RUTGERS
New Jersey Agricultural Experiment Station

VEGETABLE GARDENING

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The vegetable garden is a source of pride and may be a necessity for many New Jersey residents. This is the place where, in a matter of weeks or months, you can see, and eat, the fruits of your own labor. Having a productive garden reduces dependency on grocery stores for produce, makes fresh vegetables readily available for family and friends, and improves the diet. Gardeners lead better social lives, too. It is a well-known fact that gardeners readily share their successes and their failures with other enthusiastic "green-thumbs."

Picture juicy red tomatoes still warm from the garden, succulent sweet garden peas going from plant to pot, crisp heads of lettuce and cabbage, piles of bright green peppers, armloads of fragrant basil and cilantro, baskets of fresh tender green beans. People who appreciate the joys of fresh, homegrown vegetables and herbs; of fresh air and sunshine; of digging in the soil and watching plants grow; and who are tired of pink tomatoes, limp broccoli, and expensive cucumbers from the grocery store should start their own vegetable gardens.

Vegetable gardening is not difficult. It can be for anyone: apartment dweller or homeowner, young or old, experienced gardener or beginner, in city or country, with small sunny porch or large backyard.

SITE SELECTION

The first step in planning a garden is to locate it. Ideally, the location should have:

- Good drainage
- Minimum of 8 hours of direct sun a day for fruiting crops, 6 hours for leafy crops.
- Access to a water source
- No competition for water or sun from trees and shrubs
- Fertile soil
- A level area
- Consideration for people with special needs: i.e. the blind, the wheelchair-bound, arthritics

When less than ideal conditions exist, some corrections can be made to improve the situation. For example: If the soil does not drain well or lead levels are too high, raised beds can be used to elevate the garden. If the soil fertility is poor, compost and other soil amendments can be used to improve it. If there is not enough sun, gardening can be moved to containers in a sunny area.

CROP SELECTION

When deciding which vegetables to plant, consider:

Personal preference: What does the family like to eat? If no one eats tomatoes, despite their general popularity, don't plant them. Also consider which vegetables you want to can, freeze, or store.

Planting times: Choose crops that can be planted and harvested at a time convenient to you. There are cool and warm season crops. If the garden is not ready to plant until May, plant warm season crops. This would be the wrong time to plant peas.

Harvest dates: Seed packets and catalogs contain information on how long it takes to have a harvestable crop from the date of planting as seed or transplant. This helps determine when to plant. Example: If the

family vacations for two weeks in July, do not plant green beans (ready to harvest 55 days after seeding) that will be mature then.

Pest resistance: Many vegetables have improved varieties that are resistant to specific insects and diseases. If you have had problems in the past, select varieties that are not susceptible. Example: VFN after a tomato variety indicates that it is resistant to verticillium and fusarium wilts and to nematodes.

Space available: Planting watermelons in a small garden will not allow much room for anything else. Sweet corn also takes up a lot of space and has a relatively low yield. When space is at a premium, select dwarf or bush varieties and plant vegetables that are high yield for the amount of space they take up, such as green beans, tomatoes, and collards.

LAYOUT

To make the best use of available garden space, plan the garden on graph paper. By making a picture of placement of the vegetables and flowers that will be planted, it is less likely that you will overplant, will run out of space before planting everything you want to plant, and will have plants in the wrong places. The design includes:

Annual and perennial plants: The perennial vegetables (rhubarb, asparagus, horseradish, strawberries, and perennial herbs) should be placed together in one section of the garden to prevent problems when rototilling the garden each year. Annuals can fill in the rest of the garden and be rotated each year.

Tall and short plants: Place taller vegetables (staked tomatoes, trellised cucumbers, pole beans, corn) at the north end of the garden so they will not shade shorter plants.

Raised beds**:** Beds mounded 6" or higher or surrounded with untreated landscape timbers and filled with improved topsoil are useful when:

- ✍ Subsoil is severely compacted
- ✍ Drainage is poor
- ✍ Lead levels are high
- ✍ Disabilities or physical limitations prevent gardening on the ground

Double-cropping: Include in the plan areas of the garden where a quick maturing spring crop (radishes, lettuce, peas) can be followed by a summer planting of beans, carrots, beets, or fall-maturing vegetables. This allows twice the production from a single row.

