GROW APPALACHIA

TECHNICAL GARDENING MANUAL

Planting the seeds for a sustainable future.

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INTRODUCTION

GROW APPALACHIA

Welcome to Grow Appalachia's Gardening Manual. If you are not familiar with the program, Grow Appalachia is the largest rural food security program in the United States. The program is regionally focused in central Appalachia and our primary goal is to help Appalachian families grow as much of their own food as possible. We accomplish this goal by providing resources and education directly to families through our numerous partner sites working in over fifty counties in a six state region.

This manual is meant to be a resource to help you be successful in producing your own food. In fact, we hope you will take it one step further and go on to market the extra food you produce to increase your means, as well as provide fresh food for the community. We hope this resource makes it simple and convenient to find basic information about how to establish and/or improve your garden or small farm.

This resource is NOT meant to be all-encompassing, or the last word on how to grow you own food. Agriculture is a huge field of scientific study and there are countless resources that will offer good, as well as bad information. Our goal with this manual is to weed out the bad information and incorporate as much helpful, science based information as is reasonable in a concise format. We hope you will go beyond this manual and explore some of the attached resources that go into more depth on different topics. Like in all the sciences, agricultural science is constantly evolving and we hope you will continue to explore and educate yourself.

ORGANIC GROWING

The Grow Appalachia program is dedicated to the use of organic growing methods to produce food for our families and markets.

The reason is simple, we want to ensure the safety and quality of the food produced within the program. We feel produce grown organically provides that safety and quality and can be just as productive as growing with conventional fertilizers and sprays.

Organic gardening/farming is essentially the practice of growing food without the use of chemical additives such as:

- Pesticides
- Herbicides
- Chemical Fertilizers and soil amendments

Organic Agricultural Production is the alternative to **Conventional Agriculture Production.** Conventional producers can use one or all of the above additives to address problems in their production systems.

Organic Producers have their own set of methods and tools to help them avoid the above inputs. These tools and methods can be just as effective as conventional methods if used wisely.

Advantages of Organic Production:

- Without the presence of what can be dangerous chemicals used in conventional agricultural inputs, food produced organically is often considered to be healthier and safer
- The cost of buying chemical inputs is eliminated
- The personal risk associated with storing and applying strong chemicals is eliminated
- The environment tends to benefit greatly from organic vs. conventional production
- Because organic systems help steward the environment, they are considered more sustainable than conventional systems and in the long term, are better for your land.

Keys to Success in Organic Production

Many are under the false assumption that you can practice organic farming and gardening the same way you grow conventionally, just without using chemicals. This assumption is incorrect and can lead to failure and frustration.

- In a conventional system, chemical sprays and inputs are often used to compensate for poor growing conditions and inattentiveness to crops. This is simply not possible in an organic system and adaptations must be made.

- In order to be effective, organic farms and gardens must be managed intensively and intentionally to ensure healthy growing conditions that foster hardy plants that will resist pests and disease.

GARDEN PLANNING

The first step in successful gardening is planning. If you skip or rush through this step, you are likely setting yourself up for failure. Before you ever pick up a tool, you need to pick up a pencil, some paper and the following tools:

The tools you will need to plan for a year in the garden

Soil Test

- Soil is the foundation of a healthy garden.
- You need to have your soil tested and analyzed to determine what to grow, where to grow it, and what you will need to add to your soil before you start.
- We will provide more information on soil testing and soil amendments later in this manual.

Measuring tape

- You need to have a good idea how much area you are working with in your garden, and how you want the layout to look. This will help you plan how much seed, fertilizer, mulch, trellising and other equipment to purchase and will help you plan your irrigate system.
- Plan on starting small and expanding as you have the time and resources. You can easily plan too large of a garden only to have it go to weeds because you over committed.
- We will discuss laying out your garden in more detail in the next section.

Seed catalogs

- After you have an idea of how much area you have to work with in your garden and the soil conditions present, you will need to select what to grow and establish a timeline based on the maturity rates of your selected varieties.
- Before purchasing seed, read the variety selection section of this manual and do some re search on what grows best in your area.
- It is easy to get carried away with a seed catalog in front of you. Limit yourself to purchasing only what you know you can grow well given time and space constraints.

Recommended Seed Catalogs
High Mowing Organic Seeds, Johnny's Seeds, Fedco Seeds, Southern Exposure Seed Exchange, Baker Creek Heirloom Seeds

(See Resources Section for More Seed Sources and Information 1.)

Calendar
- Timing is crucial to planning your garden and is key to developing a successful growing system.
- Look at the maturity rates of your intended crops and account for the time it takes to prepare your beds and incorporate any amendments or cover crops with which you are planning to use to improve your soil.
- Some cover crops and amendments may take several weeks to break down in the soil to benefit your crops, so be mindful of this as you plan.

Laying out Your Garden

There are a few things you will want to consider as you lay out your garden for the year. Here are the most crucial of these considerations:

Space
- How much space is available to you?
  -You will want to determine how much square footage you are growing on for the year.
  -You may need to translate your square footage into acres to have a compatible measurement with inputs like fertilizer, lime, cover crop seed, etc.
  -You will use this information to lay out your garden to scale on paper, and plan your inputs before you buy them
- Ask yourself, do you have the time and resources to utilize all of the garden space available to you? Make sure you don't over commit yourself; your time and resources are limited. Dream big, but start small.
- After you have an idea about the size of your garden, and the varieties of crops you want to grow, you can start designing your rows, beds, pathways and other elements.
  -For your vegetable rows, find the length and width you want these to be and determine the seed-spacing recommendations on what you want to plant. Use this to determine how much seed to purchase of each variety. This will prevent you from wasting money on seed.
  -Take into account how you want to mulch the garden. Mulch is extremely important for many reasons, we will go into depth on mulch in a separate section.
  ~If you are using plastic mulch, determine the width of the plastic and take that into account as you are laying out your beds.

Water
- Planning how you are going to irrigate your garden is another vital component to determining how you will lay out your garden.
  -Locate your water sources and determine how you will get the water from the source to your garden.
  -Plan to make watering as efficient and expedient as possible so that you will water

evenly and consistently to ensure the health of your plants.
-Read the section on Watering/Irrigation for more details about how to water efficiently.

- Drip Irrigation:
  -For most situations, we highly recommend using drip irrigation to water your garden for its efficiency and the numerous benefits it offers for the health of your growing system.
  -For planning drip irrigation, you will need to have an idea about the size and spacing of your rows, the location of your water source, and how you will be controlling the water flow to different parts of the garden based on the needs of your crops.
  -We will address drip irrigation in more detail in the Watering/Irrigation section.

Access

Convenient access to the garden leads to more consistent and efficient work being done throughout the growing season. If your garden is out of the way of your daily routine, is inconvenient and/or difficult to access, the activities that will need to be done consistently and in a timely manner can easily be neglected.

Access needs to be considered in terms of you, other participants in the garden, your equipment, and any bulky materials that might be delivered or moved during the year such as compost or mulch.

- Make your paths and rows wide enough to be easily navigated by a person and any applicable equipment such as a mower, tiller, or wheelbarrow
- You may choose to maintain your paths with a tiller, a mower, or mulch, this will need to be decided and accounted for in your layout.
- Make sure all your plants are in easy reach to make weeding and harvesting convenient and efficient.
- Good vehicle access is ideal for delivery of bulky material such as mulch, compost, fertilizer, equipment, etc.

Planning your Calendar

Timing is everything in a successful gardening system. Therefore, it is important to plan ahead and at least estimate the dates you will be conducting certain activities.

Planting Dates:

- Dates to plant your flats if you grow your own transplants; these dates will be crop and variety dependent, and will also depend on the facilities you are using to grow transplants.
- Estimated dates of first and last frosts in your region, you can find this information online. These dates often correspond to the USDA's "Plant Hardiness Zones".
- Estimated times to till and prepare your beds for each season
- Dates for transplants and seeds to be planted in your garden
- Maturity dates for all of your different crops and varieties so you can use this information along with the planting dates to estimate when you will be able to harvest
- Dates for planting and incorporating your cover crops; we will discuss the importance and timing of cover crops later in the manual.

Succession Planting
Succession planting is a practice recommended by us here at Grow Appalachia for maximizing your production. It is the practice of continuously having something in the ground throughout the year, planting your next crop right behind the crop you just removed.

