard produce perfect flowers. Pollen is light and can be carried for miles by the wind.

**INBREEDING DEPRESSION:** Save seed from at least 6 different beets to ensure genetic diversity and vigor.

### **WHAT TO NOTE:**

Root color

Root shape

**HARVEST:** Cut 4' tall tops just above the root when majority flowering clusters have turned brown. Tops can be stored in cool, dry locations for 2-3 weeks to encourage further seed ripening.

**PROCESS:** Small quantities of seed can be stripped by hand as seed matures. Large numbers of tops can be put into a cloth bag and stomped or pounded. Chaff can be winnowed.

## **CABBAGE FAMILY**

Includes broccoli, brussels sprout, cauliflower, cabbage and kale.

**PLANT:** All vegetables and varieties in this large species will cross with each other. Separate different varieties at least 1000 feet for satisfactory results or at least 1 mile for purity. Caging with introduced pollinators or alternate day caging is also recommended in small gardens. Plants to be left for seed production should be mulched in the fall or carefully dug, trimmed and stored for the winter in humid area with temperatures between 35-40° F. Flowering plants can reach 4' in height and need at least 2' spacing for good seed production.

**FLOWER:** Members of the B. oleracea species, with the exception of a few early -season broccolis and cauliflowers, require vernalization (cold, winter-like temperatures for several weeks) before flowering occurs. Flowers are perfect, most of which cannot be self-pollinated. Necessary cross-pollination is performed by bees. The stigma becomes receptive before the flower opens, and pollen is shed hours after the flower opens.

**INBREEDING DEPRESSION:** Plant at least 6 different plants to protect vigor and ensure a reasonable amount of genetic diversity.

### **WHAT TO NOTE:**

Plant characteristics

Plant color: purple, green, magenta

Leaf shape: wide, entire, smooth, hairy

### **HARVEST:**

Broccoli, cauliflower, cabbage and kohlrabi heads grown for seed should not be trimmed for consumption. Brussels sprouts, collards and kale can be lightly trimmed for eating without affecting quality seed production.



If small amounts of seeds are wanted, allow individual pods to dry to a light brown color before picking and opening by hand. Lower pods dry first followed by those progressively higher on the plant. For larger amounts of seeds pull entire plant after a majority of pods have dried. Green pods rarely produce viable seeds even if allowed to dry after the plant is pulled.

**PROCESS:**

Smash unopened pods in cloth bag with mallet or by walking on them. Chaff can be winnowed.

## CARROT

**PLANT:** Separate different varieties at least 1/2 mile to ensure purity. (Queen Anne's Lace or wild carrot will cross with garden carrot.) Alternate day caging or caging with introduced pollinators allows two or more varieties to be grown for seed in small gardens. Seed to seed: Plant seeds in mid-summer. Finger-sized carrots are more winter hardy than full-grown carrots. Mulch in late-fall to ensure winter survival. Thin to 30" spacing in the spring. Root to seed: Harvest eating-sized roots in fall for replanting in fall or early spring. Mulch if planted in fall. Clip tops to 1 -2" and store at 35-40° F. in humid location or layered in sawdust or sand. Replant roots with desirable characteristics 30" apart with soil just covering shoulders.

**FLOWER:** Carrots produce perfect flowers that are cross-pollinated by a number of insects. Flowers are arranged in round, flat groups called umbels. Carrots require vernalization (cold, winter-like temperatures for several weeks) before flowering occurs.

**INBREEDING DEPRESSION:** Carrots can exhibit severe inbreeding depression. Save and mix seed from as many different carrots as possible.

**WHAT TO NOTE:**

Root color

Root shape

**HARVEST:** For small amounts, hand pick each umbel as it dries brown. Large amounts of seed can be harvested by cutting entire flowering top as umbels begin to dry. Allow to mature in cool, dry location for an additional 2-3 weeks.

**PROCESS:** Clean small amounts by rubbing between hands. Larger amounts can be beaten from stalks and umbels. Screen and winnow to clean. Carrot seed is naturally hairy or "bearded". Debearding in the cleaning process does not affect germination.

## ONION

Varieties within each onion species will cross with each other.

**PLANT:** Separate from other flowering Alliums of the same species at least 1000 feet for satisfactory results or at least 1 mile for purity. Caging with introduced pollinators or alternate day caging is also recommended in small gardens. Seed to seed: Plant seeds in late-spring or early-summer. Immature onions are more winter hardy than larger, full-grown bulbs. Mulch in late-fall to ensure winter survival. Thin to 12" spacing in the spring. Root to seed : Harvest in the fall and select the largest bulbs which produce more seed. Clip tops to 6" and store at 35-40° F. in dry, airy location. Replant in early spring with 12" spacing. Cover bulbs with 1/2" soil.

**FLOWER:** The Alliums produce perfect flowers, most of which are cross-pollinated because stigmas in each flower become receptive only after pollen in that flower is shed. Flowers in an individual umbel open and shed pollen at different times so crosses can and do occur on the same plant. Cross-pollination is performed mostly by bees. Many onions require vernalization (cold, winter-like temperatures for several weeks) before flowering occurs. Store for at least two weeks in a refrigerator.

**INBREEDING DEPRESSION:** Onions display a fair amount of inbreeding depression after two or three generations of self-pollination. Save and mix the seeds from at least two different plants.

**WHAT TO NOTE:**

Bulb color

Heat/Sweetness

**HARVEST:** Clip umbels as soon as majority of flowers have dried. Seeds will start dropping from some flowers at this time so check often. Allow to dry in cool, dry location for up to 2-3 weeks.

**PROCESS:** Fully dried flowers will drop clean seeds naturally. For small amounts, rub remaining flowers to free seeds. For larger amounts, rub heads over screens. Winnow to remove remaining debris.