A MASTER PLAN FOR CROWS' FEAT FARM

178/180 Drinkwater Rd.
Kensington, NH
May 2020

Table of Contents

Vision

Mission Statement:

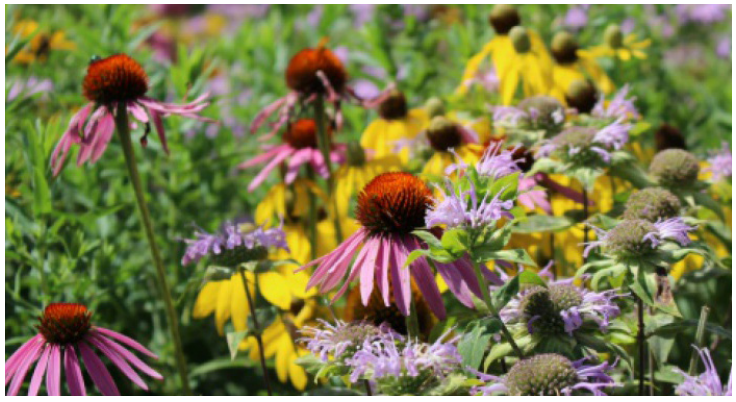
To create a **sustainable, resilient, and abundant permaculture homestead and farm** that regenerates the natural environment and provides fresh, local, healthy food to our family, friends, and the surrounding community.

Vision:

Crows' Feat Farm is a small-scale diversified homestead, farm, and demonstration site that produces useful and multi-functional crops that serve the needs of our family and the wider community. The farm achieves this while providing wildlife habitat, preserving the aesthetics of the property, and addressing larger issues such as climate change and food security. Karen and Peter, along with the help of seasonal farm apprentices and volunteer groups, steward the property and manage the farm's diverse vegetable, herb, fruit, and nut crops, chickens, and maple sugaring. Karen and Peter see their property as a community asset and seek opportunities to collaborate with local organizations such as the University of New Hampshire, Seacoast Permaculture, Seacoast Beekeeper's Association, NOFA NH, Seacoast Harvest, Three River Farmer's Alliance, the Agrarian Trust, and Slow Food Seacoast.

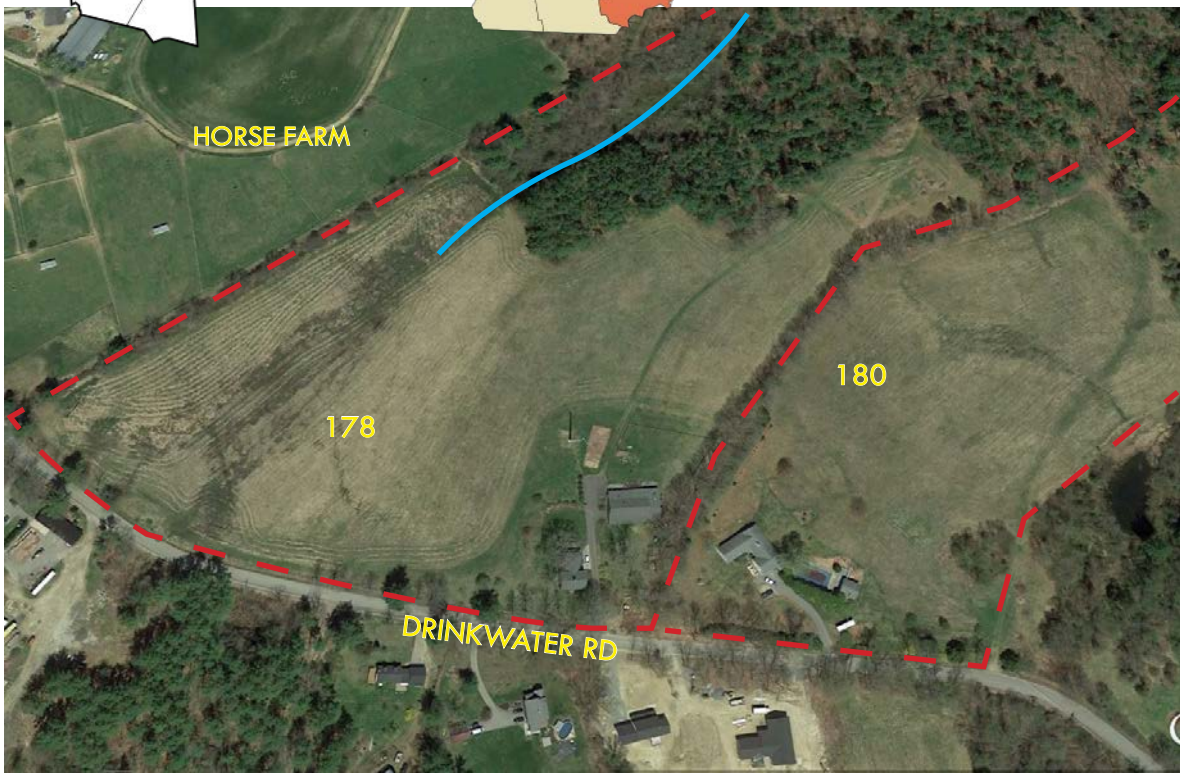
Goals:

- Produce a diversity of food crops and products grown in an ecologically responsible way.
- Respond to the needs of the region and the natural environment.
- Delineate flexible open space for programming, events, and workshops.
- Maintain aesthetics of property, especially around the barn and house.
- Build greenhouse, chicken coop, and other outbuildings to support farm activities.
- Produce all mulches and fertilizers on site to the greatest extent feasible through no till farming, composting, and integrating small livestock.
- Harvest building materials from the forest on site for farm construction projects.
- Manage water resources responsibly and sustainably on site.



Existing Conditions

The Town of Kensington is a small, rural community located in Rockingham County and the Seacoast region of New Hampshire, just north of Massachusetts. The town is largely forests, farms/pastures, rivers, and wetlands. Crows' Feat Farm, which consists of two parcels on Drinkwater Road, is a microcosm of the Town, encompassing all of these ecosystems on its approximately 100 acres. The Seacoast Region has a rich agricultural history and contemporary regional food system, providing opportunities for partnerships, collaboration, and resources. Crows' Feat Farm is surrounded by rural residential development and neighboring farms. The two parcels that comprise this farm, 178 and 180 Drinkwater Road, were once a working potato farm. Their agricultural land and prime agricultural soils make this property ideal for restoring into a working farm again. property ideal for restoring into a working farm again.



Crows' Feat Farm includes ***five distinct zones*** that have different ecological characteristics. These zones illustrate the range of crops and activities that may be available on the farm. Zone 1 refers to the Home and the surrounding gardens, farmland, and grasslands and requires the most human intervention to maintain this area of the property. It's where the most intensive activity occurs, simply by virtue of location. This may include cultivation of labor intensive crops, livestock, key built infrastructure, and other small-scale farm sytems.

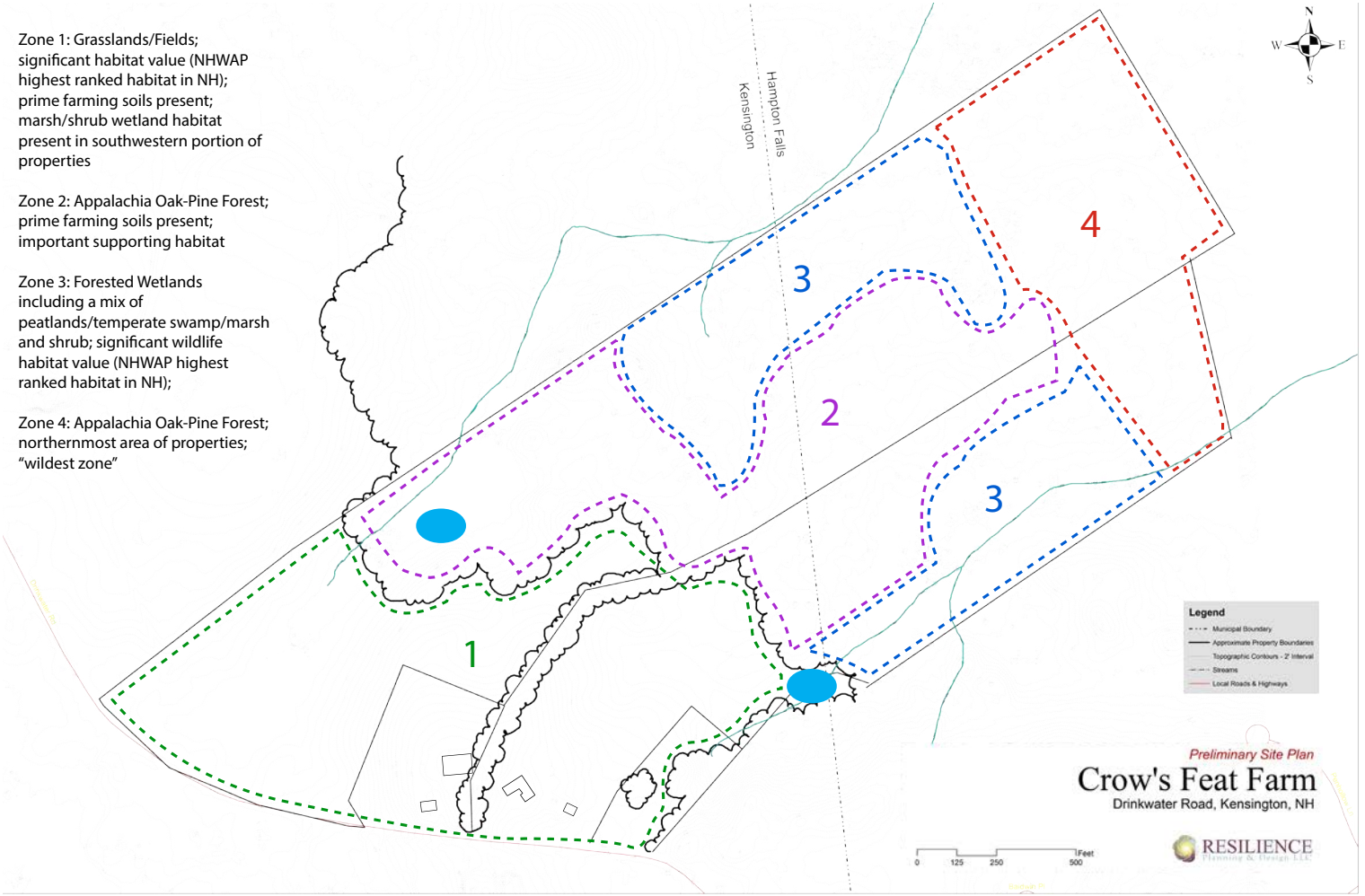
Further out, Zone 2 and 3 refers to the central forested area of the property. Zone 2/3 is often a soft edge between highly cultivated, high-input design elements and more wild, hardy, and resilient systems. This translates well to tended patches of perennial production, such as forest gardens, and forest farming mechanisms, such as silvopasture. Zone 4, in this case, is a "wild zone" that has minimal human intervention and instead functions as wildlife habitat.