For example, one of your beds might be planted in the following for the year:

Winter: cover crop, rye and clover
Spring: Spring vegetable such as radishes
Summer: Summer vegetable like beans
Fall: Cover crop or cool season vegetable

- Succession planting, especially when you utilize cover-crops, improves your garden by suppressing weeds, preventing erosion and can improve your soil quality over all.
- Use care when utilizing a succession planting strategy as it can deplete your soil of nutrients if you continuously grow nutrient hungry crops and/or fail to include soil revitalization strategies like cover crops and crop rotation.

(See our Resources Section for More Information about Succession Planting 2.)

Crop Rotation

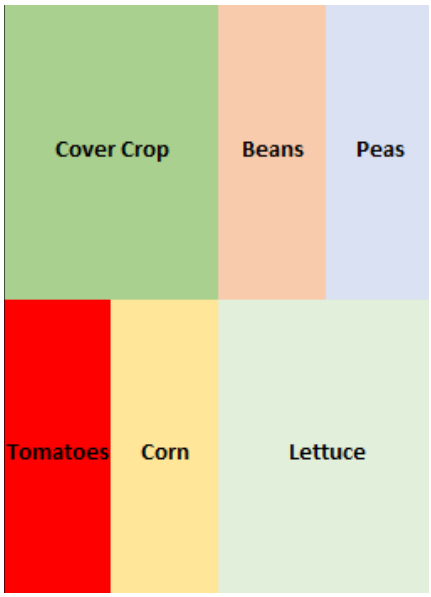
Crop rotation is a strategy that is essential to a healthy garden. Planting the same crop in the same place year after year will cause numerous problems. It will deplete your soil of specific nutrients, increase pest and disease pressure, and reduce your overall production significantly.

To avoid this, you will want to change where in your garden you grow different types or families of crops.

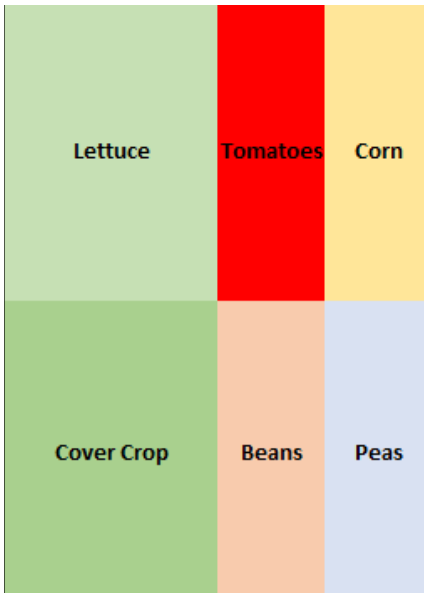
Examples of Different Plant Families in the Garden

Solanaceous Crops: tomatoes, eggplant, peppers, potatoes
Legumes: beans and peas and legume cover crops such as vetch and clover
Cucurbits: cucumber, squash, melons, pumpkins
Brassicas: cabbage, cauliflower, broccoli, kale, turnips, radish, mustard, collards
Carrot Family: carrots, parsnips, celery, dill, cilantro, parsley, caraway, fennel
Asters: sunflowers, lettuce, endive, radicchio, Jerusalem artichoke, artichoke
Alliums: asparagus, onions, leeks, chives, garlic, shallots

(For more information on crop rotations by family, see our Resources section 3.)



Why should you rotate your crops?



To reduce the pressure from pests and diseases

- Members of different plant families often share pests and diseases which will thrive if the same plants are in the same space year after year. These garden menaces will build up on a given site over time if you do not rotate your crops. Moving your plant families from place to place in the garden helps break up the life cycles of harmful organisms.

To maintain adequate fertility

- Specific crops often use some nutrients more than other, so if you plant the same crop in the same place, the soil on that site can quickly be depleted of specific nutrients.
- Some crops are heavy feeders, meaning they require high levels of fertility while other crops need less fertility to thrive. Growing heavy feeders in the same place from year to year will deplete soil fertility and quickly impact the health of your plants.

(See our Resources section for a list of light vs. heavy feeders in the garden 4.)

Crop Rotation Planning

The most effective way to plan crop rotations is to plan three or more years ahead. This sounds like a lot, but when you consider it in terms of how many planting successions take place in that period, it starts to make sense. The best practice is have a crop family in a bed for one succession, and then keep that bed free of that family for two years to break up pest and disease life cycles.

Once you have your garden broken down into sections or beds for planting different crops, you can start planning your rotations:

Consider:

-The space requirements for each crop you will grow
-The family of the crop you are growing
-Your crop's fertility needs
-How and when you will incorporate soil building practices like cover crops into your rotation

SOIL HEALTH

No other factor is as important to an organic grower as the soil in which she/he grows. Having productive, healthy soil that is conducive to growing your crops will allow the plants you grow to also be healthy and hardy, and stand up to insects and disease.

The importance of Soil Health

- Healthy plants will better resist disease and insect pressure and will be better able to compete with weeds
- Having a healthy soil structure will also help your plants deal with inclement weather factors such as too little or too much rain
- In conventional agriculture, the use of chemicals is often used to compensate for plants that struggle due to unhealthy growing conditions. This is not possible using organic methods
- Having considered the importance of soil in organic systems, commit some time and resources every year to improving your soil

The Basics of Soil Health

In order to understand and manage the health of your soil, it is important to know a few basics things about the properties of soil. One thing to understand about soils is that they are all different and unique, and how best to manage them will depend on several factors discussed in this chapter.

4 Key Features of Soil: Composition, Structure, Chemistry, Biology

Soil Composition

- Soil is made up of a variety of different soil particles
- Together, four types of particles in different ratios make up the soil. These particles each have unique sizes and properties:

-Clay
-The smallest soil particle

-Good at holding water and soil nutrients
-Responsible for compaction, bad drainage, hard soils

-Silt
-Medium sized soil particle
-Good overall size and properties for growing
-Medium drainage and soil nutrient holding capacity

-Sand
-Largest soil particle
-Promotes drainage, prevents hard soil
-Poor water and nutrient holding capacity

-Organic Matter
-Made up of decomposing plant/animal tissue
-Basis for life in the soil
-Excellent properties all around for gardens

Soil Structure

- Soil structure refers to the way soil particles fit together to form the "texture" of the soil
  -The structure/texture of the soil dictates whether it is compact, loose, porous, how easy/hard it is to till and work, and how easy it is to plant.
    -Relatively loose soils that are easy to work and have good drainage are usually preferred for growing a garden.
- Soil structure mainly depends on 3 factors: soil composition, how the soil is being managed (tillage practices and heavy equipment use), and the activity of living organisms in the soil.

Soil Chemistry

- Soil chemistry can be complicated, but for our purposes, it will mainly refer to the soil's pH; pH is a measurement of how acidic or alkaline the soil is
    -Soil pH influences soil nutrients, and how available those nutrients are to be used by plants.
    -Soil pH is influenced by the soil's composition, and by the chemical compounds present in the soil from the breakdown of minerals and organic matter.
- Soil chemistry will play a role in how fast/slow things break down in the garden to feed your plants, and will heavily influence what kind of life is thriving in your soil to help your garden.

Soil Biology

- Soil biology refers to everything that lives in your soil from worms down to the tinniest forms of life
    -The more diverse and complex the life in your soil is, the more your garden will thrive and be able to defend itself from pests and disease.
- Soil biology has a major influence on how nutrients and organic matter break down; it also influences how plants can then utilize those nutrients to thrive.

The importance of Organic Matter

Soil Organic Matter (OM), which mostly consists of broken down plant and animal tissue, is the key to creating better soil conditions for your crops

- Having a high OM content in your soil can vastly improve the properties of the 4 main soil factors: composition, structure, biology and chemistry.
- OM also improves hydrologic (water holding) properties in the soil and makes the soil easy to work with.
- OM is excellent at retaining nutrients in the soil that can be readily available for uptake by plants.
- OM itself can contain many crop essential nutrients that are slowly released as it breaks down.
- There are many ways to increase the OM content in your soil: adding compost, mulching and utilizing cover crops are some of the best.

(For more information on organic matter, see our Resources section 5.)

Soil Testing

Soil testing is an important first step in understanding the conditions you intend to grow in. It is also a crucial step in planning your inputs and will aid you in many management decisions in your garden.