Interplanting: Include quick-maturing crops between rows of longer maturing plants. By the time the slower plants have started to cover the ground, the early crops have been harvested. Example: Plant lettuce between rows of squash. By interplanting with ornamentals, the gardener can have the best of both worlds: edible and attractive. Vegetables can be woven in to the fabric of a flowerbed; flowers can be included in vegetable garden plans.

Companion planting: Organic gardeners include flowers and herbs in their vegetable gardens to attract beneficial insects (pollinators, predators, parasites,) to repel pest insects, to improve the quality of their vegetables, for cutting and to look nice.

Traffic space: Although we want to get as much production out of every square inch of ground that we can, it is necessary to allow enough space for the gardener to walk, to bring in wheelbarrows, and to pull garden hoses. A garden can look very empty before plants start to grow, and very crowded when they reach their full size.

SPACE-SAVING TECHNIQUES

When space is limited, it becomes important to get the most production in the fewest number of square feet. Make use of one or more of the following techniques, plus double-cropping and interplanting, to have more vegetables:

1. Single row vs. wide row cropping: Planting wide rows of spinach, lettuce, radishes, beans, beets, greens, and other crops instead of using the traditional single row method will increase production.

2. Single row vs. "square foot" designs: Small gardens will benefit from using square foot gardening based on 4'x4' plots with each plot divided into l6 individual planting spaces. This design makes overall maintenance easier and increases usable space.

3. Containers: When there is no space for ground-level gardening or when very few sunny spots are available, vegetables can be grown in many types of containers, including barrels, tubs, bins, pots, window boxes, hanging baskets, urns, tires, trash cans, and bags of potting mix. No matter which is selected, good drainage is a must. In container gardening, it is important to use a lightweight soilless potting mix or garden soil heavily enriched (at least 30%) with organic matter for moisture retention.

4. Vertical Gardening: Keeping plants that would normally sprawl all over the garden up in the air can save a tremendous amount of space. Tomatoes and pole beans can be grown on stakes; tomatoes and peppers grow in cages; and beans, peas, cucumbers, muskmelons, and gourds grow well on trellises and nylon netting. Fences can also be used as plant supports. Be creative!

SOIL PREPARATION

Organic Matter (OM)

For all gardening, the soil is the basis for success. Compacted, heavy, clay soils; freely-draining nutrient-poor sandy soils; and heavily cropped soils must be improved. Incorporation of organic matter every year will help turn poor soil into a loose, friable plant-sustaining soil.

Cover cropping with rye grain, oats, wheat, clover, buckwheat, or other materials that can be plowed under are an excellent source of nutrients and fast-decomposing "green manure."

Spread a layer of your favorite OM (compost, worm castings, manure, etc.) at a depth of 2 to 6 inches. For new gardens this material should be plowed or tilled under to start improving the soil quickly. Older, healthier gardens will benefit from having the material spread on top and allowing earthworms to move it.

pH and Lime

Most soils in NJ are acidic and benefit from periodic applications of limestone to make the soils less acidic. The pH for most vegetable crops should range from 6.2 to 6.8. Applying lime (ground, granular, or pulverized dolomitic or calcitic limestone) regularly without having a soil test run could eventually cause too high a pH. Have a soil test run to determine how much limestone is needed. Lime incorporated or dug into the soil corrects the pH faster than surface-applied lime.

Fertilizers

Some nutrients must be supplied for plants to grow effectively, have fruit mature properly, and to sustain the chemical reactions and life processes necessary for growth. Nutrients can be supplied by incorporating green manures or by adding fertilizer. Some fertilizers are organic or mineral in origin. Organic fertilizers included dried blood, bone meal, and cottonseed meal. Mineral fertilizers include rock phosphate and

greensand. Follow bag directions for amount to apply. These materials release slowly over a period of time and benefit soil microorganisms.

