The Spirit of Ma'at

Vol. 2 No. 9

Growing Your Own Food

by Julia Griffin

Square-foot gardening, biointensive gardening, hydroponics, and greenhouse gardening are all methods of sustainable agriculture. These are the most basic steps for those who are considering gardning or who wish to begin.

- Start small. You can add more plants or space once you learn the method
- If growing outdoors, choose a site that receives 6-8 hours of direct sunlight
- Test the pH of the soil or growing media.
- Add the proper amendments
- Buy seeds that grow well in your area and climate
- Check any purchased plants for insect infestation or disease

- If growing outdoors, observe the last spring frost date and first fall date. Extend seasons through use of shade or cold frames.[1]

Below is a brief review of the gardening methods mentioned above. Once you have chosen your approach, you may wish to invest in one of the many books available about each subject. These will give suggestions for things like companion planting, spacing, and techniques for optimizing your crops in the smallest possible space.

Square-Foot Gardening

Square-foot gardening is the brainchild of Mel Bartholomew, a retired engineer who set out to solve the problems he encountered with community gardening. Square-foot gardening works so well that Bartholomew and his partner, Suzy Valentine, are currently working on "Global Gardening" — a plan that shares square-foot gardening with third world countries.[2]

The square-foot gardening method is especially applicable for the elderly, disabled, and mentally or physically impaired.[3] This system boasts of having eliminated heavy digging, and minimized watering and weeding. It is a way of dividing the earth into four-foot by four-foot squares, each square divided into a grid of 16 one-foot-square sections. If you are going to have more than one, they should be about three feet apart.

The advantage is that you can reach all parts of each square from the sides. Weeds are under control because you use a plant mix and can protect the base of the growth medium from the original soil upon which your garden rests. Watering is less frequent because the sides of the raised beds hold the water in.

Constructing a square-foot garden

The sides of the planting squares can be made with 6-, 8-, or 12-inch wood (cedar and redwood are good because they will not rot — don't use pressure-treated wood because the chemicals will get into your food).

The boxes are then filled with your planting mix (a layer of newspapers or weed matting may be placed underneath to prevent weeds). Once you have filled the planting box, you will never need to walk on it, which eliminates the exhausting "double-digging" of the French intensive method (see Biointensive Gardening further on in this article).

When the bed is filled, a grid is made within each 4-foot by 4-foot box to create sixteen 1-foot squares. The grids can be marked in any way that works, including sticks or string. Bartholomew stresses that the grid should be visible and permanent.

A trellis for climbing plants (e.g. cucumbers, beans, tomatoes), may be placed at the northernmost edge of each box. Cotton cord is a good material to use for stringing your trellises because it is biodegradable.

Square-foot gardening feeds a family of four (with the exception of grain) on only eight 16-square-foot boxes, with trellises on four of them. Sun frames can be used over the grids to extend the growing season.[4]

Planting in the grids

The square-foot method rests on direct seeding within your grids. This avoids the waste associated with broadcasting seed.

"We look at each seed as though it were a soul." said Suzy Valentine. "One package of seeds such as carrots or lettuce, if carefully placed, can feed a small village or community. Of course, you can add two or three seeds if you want to be positive of germination, and the thinned plants can be added to the compost, so that they are not wasted. But we want to keep the life- force of those plants in

the garden."

Succession planting — planting the next crop as the first crop grows — is part of the system. Plants can be propagated in flats or cups, or new seedlings can be started in any space in a grid. The gardener learns to plan when new plants will replace the mature plants and to anticipate the next season.

Each time a plant is replaced, one scoop of planting medium is removed and a scoop of compost is put in to take its place, in order to increase fertility of the soil.[5]

Step-by-step instructions

One begins square foot gardening by building or buying the 4-foot boxes and purchasing the planting medium ingredients. The planting boxes can be built with untreated lumber or purchased from the Square Foot Company.

Here's one recipe recommended by Bartholomew for the planting mixture:

1 bale of peat moss: 6 cubic feet
1 large bag of coarse vermiculite: 4 cubic feet
10 pails (2-gallon size) of sand: 3 cubic feet
2 pails of wood ashes and charcoal
10 pails (2-gallon size) of compost: 3 cubic feet
1 coffee can of lime (4 cups or 1 quart)
1 coffee can of organic fertilizers

This is enough to fill two planting boxes to a height of 6 inches (or one to a height of 12 inches).