- A standard soil test will not tell you everything you need to know about your soil, but it is a good place to start.
- The content and layout of a soil test will vary broadly depending on where your soil test is being done. This variance will occur state to state and institution to institution.
- Your local Cooperative Extension Agency is a key resource for obtaining and interpreting your soil test.

Most Standard soil tests should contain the following information:

Macronutrients

- Macronutrients include several nutrients essential to plant growth, they are needed in higher quantities than other essential nutrients which are considered micronutrients.
- The primary macronutrients are Nitrogen (N), Phosphorous(P) and Potassium(K)
- Secondary macronutrients are Calcium(Ca), Sulfur(S), and Magnesium(Mg)

Four (4) Macronutrients commonly measured by standard soil tests:
Phosphorous(P), Potassium(K), Calcium(Ca), Magnesium(Mg)

Micronutrients

- These essential nutrients are needed in much smaller quantities than Macronutrients and can reach levels that are toxic to plants

Five (5) Micronutrients commonly measured by standard soil tests:
Boron(B), Copper(Cu), Manganese(Mn), Iron(Fe), Zinc(Zn)

Nitrogen

Nitrogen analysis and recommendations are often left off of standard soil test due to the difficulty of accurately assessing soil nitrogen levels and because Nitrogen levels can fluctuate greatly between the time you take your soil test and time you plant you garden. Testing for nitrogen may also require a different sampling method than a standard soil test.

- Many places that do soil testing have a separate option for testing nitrogen.
- If you choose to have your nitrogen tested, it is recommended you do so as close to the time you intend to apply fertilizer as possible.
- If you are taking your own soil samples and sending them away to be tested for nitrogen, you may need to take your samples differently than you would for a standard soil test; you will need to ask your test provider for instructions on how to collect samples for nitrogen.
- Further information on nitrogen will be available later in this chapter.

Important Plant Nutrients and Their Designations					
Nitrogen	N	Boron	B	Zinc	Zn
Phosphorous	P	Sulfur	S	Iron	Fe
Potassium	K	Magnesium	Mg	Manganese	Mn
Calcium	Ca				

Soil pH
- Soil pH is a measurement of your soil's Acidity/alkalinity. The status of your soil's pH can have major implications in your garden. Soil pH plays a large role in how available certain nutrients are to your plants.
- pH is measured on a spectrum from 0 - 14
  - -zero(0) is highly acidic
  - -fourteen(14) is highly basic (alkali)
  - -A pH of seven(7) is considered neutral
- For most crops, a pH between 6 and 7 is ideal
- If your pH is too low or too high, you can use certain soil amendments to change the pH
- Information on how to amend your pH will be covered in the nutrient management section

Buffer pH
- This measurement is to gauge how easily your soil responds to amendments in pH
- It is a measurement your soil's pH after a solution has been added to change the pH
- The more of a difference there is between the buffer pH and the standard pH, the easier it will be to amend your soil's pH

Cation Exchange Capacity (C.E.C.)
- C.E.C. measures how well you soil particles tend to hold on to certain nutrients

- If your soil has a high C.E.C., it will hold on to nutrients better, however because the nutrients are binding to the soil particles, they may not be as available to plants and your soil may require higher application rates of fertilizer.
- Soils with lower C.E.C. will release nutrients to plants more readily, however nutrients will be more prone to leaching out of the soil around your crop; therefore more frequent fertilizer applications may be necessary
- C.E.C. will range from 5 (low) to 50+ (high), 20-30 is optimal

Base Saturation

- Base Saturation describes the percentage of the soil's C.E.C. that is occupied by calcium, magnesium, and potassium.
- Higher percentages of Base Saturation for these nutrients will mean they should be more available to plants in higher quantities during the growing season.

Organic Matter (OM)

- Organic matter or OM is extremely important in an organic growing system; the higher your soil's organic matter content, the more potential productivity your soil will have.
- Organic matter will be shown as a percentage on your soil test.
- Not all soil test include organic matter, we recommend using those that do include OM or getting a separate OM test done to evaluate this crucial factor.
- Most soils are 2% OM or less
- The very best soils are between 10% and 20%
- Increasing your soil's OM content takes time and resources; we will discuss this process in depth later in the Soil Health chapter.

Amendment Recommendations

Most soil tests will include recommendations for nutrient and pH amendments based on the results of your soil test. While these recommendations can be useful, they do not have to be taken as the last word on how you should amend your soil.

- You should be sure to take into account what you are growing because different crops have different nutrient and pH requirements
- Not all amendments act the same way, especially organic fertilizers which tend to be less immediately available to plants, but are available over a longer period of time compared to conventional petroleum based products

(For more information on soil testing, see our resources page 6.)

Nutrient Management and Soil Improvement

Like all living things, plants need nutrients to survive and thrive. Plants obtain nutrients from the soil they grow in. Healthy soil will contain a variety of different nutrients at levels that are conducive to plant growth.

Many soils do not contain optimum nutrient levels and should be amended, taking into account:

- The information you obtain from your soil test
- What and when you intent to grow in your garden
- The type of amendments you intend to use and cost effectiveness

Nutrients are considered in two categories: *macro* and *micro*

Macro nutrients are used in the most volume by plants; these are the nutrients most often used to supplement the soil in the form of fertilizer and include:

Nitrogen (N)
Phosphorous (P)
Potassium (K)

Secondary Macro nutrients and Micro nutrients, while also crucial for plants, are necessary in smaller amounts and the most important of these are:

Magnesium
Calcium
Sulfur
Manganese
Boron
Zinc
Iron

Basic Types of Soil Amendments for your Garden:

Fertilizer

- Fertilizers contain nutrients that are easily available to plants either immediately in the form of available/soluble nutrients or over time in the form of insoluble nutrients.
- Most basic fertilizers contain different amounts of the three primary macronutrients and are given an "analysis" based on the percentage of each of these three nutrients
  - -The three nutrients are Nitrogen, Phosphorous, and Potassium
  - -An analysis will be labeled in the following way: %Nitrogen(N) - %Phosphorous(P) - %Potassium(K)
- This is known as an N-P-K analysis
  - -Example: An analysis of 3-4-3 would contain 3% Nitrogen(N), 4% Phosphorus(P), and 3% Potassium(K)
- Some fertilizers will contain other macronutrients and micronutrients
  - -They may still include the N-P-K analysis, and the percentages of the other nutrients will be labeled separately

Lime and pH Amendments

Most soils will tend toward an acidic (low) pH, so amendments for pH are commonly ones that will help increase your pH toward neutral.

- Soils in an optimal pH range will better release nutrients to plants and create a healthier growing environment overall
- Lime amendments, derived from limestone, are the most common pH amendments available
  - -There are many different types of lime that are used for a variety of applications, so make sure you are purchasing a product appropriate for the garden.
  - -Using hydrated lime on your garden is not recommended, it is caustic and may harm you or your plants.
  - -The finer the limestone is ground, the faster it will work to amend your soil.
  - -Pelletized, finely ground lime is preferable for being rapidly active, and easy to use.
  - -Calcitic lime is usually preferred over dolomitic lime for most vegetables.
- For amending high pH soils (soils with a "basic" pH), natural sulfur is an organic amendment option.

Compost

Compost, which is usually in the form of decomposed plant matter and food waste, can be an important amendment for organic vegetable production. You can buy compost from a variety of sources, or you can make your own.

Using lots of compost can help you increase the all-important organic matter in your soil. Compost can also provide a variety of good nutrients to your garden, but usually does not contain high enough quantities of nutrients to use by-itself to feed your garden.

There are some important things to consider before using compost as a soil amendment:

- Where is the compost coming from?
  - -Compost is heavy, bulky, and you need a lot to make a difference; transporting can be expensive.
- What is in the compost?
  - -If you are not making it yourself, be sure to determine what went into the compost.
  - -It may contain plant material that has been sprayed with chemicals and is not acceptable for organic production.
  - -It may also contain weed seeds that have not been sufficiently broken down and can turn into a real problem in your garden.
- How is it being managed
  - -If the compost has not been managed well, it may not contain the proper components and may be unproductive in your garden.
  - -Compost should be well broken down before it is used in your garden, make sure the compost you are using looks like soil and not scraps of plant material and food waste.

Animal Manure
Manure is higher in nutrients than compost and can provide sufficient macronutrients to sustain your garden.

Considerations for using manure:
- Like compost, manure should be well broken down before it is used in the garden; fresh manure will "burn" your plants and dehydrate them.
- Possibly the best use of manure is to let it break down over several months, and then compost it with a carbon source like leaves, decaying wood, straw .
- Manure that has not been sufficiently aged can contain weed seeds that will take over your garden.