Quickly available chemical fertilizers include 5-10-5, 5-10-10, and 10-10-10. These are acceptable if sufficient organic matter has been added to the soil, because plants don't care where their nutrients come from as long as the nutrients are in an available form. Chemical fertilizers can burn plant tissue and roots if improperly applied. The best way to determine which nutrients are needed and in which quantities is to have a soil test run. In the absence of a reliable test, incorporate 2-3 lbs./100 sq. ft. of one of the above or similar fertilizers before tilling or spading.

Additional fertilizer is used as a side-dressing midway through that plant's life or when fruit production starts. Apply side-dressings along the row where the roots grow, never on the stem or leaves.

Working the Soil

Timing**:** The best way to tell if your soil is ready to work in the spring is to take a handful of soil and squeeze. If water drips out, wait several more days before attempting to spade or rototill. The soil is ready when the handful holds its shape, but crumbles when tapped lightly with the thumb. Till only when soil conditions are right. Tilling when too wet destroys the structure of the soil and makes it clumpy.

Temperature: Cool season crops germinate when soil temperature is about 45°F. Soils containing organic matter are darker than plain mineral soils, warm faster in spring and hold heat longer in fall.

Trenching: Lifting subsoil into the topsoil zone by digging deeply and then putting topsoil into the subsoil zone is called trenching. Since the subsoil is moved to the top, it can be improved easily by adding soil amendments, such as compost.

Double-Digging: Plowing and spading usually only work the soil to a depth of 6-8". In order to improve the soil that will be the root-zone for plants, especially root crops, some gardeners employ the technique known as 'double-digging'. In this method, the workable surface soil, about 4-8", is removed and set aside. The poorer soil below is then loosened with a spade fork to a total depth of 8-16". Working down the row, the topsoil from the next section is shoveled into the first hole, then the subsoil is loosened, and so on. At the end of the row, the removed topsoil is placed back in the hole after the subsoil is loosened.

PLANTING:

Starting seed indoors

To get a jump on the growing season, some gardeners start their own seeds indoors. This can work well if you start the seeds at the appropriate time in advance of the outdoor planting date. Many enthusiastic gardeners start their seeds in February, only to find that their plants are too leggy or spindly when the planting date comes.

It is also essential to have the correct temperature (65-75 degrees) for seed starting, bright light from an indoor lighting setup or from a bright window and reflectors, a sterile potting medium, and sterile containers.

Before planting the transplants outdoors, it is essential that they be hardened off. This is accomplished by slowly acclimating the seedlings to the rigors of growing outdoors by easing off on water, not fertilizing, and exposing the plants to outdoor light and temperatures for two weeks before transplanting.

Transplanting

Purchased or homegrown transplants should be stocky and well developed for the variety and have a strong root system. To minimize transplant shock and wilting, plant outdoors anytime on an overcast day or in the early morning or late afternoon on a sunny day.

Mark the row with twine. At given intervals in prepared soil, dig a hole and insert the plant at the same depth it was in the pot. The exception to this rule is tomatoes, which can root along their stems. These are planted to their first set of true leaves, or so the bottom of the root ball is about 4" deep. If the roots are very tangled in the root ball, loosen them gently so they will be able to grow out into surrounding soil. If the plants were grown in peat pots, rip away the rim of the pot and cut or tear holes in the side of the pot before planting. Fill soil gently around the roots eliminating air pockets. Water thoroughly.

A transplant solution of water-soluble fertilizer (such as Miracle-Gro, Rapid-Gro, or Peter's) or manure or compost tea can be used instead of plain water to help reduce transplant shock. Use about a pint of solution per plant.

Some plants are found sawed off at the ground level a day, a week, or more after transplanting. A **cutworm** is usually the culprit. To discourage this injury, place cutworm collars around the plant. These can be made from tarpaper, a paper cup or tuna-sized can (washed first) with both ends removed, a 10 inch strip of landscape edging, or any material that can be stuck into the ground about 1/2 inch and will be above the ground 1 inch. (If plants are missing completely, suspect a critter problem.)