The only tools needed are trowel, spade, and water bucket. [6]

Planting methods

Plants and seeds may be chosen from the highly detailed information in Bartholomew's book, *Square Foot Gardening*,

which notes life cycles, planting times, and special instructions.[7]

Large seeds are normally presoaked. Seeds also may be started indoors and transplanted. The plants or seeds are carefully placed within the 1-foot grids.

Mulching reduces weeds, conserves ground moisture and moderates soil temperature. Decomposed hay, dried grass clippings or shredded newspapers are among recommended mulches. As the mulched plants fill the available space in the grids, they will significantly reduce weeding.[8]

Vertical frames or trellises

Plants like as tomatoes and cucumbers are grown vertically to conserve space. This results in better sunlight and air circulation. A wall of living plants can be grown on the perimeter of the garden for beauty and easy harvest. Electrical conduit, metal fence posts, steel pipes, or 2-by-2-inch wood can be used as a frame for vertical gardening. Top and sides are wired together to make the frame. They are placed 12 inches in the earth at 5-foot intervals. Plants are supported either by string or netting. Vertical frames can be arranged either as a straight fence, in a zigzag pattern (with spaces between), or as an arbor.[9]

Fertilization

Each one-foot growing space is fertilized each time that it is replanted, which will be approximately 3-6 times per year. The pH of the soil determines the proper weight of fertilizer.

Organic fertilizers can be mixed from sources of nitrogen, phosphorus, and potassium. Sources include blood meal, bone meal, wood ash, and composted leaf mold. The amount of fertilizer and frequency of application will depend on the type of crop — heavy or light feeders. Supplemental

feedings with fish emulsion or seaweed solution also are recommended.

Adding compost from one's own compost pile at regular intervals is one part of the square-foot method that results in improved soil and high food yields. Square foot gardening compost is accomplished by layering 6-to-12 inches of soil with dried grass, dried leaves, and a layer of soil, followed by a layer of weeds and garden refuse. Kitchen waste also can be added in. Manure, rock powders, and bone meal may be added. The compost is periodically turned until it matures.[10]

Watering

The square-foot garden uses twenty percent of the amount of water that a conventional garden would require because of its focus on using every inch of space. Plants are planted in a slight saucer depression to hold water. They should be watered from the sides, not overhead.

The water should be warmed in a bucket in the sun and then poured into the depression around each plant, one cup at a time. Transplants are watered immediately, and seeds and new plants are misted daily.

Watering in the morning hours is considered best. Furrows between the plants conserve additional water, and the addition of extra vermiculite and peat moss with heavy mulch will aid in compensating for dry conditions.

Special structures

Several structures can be utilized in square foot gardening. One of these is a plant-protection cage to ward off insects, animals, and frost.

For protection, a wire cage may be built to encompass the bed. This may be covered with plastic to protect from frost, or left open to protect young plants from birds and insects. The same cage can be covered with cheesecloth or

commercial shade material to extend the growing season of cool weather crops.

Biointensive Gardening

John Jeavons is responsible for the modern popularization of the biodynamic or "French intensive" system, which is a combination of two forms of late-1800 and early-1900 European farming techniques: the French intensive, and the biodynamic methods.

The French intensive technique involves growing plants closely with their leaves touching in eighteen inches of manure, thus creating a mini-climate. Nine crops per year can be harvested on the land.

The biodynamic method was originally devised by visionary Rudolph Steiner. He created his system in response to the decline in the value and yields of plants grown in nonorganic systems. His studies led to a return of the use of organic growing environments, balanced nutrients, and attention paid to the relationship that plants have to each another.

Alan Chadwick combined the biodynamic and French intensive methods and brought them to the University of California in the 1960s.[11]

John Jeavons developed his intuition about the earth and gardening while working with Chadwick. Jeavons is director and master gardener of the Grow Biointensive Mini-Farming program for Ecology Action, and author of the newly revised *How to Grow More Vegetables Now* (Jan. 2002), a detailed and applicable explanation of biointensive farming.

"The Chinese looked at the farmer as a living library, someone who knew something beyond book learning," he said. Though dubious at first, he came to accept Chadwick's premise that the "farmer begins to know, to sense, beyond what you have learned from your experience. He has an intuitive feel of his own garden, expressing that as a sense

that develops through time."

Jeavons speaks of the significant life force he finds in gardening, explaining, "Chadwick believed gardening could put an end to war. When people work with the life force found in gardening, we are transformed. He believed we are changed by our interaction with that life force."

A biointensive garden yields two to six times as much as commercial methods, while using only 1/5 the amount of water, and improving the structure of the soil. And Jeavons's system is one of the few small-space systems applicable to growing grains. It reduces water consumption by 67 to 88 percent.