(For more information about organic soil amendments, see our resources section 7.)

Understanding Different Forms of Nutrients
- Most nutrients, such as nitrogen for example, come in different forms that will determine how available and useful they are to plants.
- Sometimes nutrients are in a form that is immediately available to plants while in other cases they are tied up in certain chemical compounds. These compounds either release that nutrient slowly over time, or they can tie the nutrient up indefinitely.
  - -Most Conventional Chemical Fertilizers are soluble and will become immediately available upon contact with sufficient moisture.
  - -Many organic forms of nutrient inputs, such as organic fertilizers and manure will release slowly as the input breaks down over time.
- Nitrogen, for example, can be soluble or insoluble
  - -Soluble forms of nitrogen are released via contact with water and becomes immediately available to plants.
  - -Insoluble forms of nitrogen break down slowly over time and are not available to plants all at once.
  - -Other forms of nitrogen, such as atmospheric nitrogen, must go through very specific biological processes before it can be utilized by plants.

Soil Preparation

In order to plant a garden in most places, it is necessary to break up the soil so it can be easily planted and weeded; and to create soft, loose soil for optimum growing conditions. The most popular, and in many cases most efficient, method for doing this is tillage.

Tillage Considerations
- The advantages of tillage:
  - -Tillage breaks through hard crusts and clumps of soil to create a nice, easy to work with seed bed.
  - -It uproots weeds when you are creating your seed bed and can be used through out the season to control weeds.
  - -Tillage can increase drainage in the top level of your soil.
  - -Tilling is an easy way to incorporate plant matter, like a cover crop or mulch, into your soil to break down and become organic matter.

- Disadvantages of tillage
  - -Too much tillage can severely damage your soil's structures.
  - -Tillage disrupts healthy soil biology.
  - -It exposes soil to erosion.
  - -Some soil moisture is lost through evaporation.
  - -Turning over the soil can expose dormant weed seeds which can them germinate and create a problem.

Good Tillage Practices

- Tillage should be done sparingly and should not be mistaken for a fix-all for your soil's problems
- Using the right tools for tillage can help mitigate some of the disadvantage
- Long term improvement of your soil's structure, such as increasing organic matter and encouraging soil biology, can help you reduce the amount of tillage you need each year
- Use scale-appropriate tillage methods; this means tilling with the smallest/lightest piece of equipment you can while still being efficient
  - -This will save your soil from compaction that comes from driving bigger equipment over the soil

Tillage Methods and Tools

There are a few basic tools and methods for tilling your garden.

- Broadfork
  - -Non-mechanized hand tool for breaking up soil
  - -A well-built broadfork is a robust and effective tool that can handle tough soil
  - -A stout piece of equipment that requires adequate physical fitness
  - -Requires little maintenance and no fuel
  - -Often breaks up soil into larger chunks, you may need to break it up further with a hoe
  - -It may be difficult to penetrate hard/dry soil with a broadfork
- Rototiller
  - -Small machine that tills the soil mechanically
  - -Can be very efficient for small gardens
  - -Creates a nice fine seedbed
  - -Not heavy enough to handle tough soil conditions, tilling blades just bounce off of hard soil
- Walk-behind tractor with tiller
  - -Heavier and more powerful than a rototiller, more effective on tough soils
  - -Width of tiller and self-propelled mechanism makes it much more efficient and effective on larger gardens, up to about 2 acres
  - -Durable and worth the investment for larger tilling jobs
- Compact tractor with tiller
  - -Least labor intensive option, but also the most expensive and resource intensive
  - -Heavier equipment causes your soil to become compact deeper in the soil below the reach of your tiller; this creates what is known as a "hardpan" under the soil surface
  - -Tractors may be worth the investment, but only for larger gardens or farm, or for sharing between a number of gardens

- Disk Harrow
  - -For use with a tractor
  - -Slices through the soil, but does not invert it, which helps your soil's structure and biology stay intact; weed seeds are not as readily exposed
  - -Not very effective on hard ground

(See our resources section to find sources for garden and small scale tillage tools. 8.)

No-Till

No-Till is the practice of planting directly into the ground without tilling or breaking up the soil. This practice is only effective for growing produce in the best of soils that are soft enough to eliminate the need for tillage. To get to that point, the soil must be managed and cared for intensively, and must be high in organic matter

- No-Till Considerations:
  - -No-till maintains the integrity of the soil's structure and biology
  - -Reduces erosion
  - -Water in the soil less susceptible to evaporation
  - -There is no opportunity for dormant weed seeds to surface and become a problem
  - -Planting and weed control may be very difficult if the soil is not in good condition
  - -It can be very difficult to kill and incorporate cover crops and weeds on a large scale
- Best practices for no-till
  - -Grow intensively on a small scale to mitigate added time/labor that is necessary for management of a no-till system
  - -Adding to your soil's organic matter needs to be a top priority
  - -Mulch to control weeds and increase organic matter is even more important for no-till systems
  - -Be prepared to research and continue learning about how to manage a successful no-till garden, this can be a complex system
  - -Be prepared to do more intensive and intentional planning, it is important to think ahead to appropriately manage a no till system

(For more information about No-Till practices, see our Resources section. 9.)

WHAT TO GROW AND WHEN

Choosing what to grow in your garden can seem overwhelming. Seed catalogs contain thousands of tempting options, many of which will not be productive or appropriate for your individual location due to factors such as soil type, climate, and your personal approach to gardening. While it does require thought and intention, this can also be fun and exciting. We hope the following information will make this process simpler for you.

Basic Categories for Fruits and Vegetables

Three basic categories describe the life cycle of plants in the garden:

Annuals

- Annuals make up the vast majority of crops grown in the garden. They are planted from year to year, and they germinate (sprout) and die within a 12 month period. They mature fairly quickly
  - -Annuals include: tomato's, beans, cucumbers, melons, squash, etc.

Perennials

- Perennials live for multiple years. They are planted once and managed for the following years. Perennials tend to mature slowly
  - -Perennials include fruit trees, strawberries, raspberries/blackberries, asparagus, and alliums like onions and garlic

Biennials

- Biennials sprout and leaf in one growing season and then flower, reproduce, and die in the next growing season. Biennials in the garden are often harvested within the first year, and so are basically managed like perennials
  - -Biennials include cabbage, Brussel sprouts, kale, celery and carrots

Cool vs. Warm Season Crops

Different plants thrive in various conditions. Not everything you plant in your garden can thrive during the hot summer months. In this regard, we can think of plants being in one of two categories:

Cool season crops thrive in the spring and fall. They prefer and even require cool soil to grow in, and can easily wilt during the intensity of a summer day.

Cool season crops include:

- Cabbage
- Kale
- Lettuce
- Chard
- Beets
- Snap pees
- Turnips
- Radishes

Warm season crops need warmer soil temperatures to germinate and thrive. They usually need full sun and do not tolerate frost or prolonged cool temperatures.

Warm season crops include:

- Tomatoes
- Peppers
- Squash
- Corn
- Beans
- Melons
- Eggplant

Some crops, namely biennials and annuals, transition well from cool to warm season, though you will want to be careful to select varieties that will tolerate your specific climate.

Hybrid vs. Open Pollinated (Heirloom) Varieties

Not all plant varieties are developed the same way. Some are selected for desirable traits from the seed stock year after year creating open pollinated or heirloom varieties. Others are developed by cross pollinating two different varieties to combine the desirable traits of both; these are called hybrid.

Open Pollinated (Heirloom) Varieties

- Developed by selection of seed over a long period of time
- Seeds are viable and can be saved and replanted from year to year
- Many heirloom varieties are preferred for their flavor and unique character
- Tend to be less disease resistant although this is not always true

Hybrid Varieties

- Developed by cross pollinating two distinct varieties to achieve "hybrid vigor" and a melding of traits.
- Seeds produced from hybrids are not viable and therefore seed must be re-purchased from year to year.
- Hybrid varieties are generally more vigorous and disease resistant.
- Hybrid varieties make up the vast majority of the commercial seed market.

Considerations for Variety Selection

When it comes to selecting the crops and varieties you want to grow, there several factors that should be considered in terms of where you are growing, and how you want to manage your garden.