Zone 1: Grasslands/Fields; significant habitat value (NHWAP highest ranked habitat in NH); prime farming soils present; marsh/shrub wetland habitat present in southwestern portion of properties

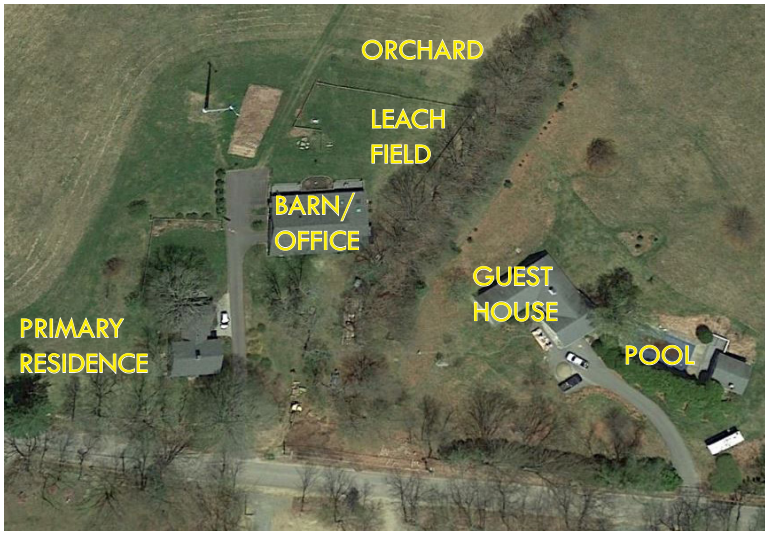
Zone 2: Appalachia Oak-Pine Forest; prime farming soils present; important supporting habitat

Zone 3: Forested Wetlands including a mix of peatlands/temperate swamp/marsh and shrub; significant wildlife habitat value (NHWAP highest ranked habitat in NH);

Zone 4: Appalachia Oak-Pine Forest; northernmost area of properties; "wildest zone"



Existing Conditions



EXISTING BUILDINGS, INFRASTRUCTURE, AND ACCESS

Crows' Feat Farm has a number of buildings on site including Peter and Karen's primary dwelling, a large barn that is sectioned off and also used as an office for Karen's business, Paladin Advisors. A rental duplex and a guest house on 180 Drinkwater Road offer additional accommodations for potential future farm workers. Half of the barn on site is utilized for storage of equipment and tools. The barn is located at the highest elevation of the site, presenting an opportunity for harvesting roof runoff for irrigation. There is a wind mill on site and the large open nature of the property presents ample opportunity for solar energy production. The leach field is located northeast of the barn. The main driveway and parking area is used by the Parker Feld family and Karen's employees.

1) PRIME FARMING SOILS

Prime farming soils are present on multiple areas of the farm, indicating the potential for highly productive farmland. Prime farmland, as defined by the USDA, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, and fiber crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other undeveloped land.

2) GRASSLANDS

Crows' Feat Farm has significant grassland habitat, shown in the photo to the right. Grasslands are increasingly rare ecosystems in New Hampshire (covering about 4% of NH's land area) and largely consist of agricultural fields such as hayfields, pastures, and fallow fields that include wildflowers, grasses, and sedges. This is largely due to forest succession and development pressures. Grasslands of any size are critical wildlife habitat. Bird species that depend on grasslands include the bobolink, eastern meadowlark, savannah sparrow, grasshopper sparrow, northern harrier, and the upland sandpiper- all but the bobolink and meadowlark like large 20+ acre grassland habitats.

3) WET FIELD

The southwestern part of the field is fairly wet and will be a major consideration in plant selection, if cultivation occurs here.

4) PONDS

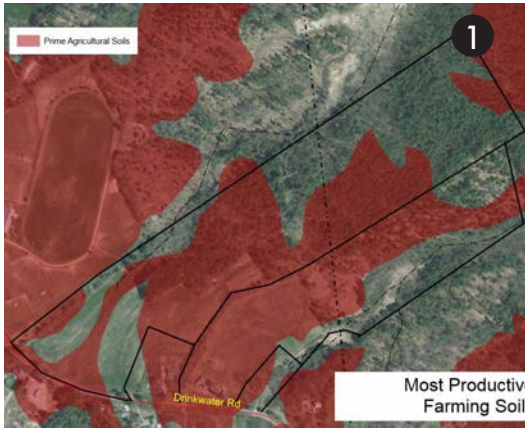
There are two existing ponds on site, shown on the zones map on page 2 and in the photo to the right.

5) ORCHARD

Karen and Peter have established an orchard that consists of apple, peach, and pear trees, as well as kiwiberries, located north of the barn.

6) ANNUAL PLOTS

There are a few tilled plots on site that have been used for vegetable production and are being converted to permaculture beds. Several perennial beds are also being built for fruits and vegetables.



Final Design Concept

Farm Structures

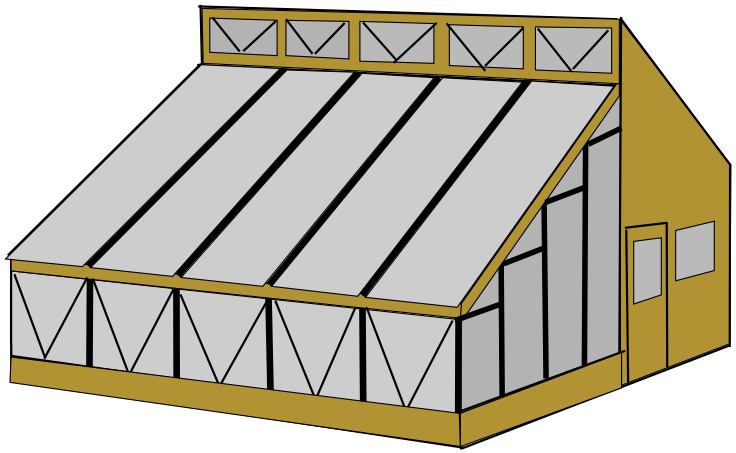
BIOSHELTER

In the northeast, incorporating season extension structures into the design of a farm is crucial for extending the growing season and increasing food production for homesteads and small market farms. A bioshelter is a high-performance greenhouse that uses the sun to power an indoor ecosystem. Compared with a typical greenhouse that relies on mechanical systems to extend the growing season, a bioshelter is designed using biological, passive storage, and mechanism systems to extend the growing season.

Through a collaborative design process, a multi-functional bioshelter concept was created that integrates a winter chicken coop, plants, space for sap boiling, rainwater catchment, and solar energy production. The design integrates passive and active solar features, a geothermal system called a "climate battery", insulation materials, and various types of mass for heat storage to achieve low energy inputs and reduced operating costs. Electricity for the bioshelter can be produced by a small roof or ground mounted PV array creating a zero-net-energy system. Permanent raised beds (for winter greens and hot weather crops in the summer) are constructed, as well as space for starting seeds, potting plants, and propagating cuttings.

INCREASING ENERGY EFFICIENCY: *THE CLIMATE BATTERY*

A climate battery is a ground to air heating system comprised of a series of underground tubes that circulate air several feet below the soil surface. The circulating air helps to regulate temperature and moisture in the greenhouse, minimizing (or eliminating) the need for propane heat in winter. It also helps reduce disease pressure by keeping air moisture low. As the sun heats air in the greenhouse during the day, the climate battery fans push the warm air from high inside the structure to several feet underground where this excess heat can be stored. The warm air is circulated through a series of



Above: A mock up of the Bioshelter, created by Peter Parker-Feld

Above: An example of a bioshelter built in Greenfield, MA.

underground tubes, transferring heat and moisture to the subsoil. Cooler, drier air emerges from the ground back into the greenhouse. When the sun isn't shining or when it's cold, the climate battery fan system can be turned on to supply warm air from the heat stored underground in the soil to the rest of the greenhouse.

GREENHOUSE MATERIALS AND NEEDS

Ventilation System

- 8" fan
- Vents

Climate Battery Heating System

- Heat exchange tubing: (6-8) 4" underground perforated pipes buried 4 feet deep with filter socks
- Climate battery controls (thermostats)
- Risers: Vertical sections of pipe for pushing air in and out of underground tubes
- Intake Riser Extension Ducting

Thermal Mass

- Straw bales or water containers in north wall (keep in mind chickens and sap boiling will also contribute to heat the greenhouse)
- Raised beds

Foundation and Floor

- Pavers with sand or pea stone for drainage as ground floor surface
- Concrete Piers