The biointensive method works well in areas with little water, while producing four times the food from that area as with commercial approaches.

Soil that has been shaded can reduce evaporation up to 63 percent, and the method reduces use of purchased fertilizer by up to 50 percent. A home garden with only 100 square feet can produce up to 322 pounds of vegetables and fruit in a four-to-six-month growing season. Savings from food amount to approximately $400.00 per 100 square feet.

Jeavons explains, "Root structure controls the plant's system. If you improve the plant's root system by 2 to 4 percent through improvement of the soil, the crop yields are multiplied 2 to 4 times. It takes six inches of topsoil to grow a plant. We have depleted the topsoil by 75 percent in 175 years. In other words, the layer of earth that it took nature 3,000 years to create, we have destroyed in 175 years. Biointensive farming creates 1 to 1.5 inches of soil in eight years. In nature, it takes 500 years to build up one inch of topsoil.

"A small farm produces 2-5 times that of a large farm. Every time you go up in size, the yields go down. Bigger is less. The average farm earns only 1/3 of its income from the farm. Two thirds of the income is produced from another

job."

If the yields alone are not an enough reason to inspire biointensive gardening, Jeavons lists the following reasons for beginning a biodynamic system: "Instead of being part of the problem — we lose 6 pounds of soil to wind and water erosion for every 1 lb. of food we eat — you'll be part of the solution. Exercise is a great reason for doing it. You'll save money, eat fresh and healthy food, and the soil techniques reduce the carbon in the atmosphere so you'll be reducing the greenhouse effect."[12]

Digging

The raised beds and their preparation is the most important stage of biodynamic/French intensive gardening. Loose soil with balanced organic nutrients is the keystone of this system. Digging the beds is labor intensive in the beginning. The initial digging of a 100-square-foot bed can take from six to twelve hours — but the bed will then take only five to ten minutes of daily maintenance, and will yield over 300 pounds of vegetables in a four- to six-month growing season.

Jeavons gives highly detailed instructions for the digging. He requires that the area be soaked for 2 hours with a sprinkler. The soil is then allowed to dry for two days before being loosened to a depth of 12 inches, and weeded.

The soil rests, then is watered and allowed to rest again. Sand is added to clay soil and is mixed in the bed, then 27 cubic feet of compost per 100 square feet is added, mixed, watered, and rested.

The bed is now "double-dug," meaning that the soil is removed from the near edge of the bed and placed at the far edge. Then the next section of the bed is dug and put into the section from which the original soil was removed. The soil from the first section will be placed in the last empty section. The bed is shaped and watered. It should remain moist and should be planted as soon as possible.[13]

In arid areas, the growing area can be shaped into a large diamond with a slight slope to the sides. This method was used by the Southwestern Native Americans.[14]

The simple act of digging and adding compost aerates the soil and builds life into it. The air spaces give the plant room to create an adequate root system. The width of the bed, varying from three to five feet, allows the gardener to avoid compacting the soil by stepping on it.

Plants or seeds should be selected for the area in which one lives. Seeds may be evenly spaced using guides of 1- or 2-inch chicken wire. The plants would be dropped into the center of the wire hexagons.[15]

Seeds

Seeds and transplants should be planted according to the phases of the moon. Short- and extra-long germinating seeds are planted two days before the New Moon. Long-germinating seeds are planted at the Full Moon and up to seven days afterward. Seedlings are also planted on the Full Moon and seven days after. There is a balanced increase in growth of both roots and leaves in the first seven days after the New Moon, and increased leaf growth after the second seven days.

The Full Moon is a time when seeds can not resist coming up. During the fourth set of seven days, the root and leaf growth have a balanced decrease in growth. Using the phases of the moon to plant is a method that improves the health and quality of plants, and this becomes even more evident as soil improvement is achieved.[16]

Jeavons recommends open-pollinated seeds "because they don't grow true to type." He states, "There is an over-reliance on the best variety that reduces genetic diversity. Ninety-five percent of all seed varieties have become virtually extinct. The term virtually extinct means that the seeds exist somewhere, but we don't know where. Hybrid

seeds don't produce the biomass that is necessary to make good compost and feed the soil. Biomass is the amount of stem and leaf material that a plant produces. An open-pollinated variety will grow 6 feet tall with plenty of green matter. A hybrid variety will grow 1 to 1-1/2 feet, with mainly seeds."[17]

Fertilizer

Fertilizing the soil is an important part of creating a balance within the garden. PH testing determines the acidity or alkalinity level of the soil. Jeavons recommends the Matte kit to reduce the error margin. Fertilizers are then chosen according to the acid or alkaline level of the soil.