Direct seeding

Mark a row with twine so that your row will be straight. Using a hoe, channel a row to the correct depth for the seed being planted. Place the seed in the channel and cover lightly with fine soil. Place a seed packet on a stake or use a label (wood stake, plastic row marker, plastic knife or spoon, wooden chopsticks, popsicle stick) with the name of the crop and the planting date on it at the end of the row. Water well.

EXTENDING THE GROWING SEASON

Some gardeners want to be the "first on the block" to harvest a red, ripe tomato or just to have the garden productive as early as possible in spring, and as late as possible in fall. Starting seeds indoors or in a greenhouse prior to the earliest planting date for that crop can ensure an earlier harvest. The following structures can be used to extend the season:

Plastic mulches: Black polyethylene weed barriers will attract the sun's rays and heat the soil earlier in spring. Clear plastic mulches accomplish the same thing, but also serve as a "greenhouse for weeds."

Cold frames: These structures are usually wood or block frames covered with old windows. Sunlight through the glass warms the interior of these enclosures and can be used to start or store plants in spring and fall.

Glass or acrylic pane shelters: These A-frames can be placed over sensitive plants to warm the air and soil faster. They do not offer as much protection as cold frames because they are open on the side.

Row-long plastic tents: Clear plastic stretched over bent coat hangers or other frames creates low greenhouses for early season plants. As the weather warms, cut ventilation windows in the sides so the plants do not "cook."

Wall O' Water caps: These cylinders, formed from soft plastic tubes that are filled with water, are placed around plants and act as mini-greenhouses. They are effective as long as plants are small and don't touch the plastic wall.

Hot caps and plastic gallon milk containers: Theses are effective in early spring to form plant-sized greenhouses for individual plants. On warm days the cap on the milk bottle can be removed to allow excess heat to vent.

MAINTENANCE

Watering

Any system that delivers one inch of water per week (1 ½" in hot, dry weather or sandy soils) is acceptable. Avoid frequent shallow watering which encourages a shallow root system. To determine how much water your sprinklers or irrigation system delivers, set coffee cans or rain gauges in several locations and time how long it takes for ½ to 1 inch of water to accumulate. If it takes 2 hours, this is how long you will have to leave the sprinkler in one spot each time you water.

Mulching

Organic mulches are very useful in a vegetable garden. They reduce weed problems, maintain an even soil temperature, prevent soil splash of disease organisms onto plants, and reduce water loss through evaporation. They eventually decompose and add humus to the soil. Good organic mulches include grass clippings (no weed killers on them!), black and white newspaper), salt hay or straw, semi-decomposed leaf mold, and well-rotted compost. Unfortunately, they also serve as harborage for critters like slugs.

Inorganic mulches such as aluminum foil, carpet sections, and black polyethylene weed barriers, serve to warm soil and to reduce some insect pests, but they have to be removed at the end of the season.

Weeding

Keep weeds from competing with your vegetable and herb plants for water and nutrients, especially while they are young. Keeping weeds down also helps keep your garden looking neat. Some weeds perform a useful service in the garden. Lambsquarter is edible and has a deep root system that loosens subsoil. Clover has nitrogen-fixing nodules on its roots that trap atmospheric nitrogen.

Thinning

Finely sown vegetable seed, such as carrot, beet, and lettuce, usually have to be thinned out so there is enough room for the plant to develop. Many more seeds germinate than there is room in the row. The best method for thinning is to use garden scissors or shears to cut out the extra plants. Pulling them may damage the roots of the remaining plants. Carefully removed seedlings can sometimes be replanted in other areas of the garden.

Staking and Tying

Some taller vegetable plants such as tomatoes and some peppers require support to keep the fruit clean and reduce disease incidence. Indeterminate varieties of tomato benefit from staking. Determinate varieties that reach a predestined size, then stop growing are not staked. Soft ties are applied in a figure-8 pattern to prevent damage to stems. Plants can also be supported with a woven-string system.