Framing and Glazing

- Wood harvested on site for lumber
- 3-layer polycarbonate for glazing

Electricity

- Solar panel attached to glazed roof or ground mounted next to greenhouse

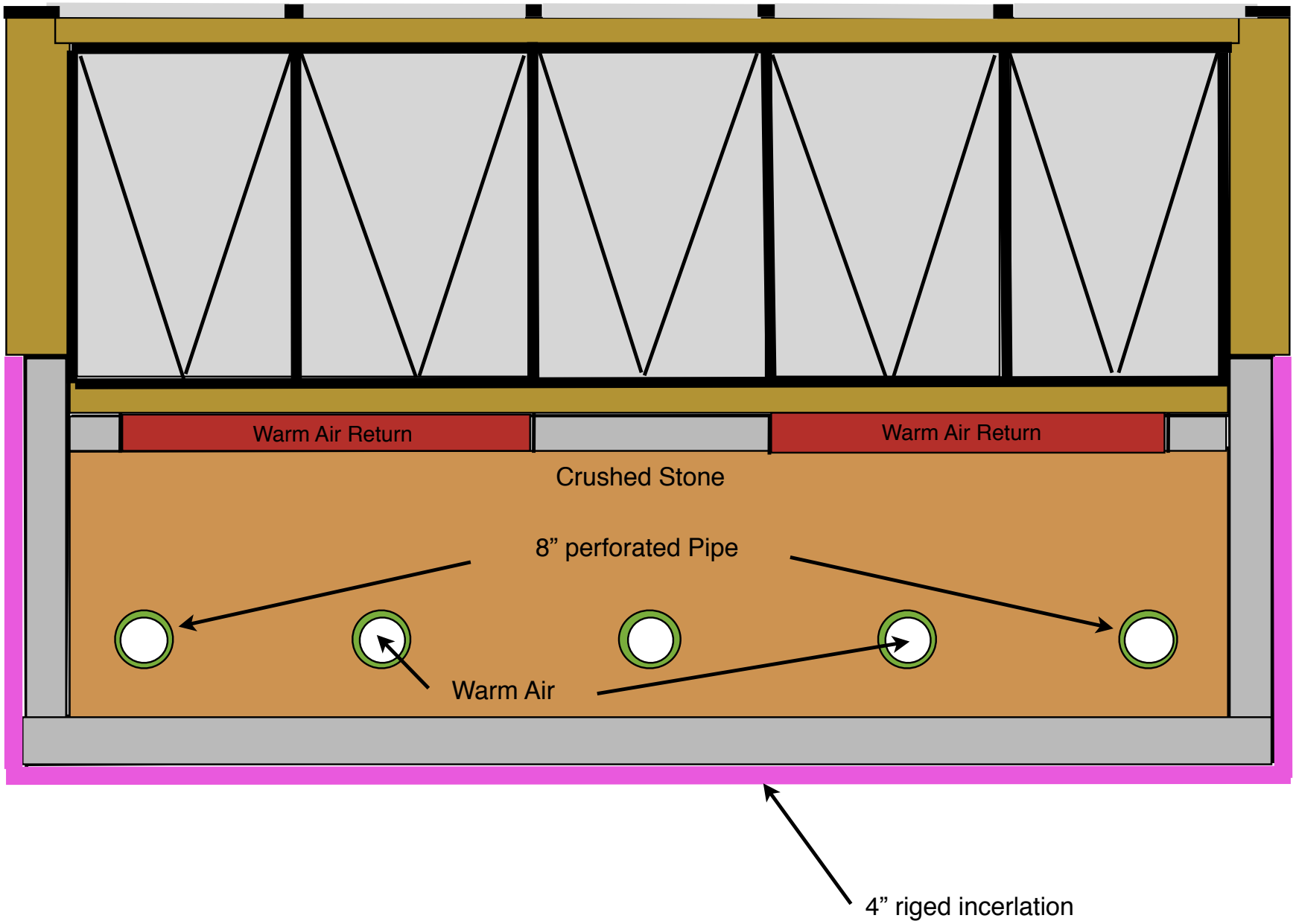
Irrigation

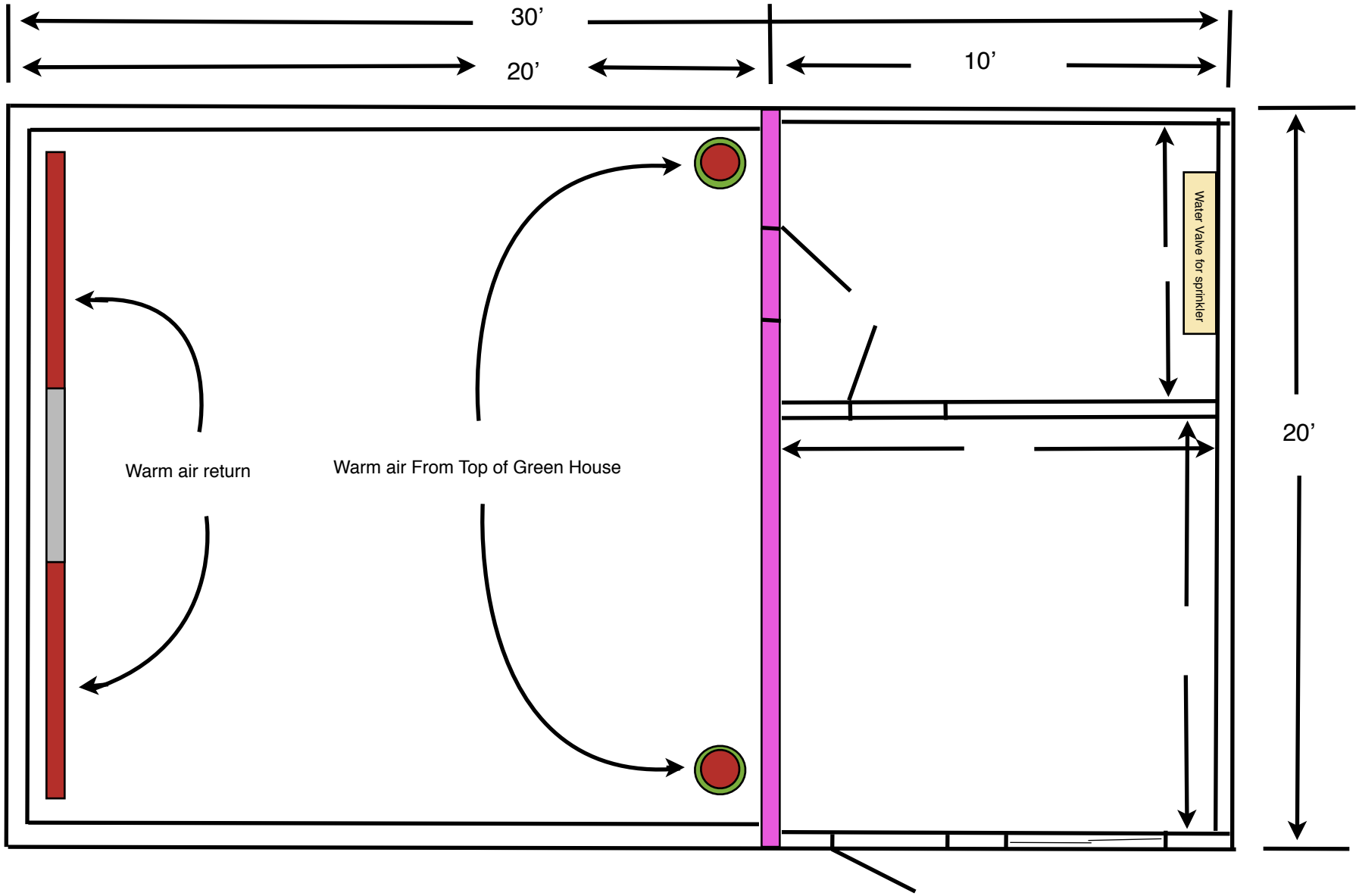
- Rain barrel and overflow system (if rain barrel can be incorporated inside the greenhouse, this could add to the thermal mass of the north side- water also has the highest heat capacity storage)

Benefits of a Multi-functional Structure

- 1 site, foundation, and power source for multiple uses sited close together
- Chicken coop requires insulated northern wall, minimizing heat loss
- Chicken coop creates a place for the chickens to lay eggs and get out of the sun
- Chickens keep the greenhouse warm in the winter

Above: Underground heat exchange tubing for a bioshelter heating system


Warm Air Return
Warm Air Return
Crushed Stone
8” perforated Pipe
Warm Air
4” riged incerlation


30’
20’
10’
Water Valve for sprinkler
20’
Warm air return
Warm air From Top of Green House

CHICKEN COOP DESIGN CONSIDERATIONS

Size of Flock and Space Requirements

- Consider the size of the flock you eventually plan on raising and ensure the coop has 3 to 4 square feet of interior floor space per hen and one nesting box for every three to four laying hens.
- For floor bedding material of the coop, the most commonly used are straw, wood shavings, and leaves. Dirt can be used as a floor surface material for the coop as well as wood or concrete.

Nesting Boxes

- Nesting boxes can be wooden, plastic or metal and should be 12 to 14 inches square, removable (for easy cleaning), and be positioned lower than your roosts to deter sleeping in them. Plastic pails or totes, wine barrels or wooden crates can all be up-cycled and used as nesting boxes. Fill these with soft bedding - pine shavings or chopped straw both work well. Dried plant material and leaves also work, as long as they're not molding.

Roosting Bars

- 8" of roosting bar per hen (2x4" lumber works well for roosting bars) is the typical requirement for design.

Ventilation

- Vents for air circulation - Windows and vents all need to be covered with 1/4" or 1/2" hardware cloth to keep predators out. 1/5 of the total wall area of your coop should be windows or vents.

Security

- Coop doors and nesting box covers need secure latches.
- Construct a chicken run that is surrounded by sturdy fencing, at least six feet tall. You can also place chicken wire 6 inches deep under both the coop and the run in order to foil diggers like foxes or skunks.

Accessories

- Chickens need to have feeders that are easy to reach and free of manure, dirt, and other debris. Hanging feeders, or an automated trough system with a gravity feed, are both good methods. While chickens can be supplemented with grain as food in the winter, there are other opportunities to provide them with food grown right on the farm, free-range style. This includes:
  - Comfrey and Stinging Nettles (two soil buiding plants)
  - Weeds such as lamb's quarter, burdock, yellow dock, and dandelion.
  - Yard trimmings

Above: A typical interior of a chicken coop. Nesting boxes with a ramped entryway provide a place for laying eggs. Roosting bars line the back wall. Shelving provides space for storing materials, such as wood shavings.

- Kitchen scraps/compost
- Wild seeds and fruits
- Cover crops, such as buckwheat, clover, and chicory
- Garden insects, l including Japanese beetles and slugs

- Chickens also need regular access to clean water. An automatic gravity-feed waterer on a cinder block and a hanging 5-gallon bucket with nipples can serve as good mechanisms.

CHICKEN TRACTOR DESIGN CONSIDERATIONS

A portable chicken coop provides many benefits to a flock: the chickens receive a diverse, high-quality, and nutritious foraged diet, fertilize your garden beds, graze grasses and cover crops, and manage garden pests. A chicken tractor provides shelter and safety for your chickens while also allowing for them to scratch on the ground for bugs, insects, seeds, and other edibles, acting as "mini-plows". If you want to clear a small patch of land for a garden bed, leaving the chickens for several days in that area will result in a piece of land cleared of almost all vegetation and well fertilized with chicken manure. Joel Salatin of Polyface Farm found that his soil quality improved dramatically through the fertility provided by chicken manure. As a chicken tractor is moved around a property, your chickens will be fed, your land will be fertilized and larger pests will be exterminated, and your chickens will even "till" your soil with their incessant scratching and clawing at the ground.

A portable chicken coop should be movable and easy to hitch to a trailer if it will be moved with a truck or tractor. It should also be accompanied by electric net fencing to create a yard area around the coop. Every week or two, the hens, coop, and fencing are moved to fresh ground or as needed to keep them grazing on fresh grass.

Mobile chicken coops are typically easier and less expensive to build than permanent all-weather stationary coops, but usually house smaller flocks (~6 chickens). Having a permanent chicken coop in the bioshelter provides space for the chickens in the winter and allows, if the flock is larger at some point, for some to be taken and moved around with the chicken tractor during the growing season.

Pictured above are various designs for mobile chicken tractors.

HOOP HOUSES & HIGH TUNNELS

A hoop house or high tunnel is another season extension method that can be used to start plants earlier in the season. Once the farm moves towards producing a higher amount of food, and potentially moves in to the commercial market, a hoop house can greatly increase productivity.

HIGH TUNNEL

High tunnels are similar to greenhouses, however they accommodate one specific need: the ability to bring tractors, tillers, and other tall farm machinery directly into the growing space itself. Crops are planted directly in the ground under the high tunnel (as opposed to in raised beds, as in a greenhouse). Typically utilizing just a single layer of poly covering (rather than the multi-layer poly used on a traditional greenhouse), a PVC pipe frame, roll-up side curtains, and often no electricity or environmental controls, high tunnels maximize efficiency without needing to leave room for extensive additions or specialization. They also do not require a foundation and are movable and light weight.

HOOP HOUSE

A hoop house, sometimes referred to as a "caterpillar tunnel" is a smaller, more nimble high tunnel, usually associated with backyard gardens and small-scale farms. They are smaller in size and maximize simplicity while preserving many of the same benefits as a high tunnel or greenhouse. They typically can be erected in the spring and taken down in the fall, as opposed to a high tunnel where the plastic is removed, but the frame remains standing year-round.

Hoop houses typically utilize simple, curved purlins with poly covering stretched over the top. Hoop houses can be installed quickly over an existing crop bed or above a planned crop area to provide season-extending protection within a growing space. These can be constructed with metal piping, ground framing, and a layer of polyethylene plastic.

Managing Insects in Established Garden Beds

- Provide your chickens supervised time in the garden. Allow them in the garden for a limited time towards evening. They will naturally seek shelter at dark, and won't have time to turn their attention from the bugs to your produce.
- Chickens like bugs more than they like produce, so with timed grazing, most of your veggies should be safe.
- It's almost guaranteed that your chickens will get some of your produce with this method. In reading other's anecdotes, the debugging seems to be well worth the cost of a few veggies.
- If your garden is small enough, you could protect your produce with chicken wire or similar and allow the chickens constant access for bug control.

Pictured above is the interior of a high tunnel.

Above: A mix of annual vegetables growing in hoop house beds.

Above: A high tunnel outfitted with raised beds for an extended growing season.

Above: A caterpillar tunnel, or hoop house, is removable and smaller than a high tunnel. The bottom right photo shows raspberries being grown in a season extension structure to get a fall and spring crop.

Soil Management

Healthy soil is the foundation of an ecological, permaculture farm and homestead. When we focus on building healthy soil, we are creating the conditions for a soil ecosystem to thrive. Microbes, earthworm, grubs, and beetles aerate the soil and create organic matter, making them primary partners in food production. Typically, the healthier the soil, the more nutrient-dense and higher quality the crops. When we create a soil ecosystem, microorganisms actually help us by "biologically tilling" the soil. Below are regenerative farming methods that can be used to build soil throughout the farm and where/how they can be applied.

Benefits of Soil Health

- Increase organic matter formation
- Increase water holding capacity of soil
- Improve carbon storage in soil
- Reduce leaching and runoff of nutrients

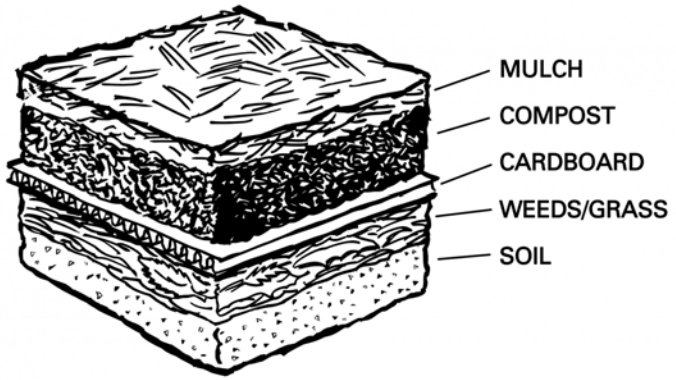
IN THE ANNUAL GARDENS...