Acid soil has a lower pH; alkaline has a higher pH level. Most plants grow best with a pH between 6.0 and 7.0. The pH can be lowered to make the soil more acidic by adding pine needles, decomposed pine or oak sawdust, or manure. The addition of dolomitic lime raises pH or lowers acidity.

Natural amendments such as cottonseed meal, bone meal, and kelp, or other organic sources, are mixed to ensure proper balances of nitrogen, phosphorus, and potash. Organic fertilizers break down more slowly, providing nutrients for a longer period of time.

The bed is shaped after the plants have been harvested, and fertilizer and other amendments are added to the top 2-3 inches of soil. The nutrients move downward into the bed with the growth of the plant, nourishing the plant as it matures.[18]

Companion planting

Companion planting is recommended for harmonious gardening. This is based on the concept that certain plants exert either a negative or positive influence on the certain other plants grown near them. For example, green beans grow well with lettuce or spinach, but onions and garlic inhibit the growth of peas and beans. Lemon balm or

marjoram create beneficial effects on surrounding plants (lemon balm is a perennial and would be established at the end of a bed). Other herbs such as chamomile or valerian can stimulate lime or phosphorus activity in the soil.[19]

Watering

Beds can be watered each day until the shiny layer created by the water on the earth remains for 1 to 15 seconds after watering has stopped, or the soil texture can be tested with one's finger for moisture. Late afternoon is suggested as the best time for watering to eliminate evaporation that is created by watering in the morning, or rust or mildew problems created by evening watering. Daily watering creates healthy, clean plants and a moist atmosphere for them.[20]

Compost

Composting plays an important role in this system of gardening, mimicking the natural life cycle of life and rebirth in which animals and plants die, with death allowing rebirth through the breakdown of the physical form.

Compost improves the structure, aeration, and water retention of the soil, while making nutrients easily available to the plants. Compost creates humus, which carries a negative electrical charge, thus attracting plant nutrients that have a positive charge, such as calcium or magnesium. Humus decreases erosion while promoting an open, porous condition for the soil.

The biodynamic/French intensive method of composting is by weight: 1/3 dry vegetable, 1/3 green vegetation and kitchen waste, and 1/3 soil. The ground under the pile is loosened, and the materials are added in layers. The compost pile is covered with a layer of earth and is kept moist. It can be kept in a container or on the ground. Mature compost is sifted, and a minimum dressing of 1/2 pound per square foot is added to the garden.[21]

Crop rotation

Crop rotation is another integral part of the biodynamic/French intensive method. Heavy feeders, which means most of the popular vegetables that we consume, are followed by crops that are heavy givers: plants that fix nitrogen in the soil. Heavy givers include peas, alfalfa, clover, and vetch.

Food value, calories, and protein should be considered when choosing crops. Tree crops, berries and fruit also can be added in the bed system. Two crops of light feeders may follow one crop of a heavy feeder. This allows the soil to be nourished through a natural growing method.[22]

Eco-Balance

Birds and bees are encouraged by the growth of colorful flowers and fragrant herbs like bee balm, hyssop or thyme. A wren house can be erected to drive away birds that eat or damage fruits. Insects are brought into balance with the environment by the introduction of natural insect control, traps, and hand picking. Soap detergents are encouraged for spraying, not pesticides. Insect damage is carefully examined to see if it is extensive enough to matter.

Crops may also be grown to attract butterflies, for their beauty. Beauty is considered important. Biointensive gardening is a whole system, meaning that all the components work together toward creating a life-giving and food-providing garden. All of the components, used together, generate a synergistic effect.[23]

The future

Jeavons teaches the biointensive method in 130 countries. Research at the Environmental Research Laboratory at the University of Arizona indicates that high yield and reduced resource consumption may be possible with Biointensive agriculture on a sustainable basis. This offers hope for the depleted world soil situation.

Jeavons's goal is to create agricultural centers throughout the world to share and demonstrate techniques and provide instructional materials relating to the biointensive method. He also teaches Biointensive workshops in which he shares "thirty years of experience in one day or three days." He recommends that anyone taking the workshop first read his books or watch the videos, and actively incorporate biointensive methods for a minimum of one year.[24]

Hydroponic Growing

The Hanging Gardens of Babylon and the Floating Gardens of China are two examples of early hydroponic gardening. The word "hydroponics" is derived from the Greek words *hydro,* meaning water, and *ponic,* meaning labor.[25]

A hydroponic garden is simply a pot filled with rock or other inert growing media and watered by hand. The water is mixed with the elements that the plant cannot take from the air but which are required for growth. A nutrient solution will typically contain nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, zinc, molybdenum, boron, and chlorine.[26]

The advantages of hydroponic gardening include:

- The ability to produce fresh garden vegetables such as lettuce or tomatoes
- The small amount of space needed (as little as 30 square feet per person)
- The production of fresh vegetables throughout the entire year with minimal requirements of soil and water.