Varieties Suited for Organic Production

- Not all varieties have been developed with organic production methods in mind
- Many commercial varieties were developed strictly in a conventional system; so, while they may work just as well in an organic system, there is a potential for difficulty in adapting them to an organic garden.
- There are varieties available that were developed specifically for organic production and have been tested in that context.
- We recommend exploring varieties that are developed for use in an organic production system.

(See our resources section for sources of seed produced for organic production 10.)

Regional/Climate Appropriateness

- Depending on where a variety is developed to thrive, it may or may not be appropriate for your climate or region; For example: a tomato variety that thrives in the deep south may perform very poorly in the Appalachian mountains.
- It is always best to research any variety you are interested in trying and establish that it has been successful in a similar climate or region to your own.
- One helpful strategy is to seek out gardeners and farmers in your region who are experienced and growing successfully, and select your crops and varieties based on what is already proven locally;
    - -if you use this strategy, keep in mind that this does not guarantee success; other growers may have a different soil type, or may not be growing organically.

Maturity Rates/Days to Harvest

- Not all varieties take the same amount of time to the reach the point where they are ready to harvest.
- Varieties that take longer to mature are not necessarily inferior, quick development can sometimes come with trade-offs.
- You do need to consider maturity rates/days to harvest in terms of your climate and calendar.
    - -For example: if you plant a warm season variety 90 days to maturity, and the first anticipated frost date for your area is in 60 Days, you will likely lose your crop before you can harvest.

-Plants with fast maturity rates can be very helpful if you are succession planting, meaning another crop is scheduled to go in the same place soon after you harvest the current crop.
-You can get more planting successions in one place throughout the year if your varieties have faster maturity rates.

Growth Habits

- Not all varieties of a crop species have the same growth habit; you should select varieties based on how you intend to manage them.
- A notable examples of a species with different growth habits among different varieties is the tomato.
  -Indeterminate tomatoes grow long vines and produce fruit all season; they must be trellised (tied up vertically) to be successful.
  -Determinate tomatoes only grow to a specific height and produce all of their fruit at one time: they tend to be shorter and therefor it is less necessary to trellis them.
- Beans also vary in growth habit by variety
  -Bush beans grow outwards instead of upwards, staying close to the ground, but taking up more space.
  -Pole beans vine upwards and must be provided a trellis to grow upwards on.

Disease Resistance

- Different varieties are developed to be resistant to certain diseases and pests.
  -This inherent disease resistance an important tool for growing organically.
- Plants developed and proven to be resistant to specific diseases have what is known as a "disease package" which includes all the diseases they are known to have resistance to.
  -Be careful to select varieties that have good resistance packages that address the specific disease issue in your area.
  -Identify common diseases in your area using resources such as your own records from past seasons, other local growers, or your local agricultural extension service; use this information to select your disease packages.
- To identify different diseases in a disease package, many seed companies use codes to designate which diseases the variety is resistant to.
  -For example the code "DM" designates downy mildew.

(For a list of disease codes, see our resources section 11.)

Sourcing Seeds and Transplants

It is important to source seeds and transplants from reliable sources in order to insure viability and success. This is a key piece of investment for you garden each year. It pays to start with quality seeds and transplants.

Sourcing Seeds

- Buying seeds off the shelf at local store can be a gamble.
  -Often times, the seed packets have been on the shelf for some time and may have issues with viability and germination.
  -Best practice is to use seed that was produced the year before.

-As seeds age, germination rates go down; seed that is several years old may not germinate at all.

- Invest in high grade seeds from a reputable source that serves serious gardeners and market producers
- Buying seed in bulk can greatly reduce cost; coordinate with others and combine seed orders when possible.

Recommended Seed Sources:

High Mowing Organic Seeds
Johnny's Seeds
Fedco Seeds
Southern Exposure Seed Exchange
Baker Creek Heirloom Seeds

Saving your own Seeds

- Saving your own seed works well if you are obtaining seed from open pollinated fruit and vegetable varieties.
- Saving seeds from hybrid fruit and vegetable varieties is not an option; hybrids do not produce viable offspring.
- Seed saving techniques are different for each species of fruit or vegetable, so knowledge and research is required.
- Save seeds from your healthiest plants and best fruit to ensure good genetics

(See our Resources section for more information on how to save seed 12.)

Sourcing Transplants

- Transplants for an organic garden must come from a source that uses organic potting medium and organic fertilizers; this can be a challenge as many available sources of transplants aren't organic, or don't give you that information.
- Look for transplants that appear healthy and are not wilted or spindly.
- Also check the roots and make sure they are not bunched along the sides and bottom of the container; this means the transplants are "root bound" and have been growing too long in the container; their growth may be stunted even when transplanted to a bigger pot or a bed.

Starting Your Own Transplants

- If starting your own transplants, having adequate light and warmth in extremely important.
- Pale light from a single window is not enough for successful transplants.
- Temperatures should be between 60 and 80 degrees for most plants.
- Grow lights can be a good option, but specific bulbs are required to give adequate light, so do your research before you try to use any old light source you can find.
- Grow lights should be maintained at a distance of 2-4 inches from your seedlings as the grow.

(For more information on starting transplants, see our Resources section 13.)

CULTURAL PRACTICES AND GARDEN MAINTENANCE

Planting healthy seeds/transplants in healthy soil is just the start. Throughout the season, your garden must be watered, weeded, and kept free of pests and disease. There are important, labor saving steps to take to make sure your garden remains healthy and productive throughout the growing season.

Watering/Irrigation

Ways to Water your Garden

- By hand with a watering can, bucket or any other container
  - -This method is labor intensive and inefficient and should not be the primary way your garden is irrigated.
- With a garden hose
  - -While more efficient than watering by hand, it can still take a lot of time to give. Your entire garden enough water to thrive using this method, unless only managing a few beds.
  - -Watering with a hose allows moisture to get on the leaves of your plants; this may cause increased disease problems.
- With a sprinkler System
  - -Sprinklers free up time and reduce labor; the user can turn them on and leave, or work on other projects.
  - -Some water will be wasted to evaporation and to areas that don't need to be watered such as your pathways.
  - -Also with this method, moisture will get on the leaves and encourage disease.
- Drip irrigation system (highly recommended for larger gardens or farms)
  - -Water is delivered right to the roots of the plant where it is needed; very little is wasted.
  - -The only time/labor that is required is set up, and to turn it off and on; it can also be put on a timer.
  - -Moisture from irrigation is kept off the leaves decreasing the chance of disease.
  - -Water is introduced gradually which is better for the plants.
  - -There is some up-front cost for the system, and drip tape must be replaced each year.
  - -Can be intimidating for first time users to set up.

When to Water

When you water can be just as important as how you water in terms of disease control and plant health.

- The preferred time to water is in the morning, when water has more time to enter the soil and be taken up by plants before it evaporates.
  - -Moisture that gets on the leaves will evaporate as the day heats up.
- Watering in the evening or after dark is not recommended for vegetable as moisture on the leaves may not be allowed to evaporate until the following day creating potential for disease (less of an issue with drip irrigation).
- Watering during the heat of the day is not recommended as this can damage your plants and waste water to evaporation.

How Much to Water

Plants require sufficient water to survive and stay healthy, but too much water can be just as harmful to your plants as a lack of water. Also, different plants have different watering requirements; and temperature as well as humidity play a role in how much water plants will use.

- Most vegetable crops require around 1 inch of water per week.
  - -More will be needed if the air is hot and/or dry.
  - -Less may be required if cool and wet conditions prevail.
  - -Some crops may need more or less water depending on their growth habits, and what stage of growth they are in.
- Gauge how much water falls in your garden.
  - -Use a small container and make a mark at 1 inch; be sure to empty this each time it rains and keep track of how much water has accumulated in a log book.
  - -You can also purchase a rain gauge.
  - -An easy way to judge your soil moisture is to simply dig several inches into the soil; if the soil is damp, you should have adequate moisture in your soil for your plants.
  - -A more expensive and advanced way to measure soil moisture is with an irrometer which measures osmotic pressure in the soil related to moisture content.
- If fields are muddy for several day, or have standing water on them for more than a few hours, plants can be damaged or killed because their roots aren't receiving enough oxygen.
  - -Raised beds are a good option for spots that consistently receive or hold too much water.
- Make sure moisture is penetrating at least 6 inch into the soil when you water your garden
  - -If only the first couple of inches is staying wet, the roots of your plants may only grow very shallow in the soil which can cause malnutrition and instability.