REDUCE TILLING YOUR SOIL OVER TIME

Tilling the soil annually disturbs soil structure, causes erosion, reduces organic matter, and kills fungi and microorganisms. In contrast, no-till and perennial food production builds soil, promotes microbial activity, stores carbon, reduces weed pressure, reduces the need for heavy machinery and compaction, improves soil health, and creates a fungal-dominated system that is beneficial to plants. No-till or low-till farming is the practice of farming without disturbing the soil through traditional means of tilling or by minimally tilling the soil. The appendix includes three case studies that detail the process of three northeast farms as they transitioned from tillage based farming to no-till farming.

BUILDING AND MAINTAINING NO TILL ANNUAL BEDS

1. Mow or cut your lawn, weeds, or other vegetation right down to the ground.
2. Utilize string and stakes to lay out the beds (24-32 inches for production beds is ideal width; 18-20 inch pathways).
3. Smother sod using cardboard or brown paper- this also acts as a weed barrier (leave to compost directly on beds, adding carbon to soil).
4. Add 4-6 inches of compost or composted manure onto beds.
5. Add 4 inches of straw, leaves, or woodchips (ramial woodchips, which are woodchips made from small-medium diameter pieces of wood, encourage fungal hyphae relationship and is an ideal choice) on top of compost.
6. Add 4 inches of woodchips on pathways .
7. Sow a cover crop that will cover the soil and fertilize the soil; once it dies or right before it begins to set seed, chop and drop to decay and contribute biomass and nutrients to the soil.



Above: Sheet mulching is a great way to build garden beds and improve soil by layering materials to smother grass, suppress weeds, and support growing plants.

8. Ideally, let the beds sit for ~1 year once built before planting in them.
9. At the beginning or end of the season, before planting, test your soil to assess any deficients.
10. In the spring, rake the cover crop off the bed, transplant your plants, and then rake back on the beds. Add a layer of straw or leaf mulch. If direct seeding, leave soil bare. Once seeds grow into plants, they typically cover the soil themselves creating a living mulch.
11. At the end of every growing season, if not cover cropping, add compost/manure and mulch on top of beds (the lasagna gardening method).
12. One major advantage of no till beds is that drip irrigation tape can be laid out year-round, rather than having to pack it back up at the end of each season and set up at the beginning of the season.

Some no-till farmers will also use silage tarp, which is a reusable plastic material. 80x100 foot pieces of black plastic silage tarp can cover fields after they have been harvested, and then to terminate cover crops. The black plastic conducts a lot of heat and retains moisture, allowing weed seeds to germinate and then die before planting. The heat also allows for more active soils in the spring. As opposed to tilling, using silage tarps not only encourages worm activity, but also maintains mycorrhizal networks in the soil that tilling typically destroys.

FERTILIZERS

All plants need three important macronutrients in order to grow and thrive; these are nitrogen, phosphorus, and potassium, often labeled as NPK on fertilizer mixes.

- **Nitrogen** is crucial for healthy growth and helps plants produce green leafy foliage.
- **Phosphorus** encourages vigorous growth and helps protect plants from diseases and pests.
- **Potassium** promotes fruit and flower production in perennials and mature fruiting annuals such as tomatoes and peppers.

For giving plants a slight boost, try a simple 3–1–1 mixture of fish meal, rock dust, and kelp, respectively. You can use this mix all over the garden: when transplanting, as a side-dressing, and mixed into potting soil. Other fertilizers that can be used are outlined on the following page.

Cover Cropping

In no-till cover crop systems, the known benefits of cover crops are maximized by allowing them to grow until shortly before planting the vegetable or other cash crop, and by managing the cover crop without tillage. The best cover crops will:

- produce a high amount of biomass
- are readily killed by mowing, rolling, or other mechanical means, forming a mulch OR are reliably winter-killed, leaving a mulch for spring no-till planting, OR die down naturally in time to plant summer vegetables
- have residues that are sufficient to provide effective weed control in the subsequent vegetable crop
- provide habitat for natural enemies of vegetable crop pests
- have favorable effect on levels of available soil nitrogen, phosphorus, and pottassium
- not suppress the crop through chemical (allelopathic) or microbial effects

The most widely-known and extensively researched organic no-till systems are those based on hardy winter annual cover crops, mostly combinations of cereal grain rye (or winter rye), hairy vetch, crimson clover, and Austrian winter peas. These are planted in the early fall, mowed or rolled after they flower the following May. Vegetables are then planted as transplanted or direct seeded no till into the cover crop mulch. Many farmers create cover crop cocktails, which can enhance biomass production. It also offers a balanced carbon-nitrogen ratio, enhances diversity of beneficial soil microbes, and increases nutrient effects.

Biochar

One of the most effective organic fertilizers is biochar. While biochar is not technically a fertilizer, it allows processes to take place that help the crops succeed. Biochar has the ability to soak up unused nutrients, and then release them when they're needed. It's a charcoal-like substance that's made by burning organic material from agricultural and forestry wastes (also called biomass) in a controlled process called pyrolysis. It can be purchased already made or created by burning organic material on site. The biochar also has a lot of pore space, providing moisture and a refuge for soil creatures that would normally die off when a plant is harvested. This way, the sugar exchanges remain active in the soil. Because biochar is such a strong purifying agent, farmers typically either use a 20% blend with compost, or pre-inoculate the biochar. Biochar can be pre-inoculated with a worm compost tea and a lactobacillus EM1. Additionally, you can use a 5% blend with compost for potting soil, which helps to refine and protect against herbicide or other chemical residues that may exist in the compost.

Compost Tea

Compost Tea is made aerobically by fermenting finished compost in water for 12-24 hours. Compost tea is proven to overcome and prevent plant disease and vigor of soil communities. You can easily make compost tea in small quantities (using a five gallon bucket) or large quantities (using a 50 gallon drum) and a small pond pump. Fill the container with rainwater and set up a wooden dowel over the open container with a dangling mesh of compost into the water, which acts as a tea bag. Submerge the pump and turn it on and in 24 hours, it will be ready. This can also be hooked up to an irrigation system to directly apply the tea.

Jauche (YOW-KUH) or Nettle Tea

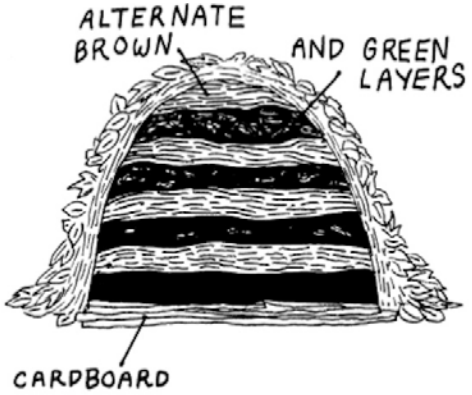
Nettle tea makes a great fertilizer for young plants, regulating iron and helping prevent or eliminate pest pressure. Add two pounds of fresh nettle greens to two gallons of lukewarm water. Let this sit and steep for twenty-four hours, then sieve and spray on leaves. Use the leftover sludge as a mulch around perennials. Spray as often as twice a day for diseased plants, or dilute and use periodically for a general health boost.

Comfrey

Comfrey is a "dynamic accumulator" in permaculture terms, which means that the plant can gather certain minerals or nutrients from deep in the sub-soil and store them in a more bioavailable form and in high concentration in their tissue. Comfrey is a rich source of nitrogen, phosphorus, and pottasium as well as important micronutrients such as calcium and magnesium that are critical for plant growth. The plant has deep taproots that draw these nutrients up from the soil and stores them in their leaves. These leaves can be used as liquid feed in comfrey tea, as mulch, or to boost compost. Comfrey tea can be made the same way as the described Jauche above.

Above: An example compost tea brewing set up.

Above: Comfrey can be chopped, and dropped around the base of fruit or nut trees to add fertility to the soil.



Above: A typical compost pile.

COMPOSTING

Good compost supplies both the organic matter for soil building and fertilizer for crops, and, most importantly, it's packed with soil organisms that trigger biological activity. It inoculates your soil with microbes that will digest nutrients present in the soil and feed your plants. Composting is a natural, biological process in which microorganisms use organic materials as food and leave a residue of digested organic matter that is nearly completely decomposed. Composting is the same as the decomposition that happens to all living things when they die, except that we can control composting to provide optimum conditions for the microbes. The compost system should include three bays so compost can be started and left to sit at various stages (as shown in the images on the right).

Above: A three-bay compost bin system on a gravel pad.

Above: A three-bay compost bin system using concrete blocks instead of lumber.

Best Practices

- Build the compost piles in layers with 6 to 8" layers of plant material with a one inch layer of soil or previously made compost in between.
- Add yard and garden residues and other organic materials to the compost pile, including leaves, grass clippings, straw and hay, sawdust, and finely chopped or shred tree and shrub prunings. Add food scraps from produce items, such as apple cores, banana and orange peels, melon rinds, eggshells, coffee grounds, etc.
- Add a combination of green and brown plant material. The green provides the nitrogen and the brown adds the carbon. Both are necessary for the microbes that break down the organic material.
- Shred or cut large items before adding them to the compost pile, such as branches and twigs, newspaper, etc. Smaller particles decompose faster.
- Turn the pile over occasionally or turn into another bin to mix; this aerates the material for more rapid decomposition.
- Add water occasionally if it doesn't rain so the pile is damp, but not soggy.
- Have patience. It will take two to four months for plant material in a compost pile to decompose if it is turned regularly.
- Use the compost as a soil amendment to your garden to improve the physical, chemical and biological properties of your soil.

Avoid

- DON'T add meat scraps, bones, grease, whole eggs, or dairy products to the compost pile because they decompose slowly, cause odors, and can attract rodents.
- DON'T add pet feces or spent cat liter to the compost pile.
- DON'T add diseased plant material or weeds that have gone to seed. Disease organisms and weed seeds will not be destroyed if the temperature

in the pile does not reach 150 to 160 degrees Farenheit.

MULCH

Mulch is a biodegradable layer of organic material added to the top of soil in garden beds. In the permaculture garden, mulch mimics the forest floor, which is usually covered with herbs and shrubs, sticks and twigs, and leaf litter. Mulch retains moisture, prevents erosion, creates humus, fertilizes the beds, suppresses weeds, and makes an attractive top dressing. Living annual plants can act as a mulch, such as head lettuce, carrots, and mesculun mix. Seeds are sown densely and grow to cover the soil. Other mulches include lawn grass clippings, leaves, straw, wood chips, and cover crop residue. The mulch is then left on the surface to decompose and is reapplied annually.

Above: Wood chip pathways surround permanent raised beds for annuals and perennials.

IN THE FOOD FOREST GARDENS AND ORCHARD...

A food forest garden is a deliberately designed, high-yielding, perennial plant system developed by hyman beings for sustenance and for their ecosystem services. The classic model for a forest garden is the "seven layers" we see in a forest. This includes a canopy, subcancopy, shrubs, herbaceous species, climbing plants, groundcover, roots and tubers, and the underground layer of mycorrhizal fungi.

- **Build forest garden beds and pathways through sheet mulching.** Sheet mulch around the existing orchard to create space for planting insectary plants, herbs, and dynamic accumulators.
- **Improve soil through cover cropping.** Preparing the soil prior to planting offers certain advantages. A year of cover cropping (with Crimson Clover or other nitrogen fixer) and woody mulching not only offers a chance to build organic matter and correct fertility imbalances but, most importantly, accelerates fungal dominance. Fruit trees generally prefer high-quality soil and that's why it is particularly important to achieve a good layer of humus and to try to use as much biomass as possible on the soil.
- **Inoculate your soil with mycorrhizal fungi.** Food Forest soils ideally contain a fungal presence ten times higher than that of bacteria. Since

Above: A typical forest garden that includes multiple layers of vegetation and a diversity of edible and medicinal plants.

the start of these gardens are on bare field, we can assume there is little fungi present increasing the importance of encouraging mycorrhizal associations through inoculation with fungi.