Although hydroponic gardening cannot provide adequate supplies of grains or cereals, it is recommended as an adequate system of growing supplemental food.[27] The completely hydroponic system may be the best way to set up a growing area for the urban dweller.[28]

The hydroponic method results in little evaporation, uses considerably less water and fewer pesticides, and top soil

erosion is not an issue.[29] A closet or shed can be transformed into a high-tech hydroponic garden, and the method can be used indoors, outdoors, or in a greenhouse.

The growth rate of hydroponic plants is 30-50 percent more rapid than that found in plants grown in soil. Scientists believe that the additional oxygen in the growing medium stimulates growth because of the more rapid absorption of nutrients. Yields from hydroponically grown plants are also higher, and there are fewer diseases and fungi, and less insect infestation.[30]

Basics

Tom Alexander, owner of The Growing Edge Corporation, recommends starting small with 3-by-3-foot or 6-by-6-foot flats. "Anyone can set up a small system," he said, "if they're mechanically inclined, by beginning with Styrofoam coolers in windows and a pump. If you're not mechanical, then buying a start-up system would be the best way to begin."

Alexander recommends starting in the spring with simple crops, and adding light, such as Halides, in the fall for year-'round vegetables.

"There are two phases of growth in hydroponics," he said. "The first is simple cultivation, or promotion of growth, of leafy greens such as lettuce, basil and spinach. The other phase involves blossoming plants like tomatoes or peppers." Alexander recommends starting with light feeders (plants with low nitrogen needs) that do not bloom, and graduating to the plants that produce blossoms.

Trays or other containers must be purchased for both plants and growing medium, their specifications depending upon the type of system and method chosen. Hydrocorn, rockwool, perlite, vermiculite and different grades of sand are commonly used growing media. The root system of the plant is anchored by the growing medium, which also aerates the plant while channeling the water and nutrient

solution.

Nutrient Solution

The plants are fed with a commercial purchased nutrient mix. Food and water are delivered to the root directly, several times a day, through the nutrient solution, which delivers the minerals that a plant would normally absorb from the earth and air.

Nutrient mixes are of two types: bloom, and grow. They are available in powder or liquid form from hydroponics and gardening stores. Either organic or chemical nutrients may be used, but organic hydroponic systems tend to be more difficult but still are feasible.[31]

Distilled water should be used, and caution should be taken when disposing of old nutrient solution as it can cause imbalances in aquatic systems.[32]

Active and passive hydroponic systems

An active hydroponic system moves the nutrient solution automatically, usually by way of a pump. A passive system uses a wick to the root system. The wick system is probably easiest to use and set-up initially, but it can be less effective, as plants can get too wet this way, lowering the oxygen supply to the roots.

Active recovery systems

An active recovery system uses a submersible pump in a reservoir, with plants in an upper tray. The pump delivers the nutrient solution to the plants in the upper tray, and can be set with a timer that regulates the flow. This is a low maintenance form of hydroponic gardening recommended for beginners.

Another type of active recovery system moves the solution through grow-tubes that hold the plants (no planting medium is used in this type of hydroponic system). The

grow-tubes are angled so that the solution runs over the roots and back into a reservoir, flowing continuously, 24 hours a day. A collar holds the plants in the grow tubes. This approach is also known as aeroponics, since it uses air and not soil. It's considered more difficult and unforgiving than other systems, at least for beginners, because of its dependence upon electricity. If the electricity goes off, the plants will quickly die.

Continuous drip systems

These can be either active recovery or non-recovery system. They use a submersible pump in a reservoir, but instead of circulating through the medium, they deliver the nutrients through supply lines to each plant. A drip emitter for each plant can be individually adjusted, and with an active-recovery system a drip tray under each plant sends the solution back to the reservoir. The advantage of a continuous drip system lies in being able to control the flow of solution to each plant. Any growing medium can be used with this system.[33]

Light

Of course, all plants need light — the photosynthesis process that collects carbon dioxide from the atmosphere and converts it to chemical energy in the form of sugar. It is the products of photosynthesis that nourish the plant and enabling it to release oxygen.

While hydroponic systems can function with natural light during the months when the sun is high, artificial lights must be used during the months when natural light is limited.