(For information about watering and Irrigation, see our Resources Section 14.)

Mulching

Mulching is an excellent practice that suppresses weeds, improves your soil, retains moisture and helps control disease. Many types of mulches have been adapted to vegetable production, some require more management than other. We encourage everyone to utilize mulch in whatever way they can that makes sense. However some options will be better than others for your system.

Benefits of Mulching

- Creates a physical barrier that smothers weeds by physically restricting them and by cut ting off light.
- Cuts down on weed seeds that lay dormant in your soil by creating ideal conditions for them to germinate and then smothering growth; weeds germinate and then die without producing more seed.
- Helps soil retain moisture by preventing evaporation.
- Effectively eliminates soil erosion.
- Reduces disease pressure by creating a barrier between disease-harboring soil and the susceptible leaves of your crop.
- Helps regulate soil temperatures.
- Natural mulches also break down over time to increase organic matter in the soil.
- Mulches not only control weeds that haven't emerged, they can be used to smother existing weeds before planting. Example: a black plastic tarp staked down over weeds for several weeks.

Types of Mulch

Natural Mulches

Natural Mulches break down to become organic matter and improve your soil. They may take more labor to manage.

- Straw
  - -Best Natural Mulch
  - -Can contain weed seeds
  - -Source Carefully
- Grass Clippings
  - -Can contain weed seeds
  - -May have residual herbicides/pesticides
  - -May break down too fast
- Leaves
  - -Can acidify soil
  - -Shred to prevent them from blowing away
- Woodchips/Saw Dust
  - -May rob nitrogen from your plants
  - -Don't use anything that has been sprayed or treated with chemicals
  - -Best in pathways, not in the beds around plants
- Cardboard/Paper
  - -May not be very nice to look at
  - -Cheap if you collect your own
  - -Don't use glossy paper

Synthetic Mulches

Synthetic mulches form a more impermeable barrier to weeds and moisture loss. They don't contribute to organic matter and they must be removed from your garden and thrown away making them less sustainable than natural mulches. Drip irrigation should be used under these mulches for proper irrigation.

- Polyethylene Plastic Mulch
  - -Most popular mulch for larger producers
  - -Requires specialized equipment to install on a large scale
  - -Starts to break down after one season of use
  - -If left too long, can become a mess in the garden
- Woven polypropylene UV resistant ground cover
  - -Great product for small scale growers
  - -Thicker and more durable the standard plastic mulch
  - -UV resistant means it can be used for multiple seasons
  - -Ground staples required for installation
- Landscape fabric
  - -Fairly inexpensive
  - -Not very durable
  - -Does not retain moisture as well

(To find out where you can purchase some of the above mulching systems, see our Resources page. 15.)

Trellising

Many vining varieties of crops such as beans, most varieties of tomatoes and cucumbers, greatly benefit from being trellised. Trellising provide your crops some form of vertical structure to climb or be secured to. Trellising allows these plants to grow upward instead of growing along the ground where they are susceptible to pests, disease, and getting stepped on.

Types of trellising:

Florida Weave for Tomatoes
We recommend this trellising technique for tomatoes. Posts are set between every 2 or 3 plants. A string is wrapped around the first post, woven in between the plants, and then wrapped around the next post until you come to the end of your row. Once at the end, you then go back using the same technique on the opposite side of each plant. You will create multiple figure eights around the stems using this technique which will act to support the stem. You will add more strings in this manner as the stem grows upwards, with a string about every 8-12 inches.

Tools/materials for the Florida weave:
- 7 foot T-posts which are strong and durable for many years of use
  - -1 post for every 2-3 plants + 1 post for each end
- T-post driver as well as a T-post puller for the end of the season
- Tomato twine or synthetic bailing twine; do not use weaker strings
  - -About 300 feet of twine per 100 foot row

- A small diameter PVC tube about 2 feet long
  - -Run the string through the tube and hold the tube on one end to keep you from having to bend over when running the twine lower down.

Hortonova Netting for Beans, Peas and Cucumbers

Hortonova is a plastic horticultural netting with 6 inch squares. It can be purchased in many lengths and widths. For beans, we use a 5 foot width on 7 foot T-posts. The length just depends on how long your rows are. We drive the T-posts in the ground every 4 feet along the row and use nylon outdoor grade rope to run along the top of the posts. The netting is hung vertically from the ropes as well as being secured to each T-post with twine or zip ties. We keep the netting 6 inches off the ground so we can weed and mulch under the netting.

Tools/Materials for Hortonova Netting:

- Hortonova Netting
  - -5 foot width is good for most uses
- T-posts
  - -1 post for every 4 feet in your row
  - -7 feet or taller to allow room for climbing beans
- T-post driver; T-post puller for removal of posts
- Nylon outdoor grade rope for the top of the posts
  - -You don't need a thick rope, just one that is strong and in good shape that will hold up to being outside.

- Twine or zip ties to secure netting to the rope and posts
- Stakes for the ends of the row to secure the rope and lend extra support
  -Shorter T-posts driven at a 45 degree angle away from the end posts will work for this.

Pruning

Pruning is the practice of removing non-essential parts of your crop to increase the overall health of your crop. Tomatoes are the best example of the usefulness of this practice in the garden. Tomatoes should be pruned fairly heavily in order to reduce disease, increase fruit production, and make the crop more manageable.

Benefits of Pruning

- Pruning reduces disease by removing foliage near the bottom of the plant that can be susceptible to picking up disease from the soil.
- Pruning also reduces disease by thinning foliage to increase airflow; this helps keep the leaves dry and less susceptible to disease.
- By removing excess plant material, more energy is available to go into fruiting which will increase production.

How to Prune Tomatoes

- Only indeterminate tomato varieties need to be pruned
- Pruning tomatoes is traditionally done using a technique called “suckering”

- Suckering a tomato plant is done several times as the plant grows by removing a part of the plant called a sucker.

- Suckers grow between the main stem and the branches of the tomato plant
- Suckers are identified by their location, and by the fact that they are rounded, unlike a branch which will be flatter.
- Suckers should be removed during the early stages of growth before they have be come too big as removing well developed suckers can damage the plant.
- The top sucker on each plant can be left to become a second leader, which is a secondary main stem.

Tomato Pruning Techniques Online Resource

Weed Control

Practicing efficient weed control in the garden is important for saving time and labor. Pulling established weeds on a hot summer day can be miserable and extremely time consuming. The following methods focus on preventative weed control and address weeds early on when they are small and easy to remove.

Many of the methods for preventative weed control have already been addressed in other sections of this manual. This section will list these.

Steps for controlling weeds in the garden

- Use mulch around your crops whenever possible to smother weeds
  - -Leave as little soil uncovered as possible in your garden.
  - -If using natural mulch like straw, be careful not introduce weed seeds with the mulch.
  - -See the section on mulches in this manual for more details about mulch
- Address weeds as soon as they emerge
  - -Especially important for managing large areas of bare soil
  - -Managing weeds at this stage is far less time consuming and labor intensive.
  - -Plan small amounts of time each week for weeding instead of waiting and having to commit a large block of time.
- Invest in quality tools that make weeding easier.

-Crouching down and pulling weeds by hand may seem like a lot of work, but very little is accomplished by this method.
-There are some fantastic weeding tools out there that are well designed to make this job easier on you; some of these tools are outlined below.
-Invest in several tools that are good weeding in specific conditions; no one tool is good at doing everything.

Tools for Weed Control

For Mulch, see the section on Mulch in this manual.

Scuffle Hoe

- Different sizes and shapes available
- Each hoe has several cutting surfaces of various size/shape for getting into tight spots while also being about to clear larger areas
- Good in tight quarters on a small scale
- Can be inefficient for larger areas
- Works best in loose soil

Stirrup Hoe

- Cuts on the push and pull
- The blade is sturdy enough to cut out larger weeds
- Comes in different sizes
- Blade runs nicely under the surface of the soil
- Not a great tool for narrow spaces or close to crop (exception might be smaller sizes)
- Better for larger areas than a scuffle

Wheel Hoe

- Improves ergonomics, with less energy involved in weeding
- Interchangeable blades for many different tasks
- Robust enough for tougher weeds
- Handles large spaces efficiently
- Does not work well in close quarters or in between plants

Other Hoes Designed for Weeding

- Chopping Hoe
- Swan-neck Hoe
- Collinear Hoe
- Dutch Hoe

Smaller Hand Tools for Weeding

- CobraHead
- Asparagus Knife
- Cape Cod Weeder

(For more information on tools for weeding and cultivation, what they do and where to get them, see the Resources section 16.)