- **Maintain organic matter with woody mulch and compost.** Compost, deciduous wood chips, and other woody material can be added on top of the green manure crops. The woody material is what drives the fungal dominance you want for a healthy food forest. Mulching with wood chips and chopping and dropping woody plant material on the ground helps mycorrhizae thrive, and it's this fungal connection that provides the balanced nutrition necessary for a tree to better withstand disease.
- **Create self-sustaining fertility with nitrogen fixing trees and dynamic accumulator plants.** The self-fertilizing nature of the food forest comes from the use of nitrogen-fixing plants along with other plants like comfrey that are particularly good at raising nutrients from the subsoil. With these plants in place, efficient nutrient cycling develops in a forest-like system, maximizing fertility for other plants to grow. Nitrogen fixers are extremely useful fertility providers in a food forest. Techniques like 'chop and drop' mulches, coppicing and pollarding from these plants in particular can release the nutrients they have extracted over time from the earth.
- **Build hugelkultur beds within the forest gardens.** Hugelkultur (in German hugelkultur translates roughly as "mound culture") is a gardening and farming technique whereby woody debris (fallen branches and/or logs) are used as a resource. Hugelkultur allows gardeners and farmers to mimic the nutrient cycling found in a natural woodland to realize several benefits.

Building a Hugelkultur Bed

Building a hugelkultur beds can be done by the following process:

1. Build hugel beds on contour so they can capture and filter rainwater runoff.
2. Gather materials for the project:
    - Fallen logs, branches, twigs, fallen leaves (the "under utilized" biomass from the site). Avoid using cedar, walnut or other tree species deemed allelopathic.
    - Nitrogen rich material (manure or kitchen waste work well and will help to maintain a proper carbon to nitrogen ratio in the decomposing mass within the hugelkultur bed).
    - Top soil (enough to cover the other layers of the bed with a depth of 1 – 2") and some mulching material (straw or woodchips works well).
3. Lay the logs (the largest of the biomass debris) down as the first layer of the hugelkultur bed. Next, add a layer of branches, then a layer of small sticks and twigs. Hugelkultur beds work best when they are roughly 3 feet high.
4. Water these layers well.
5. Begin filling in spaces between the logs, twigs and branches with leaf litter and manure of kitchen scraps.
6. Finally, top off the bed with 1 – 2" of top soil and a layer of mulch.
7. The hugel bed will benefit from "curing" a bit, so it is best to prepare the bed several months prior to planting time (prepare the bed in the fall for a spring planting, for example, in temperate northern climates), but hugelkultur beds can be planted immediately. Plant seeds or transplants into the hugel bed as you would any other garden bed.

Above: A hugelkultur bed creates a privacy hedge, serving multiple functions.

Above: Pathways wind through edible forest gardens. An arbor creates an entrance into the garden and provides vertical growing space.

Above: Cardboard is laid around already established fruit trees as the first step of the sheet mulching process. Compost and mulch will be added and perennial wildflowers and edibles will be planted around the trees.

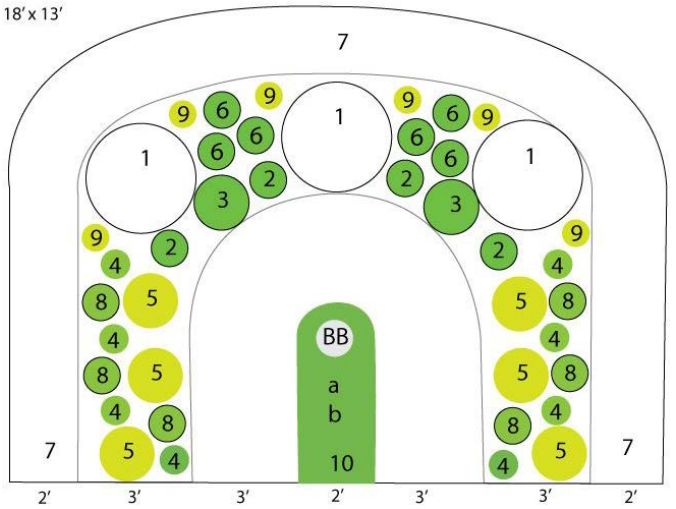
Above: Straw mulch pathways surround annual gardens.

Permaculture Food Production

MIXED ANNUAL AND PERENNIAL PRODUCTION AREA

Diverse annual vegetables and herbs that are grown by low-till or no-till farming mechanisms preserve soil health, store biomass and carbon underground, and encourage microorganism activity and a healthy fungal network. In a permaculture farm, perennial vegetables and herbs replace annuals wherever possible to avoid the backbreaking and redundant labor annual production requires. Additionally, annuals and perennials are integrated in mixed production spaces so that they mutually benefit each other. See an example of a salsa garden plant guild to the right which does just that. The barn is utilized for storage, packing of produce, and curing crops like onion and garlic.

SALSA GARDEN PLANT GUILD



PERENNIAL MANDALA GARDEN

Consider the following perennial vegetables and herbs to include in the perennial mandala garden:

- Asparagus
- Strawberries
- Lemon Balm
- Good King Henry
- Rhubarb
- Horseradish
- New Zealand Spinach - climbing vine
- Groundnut
- Sunchokes/Jerusalem Artichokes
- Sorrell
- Sweet Potato
- Walking Onions

ID	Species	Type	Form	Ht x W	Root	Uses/Functions	Spacing	# Plants
1	Tomato	Annual	UR	36"x36"	Fibrous deep	Aromatic pest repellent, fungicide	30"	3
2	Basil	Annual	UR	18"x12"	Fibrous shallow	Flavor enhancer, Aromatic pest confuser	10"	4
3	Borage	Annual (self-seeding)	Mound	24"x18"	Tap	Aromatic pest repellent, insecticide	16"	2
4	Collards	Annual	UR	36"x10"	Tap	Aromatic pest repellent	10"	2
5	Sea Kale	Perennial	UR	30"x18"	Fibrous deep	Insectary, mulch maker, soil builder	16"	2
6	Peppers	Annual	UR	14"x16"	Fibrous shallow	Insecticide	12"	2
7	Nasturtium	Annual (self-seeding)	Mound	14"x12"	Rhizome	Aromatic pest repellent	8"	20
8	Onions	Annual	UR	24"x9"	Fibrous shallow	Aromatic pest confuser, fungicide	9"	6
9	Cilantro	Annual	UR	24"x18	Tap	Insectary	24"	8
10a	Comfrey	Perennial	UR	30"x48"	Tap	Chemical barrier, dynamic accumulator, mulch	24"/3'	8
10b	Asparagus	Perennial	UR	54"x24"	Tap 10'	Nematocide	24"	12

Orchard & Nut Groves

In permaculture, there is a focus on the need to improve resiliency on a homestead or farm. Resiliency is the ability of a person(s) or system to handle and quickly recover from adverse conditions. For farmers and gardeners, resilient and regenerative agricultural systems mean integrating annual crops and perennial food production, such as fruit and nut tree crops, shrubs, herbaceous species, and fungi.

FRUIT/NUT TREE POLYCULTURES

Polycultures are communities of plants that form a self-sufficient system, with each plant having multiple functions and performing a unique role in the ecosystem that benefits the surrounding plants. Usually, polycultures are set up around a central fruit or nut tree, with understory bushes, perennials, and ground covers planted to complement the central tree and enhance its health and productivity. Polycultures are a fundamental technique of permaculture plantings. Because fruit tree guilds are planted to form mutually symbiotic relationships with the other plants as well as nearby animals, they are inherently beneficial.

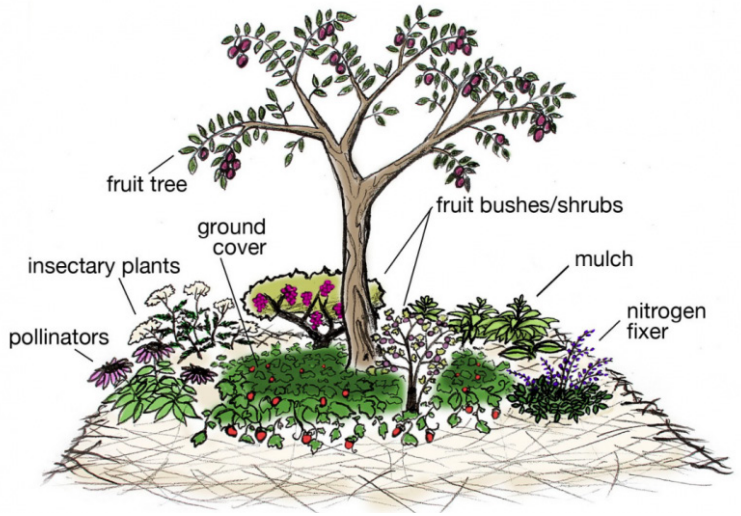
Tree guilds are typically made up of six categories. These can also be thought of as different niches or roles within an ecosystem.

- **Suppressors:** plants that suppress weed growth through there own growth habits and provide a cover for the soil (examples include strawberries, thyme, oregano, bulbs, alliums)
- **Insectaries:** plants that attract pollinators and other beneficial insect to the tree (yarrow, bee balm, buckwheat, skullcap, butterfly weed, lupine, and mustard).
- **Repellers:** plants that repel unwanted pests from feeding on your fruit tree (nasturtiums, marigolds, lemon balm, and almost any allium like garlic, chives, or perennial onions)
- **Mulchers**: plants that provide a natural mulch (comfrey, hostas, rhubarb, buckwheat)
- **Dynamic Accumulators:** plants that "mine" nutrients from deep in the soil

Planning an Apple Tree Guild

A common example of a guild is the apple tree guild. You can prevent grass from creeping under the tree and repel pests and other wildlife by planting a ring of daffodils and garlic chives at the drip line of the tree.

Bee balm, dill, and fennel peppered underneath can attract pollinators. Comfrey, dandelion, yarrow, and white clover may accumulate nutrients and fix nitrogen to fertilize the soil. Comfrey and nasturtiums provide mulch or green manure. Bee balm, garlic chives, and yarrow emit strong scents that may repel pests. Because apple scab fungus is a common ailment of apple trees, fennel and garlic chives provide some anti-fungal properties.



and bring the to the surface where other plants will be able to access them (comfrey, borage, and chicory)
- **Nitrogen Fixers:** plants that are nitrogen fixing meaning that they add nitrogen to the soil as they grow (white clover, red clover, beans, lupine, and peas)

PLANTING A FRUIT OR NUT TREE POLYCULTURE

- Measure a circle around the fruit tree to the expected width at maturity.
- Layer cardboard under the tree, thoroughly covering any grass, and moisten the cardboard as you go. Cover the cardboard with compost or soil about 3-12 inches deep. Allow this to decompose and rest for 3 months or so before planting.
- Plant herbs and perennials within the circle.
- Plant your understory selections, watering them well, and tend to them throughout the season.

INTERCROPPING WITH PROFITABLE FRUIT & NUT SHRUBS

Between the fruit tree rows in the existing orchard, there is potential to maximize the space by interplanting rows of fruit and nut shrubs. These may include:

- Raspberries: delicious berries eaten raw and used for jams, leaves are medicinal.
- Aronia or Chokeberry: popular "superfood", suitable for juice, jam, cider, or other value-added product, 2-3 years before yield.
- Elderberry: medicinal immune system boosting berries, suitable in syrup, honeys, tonic, tincture, wine, preserves, and juice, 2-4 years to yield depending if propagating from cuttings or as potted plants.
- Seaberry: easy to grow and productive, nutrient dense superfood berry, widely adaptable.
- Hazelnuts: high protein content and nutritious nut, can be used in flour, oil, and spreads; research suggests demand exceeds supply, 4-5 years to yield.

NUT GROVES

Together, chestnuts and hazelnuts represent an opportunity to advance agroforestry as a carbon farming practice in the northeast with the added benefit that their nuts are a profitable new cash crop for the region's agricultural economy.