Lamps may be incandescent, fluorescent (which need ballast), or high-intensity discharge lamps (sodium or halide). The high-intensity lamps can be purchased in 250, 400 or 1000 watts, and will supply light for areas of 9, 36, and 49 square feet, respectively.

High-pressure sodium lights provide more red/yellow color

and less blue, promoting a high flower-to-leaf ratio; and metal halides provide blue light, best for leafy growth.[34]

The pH factor

Most plants grow within a pH of approximately 6 to 8 (5.8 to 6.8), and plants will show signs of deficiencies if pH is too high or too low for them.

The pH of a hydroponics system requires weekly testing. Potash is used to raise pH, and phosphoric acid is added to lower it. An inexpensive pH testing kit can be purchased at a hardware store, or a more expensive pH meter can be purchased from a gardening shop or hydroponics supplier.

Humidity and Temperature

Exchanging outside air or purchasing a dehumidifier if the area becomes too humid can control humidity. Reducing artificial light, exchanging indoor air with outdoor air, or cooling with an air conditioner are the best methods of controlling temperature. Temperature is raised by the use of artificial light, so at some times of year cooling may be required.

Carbon Dioxide

Carbon dioxide is sometimes added to the indoor garden with a CO_2 generator, which can increase plant growth by as much as 30 percent. CO_2 generators or regulators can be used to add carbon dioxide to the room. Generators also raise temperatures, and they burn propane or natural gas. Regulators use CO_2 tanks and do not raise temperatures.

Seeds

All seeds have their own requirements of light, darkness, and humidity. The seeds you use for hydroponic methods must be ones that like growing in containers to limited heights, and that produce their main crop within a short

period of time.

Cloning, or rooting of cuttings, is another way of plant propagation that is possible through hydroponics. A cutting is taken from the "mother" plant and rooted to create a clone of the original plant. Hormone powder is put on the edge of the cut to encourage rooting, and new roots are generated in as a few as ten days.[35]

Greenhouse Gardening

Greenhouses range from an enclosed room or shed to the immense glass buildings used to force flowers, vegetables, and fruits out of season. Their purposes include over-wintering plants, extending growing seasons, starting seedlings, and housing hydroponic systems.

The first greenhouses were cold frames, which were placed over plants to hold in the sun's heat and thus extend the growing season. They are still often used to start seedlings in colder climates. At the other extreme, a commercial greenhouse can maintain year-'round growing conditions. [36]

Commercial or conventional greenhouses

Some of the major considerations when building a greenhouse are size, space, the type of plants grown, and the use to which it will be put. Conventional greenhouses are heated by external sources like electricity or propane generators. Solar greenhouses are designed so that the sun provides all necessary heat and light.[37] Whether solar or conventional, greenhouses can be free-standing structures, or attached to one wall of a house or outbuilding. South-facing greenhouses will act as passive collectors of heat.

A conventional greenhouse requires a heating system,

preferably propane or gas so that the heat does not disappear if there's an electrical outage. Exhaust fans, shade cloth, and watering equipment also are needed. Fans, vents, and evaporative coolers are used to decrease heat during the warm months.[38]

Cherry Cratty, co-owner of Plant City Bonsai, a national bonsai company, gives this tip: "The height and flooring of a greenhouse can play a substantial part in heating and cooling. For instance, if the greenhouse is fourteen feet tall, the heat will accumulate at a higher level than it will in a greenhouse that is, say, seven feet tall, and a smaller greenhouse will be hot all over, all the time. One of our greenhouses has a concrete floor, which is great in the winter, but holds too much heat in the summer. We use fans that come on when it's too hot, along with vents that open automatically when the fan comes on.[39]

Solar Greenhouses

The two types of systems employed in solar greenhouses are passive and active. A passive system collects the energy and transports it throughout the greenhouse without using outside power. If supplemental power, such as an electric fan or water pump, is used to distribute the sun's energy, then you have an active system.

Greenhouses may be freestanding, attached, or built inside a pit. The weather and cloud cover of the area in which it's built, the height of the greenhouse, the slope of a glazed south wall, and the existence of a rear slope are other considerations.