Pest and Disease Control

Organic does not mean there are no options for pest and disease control. There are effective pesticides and disease control methods that are allowable for use in organic systems. More importantly, there are also strategies to reduce pest populations before they become a problem. These strategies take more foresight and planning but are proven effective.

Strategies for Pest and Disease Control

- Scouting for pests and disease among your plants is important for identifying problems early to make control more effective.
- Organic growers should take a broad, system wide, preventative approach to pest control instead of only addressing problems when they happen.
- Select varieties that will be resilient/resistant to diseases and pest.
  -See section on Variety Selection
- Maintain healthy plants that will resist pest and disease pressure.
- Use mulches to protect foliage from soil-borne disease.
  -See section on Mulch
- Prune your plants to control disease
  -See section on Pruning
- Rotate your crops to control buildup of disease.
  -See section on crop rotation
- Remove and disposed of any heavily diseased plants that are finished for the season, or too far gone to save.
  -Collect disease plant matter and either burn it or bag it and send it to the dumpster.
- Water your crops properly to avoid creating favorable conditions for disease.
  -See section on irrigation

Row Cover/Insect Netting for Pest Control

Using a physical barrier such as row cover or insect netting is an extremely effective strategy called "exclusionary pest control". This method may not be effective at controlling all pests, but is for most.

- Row cover is a thin fabric designed to hold some heat around plants and exclude pests.
  -Light can penetrate and reach your plants, but is reduced.
  -Row cover comes in different weights; the lighter weight the row cover is the more light will get through to your plants.
  -Heat build-up may be an issue for some crops and/or seasons.
- Insect netting holds almost no heat and is very transparent, allowing a lot of light through to your plants.
  -More expensive than row cover.
  -More useful when growing summer crops.
- Install row cover or netting as soon as you plant to keep pests from being introduced.

- Install hoops every 18-24 inches to help support the row cover over your plants to give your plants room to mature.
- The row cover or netting must be secured to the ground around the edges of your bed.
    -Use sod staples or weights every few feet to hold the row cover down.

Powders and Sprays for Organic Pest Control

There are effective powders and sprays available to use in organic systems to treat pest and disease problems that are not manageable in any other way. Always do your research before using these products as some may be harmful (though usually less harmful that conventional chemicals) and all take a degree of knowledge to use correctly.

Considerations:

- Products may be harmful for you or the environment, especially if used incorrectly.
- These products are expensive so you will want to use them as little as possible.
- Early and consistent application of these products are required for effectiveness.
- They are not systemic, which means they easily wash off of plants after application.
    -Rain or spray from a sprinkler or hose will render most organic products useless.
- Effective on specific pests at specific stages adding complexity to their use by gardeners.
- We recommend varying the mode of action when utilizing these products so pests don't build up a tolerance.
    -This means using several different products in rotation.

(For more information on this organic pest and disease control, please see our Resources section. 17.)

Extending the Growing Season

It is important to be able to have fresh produce from your garden for more than just the summer months. But growing in the spring, fall and winter presents a set of unique challenges. Technology has allowed us to address those challenges to a fair degree and keep growing food even when it's cold. Here's what you need to know to start.

Three Systems for Extending the Season

There are three main systems available that help extend the growing season by regulate temperatures around your plants. Generally speaking these systems consist on similar elements which include some kind of frame and a transparent covering that allows light to get to your plants. These systems create what is known as the greenhouse effect which allows light from the sun in and then traps the heat energy created by that light. Some of these systems can also be actively heated by an introduced heat source like a radiator or electric heater to supplement the heat energy from the sun.

Sometimes these systems are mixed up with each other, but each have their own unique uses and management requirements, so it is important to know the differences in the definitions and how they should be used.

Greenhouse

- A greenhouse is an enclosed system that consist of a structural framework covered by hard plastic or glass panels.
- Greenhouses use supplemental heat in various forms to create and maintain a fairly precise temperature despite outside conditions.
- Greenhouses are very expensive to build, maintain and keep heated so the space inside is at a premium.
- Because of the cost, these systems are not generally used to grow on a large scale
- The most cost effective use of greenhouse space in a gardening system is to start quality plant seedlings for high value crops to transplant in the field when the outside conditions are right.

High Tunnel

- A high tunnel or hoop house are structures framed by many bows or "hoops" lined up in a row and covered with clear soft plastic sheeting.
- High tunnels can be dual or single wall, referring to the number of sheets of plastic covering the structure.
    - -Dual wall high tunnels have two sheets of plastic cover the tunnel; these sheets are separated by an air pocket in between.
        - -Dual wall tunnels generally stay warmer inside.
        - -Two sheets of plastic block more light than one sheet which can cause plants to grow more slowly.
        - -A blower fan is required to maintain the air pocket between the plastic.
    - -Single wall tunnels are simply covered with a single sheet of plastic.
        - -Cheaper than a dual wall.
        - -No extra equipment is required.
        - -Often easier to manage.
- High tunnels can be heated with an external heat sources, but are often unheated, relying on the suns energy for warmth.
- High tunnels can be much larger than greenhouses because of the cost effectiveness of the structure; so crops can be grown inside a high tunnel on a much larger scale.
- High tunnels need to be ventilated to prevent excessive buildup of heat and moisture on warm days.

(For information on how to purchase a high tunnel, see our Resources section 18.)

Low Tunnel

- Low tunnels have a similar design to high tunnels, but are much shorter and closer to the ground; they are not a walk in system, but have to be accessed by removing the cover.
- Low tunnels, like high tunnels can be covered with a clear plastic sheet, but a fabric row cover is the more economical approach.
  - -Row cover is a fabric that allows light to penetrate, though not as much light as clear plastic; it is less expensive than plastic.
- The bows/hoops of a low tunnel can be made from heavy gauge wire, steel conduit, or PVC (PVC is not recommended due to short life span).
- Low tunnels are the most economical season extension option, but can be fairly labor intensive to manage.

RESOURCES

1.) Sources of Seed/Information on Varieties

The Sustainable Mountain Agriculture Center - A large variety of regional heirloom tomato and bean seeds
http://www.heirlooms.org

General variety recommendations for widely successful varieties
http://all-americaselections.org/winners/index.cfm

Great source of seeds, tools and information for market producers
http://www.johnnyseeds.com/

Heirloom southern seeds
https://www.southernexposure.com/

Discounts on bulk orders. Good quality seed
http://www.fedcoseeds.com/

Completely organic seed, proven varieties for organic producers
http://www.highmowingseeds.com/

2.) Succession Planting

Rodale's Organic Life - Succession Planting: Keep it Coming
http://www.rodalesorganiclife.com/garden/succession-planting-keep-it-coming-0

3.) Crop Rotation by Family

Penn State University: Rotations Based on Plant Families
http://extension.psu.edu/plants/gardening/fact-sheets/general-gardening/plant-rotation

4.) Crop Rotation by Nutrient Needs

Harvest to Table - Heavy vs. Light feeders in the garden
http://www.harvesttotable.com/2010/04/vegetable_crop_rotation/

5.) Organic Matter

Detailed look at what organic matter is and how it interacts with different soil textures. Also includes expected returns from increased % of organic matter
http://www.extension.umn.edu/agriculture/tillage/soil-management/soil-management

6.) Soil Testing

Clemson – Standard Soil Test
http://www.clemson.edu/agsrvlb/interest.htm

University of Kentucky – How to Take Soil Samples
http://www2.ca.uky.edu/agc/pubs/agr/agr16/agr16.pdf

County Map for Kentucky- Select your county and contact information for your local extension agent should be available. Your local agent will help you with soil sampling. Cost should be minimal ($0-$10)
http://www2.ca.uky.edu/county/

If you would like a more detailed test, including organic matter content levels and nitrogen levels. Will cost more ($10-$20)
http://watersag.com/

7.) Soil Amendments

University of Wisconsin - Building Soil Organic Matter with Organic Amendments
http://www.cias.wisc.edu/wp-content/uploads/2008/07/soilorgmtr.pdf

List of organic amendments and what they contribute in the form of nutrients
http://www.ext.colostate.edu/mg/Gardennotes/234.html

Source for an excellent multi-purpose organic fertilizer – Grow Appalachia: Contact Mark Walden at mark_walden@berea.edu