- Hazelnuts: see details above
- Chestnuts, Chinese/Hybrid: edible nut, demand generally exceeds supply; strong opportunity for growing regional markets; 6 years before yield, can add to flour, baked goods, spreads
- Black Walnut: Allelopathic. Supplemental watering or irrigation may be necessary during establishment during droughts; edible nuts and good for lumber dry years.
- Black Locust: Easy to grow, numerous benefits including N-fixing, source of food for bees, wood has high BTU and is rot resistant; products include lumber and fire wood

PEST MANAGEMENT FOR THE ORCHARD

Japanese beetles, a grubs which are the larval stage of the beetle, can cause significant damage of fruit trees and shrubs and are considered to be a prevalent "pest" in our region. Adult Japanese beetles primarily eat foliage, but will also consume flowers and fruit. They tend to feed in large groups; you'll often see whole sections of a plant covered in beetles. In this area of the country, Japanase beetles typically lay their eggs in July and August. The young grubs begin feeding on foliage within one or two weeks. Feeding activity reaches its height in late fall. Grubs burrow deeper into the soil as the weather cools and spend the winter underground. As the soil heats in spring, they resurface and containue eating until pupating into adult (beetle) form in June.

CONTROLLING ADULT JAPANESE BEETLES

For smaller plants and limited infestations, hand-pick the beetles (or shake them off the plant) and drop them into a bucket of soapy water. The best time to do this is early morning as they're less active before the sun warms them up. Netting can also be helpful in keeping beetles off individual plants. For larger plants or infestations, there are numerous organic-certified insecticides available for Japanese beetle control although they usually require 2-3 applications. Many gardeners use use neem oil, which is an anti-feedant derived from the Neem tree and has limited toxicity for non-target animals. Keep in mind that even Neem Oil can impact beneficial insects such as praying mantids, lacewings, and bees, as well as aquatic life, so be sure you really have no other options before using this and make sure where you spray is away from rivers, lakes, and ponds. Always follow label directions and reapply after rain. As for Japanese beetle traps, many sources do not reccommend using Japanese beetle traps, as they often attract beetles from neighboring properties, causing more problems.

ASSESSING WHETHER GRUBS ARE A PROBLEM

In late summer, dig up a one square foot piece of sod approximately every 10 feet throughout your lawn and count the number of grubs in the soil below the turf (dig about 3 inches down). Focus on areas where there has been grub damage in the past. If there are fewer than 5 grubs per sample there's no need for treatment. But if you see 10 or more grubs then it's time to consider treating your lawn with a grub control product. After putting back the sod, don't forget to water well to help the grass get re-established. Your primary grub control treatment should be performed in late summer before damage becomes apparent (mid-July to August).

GRUB CONTROL TREATMENTS

- Mowing your grass high, maintaining a healthy, vigorous lawn, and encouraging beneficial insects in your garden will help to some extent.
- Bacillus thuringiensis galleriae (Btg) is a biological control that works against adult beetles and grubs, and has proven to be as effective than most alternative treatments. It's labeled for organic production and is safe for adults, children, pets, birds, aquatic organisms and the environment. Best of all, it has no effect against beneficials, such as bees, butterflies, parasitic wasps, ladybugs, beneficial nematodes, etc.
- Btg can be used as a soil drench to kill larval grubs in the ground, as well as sprayed on the leaves of plants that are under attack. When the target insect eats the sprayed leaves (or in the case of beetle grubs, drenched roots), it causes them to stop feeding and quickly die.

Forest Farming

Forest farming is the intentional cultivation of edible or medicinal specialty crops beneath native or planted woodlands that are managed for both wood and understory crop production. Forest farming can provide profitable opportunities for forest and woodland owners, nut growers, sugar maple growers, and herb growers. Suitable species for forest farming consist of shade-loving plants that are naturally adapted to growing under forest conditions. In order to maximize forest farming opportunities, its recommended that a more detailed forest management plan is created and that it integrates forest farming enterprises as part of its goals.

Above: Growing ramps protects wild populations and contributes to the longevity of this species, especially as threats of overharvesting loom over native populations.

Above: Before Ostrich Ferns unfurl their leaves, they produce these delicious fiddleheads which are a popular spring edible.

BENEFITS OF FOREST FARMING:

- **Extra income and diversification.** Cultivation of specialty crops in a forest setting provides new sources of income aside from (or instead of) timber harvests.
- **High value products.** A wide variety of plants can be grown in a forest to produce natural or value-added edible, herbal, medicinal, and craft products.
- **Ecologically responsible.** The intensively-managed cultivation of forest plants that are endangered in the wild due to over-harvesting is a responsible alternative to wildcrafting.

On Crows' Feat Farm, maple syrup can be harvested from the woodlands on site and native edible woodland species can be planted including ramps, ostrich ferns (which have already been planted), American ginseng, and goldenseal, offering seasonal cuisine and wild medicine products. These native woodland plants are not heavy feeders like the "potatoes, corn, and beans" and can obtain their soil fertility needs through the forest's natural functioning. There is no need to weed or fertilize woodland beds as the overstory

Above: Sugar Maple trees are tapped and sap is collected to make syrup.

trees provide deep enough shade and the plants create a dense, shallow, rhizomatous root mat. Deer browsing is the largest concern related to yield. Mushrooms, such as shitake, King Stropharia, and Lions Maine are grown near the forest edge garden, for home use and, potentially, as a valuable small-scale commercial crop. A utility area nearby includes a space for storing woodchips, compost, and woody debris (for hugelkultur beds) that can be used to increase fertility and water retention of garden beds, and a sawmill for milling lumber as needed. Resources are managed carefully on site to promote good land stewardship.

FUNGI

Gourmet and medicinal mushrooms can be integrated into edible forest gardens and forest farming areas as key organisms, recycling agricultural and forest by-products. Mushrooms are a protein-rich food source for humans and many contain significant medicinal compounds.

Growing Shitakes:

Shitake mushrooms can be grown by inoculating logs. These can be partially buried, or lined up in fence-like rows.

- During spring time, inoculate your shitake logs.
- Order your shitake mushroom plugs. 100 plugs will be enough for two (6") diameter logs that are 3-4' long. If you can't use your shiitake plugs within a week of arrival, stick them in the fridge.
- Cut hardwood tree sections that are 4-6 inches in diameter and 3-4 feet long. Oak is ideal, however other hardwoods are fine. Keep in mind, The longer you let your logs sit without inoculating them with your shiitake mushroom plugs, the more time you give fungal spores from other species to land on your logs and start to grow.
- Insert your plugs into the logs. Use a power drill with a 5/16" drill bit attachment to drill offsetting, parallel rows of holes in each log (diamond pattern). Each hole should be about 1 1/4" deep and no more than 3-4' apart. Ideally on a 3ft log, you should have 50 holes per log.
- In a shaded area, separate your plugs into two piles of 50 plugs (assuming you're using 3ft logs). Put the plugs on a clean surface, like a washed plate or a ziplock bag.
- Put your logs on newspaper or plastic if you don't want melted wax on the floor/ground. Insert your shiitake plugs into each hole. Immediately tap them in with your rubber mallet or hammer. Make sure each shiitake plug is well set into the hole so that the surface of the plug is at or below the surface level of the log. Don't leave any drilled holes empty! If needed fill any empty holes with wax, or another species of mushroom will take hold there.
- Melt and apply wax to your shitake logs. On a stove top, grill, or camp stove, heat your wax until fully melted. Using a cheap paint brush, seal each cut end of the log completely with melted wax. Next, seal each hole thoroughly with wax so that each shiitake plug has its own tight little

Marketing Non-Timber Products from Forest Farming

- **Market survey.** Visit both retail outlet and wholesale buyers in your area to learn what forest-grown products they buy. Learn about the buyer's specific requirements regarding quantities, sizes, seasons, prices, etc.
- **Direct marketing.** Retailing value-added products made from understory crops directly to buyers takes time but will give the best return to the landowner. Potential buyers might include restaurants, ethnic markets, natural food stores and the public via the Internet.
- **Wholesale.** By harvesting and processing understory crops grown in your forest, they can be sold to wholesale buyers.
- **Leasing.** The simplest way to generate cash income may be to lease a portion of your forestland to others who will grow and harvest understory crops. A clear lease contract is important.

"house," safe from other competing fungi that might come knocking

- Incubate your shitake logs for 6-12 months. Place your shiitake logs in a shady, moist location off of the ground but within reach of a garden hose. You don't want too much sunlight to hit the logs, and you don't want the logs touching the ground, which encourages other competing fungi to come aboard. An old palette, bricks, or concrete blocks are good for this purpose. Ideally, you can also cover your logs with a breathable cloth (such as a shade cloth or weed blocker) to help keep out sun while allowing moisture to come through, Don't use plastic since this will make your logs mold!
- Water your shiitake logs once per week for about 10 minutes during a dry week in which it doesn't rain. If you get a good soaking rain, don't worry about watering them).
- Initiate your shitake logs. Under ideal conditions, your shiitake logs will be ready to fruit after 6 months, but it's recommended that you wait at least 9-12 months before "initiating" them. "Initiating" them means forcing them to fruit and produce mushrooms. Your logs will do a pretty good job of telling you when they're ready: keep an eye on the cut ends of the logs that you sealed with wax, and if the surface area looks dark and mottled, then you know the colony has taken over the log and is ready to fruit. Once you've determined that your shiitake logs are ready to be initiated, you'll want to submerge them in water for 24 hours. You can use a bathtub, a pail, a contractor bag, a natural (clean) body of water, or whatever else you can come up with that's big enough. After 24 hours of soaking, place your logs back in a shady area and in an upright, vertical position. This insures that when mushrooms start forming, they don't get dirty. You'll see "primordia" (baby mushrooms) form sometime between 2-14 days. Make sure the shiitake logs stay moist during this waiting period by watering them 1-2 times per day for about 5 minutes each time.

ESTABLISHING A BASIC MUSHROOM PATCH

Create lasagna layers of whatever cardboard, wood chips, sawdust, or other substrate you have nearby with mycelium mixed in, in the right proportion. Mushroom patches can be layered over garden beds with holes for plants to achieve a companion-planting scenario.

1. First clear your chosen site of existing debris, which may be hosting other fungi. Let's imagine it's a 3 x 6 foot space.
2. Lay cardboard over the site and cover with moist sawdust or wood chips that are 1 to 2 inches thick.
3. Spread an approximately 2-quart bag of sawdust spawn.
4. Lay bits of ripped cardboard randomly, with the corrugation facing the sawdust spawn.

(The corrugation is easily exposed if the cardboard is soaked and pulled apart.)

5. More sawdust or wood chips 1/2 to 2 inches thick.
6. More cardboard—with a goal of 80–90 percent coverage.
7. More sawdust/wood chips—total coverage if possible.
8. Add water.