TROUBLESHOOTING

COMMON VEGETABLE DISORDERS

Damping off of seedlings
Blossom end rot of tomato, pepper, eggplant, cucurbits
Blossom drop
Bolting
Nutrient Deficiencies
Sunscald
Black heart

COMMON PEST PROBLEMS

Fungal diseases
- Anthracnose
- Clubroot of crucifers
- Early blight
- Fusarium wilt
- Late blight
- Powdery mildew
- Rust
- Verticillium wilt

Bacterial diseases
- Bacterial spot
- Bacterial wilt of cucumber

Viral Diseases
- Squash/cucumber mosaic
- Tobacco mosaic virus
- Tobacco ring spot virus

Nematodes

Insects:
- Aphids
- Beetles, such as Colorado potato beetle, Flea beetle, Cucumber beetle, Mexican bean beetle
- Caterpillars, such as cabbage looper, imported cabbageworm, tomato hornworm, corn earworm, cutworm
- Leafminer of spinach, beet, and chard
- Squash vine borer
- Tarnished plant bug
- Whitefly
- Wireworm

Other
- Animals, such as deer, woodchucks, squirrels, voles, rabbits, raccoons
- Birds
- Slugs and snails
- Spider mites
- Weeds

PEST CONTROL

Eventually pests will find your well-tended garden. First identify which critter or disease is causing the problem. Then determine if the problem is causing an unacceptable economic loss. If control is necessary and you're armed with not only the name of the pest, but also the possible controls, it is more likely that the problem can be brought to acceptable levels. Eradication is seldom possible.

After several years of following proper organic gardening methods, pest problems seem to be reduced. Not only are the plants healthier, but nature has a way of keeping pests in balance by biological means. The constant use of chemical pest controls to zap insects or diseases, can eventually lead to pesticide resistance (the chemical no longer kills the pest) and to the destruction of beneficial insects. Chemical controls may be used in some cases, but only on problems not controlled by other methods and only on the affected plants. Control methods include:

Biological control: Beneficial insects (such as lacewing larvae, lady bird beetles and their larvae, rove beetles, spined soldier beetles, tachinid flies, and parasitic wasps), biological pesticides (such as *Bacillus thuringiensis*) and beneficial nematodes (such as *Steinernema carpocapsae*) reduce pest populations.

Mechanical control: Hand picking and crushing, pruning infected plant parts, destroying severely infested plants, hanging yellow sticky boards to trap pests, using spun bond polyester row covers to exclude insects, hoeing, and washing off insects with a stream of water are mechanical controls.

Cultural methods: Selecting pest resistant varieties, planting companion herbs which repel some pests, planting members of the same plant family in different areas of the garden in the same season to confuse pests, and crop rotation (planting members of the same plant family in different areas of the garden in successive years), control pests culturally.

Chemical methods: Chemical sprays and dusts, both synthetic and botanical, are chemical means of control, and should be used as a last resort on individual plants.

FURTHER READING:

Bartholomew, Mel, 1981, Square Foot Gardening, Rodale Press 347 pp. Soft. Covers spacing for high yield/small space gardens, plus cultural info for vegetables.

Brickell, Christopher (Editor), 1993, The American Horticultural Society Encyclopedia of Gardening, Dorling Kindersley. 647 pp. Outstanding reference. Full color. A to Z.

Reader's Digest Illustrated Guide to Gardening, 1978, The Readers Digest Assoc., NY. 672 pp. Excellent basic gardening text. Black & white and some color sketches and line drawings.

Staff of Organic Gardening Magazine, 1978, Encyclopedia of Organic Gardening, Rodale Press 1236 pp. Somewhat useful on organic gardening info. Not very good as a single general reference.

The American Horticultural Society Illustrated Encyclopedia of Gardening, 1980, Vegetables, The American Horticultural Society, 140 pp.

Weaver, William Woys, 1997, Heirloom Vegetable Gardening, Henry Holt & Co., 439 pp. Interesting vignettes on the history of vegetables and good heirloom varieties.