7 Springs Farm - Source for purchasing organic amendments
http://www.7springsfarm.com/organic-farming-gardening-supplies-catalog

8.) Tools for Tillage/Bed Preparation

Professional walk-behind tractors, implements, and garden hand tools
http://earthtoolsbcs.com

Johnny's offers many efficient hand tools and seeders
http://www.johnnyseeds.com/c-5-tools-and-supplies.aspx

9.) Information on No-Till

Eartheasy - No-Till Gardening
Good Summery of No-Till gardening practices
http://learn.eartheasy.com/2009/01/no-till-gardening/

Information about why No-Till works
http://extension.psu.edu/plants/sustainable/news/2011/sept-2011/4-org-no-till

10.) Organic Seed Sources

Source of Seed for Specifically for Organic Producers
http://www.highmowingseeds.com/

11.) Disease Resistance Codes

Johnny's Seeds – Disease Resistance Codes
http://www.johnnyseeds.com/t-disease-resistance-codes.aspx

12.) Saving Seed

How to Save Seeds
http://www.howtosaveseeds.com/

13.) Growing Transplants

Utah State University - Grow your own transplants at home
https://extension.usu.edu/files/publications/publication/Horticulture_HomeHorticulture_2011-01pr.pdf

14.) Watering Irrigation

Recommendations for a low cost drip irrigation system
http://www.motherearthnews.com/homesteading-and-livestock/low-cost-drip-irrigation-system-zmaz02aszgoe.aspx?PageId=4

Beginners Guide to Drip Irrigation
http://www.rodalesorganiclife.com/garden/beginners-guide-drip-irrigation

Clemson University – Irrigation
Several publications available that span several topics around watering/irrigation
http://www.clemson.edu/extension/hgic/plants/other/irrigation/

15.) Supplies for Mulching/Trellising

Johnny's Seeds – Mulch and Trellising Supplies
http://www.johnnyseeds.com/c-5-tools-and-supplies.aspx

Excellent sources of mulch, trellising, and produce equipment and supplies in Central and Western Kentucky

- Martins Produce Supplies - Liberty, KY- (606) 787-9389 call and ask for a catalog
- Deerfield- Elkton, KY- (270) 265-2425 call and ask for a catalog

16.) Hand Tools for Weeding

Johnny's Seeds – Source for weeding/cultivation hand tools and how to use them
http://www.johnnyseeds.com/c-218-hand-tools.aspx?pagesize=15&list=1&pagenum=1

Great selection of hand tools as well as small-scale mechanized equipment
http://earthtoolsbcs.com

17.) Resources for Pest Control

Exclusionary pest control, using row cover to protect your plants
http://www.gardeners.com/how-to/row-covers/5111.html

Biopesticides for Disease Control
http://articles.extension.org/pages/29380/biopesticides-for-plant-disease-management-in-organic-farming

Organic Pesticide Products and How They Work

http://www.jbiopest.com/users/lw8/efiles/suman_gupta_v31.pdf

Organic Pesticide Guide
http://www.aces.edu/pubs/docs/A/ANR-1428/ANR-1428.pdf

Insecticides for Organic Production
http://www.aces.edu/extcomm/timelyinfo/entomology/2012/May/organicInsecticides.pdf

Penn State - Disease Resistance in Integrated Pest Management
http://extension.psu.edu/

Sustainable Agriculture Resources and Education (SARE) - SARE publication on comprehensive pest management
http://www.sare.org/Learning-Center

18.) How to Purchase a High Tunnel

Grow Appalachia manufactures and installs scale-appropriate and cost efficient high tunnels in Kentucky. Please see our webpage for more information
http://www.growappalachia.org

OTHER RESOURCES BY TOPIC

Soil Testing

1. http://www2.ca.uky.edu/county/
County map for Kentucky- Select your county and contact information for your agent should be available. Cost should be minimal ($0-$10)

2. http://watersag.com/
If you would like a more detailed test, including organic matter content levels and nitrogen levels. Will cost more ($10-$20)

Cover Crop Seed

Most of the seed companies listed below offer pre-mixed multi-specie cover crop mixes. Local farm stores can also be a good source for seed, although they are normally less focused on organics. Ask for untreated seed. Inoculated is ok, but no fungicides.

1. http://www.johnnyseeds.com/assets/information/farm-seed-comparison-chart.pdf
This chart describes planting windows, intended benefits, seeding rates, and other useful information.

2. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1192459.pdf
This is a cover crop periodic table- great for choosing cover crop seed.

3. http://www.fedcoseeds.com/ogs/?cat=FarmSeed
Encourages cooperative-type orders (Larger quantities= lower prices)

4. http://sustainableseedco.com/compost-cover-crops/
Higher priced, but has great selection of seed typically needed

5. http://www.johnnyseeds.com/c-4-farm-seed.aspx
Tailored towards market farmers. Has great information and resources for growers. Shipping can be high cost for small orders.

6. http://welterseed.com
Mid-level farmers. Pallet orders are most efficient.

Crop Rotations

1. http://pubs.ext.vt.edu/
A publication from the Virginia Cooperative Extension on plant families.

2. http://www.neon.cornell.edu/croprotation/DACUMcroprotation.pdf
An in-depth SARE publication. Technical and all-encompassing of a full crop rotation system

Organic No-Till

1. http://extension.psu.edu/plants/

Equipment

1. http://earthtoolsbcs.com
Professional walk-behind tractors, implements, and garden hand tools

2. http://www.johnnyseeds.com/c-5-tools-and-supplies.aspx
Many efficient hand tools and seeders

Farm Supplies

1. Martins Produce- Liberty, KY- (606) 787-9389 call and ask for a catalog
2. Deerfield- Elkton, KY- (270) 265-2425 call and ask for a catalog

High Tunnel Kits:

1. http://growappalachia.org 859-985-4178
Scale appropriate sizes: 15ft x 48 ft Gothic Peak, or 12ft x 40ft Quonset style

Seed sources:

1. http://www.heirlooms.org
Bill Best's company- a large variety of regional heirloom seeds

2. http://www.johnnyseeds.com/assets/information/corn-sweet-types-comparison-chart.pdf
Publication describing sweet corn genotypes

3. http://www.uvm.edu/vtvegandberry/factsheets/corngenotypes.html
University of Vermont publication on sweet corn genotypes

4. http://all-americaselections.org/winners/index.cfm
General recommendations for widely successful varieties

5. http://www.johnnyseeds.com/
Great for market producers

6. https://www.southernexposure.com/
Heirloom southern seeds

7. http://www.fedcoseeds.com/
Discounts on bulk orders. Good quality seed

8. http://www.highmowingseeds.com/
Completely organic!

High Tunnel Grower Resources

1. http://hightunnels.org
Great high tunnel LISTSERV- many growers open to questions

2. http://www.growingformarket.com/
Most respected trade publication for local food producers

3. www.johnnyseeds.com/t-growers-library-vegetables
Johnny's seed grower resources- vast amounts of information

4. http://ukhtrf.webs.com
University of Kentucky high tunnel research website. Great information!

5. http://smallfarms.cornell.edu
Cornell has a great sustainable agriculture program

Funding

1. www.nrcs.usda.gov
National funding through state offices

2. http://www.soarfarmloans.org
Low interest loans up to $7500

Soil

1. http://www.noble.org/ag/Soils/SoilWaterRelationships/
Great article on soil and water relationships, written by Jeff Ball

2. http://www.extension.umn.edu/agriculture/tillage/
Detailed look at what organic matter is and how it interacts with different soil textures. Also includes expected returns from increased % of organic matter

3. http://www.soilhealth.com/soils-are-alive/index.htm
Website dedicated to the understanding of soil health, from asking the basic question of what soil is to how soil organisms are relevant to sustainable land management

4. http://www.sare.org/Learning-Center/Books/
Comprehensive guide to cover crops. Information about many different species and their uses. Easy to use format

Pest Management

1. http://www.sare.org/Learning-Center/Bulletins/
SARE publication on comprehensive pest management

General Production Information

1. http://www.uky.edu/hort/node/1639
2016 Vegetable Production Guide from the University of Kentucky. Contains some information about organic growing practices

2. https://attra.ncat.org/organic
Great source of publications to inform organic farmers. Many are free, some cost.

3. http://www.sare.org/Learning-Center
Another great source for publications about sustainable farming practices