OTHER FUNGI TO GROW

- King Storapharia/Garden Giant
- Lion's Mane
- Blue Oyster
- Reishi
- Turkey Tail
- Maitake

SOURCES TO PURCHASE FUNGI/CULTIVATION SUPPLIES

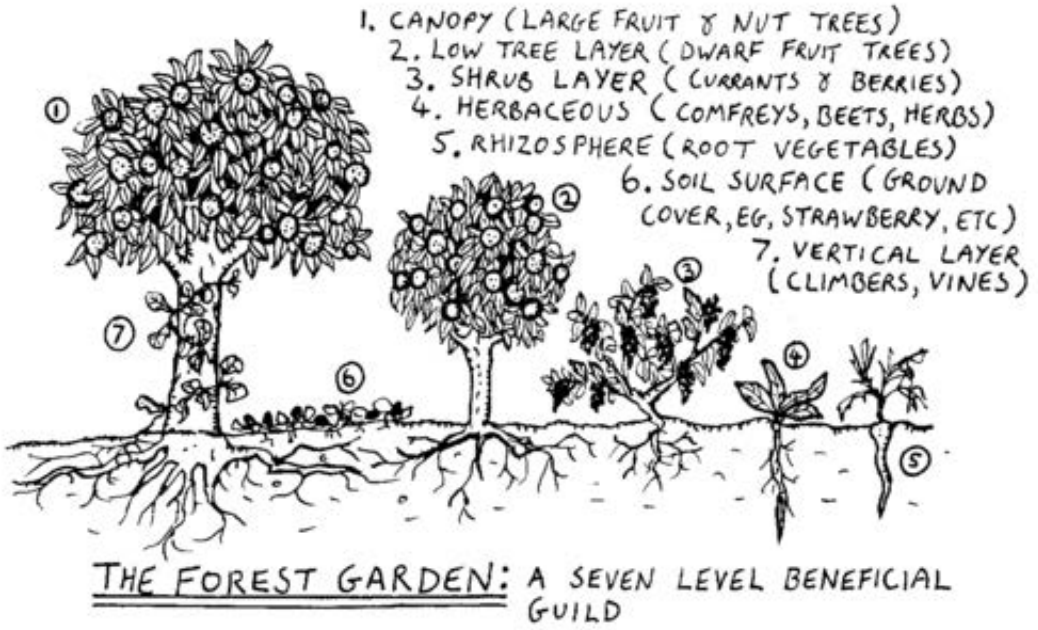
- Wichland Woods
- Fungi Perfecti
- Field and Forest Products

Edible Food Forest Gardens

A food forest, also called a forest garden, is a diverse planting of edible plants that mimics the ecosystems and patterns found in nature. Food forest gardens are an a larger application of th polyculture concept that was discussed earlier in this plan. They can be thought of as three dimensional designs, with life extending in all directions – up, down, and out. Generally, we recognize seven layers of a forest garden – the canopy, the subcanopy, the shrub layer, the herbaceous layer, the root layer, the ground cover layer, and the vine layer. We can also recognize the mycelial layer, which is considered to be layer eight (mushrooms). Ultimately, a food forest garden is a combination of plant polycultures, or an assemblage of plants that work together in a plant community to support each other (much like a natural ecosystem).

Food forests are a relatively new farming concept in our area, but they have been used for thousands of years in other parts of the world. A food forest does not have to be re-planted year after year, making it much more low-maintenance than annual system. Once it is established, it is generally very resilient.

The following pages include a few plant palettes for various patches within the edible forest garden. These were chosen based on species niche and by layer in the garden.



Forest Gardens Can Reduce Inputs By:

- Placing larger emphasis on trees, shrubs, perennials, and self-seeding annuals,
- Planting vegetation densely and using ground covers to shade soil and suppress weeds,
- Using nitrogen-fixing and nutrient-accumulating plants, chop-and-drop techniques, and returning wastes to the land to create healthy soil rather than applying fertilizer,
- Planting a variety of plants that attract beneficial insects to pollinate the fruit crops and keep pest populations down,
- Utilizing several ground-shaping techniques to keep water on the site, and

EDIBLE FOREST GARDEN PLANTING PALETTE

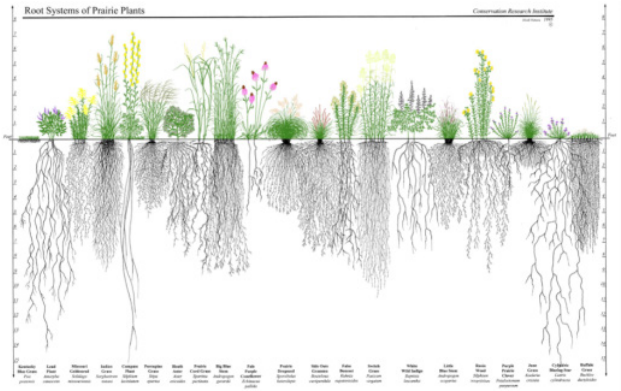
COMMON PLANT NAME	LATIN PLANT NAME	PLANT TYPE	NOTES
PAWPAW PATCH			
Pawpaw	Asimina triloba	Tree	shade tolerant, wildlife shelter, edible fruit, needs cross pollinator from another variety
Witch Hazel	Hamamelis virginiana	Small tree	resistant to most pests, medicinal, can be kept smaller through pruning
Common Filbert	Corylus maxima	Shrub	nitrogen fixer, edible nuts, insectary, wildlife food source
Siberian Pea Shrub	Caragana arborescens	Small shrub	nitrogen fixer, hardy, edible pods
Comrey	Symphytum	Clumping herb	dynamic accumulator, insectary, soil builder, mulcher
Sweet Fern	Comptonia peregrina	Small shrub	nitogren fixer
Sweet Cicely	Myrrhis odorata	Clumping herb	edible roots when cooked, sweet anise flavor, pest confuser
Borage	Borago officinalis	Clumping herb	annual, self-sows easily, edible flowers
Lavender	Lavandula angustifolia	Clumping herb	pest confuser, medicinal flowers
Yarrow	Achillea millefolium	Spreading herb	dynamic accumlator, insectary, medicinal
Daylillies	Hemerocallis	Flowering Bulb	onion flavor edible bulb
German Chamomile	Matricaria chamomilla	Groundcover	annual, self-sows easily, medicinal flowers
Dutch white clover	Trifolium repens	Groundcover	fast growing, nitrogen fixer
AMERICAN PERSIMMON PATCH			
American Persimmon	Diospyros Virginiana	Small tree	edible fruit, insectary, need male and female trees, tolerates jugalone so it can be planted near walnuts
Goumi	Eleagnus Multiflora	Shrub	nitrogen fixer, edible fruit, insectary, medicinal
Dwarf Mulberry	Morus nigra	Small tree	fast growing, edible fruit
Nanking Cherry	Prunus tomentosa	Shrub	edible fruit, hardy, insectary, wildlife food source, windbreak, produces better with more than 1 cherry
Hog Peanut	Amphicarpaea bracteata	Groundcover	nitrogen fixer, insectary, wildlife shelter plant, edible seeds and roots, annual but reseeds easily
Canada Milk Vetch	Astragalus canadensis	Clumping herb	nitrogen fixer, nectary, wildlife food source
Comrey	Symphytum	Clumping herb	dynamic accumulator, insectary, soil builder, mulcher
Dwarf False Indigo	Amorpha nana	Small shrub	insectary, nitrogen fixer
Dutch white clover	Trifolium repens	Groundcover	fast growing, nitrogen fixer

Chives	Allium schoenoprasum	Clumping herb	culinary herb, insectary, pest confuser
Broad Leaved Sorrel	Rumex acetosa	Groundcover	likes partial shade, lemony flavored edible greens, dynamic accumulator, drought tolerant
Good King Henry	Chenopodium bonus-henricus	Clumping herb	edible shoots (asparagus-like), edible flower buds (broccoli-like), edible leaves but should be eaten in moderation
PEACH TREE PATCH			
Peach Tree	Prunus persica	Tree	edible fruit, self-pollinating
Goji Berry	Lycium barbarum,	Shrub	edible fruit, insectary
False Blue Indigo	Baptisia australis	Shrub	nitrogen fixer, insectary
Echinacea	Echinacea purpurea	Clumping Herb	medicinal, insectary, wildlife food, tolerates drought
Valerian	Valeriana officinalis	Clumping Herb	cold hardy, medicinal, insectary
Lovage	Levisticum officinale	Clumping Herb	edible leaves are used as culinary herb, edible roots, medicinal, insectary
Bee Balm	Monarda didyma	Spreading Herb	insectary, medicinal, does not spread as virgorously as others in the mint family, but be prepared for it to grow in a mass
Anise Hyssop	Agastache foeniculum	Clumping Herb	insectary, medicinal, pest confuser
Dutch white clover	Trifolium repens	Groundcover	fast growing, nitrogen fixer
Chicory	Cichorium intybus	Spreading herb	edible greens, edible roots, dynamic accumulator, forage species, insect shelter plant, insectary
Ostrich Fern	Matteuccia struthiopteris	Groundcover	edible fiddleheads, tolerate shade and damp soil
ASIAN PEAR PATCH			
Asian Pear	Pyrus pyrifolia	Tree	edible fruit, insectary, wildlife food and shelter
Lilac	Syringa vulgaris	Shrub	spring bloomers, edible flowers
Sea Kale	Crambe maritima	Clumping herb	edible roots, shoots, leaves, and flower hads, drought tolerant, insectary
Lady's Mantle	Alchemilla vulgaris	Clumping herb	tolerates shade, nectary, medicinal
Lupine	Lupinus polyphyllus	Spreading herb	nitrogen fixer, insectary, wildlife shelter, dynamic accumulator

Sage	Salvia officinalis	Spreading herb	pest confuser, edible leaves and flowers, medicinal and culinary species, insectary
Groundnut	Apios americana	Groundcover	edible root, edible seeds and pods, insect shelter plant, nitrogen fixing, insectary
Greek Oregano	Origanum vulgare hirtum	Clumping Herb	culinary herb, pest confuser, medicinal, insectary
Lemon Thyme	Thymus citriodorus	Groundover	culinary herb, medicinal, pest confuser, insectary
Strawberry	Fragaria × ananassa	Groundover	mulcher, edible fruit
PARTIAL SHADE-TOLERANT PATCH			
Shadberry	Amelanchier arborea	Tree	early spring bloomer, insectray
Redbud	Cercis canadensis	Small tree	insectary, wildlife shelter
Turkish Rochet	Bunias orientalis	Clumping herb	edible leaves, stems, shoots, and flowers, insectary, dynamic accumulator, forage species, drought tolerant
Bleeding Heart	Dicentra eximia	Clumping herb	insectary
Wintergreen	Gaultheria procumbens	Groundcover	edible fruit and leaves, medicinal, nectary, suppresant, dynamic accumulator, drought tolerant, wildlife forage
Columbine	Aquilegia canadensis	Clumping herb	insectary, wildlife attractor
Spotted Cranesbill	Geranium maculatum	Groundocver	medicinal, insectary, suppressant
False Solomon's Seal	Maianthemum racemosum	Clumping herb	insectary
Christmas Fern	Polystichum acrostichoides	Clumping Herb	evergreen, groundcover, easy to establish
Hay-Scented Fern	Dennstaetdia punctilobula	Clumping Herb	groundover

Restoring a Meadow

Lawn or grassland, though easy to manage, uses high quantities of fuel for maintenance. Meadows, on the other hand, offer significant forage for bees and insects, provide habitat for pollinators and ground birds, and offers beauty in its mix of native wildflowers, grasses, and sedges. As Larry Weiner, renowed meadow restoration expert says, "wildflower meadows, if planned, installed and managed properly, can contribute tremendously to naturalizing the American Landscape." In order to fulfill the requirements of long term sustainability and achieve a low maintenance landscape, the meadow must be designed as a functional plant community first and a flower garden second. Only by understanding and incorporating the compositions, patterns and processes inherent in our naturally occurring meadows and prairies can low-maintenance meadow landscapes be created.



ESTABLISHING A MEADOW

Successfully establishing a meadow from seed is a three-year process, with the first year devoted to good site preparation. Because establishing a meadow takes multiple years, its recommended that meadow restoration occur at the bottom of the slope of Crows' Feat Farm on the western edge of the property. Once established, the meadow will provide significant ecosystem services and aesthetic value, while also ensuring that its "establishment phase" not seen as clearly from the road.

Control existing vegetation (common weeds and cool-season grasses) prior to planting is key to success. In order to establish a meadow on the property through organic methods, we recommend a consultant (such as Dr. Cathy Neal of the UNH Cooperative Extension) be hired to complete the transformation, as knowledgeable personnel and contractors are required to carry out the job successfully. Plan on a full season to achieve vegetation control (depending on variables such as noxious weed species, weather conditions, etc).

From 2009 to 2019, Dr. Neal conducted significant research on meadow establishment methods at the Woodman Horticultural Research Farm. Based on her findings, here is a recommended approach to preparing an area of field for meadow transition. She compared numerous methods including tilling, black plastic, clear plastic, herbicides, and a combination of some of these. The most successful method of meadow establishment was the no-till, black plastic/landscape fabric method. This is outlined on the following page.