Glazing in a solar greenhouse is usually of fiberglass or some type of glass that will reduce heat loss. Fiberglass with a film that reduces the oxidation caused by ultraviolet light and oxygen is made specifically for greenhouses. Fiberglass insulation also reduces heat loss. Additionally, plastic can be stapled to the inside glazing.[40]

Thermal mass

Thermal mass — the ability of the greenhouse to store heat — is important in the design. Heat storage can be achieved through painting 55-gallon drums black, filling them with water, then stacking them against the far wall. Smaller containers, such as metal cans or milk jugs, also can be used, but they must be stacked in a proper configuration. Placing filled water jugs beneath growing beds also will increase heat storage.[41]

A greenhouse requires approximately four times the air exchange as the same space in a home. Fans and evaporative coolers are suggested to decrease heat where necessary. An evaporative cooler is placed at one end of the greenhouse, with an exhaust vent at the opposite end. A thermostat-driven motor first opens the vent, then turns on the cooler as the temperature rises. Pumps, fans, or additional heat sources are often used to facilitate movement of air and heat.[42]

Special considerations should be taken into account with a solar greenhouse. For example, solar greenhouses often have daytime temperatures of 85 to 90 degrees, and nighttime temperatures of 40 degrees. A minimum-maximum thermometer helps to record the fluctuations of temperature. Only plants that can tolerate this fluctuation can live in a solar greenhouse.[43]

Alternate Greenhouses

Roald Gunderson, an architect from Econe, Minnesota, has fine-tuned the solar greenhouse with his construction of straw-bale and cold-climate greenhouses, using a hybrid of active and passive solar systems. His construction costs range from $10 to $20 per square foot, depending on material selection.

If a photovoltaic solar array and wind-power generator are employed, the energy costs can be as low as 3 to 5 cents per day. A soil-bed thermal system balances daily temperatures and humidity. A thermal envelope lies

beneath the greenhouse, in the soil, with a system of plastic drainage piping. Fans blow in hot air through the pipe and into the soil, heating the plants and soil. Shutters alternately shade the greenhouse in the summer, reducing heat, or open in the winter to allow in heat and light.

A Gunderson greenhouses holds a temperature of 80 degrees during the day and 50 degrees at night, even when the outside temperatures go to 40 degrees below zero.[44]

Gunderson's straw-bale solar greenhouse is constructed from hay bales, wire, black locust trees, and roofing material. Black locust trees, previously thought to be unusable except for fence posts, are peeled with treeing equipment and then cut to form the exposed structure of the building. Hay bales are wired into the ceiling and covered with roofing materials. Gunderson says, "The hay became very dry from the heat of the roof, and the thermal mass maintains the temperature throughout both winter and summer." Sustainable and affordable food from solar greenhouses that clean the air while using little energy are the result of Gunderson's inventiveness.[45]

Green roofs

Green roofs are the next step beyond rooftop gardens and rooftop greenhouses. Green roofs are being utilized in Chicago to reduce pollution by cooling buildings. The "roof" reflects the sun's rays, and the plants on the roof cool the air by the process of evapotranspiration, in which the plants secrete water through their pores, and the water cools the air through evaporation.

Green roofs begin with a membrane of hot, rubberized asphalt. A layer of gravel, then soil, ranging from 3 to 30 feet thick, goes on top of asphalt, and the soil is then planted with shallow-rooted plants and trees.

These green roofs typically retain 50-70 percent of rainfall through a floradrain, reducing the need for irrigation. Besides growing plants and creating oxygen, green roofs

insulate the building, clean the air, and help to control the climate, while reducing energy costs.[46]

Greenhouse atmosphere

Balances of carbon dioxide and humidity are necessary in a greenhouse. Moisture in a greenhouse is primarily carbon dioxide and humidity. Carbon dioxide is necessary for plants' growth.

Venting and organic matter can provide the carbon dioxide that plants require. Composting creates carbon dioxide but must be used with care inside a greenhouse, making sure that ammonia gas is not released into the atmosphere. Balancing manures with straw and hay will help control ouput of amonia.

Humidity can become too high when heat and moisture are high, so venting can be used to reduce heat and humidity and increases carbon dioxide, although it must be avoided in the winter.

Watering greenhouse plants

Irrigation methods depend on container size and the medium used. A shallow container holds less water and can most easily be over watered, but nevertheless it requires more water. Clay pots are porous and also require more water. Beds must have drainage, and drain slowly.

Double watering is sometimes necessary to ensure that the soil mass is soaked. This means watering once and letting the water seep into the soil, then watering again, so that the water goes deeper this time. As soil mix becomes drier, fertilizer becomes more concentrated, so double watering also acts to help disperse the fertilizer throughout the soil.

Greenhouse containers and growing media

Standard pots and flats with drainage holes can be purchased. Household containers also can be recycled as

pots, with drainage holes punched into the bottom. A tomato or squash plant will require a full gallon container. Some containers that can be used include large fruit baskets, ice cream cartons, and cottage cheese containers.