1. Because aesthetics are a concern, its recommended that you START SMALL. Select a patch of 400-500 square feet to experiment with.

2. Collect soil samples in the designated space to understand the baseline conditions of the soil.
3. Mow the area as short as possible once or twice after it greens up in the spring. Then, rake off any excessive organic matter to create a smooth surface.
4. In June-August, solarize ground with black or clear plastic or black landscape fabric for several weeks to kill existing grasses and create a seed bed. Bury all the outside edges with soil, and/or hold the material down with rocks, cinderblocks, bricks or other available materials to exclude light. Weeds without light are unable to photosynthesize and will eventually run out of energy and die. Cardboard can also work with a layer of organic mulch (woodchips) laid on top can also work as long as light is kept out, making it less conspicuous than an expanse of plastic or cardboard..
5. Consider planting a quick-growing cover crop species like buckwheat once uncovered to smother any additional weed growth OR remove the plastic and seed meadow mix directly into clean seed bed. Do not till the prepared area or you may stimulate more weed growth. Do not apply compost, manure or other nitrogen-rich material, because wildflowers do best in soil that is low in nutrients.
6. Utilize the UNH Wildflower and Grasses Plant List to determine a desired seed blend. Include species like Black Eyed Susans, which bloom during the first year of establishment. During the first year, things can look a little weedy, and the additional color add some aesthetic value. The second year, it will look better, and the third year typically is when the meadow will look more like a “meadow”. Knowing your site characteristics (wet, medium or dry soil and full sun, filtered sun, or shade, at a minimum) is essential to understanding which species will thrive on your site and create a mixed meadow that knits together in a mosaic of colors and textures. An ideal meadow mix will provide a continuous sequence of bloom from a dozen or more native perennial wildflowers (a.k.a. forbs).
7. Seed (using a seed drill) in the fall. For a neater, more designed meadow look, purchase small transplants instead of starting from seed, and plant in intentional groupings as in a garden. Eliminating competitive weeds before you plant is essential to long-term success.

Irrigation

PURPOSE

Rainwater is an invaluable resource on any given property and can be captured and stored to irrigate crops and other uses. A key part of any permaculture design is an integrated rainwater catchment and storage system. The office/barn structure provides a large catchment surface located on a high point of the site, revealing an opportunity for constructing a cistern that captures and stores rainfall. An irrigation pond can provide space for overflow and be used as a back up water source during dryer years. On average, Kensington receives 50 inches of rain per year, or 4.16 feet. We estimated the roof size being 6,600 square feet, based on aerial imagery. Annually, 204,877 gallons of water can be captured from the roof of the office/barn. We calculated the size of this cistern based on a 2-inch rainstorm event. This would mean that accommodating for high rainfall storms or times during the year where rainy days may occur consecutively, a tank that holds at least 7,898 gallons of rainwater would be needed.

DESIGN CONSIDERATIONS

CISTERN SIZE

There are numerous types and sizes of cisterns available on the market. A ~7000-8000-gallon cistern will be a costlier investment, but would provide you with significant water storage capacity for irrigation needs. If desired, consideration could be given to purchasing a smaller cistern (or multiple barrels connected to each other) and designing a more comprehensive overflow system of swales and ponds, understanding that depending on the rain event and season, this system would overflow more frequently. Smaller tanks have more potential to be elevated on a standing structure to improve drip irrigation capability (see right).

UNDERGROUND OR ABOVE GROUND

Underground cisterns save space on a property, especially for larger tanks, but do require excavation. They also do not visually impact a landscape the same way as above ground cisterns can. Above ground cisterns are less expensive to place on the property. See diagram for above and below ground cisterns below.

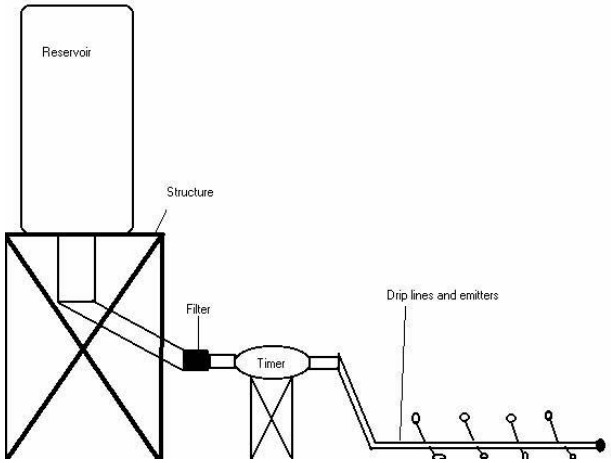
LOCATION OF CISTERN

You may want to place the tank next to the house or shed, which makes water collection simpler and reduces pipe runs. If the tank needs to be placed

away from the house, the plumbing will be more extensive, complex and expensive. If you locate the tank away from the collection gutters, you may need to use what's called a 'wet' system, which can add to costs and complexity.

CISTERN MATERIAL

- **Polyethylene Tanks:** Polyethylene tanks are one of the most common types of tank being sold today and are readily available at most farm, ranch supply, and large landscape retailers. They vary greatly in size, shape, and color, and can be used above or below ground. Polyethylene tanks are comparatively inexpensive, lightweight, and long-lasting and are available in capacities from small 50-gallon barrels to large 10,000-gallon tanks. Most poly tanks will slowly degrade over time with exposure to the sun, despite having UV inhibitors added to the plastic. Poly tanks pose an interesting problem at end of life: if they have degraded to a point where they can no longer hold water, the plastic will have reached a point where it can only be recycled into a limited range of other products. Unless the manufacturer/supplier has a recycling system available, they will usually end up in a landfill.
- **Galvanized Metal:** Galvanized tanks will also have a long life, provided the water is not too corrosive. Galvanized sheet metal tanks can be an attractive option. They are available in sizes that range from small tanks of 150 gallons to medium-sized 2,500-gallon tanks, and are lightweight and easy to relocate if required. For rainwater catchment off the barn/office, multiple metal tanks could be utilized at smaller sizes. These tanks are for above-ground use.
- **Concrete:** The most versatile of tanks, concrete tanks can either be poured in place or prefabricated. They can be constructed above or below ground. Concrete tanks can be quite durable, but they do tend to sweat if they don't have a plastic or rubber liner.
- **Ferrocement:** Ferrocement is the term used to describe a steel and mortar composite material. These tanks can be above or below ground and can be done by contractors or homeowners. They were developed in developing countries to be relatively low-cost and durable. They are listed separately from concrete, not just because of the materials used to construct them, but also because they have differing problems and advantages. These tanks are typically built with concrete, but have multiple layers of wire mesh - typically chicken wire-wrapped around a light framework of rebar, embedded in the concrete. Walls can be as thin as 1" and still be strong. Ferrocement, like concrete, will need maintenance and repair as cracks appear.
- **Fiberglass:** Fiberglass tanks are light-weight, reasonably priced, and long lasting.



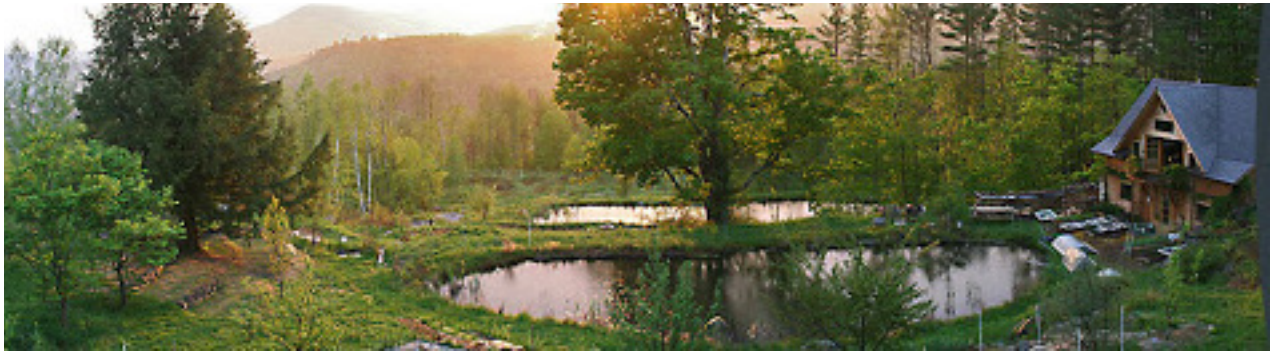
They are built in standard capacities from small 50-gallon barrels to much larger 15,000-gallon tanks and are available in both vertical cylinder and low-horizontal cylinder configurations. Smaller fiberglass tanks (i.e. under 1,000 gallons) are expensive for their size, so polyethylene might be preferred. The durability of fiberglass tanks has been thoroughly tested and proven to last for years and can be easily repaired. The fittings on fiberglass tanks are an integral part of the tank, eliminating one common potential problem - leaking fittings.

DISTRIBUTION

A gravity fed drip irrigation system can be hooked up to the cistern to irrigate the orchard and perennial plantings as well as some of the annual row crops. Normally, a pump would have to be required to produce enough pressure for a drop irrigation system, but because the gardens are downhill, a gravity fed drip system may be possible and is the most energy and cost efficient.

OVERFLOW

An overflow system to an irrigation pond can provide a backup source of water for the gardens on site. This pond can be planted with wetland species to create an aesthetically pleasing environment. There is a significant amount of rainwater coming off the roof of the barn and into the cistern. Constructing a system to divert overflow to the pond will enable that water to be used in dryer seasons and create additional habitat on site. We recommend that a more detailed design be created for the pond before constructing it and that it happen concurrently with the permitting process.




Cistern over flow
water from cistern
Rain water from barn
New pipe to Pond
Irrigation Pond


Existing waterline From gutter on barn
Water to Cistern
Pond
New waterline to pond
water from cistern


over flow to pond
water to drip irrigation


Gutter for Cistern

Implementation Timeline

PHASE 1 (1-2 YEARS)
Start building mixed annual/perennial garden beds.
Construct mobile chicken coop.
Construct bioshelter.
Set up drip irrigation (hook up to well to start) system for annual/perennial gardens and orchard/edible forest garden.
Contact a consultant for the wildflower meadow.
Sheet mulch around fruit trees in the fall to prepare for planting next spring. Plant berry shrubs between orchard trees.
Build beds and begin planting perennial mandala garden.
Develop a phased plan for the three perennial edible forest gardens.
Construct three-bay compost system. Begin collecting and saving organic material and lumber on site (creating wood chips, finished compost for gardens, straw, etc.)
Create a refined design and implementation plan for the pond.
Work with a forester and create a forest management plan.
PHASE 2 (3-4 YEARS)
Begin experimenting by restoring a small patch of grassland to meadow.
Start seeds for annual gardens in finished bioshelter.
Continue building and expanding annual and perennial garden beds.
Move chickens around gardens to contribute to soil fertility.
Build edible forest gardens/forest edge garden and pathways.
Install ground mounted solar system.
Purchase rainwater cistern and construct the pond.
Create mushroom cultivation area.
PHASE 3 (5+ YEARS)
Construct hoophouse.
Plant vineyard.

Resources

BOOKS

Edible Forest Gardens Volume 1 & 2 by Dave Jacke
Farming the Wild Side by John and Nancy Hayden
Perennial Vegetables by Eric Toensmier
The Bioshelter Market Garden by Darrel Frey

PLANT NURSERIES

Edgewood Nursery
Fedco
Johnnys Seeds
High Mowing Seeds
Found Well Farm
A Perfect Circle Farm
Elmore Roots Nursery

POTENTIAL PARTNERS

University of New Hampshire
UNH Cooperative Extension
Seacoast Permaculture
NOFA-NH
Seacoast Eat Local
Seacoast Grower's Association
Slow Food Seacoast
NH Gleans
Three River Farmer's Alliance
NH Department of Agriculture, Markets and Food
New England Small Farm Institute
Northeast Sustainable Agriculture Working Group

Appendix

The following pages include three no-till farming case studies that are intended to serve as resources for Crows' Feat Farm.