Perlite, vermiculite, or peat moss can be used for potting. Field dirt can also be cooked in the oven or aerated with steam to kill microorganisms and used as potting soil.

Fertilizer

Greenhouse crops cannot receive nutrients from deep or extensive root systems of plants, so it's important to add leaf mold or compost to the growing medium. Manure, fish emulsion, and blood meal can be made into solutions or "teas" for the plants. Bone adds phosphorus, and greensand adds potassium. Gypsum adds magnesium and calcium.

Bugs

Observation is the first step in preventing bug infestation. Regular inspection of plants and soil can prevent heavy infestations. Pick off dead leaves and kill any diseased plants, removing them from the greenhouse.

Good air circulation is essential for healthy plant growth. Spacing plants adequately helps to ensure good circulation. Use only sterile containers and soil mixes. Use disease-resistant plant varieties, and isolate new plants for a few days to avoid introducing bugs or disease into the greenhouse.

Always wash your hands before and after working in the greenhouse, and sanitize containers before reusing them. And never smoke in the greenhouse. Some tobacco smoke contains chemicals that will cause your plants to die.

Predator bugs like ladybugs, preying mantis, or green lacewings can be introduced in the greenhouse to naturally reduce the bug population. Natural plant chemicals such as

rotenone and pyrethrum also are effective if application is repeated and consistent. Companion plants such as garlic, chives, and marigolds will repel some insects.

Plants

Greenhouse plants are basically of two types: those that will be grown there to maturity, and those that are used to start seedlings for transplanting to your outdoor garden. So a greenhouse allows more intense gardening activity throughout the year.

If the greenhouse is being used both for starting seedlings and for growing plants to be harvested in the winter, it may be left empty in southern climates, or used to start seeds for succession planting in the north.

Seedlings planted for your garden have to be planned in accordance with the frost dates for that region, and a cold frame is recommended to "harden seedlings off" before they are transplanted to the outdoor garden.

There are a few differences in greenhouse gardening from gardening outdoors. For example, some varieties of spinach and radish will flower in the greenhouse when the days lengthen. Squash, cucumbers, tomatoes, and strawberries must be hand-pollinated if grown to maturity in the greenhouse (a paintbrush or feather can be used to move the pollen from one plant to another).

And it's necessary to be careful when transplanting plants from the garden or moving containers into the greenhouse, as they can bring in pests or disease from outside.[47]

Starting from seed

To use seeds, collect or purchase greenhouse flats and plastic growing cells, plus germination mix, plastic labels with indelible marker, fertilizer, and watering equipment. Seeds have different temperature ranges for germination. Air temperature should be 75 to 77 degrees Fahrenheit to

maintain 70 degrees in the seedbed.

The flats are filled with germination mix. Make trenches with the finger or planting stick for the seeds. Plant the seeds and water gently and slowly without allowing water to stand or puddles to form. The surface must remain damp until the seeds have germinated. When the first true leaves appear, fertilize with a weak solution. Transplant the plants when they are 5-6 days old, or the first true leaves have appeared, in cells that have been filled with dirt. A depression is made in the soil to the appropriate depth for the seedling. Lift the seedlings from the flat and carefully separate a seedling and its roots. Transfer to the cell and water with a weak solution of soluble fertilizer.[48]

We interviewed **John Jeavons** on Wednesday, March 20. Jeavons is director and master gardener of the Grow Biointensive Mini-Farming program for Ecology Action and author of the newly revised *How to Grow More Vegetables Now.* More information about Ecology Action and biointensive workshops can be found at GrowBiointensive.org. More information about John Jeavons at is at JohnJeavons.info.

We interviewed **Roald Gunderson** on Wednesday, March 20. Gunderson is an architect who works at Ecoclime. He specializes in cold climate greenhouses. More information on his architecture can be found at mwt.net/roald. He can be reached at Roald@mwt.net, tel. 608-452-3894.

We interviewed **Cherry Cratty** on Sunday, March 17. Cratty is co-owner of Plant City Bonsai, a national bonsai company. Her website is PlantCityBonsai.com, and she can be reached at PCBonsai@mindspring.com.

We interviewed **Tom Alexander** on Friday, March 15. Alexander is the owner of The Growing Edge, a hydroponics company that specializes in greenhouse and hydroponic publications and magazines. More information on hydroponics can be found at GrowingEdge.com, tel. 800-888-6785.

We interviewed **Suzy Valentine** on Thursday, March 14. Valentine is involved in Square Foot Gardening and the "Global Gardening" project. More information can be found at SquareFootGardening.com, email

Info@SquareFootGardening.com.

Top of Page Print Version